

# Ⅲ. 大学院学位論文

## DISSERTATIONS

### A. 大学院博士課程論文梗概

## Doctor's Dissertations

### 電気工学専攻

#### A1. 多輪独立駆動電気自動車の動的制駆動力配分制御

賀 鵬

#### **Dynamic Force Distribution Control for Multi-Wheel-Driven Electric Vehicle Utilizing Actuator Redundancy By Peng HE**

This dissertation deals with dynamic force distribution control for a modern electric vehicle (EV), which has multi-driving electric motors.

In recent years, considering environmental protection and energy conservation, researches for EV have been put forward greatly. Besides, new vehicle configurations have been developed continuously. In motor vehicles, it is naturally acceptable that electronic units replace the traditional hydraulic and mechanical linkages to be used for EV motion control. For example, in-wheel motored EV has its driving motors installed into multi-wheels. The multi-motored wheels can be controlled independently. Although there are no conventional power transfer shaft and differential gear, it is easy to implement force control of those motored wheels directly through "by-wire" methods. Hence EV motion control will be more easily practiced because of the aviation of such novel motored multi-wheels. Based on those inspiring things, EV must be controlled far more adaptable than before.

Therefore, it inevitably further stimulates the advocating of the "drive-by-wire", which is argued to be the kernel technology of EV motion control in the near future by car manufactures.

Undoubtedly, dynamic force distribution and control of EV is the "key point" of that newfangled "drive-by-wire". It is the basement for almost all advanced motion control strategies of EV. There is considerable interest in increasing functionality and safety of EV by developing force distribution and control system.

Multi-wheel driven EV is referred to as an over-actuated system in the analysis and synthesis of dynamic force

distribution and control. One of abstractive characteristics of over-actuated system is the application of actuator redundancy. Redundancy means "more than what is needed, desired, or required". In an intuitively clear way, just the same as "fly-by-wire" aircraft, the primary motivation of utilizing redundant actuators is usually to increase the reliability of "drive-by-wire". Furthermore, as for EV motion control, besides obtaining more power, it is meaningful to take advantage of redundant motors for several purposes or secondary optimal objectives, for example, optimal tire load ratio, active anti-slip control, and so on.

Because of the properties of dependable, adaptable and optimizable, it is a potential development to use redundant actuators for dynamic force distribution and control for multi-wheel-driven EV. It would be an epoch-making work for the realization of "drive-by-wire" on modern EVs, such as the newly developed four-wheel-driven MIEV.

However there are fewer researches about those topics. So far there is even no practical application on the real multi-wheel-driven EV. Therefore, it is the original stimulation of this thesis to obtain a reliable dynamic force distribution control throughout the management and use of redundant driving motors for multi-wheel-driven EV.

In this thesis, the novel dynamic force distribution control for multi-wheel driven EV is proposed. Next, researches on applying actuator redundancy for control are mentioned as the theory basement. And then the author's researches on that theory theme are discussed. Last for the purpose of evaluation and industrial application, which are the author's original work, the proposals are practically implemented on a real multi-wheel-driven EV.

In chapter 1, the background, purpose, and outline of this thesis are given in a general way. Chapter 2 describes dynamic analysis and motion control of EV. It is the preliminary for understanding the usage of force distribution control. Moreover, history and present researches on force distribution control are also mentioned. Chapter 3 analyzes the characteristic of dynamic force distribution control for multi-wheel-driven EV. And then the novel dynamic force distribution control method for that over-actuated system is proposed. As the preparatory for the rest contents, this chapter

previously explains the control system utilizing actuator redundancy to some extent. Chapter 4 gives fundamental issues of applying actuator redundancy for control system. Three main different approaches are discussed in detail. Mathematic representations and theoretical analysis are given too. Chapter 5 mentions the numerical methods for practical implementations of redundancy. In this chapter, two new algorithms, which are based on dynamic quadratic programming (DQP) and sequential quadratic constrained quadratic programming (SQCQP), are proposed. The comparisons among existing and proposed algorithms are preformed. Chapter 6 analyzes the stabilization of control which utilizes actuator redundancy. Chapter 7 mentions and compares dynamic force distribution controls which employ different realization methods of actuator redundancy. Chapter 8 and 9 are evaluations and industrial applications of dynamic force distribution control. In chapter 10, the above chapters are concluded and the future works are mentioned.

By the research of dynamic force distribution control utilizing the redundant actuators for over-actuated system, it is well known that the degree of freedom of redundancy can be really used for additional design specifications. It is also believable that there have several subtopics in this domain needed to be further studied. In the future, with the intelligence of mathematicians, there must be more and more efficient algorithms for that constrained optimization problem. Integrated with the developed powerful hardware, it must be easier to utilize redundancy for the control of mechanical systems or more complex autonomy.

## A2. 広域電力系統における低次線形モデルを用いた適応型 PSS の構築

杉原 俊雄

### Adaptive PSS by Using Low-order Linear Model for Large-Scale Power System By Toshio Sugihara

In modern electric power system, control areas are interconnected among others. Every generator must be operated keeping the synchronization to maintain stability of the system. Because the distance between generation side and load area is becoming long and the load is growing, small signal stability (steady-state stability) problem has become a great concern in Japan and other nations. The problem may cause the oscillation of power flow in a wide area. For example, the oscillation whose period is several seconds is sometimes observed in western system of Japan. Small signal stability problem in the wide area is caused by interaction among generators and their control systems in the power system. A method for maintaining the transient stability is not suitable to deal with this kind of problem. Power System Stabilizer (PSS) is an excitation voltage controller equipped with generator. PSS can improve the small signal stability when its control parameters are tuned properly. The small signal stability can be analyzed by using eigenvalue analysis of the linearized system of the power system. The real part of the

eigenvalue stands for the stability index of the system, and is calculated by using control parameters of generator (including PSS) and other parameters of transmission system, load and so on. Therefore, evaluation of the relationship between PSS parameters and the system stability is possible. However, the conventional eigenvalue analysis requires so much information on power system that it is not practical in the real large-scale power system. In addition, the analysis cannot be used for on-line monitoring of the power system stability. In recent years, some simplified methods using measured information are proposed to evaluate the system stability. Simplified eigenvalue analysis using low-order linear model can easily be implemented for on-line monitoring system because accurate time-stamps are available by using the GPS receivers.

In this research, adaptive tuning of PSS parameters based on the simplified eigenvalue analysis is operated. In the proposed method, parameters in the PSS are tuned repeatedly because the structure of the system and the power demand are continually changed. A simple generator model including PSS control block and elements to be identified is proposed to evaluate the stability of the whole power system. Some elements of the simple generator model can be identified by using measured variables of the power system. Then, eigenvalue sensitivities which indicate the relationship between PSS parameters and eigenvalues of the system are calculated. Parameters of the PSS are tuned by using linear programming to improve the stability index. The identification and tuning are repeated while the dominant oscillation exists in the system. The parameters of the PSS may sometimes be changed to the wrong values because the simplified model does not always represent the true stability, and the accuracy of identification is limited. The amount of a parameter change at one time is limited strictly to avoid that the stability is lost in a short time. To update the parameters frequently during a long period makes it possible to improve the stability even if the wrong tuning is occasionally done. It is expected to keep the system stable even when the operating condition of the system is changed. Transient stability simulation is carried out for IEEJ WEST10-machine system model, when a random load change is given at each load node to excite oscillatory modes of the system.

The following points have been made clear; (1) It is possible to obtain the dominant oscillatory mode by using the proposed identification method when only one oscillatory eigenvalue is dominant. (2) The stability of the system is improved when the proper dominant mode is detected by the identification. (3) Eigenvalues detected by using low-order linear models shift at random by a large amount when the amplitude of the oscillation of the system is very small. In such case, the stability of the system has already been maintained because the oscillation is not excited by the load demand fluctuation, and the steady-state stability cannot be improved by tuning the PSS parameters. (4) The proposed algorithm to determine whether to update the PSS parameters by using measurement can skip the parameter tuning of the PSS when the system is already stable and the proper oscillatory mode is not detected from the

low-order model.

### **A3. シリコンフォトニックMEMS技術による集積化マイクロメカニカル光変調素子に関する研究**

肥後 昭男

#### **A Study on Micromechanical Optical Modulators by Silicon Photonic MEMS Technology By Akio Higo**

Optical waveguides of high index contrast has significant effect in reducing the device size of photonic integrated circuits (PIC). In particular, photonic crystal (PhC) / silicon photonic wire waveguide can be designed to have sharp bending corners with ideally zero propagation loss, which is necessary for the ultimately small device sizes. Silicon is an enabling material for such waveguides because of the high refractive index and the micro/nano fabrication compatibility.

We have developed a fabrication process that is compatible with MEMS-PhC / MEMS integrated with silicon photonic waveguide devices by using the polysilicon surface micromachining technique combined with the silicon-on-insulator (SOI) micromachining technique. The original concept of MEMS optical modulator combined with the conventional optical waveguides has been proposed by Dangel and Lukosz in 1997. Different from their work, our study is focused to make yet smaller lightwave circuit systems by using the Photonic waveguides integrated with MEMS optical modulators.

My thesis consists of following chapters:

Chapter 1 is the introduction of my work and its background. Recent optical MEMS progress in optical networking are described and the strategy of MEMS/photonic waveguide integration is discussed.

In chapter2, theoretical model are explained. The suspended structure is driven to the close vicinity of the waveguide, where it is called the evanescent field, by using the electrostatic attraction force from the counter electrodes. The light traveling in the waveguide experiences the change of effective refractive index, and is intensity-attenuated by the evanescent coupling with the suspended silicon beam. Finite Difference Time Domain (FDTD) method was used to estimate the optical intensity modulation for the device with a silicon piece of 5  $\mu\text{m}$  wide and 10  $\mu\text{m}$  long (measured in parallel with the waveguide) is suspended at a 300 nm height over the PhC waveguide; we found 5 dB attenuation when the piece was brought into a 200-nm-gap, where electrostatic pull-in was expected. Modulation could be controlled in an analog manner by gradually changing the position in the first 100 nm range. MEMS grating integrated with photonic waveguide and MEMS switch are also designed. Periods of grating is 700 nm, and the gap between the waveguide and grating part is 2-3 $\mu\text{m}$  on SOI layer. When silicon wire waveguide is electrostatically brought into contact with the grating, a particular wavelength is prohibited from propagation, and the waveguide has a stop-band.

Chapter 3 deals with fabrication technique and Optical

performance of MEMS-PhC, sub-micron structures of the photonic crystals and the waveguide were first made by the electron-beam (EB) lithography and high aspect-ratio dry etching in a 200-nm-thick active layer of an SOI wafer. The surface was then covered with a protective low-pressure chemical vapor deposition (LPCVD) silicon nitride layer of about 40 nm thick, which was chemically inert to the vapor of hydrofluoric (HF). The surface was again covered with a sacrificial LPCVD silicon oxide layer of over 300 nm thick, which corresponded to the initial separation of the optical modulator. After forming the anchoring sites, a structural layer of about 400-nm-polysilicon was deposited and patterned into the micro cantilevers or bridges. Finally, the micromechanical structures were sacrificial-released by the partial etching in wet HF, followed by the complete release in vapor HF. At this moment, we frequently found a chemical byproduct as a result of vapor HF etching even in the gap under the mechanical structures. The residue was completely removed by annealing the device for 1 min at 200 degree C. We used piezo-stage controller to position the single-mode optical fibers for coupling with the wire waveguide. Total insertion loss at a wavelength of 1580 nm was found to be 27 dB, which was mainly attributed to the optical coupling loss at the input and output ends of the waveguide and to the propagation loss of the PhC waveguide. We achieved the waveform of the optical output modulated with a sinusoidal voltage of over 40 V<sub>peak</sub> with a bias voltage of over 40 V<sub>dc</sub>. Modulation depth of 2 dB at peak voltage of 86 V was experimentally observed as a proof-of-concept demonstration of the MEMS PhC modulator.

In chapter 4, fabrication technique and mechanical actuation are demonstrated by MEMS integrated photonic waveguide. sub-micron structures of photonic waveguide, grating and MEMS were first made by Deep UV lithography and high aspect-ratio dry etching in a 500-nm-thick active layer of an SOI wafer. the micromechanical structures were sacrificial-released by vapor HF. We achieved the waveform of the optical output modulated with a sinusoidal voltage of over 50 V with grating and 80V with optical switch.

In chapter 5, we discussed optical anchors for silicon wire photonic MEMS and we achieved ellipse shape is good for optical anchor. MEMS-PhC and MEMS integrated with photonic waveguide are compared.

Finally, the dissertation is summarized in chapter 6.

## **電子情報学専攻**

### **A4. プライバシーと権限を守るための安全な多者間プロトコルの効率化に関する研究**

古川 潤

#### **Efficiency Enhancement of Secure Multi-Party Protocols for Privacy and Privilege Protection By Jun Furukawa**

Secure multi-party protocols are cryptographic protocols

which multiple players engage in. Many application specific multi-party protocols have been proposed, which include electronic voting, electronic cash, electronic auction, broadcast encryption, traitor tracing, anonymous authentication, group signature, secret sharing, conference (group) key distribution, group key generation, etc.

These multi-party protocols are designed mainly so as to carry out social activities in the network.

The technique of general multi-party computation that enables multi-party to securely compute any efficient function is known. However, its results are mostly far from practical efficiency in the sense of computational, communication, and round complexity. This is the major reason why a large number of specific constructions of multi-party protocols has been proposed.

Since a multiple number of players engage in multi-party protocols, they often have complex security requirements. Such circumstance, besides the fact that the number of players itself is large, makes it hard to construct efficient multi-party protocols. Thus, efficiency enhancement is the major and crucial interest in these designing of multi-party protocols.

Among these examples of multi-party protocols presented above, electronic voting, broadcast encryption, and group signature can be listed as most useful multi-party protocols. This dissertation presents

several efficiency enhanced variants of these protocols. They are an efficient publicly verifiable shuffle scheme, an efficient publicly verifiable shuffle and decryption scheme, an efficient publicly verifiable hybrid mix-net scheme, an aggregate shuffle argument scheme, an efficient compiler from Sigma-protocol to deniable zero-knowledge argument, a black-box traitor revocable broadcast encryption scheme, a group signature scheme for separate and distributed authorities, and an efficient group signature based on bilinear mappings. These protocols are efficient enough for practical purposes.

#### **A5. IPマルチキャストにおけるトラフィックエンジニアリングに関する研究**

山本 成一

##### **A study of traffic engineering for IP multicast By Seiichi YAMAMOTO**

Nowadays, most of case, the Unicast traffic type is used for the communication of end-host on the Internet. From the perspective of future Internet, it is considered that there are so much needs of communication type for increasing the number of end user host. Therefore, it is need to have strong demand of using practical Multicast, which is the another communication model such as "One to Many" or "Many to Many".

Most of the case, the PIM-SM protocol is used to manage Multicast routing. This protocol will make Multicast routing table from constructed Unicast routing table. So the Multicast routing table always follow the Unicast routing table.

Therefore, when there exist some multicast group on the managed routing area, and there are multicast

sender hosts and listener hosts across the multicast groups, this situation makes overlapped multicast routes. These overlapped traffic routing table will induce network congestion.

Generally, for the congestion which is regarding with unicast traffic, the Unicast Traffic Engineering is used to avoid the congestion by making bypass route for specific unicast traffic.

However for the congestion which is regarding with multicast traffic, it is the essential point to consider not only multicast routing but also unicast routing from the point of multicast routing binding by unicast routing.

From the this point of view, We could not find current practical and

operational multicast traffic engineering architecture from our survey.

So it is strongly need to build up practical and operational multicast traffic engineering architecture for the robust operation of unicast and multicast on the future Internet.

On this dissertation, we analysed multicast network architecture with comparing unicast network model and multicast network model, and discussed

the essential point for multicast traffic engineering from the architectural point of view.

And we selected and consolidated the key point to do a multicast traffic engineering not only for the PIM-SM protocol but also for other protocol from the raised point.

We designed the traffic engineering architecture for PIM-SM as a sample of practical multicast traffic engineering architecture.

From this designed architecture, we validated to make a traffic engineering for specific multicast traffic from the multicast route which binds unicast route.

Furthermore, for the multiple multicast group which has overlapped multicast tree, we also validated to do multicast traffic engineering for specific multicast group from the per-group based split of multicast route.

From this validation, it is proofed that to make a bypassed route for any specific unicast or multicast route on the specific area from this practical traffic engineering architecture.

And, from our generalized traffic engineering architecture, it is also considered that this basic architecture is adaptable not only on this exmapled PIM-SM's multicast routing on IPv4 but also on other any protocols

As a result, this dissertation achieved to provide practical traffic engineering architecture for multicast traffic architecture, and achieved to increase the performance of operation on normal managed network such as mixed unicast and multicast. We showed to contribute the deployment of multicast by this dissertation.

#### **A6. マルティメディア情報分析・記述におけるセマンティックコンテンツ生成支援システムに関する研**

究

武 小萌

**Study on Semantic Content Generation Support  
System for Multimedia Information Analysis and  
Indexing  
By Xiaomeng Wu**

In this thesis, a semantic content generation support system is proposed for multimedia information analysis and indexing. This system aims at mapping low-level descriptions to semantic concepts so as to identify identical object and facilitate indexing, browsing, searching, and managing the multimedia database. The system includes three layers: a content provider layer, an application service provider layer, and an end user layer. In the content provider layer, raw video data is processed to scenes, shots, keyframes, and regions. By applying semantic object modeling and annotation with these fundamental video units as the target, a semantic content database, in which high-level indexes and low-level descriptions of each object in the video are annotated, is generated as the result of this layer. The application service provider layer provides application-oriented operations that are used to establish application-dependent services based on the output from the content provider layer. Finally, the end user layer includes an interface planner that connects the user side and the system side.

In this work, movie and variety video is the main target video source, and a correspondence relation between keywords and the corresponding models is created. Based on low-level features, a database of ontological semantic object models is constructed, which allows content provider to get information about specific semantic objects. We proposed a semantic object model, which has a hierarchy structure from semantic concept, salient regions to low-level features. The system searches the database for keyframes in the video to detect similarities in detailed low-level features. From these results, content provider can select relevant keyframes interactively, and the matched objects in them are then automatically annotated according to descriptions that are added to the model in advance.

Semantic concepts of objects do not occur in isolation and there is always a context to the co-occurrence of objects and backgrounds in a video scene. It is believed that it can be beneficial to model this context. In this work, a block-based background classification engine is used to recognize the backgrounds where the objects appear in the video. To extract similar backgrounds from the video, a model image, which is a template representing the feature of the background and serves as the background model, is selected from keyframes. Each model image is inspected to find the closest match based on the similarity measure between the model image and the target keyframe. On the other hand, a probabilistic Bayesian network is used to model the context between objects and backgrounds, and to demonstrate how this leads to an improvement in the performance of object query and annotation.

In the case of model matching, a fuzzy mode similarity

measure is proposed to adaptively calibrate the feature matching criterion based on the illumination instability. We first use an information-theoretic measure as a quantitative measure of the information distribution within an image. This measure is further extended to the video case and used to quantitatively represent the lighting condition of each single scene. The illumination instability of the video is thus measured by calculating the instability of the features extracted from the extended measure. Based on this information-theoretic illumination instability measure, characterizing the similarity between the model regions and the retrieved keyframes becomes two issues, one being model distribution prediction and the other being similarity measure according to the degree of lighting changes and the shape of model distribution.

We store 15 videos with total of 15,708 keyframes to generate experiments for examining the performance of the proposed approaches. In case of one video, the total processing time is 655.2 minutes, less than 11 hours. From the experimental results illustrated in the manuscript of this thesis, it is demonstrated that the proposed instability measure successfully reflects the relationship that the performance of color-based video system decreases as the lighting condition of the object video becomes unstable. The experimental result of semantic object model matching, fuzzy mode similarity measure and context relationship network (CRN) demonstrates significant improvement in performance of semantic object extraction by using CRN than without using it. Furthermore, the retrieval performance is improved by the fuzzy mode similarity measure. Compared to conventional approaches, the proposed system greatly holds down the indexing cost of content provider.

As the result, we build up a semantic content database, which stores video content metadata and the operations that manipulate such kind of metadata. Based on this database and the corresponding operations, the proposed system generates a general video management and utilization framework to provide a great potential environment for development of interactive multimedia applications. In this thesis, two novel practical applications are constructed and implemented to show the practicability of the proposed semantic content generation support system. Following BS digital broadcasting from 2001, the terrestrial digital broadcasting started on Dec. 1 of 2003 in Japan, and the analogue broadcasting will be ended in 2011. Against this background the necessities of semantic video indexing system and interactive multimedia application increase rapidly. We believe that our research will contribute greatly to the related fields.

**A7. 耐ソフト・エラーのキャッシュ・アーキテクチャ  
ルオン ディン フォン  
Soft-Error Tolerant Cache Architectures  
By Luong Dinh Hung**

The problem of soft errors caused by radiation events are expected to get worse with technology scaling. This thesis

focuses on mitigation of soft errors to improve the reliability of memory caches. We survey existing mitigation techniques and discuss their issues. We then propose 1) a technique that can mitigate soft errors in caches with lower costs than the widely-used Error Correcting Code (ECC), 2) a technique to mitigate soft errors in Content Addressable Memories, and 3) a cost-effective cache architecture achieving both variation-induced defect and soft-error tolerance.

ECC is widely used to detect and correct soft errors in memory caches. Maintaining ECC on a per-word basis, which is preferred for caches with word-based access, is expensive. We propose Zigzag-HVP, a cost-effective technique to detect and correct soft errors for such caches. Zigzag-HVP utilizes horizontal-vertical parity (HVP). Basic HVP can detect and correct a single bit error (SBE), but not a multi-bit error (MBE). By dividing the data array into multiple HVP domains and interleaving different domains, a spatial MBE can be converted to multiple SBEs, each of which can be detected and corrected by the corresponding parity domain. Vertical parity update and error recovery in Zigzag-HVP can be performed efficiently by modifications to the cache data paths, write-buffer, and Built-In Self Test. Evaluation results indicate that the area and power overheads of Zigzag-HVP caches are lower than those of ECC-based ones.

We propose STCAM, a soft-error tolerant Content-Addressable Memory (CAM). Soft-error mitigation in a CAM is difficult due to the un-availability of data outside the cell array in a CAM access. Since CAMs are used in several components of a processor, making those CAMs being resilient against soft errors is required to attain high processor's reliability. STCAM can successfully detect and correct false hits and false misses caused by soft errors in a CAM. This is achieved through subdividing a CAM and providing backup checking for cases the input tag is partially matched in the CAM. An original encoding scheme is proposed to reduce the frequency of backup checking. Modifications to support STCAM do not increase access latency. Performance degradation incurred by backup checking is very low.

We present SEVA, a soft-error- and variation-aware cache architecture. As memory devices are scaled down, the number of variation-induced defective cells increases rapidly. Combination of ECC, particularly Single-Error Correction Double-Error Detection (SECDED), with a redundancy technique can effectively tolerate a high number of defects. While SECDED can repair a defective cell in a hardware block, the block becomes vulnerable to soft errors. SEVA exploits SECDED to tolerate variation-induced defects while preserving high resilience against soft errors. Information about the defectiveness and data dirtiness is maintained for each SECDED block. SEVA allows only the clean data to be stored in the defective blocks. An error occurring in a defective block can be detected and the correct data can be obtained from the lower level of the memory hierarchy. SEVA improves both yield and reliability with low overheads.

Having memory caches to be tolerable from soft errors is essential for attaining high processor's reliability. Incurring low

area and power overheads, Zigzag-HVP allows support for soft-error tolerance to be more affordable and therefore pervasive. STCAM increases in the coverage of soft error protection in a processor. Finally, SEVA shows that soft-error tolerance for reliability and defect tolerance for yield can be achievable with reasonable costs, paving the way for successful SRAM designs in future process technology.

## A8. 複数トピックの包括的提示による検索支援に関する研究

若木 裕美

### Query Refinement based on Comprehensive Representation of Multiple Topics By Hiromi Wakaki

When we use existing search engines, we enter only a few terms to form a query. Even if we use effective query terms, e.g., proper nouns and technical terms, such a short query is likely to be ambiguous. As a result, we often have to select the documents of interest from a large number of retrieved documents, which may have a wide variety of content. I propose a method for supporting query refinement by using term clusters of topical terms extracted from a retrieved set of documents.

First, I assume that a topic is implied by a specific set of terms that frequently co-occur in the same documents. Here, I introduce a new measure of term importance called Tangibility. A term is said to have tangibility if it frequently co-occurs exclusively with a specific set of terms. Existing methods for term extraction aim to extract terms corresponding to the dominant topic of a given document set. However, because such terms likely co-occur with a wide variety of other terms, we cannot distinguish isolated topics. In contrast, my method aims to extract terms exclusively related to one of those topics. I propose three new term-weighting methods, i.e., TNG1, TNG2, and TNG, based on Tangibility and compare their performances with those of other existing term-weighting methods on multiple data sets. The results show that they can extract terms strongly related to any one of several topics contained in the document set. After extracting these terms, I divide them into clusters by using a distributional clustering algorithm, which leads to agglomerates of terms frequently co-occurring with each other. With respect to the average precision of documents retrieved by the clusters, TNG outperforms other existing methods, e.g., Mutual Information, Kullback-Leibler Divergence, and so on. Furthermore, TNG has good completeness of categories of documents retrieved by the term clusters. I conclude that TNG is an efficient term-weighting method for detecting topics included in a heterogeneous set of documents.

I also examine the quality of term clusters by checking whether the clusters can support query refinement. I first extract topical terms from a synthesized heterogeneous document set, which is a surrogate for a document set retrieved by a real search engine. Then I construct clusters of extracted terms and use each term cluster as a query to assign a ranking

to the documents based on the probabilistic information retrieval model. I use two evaluation criteria: concentration and completeness. First, when the top-ranked documents given by each term cluster relate to the same topic, a topic-focusing search can be realized by using any one of the constructed clusters. Second, when different term clusters provide different sets of top-ranked documents, a search covering a wide variety of topics can be realized by using all term clusters. I evaluate TNG with these two criteria, and find that TNG outperforms other existing methods by a wide margin.

To evaluate objectively and numerically whether a term-weighting method can extract topical terms, I propose two new tools: Topic Label and Topical Skewness. Topic Label indicates the topic to which a given term is most closely related. Topical Skewness shows how exclusively a given term relates to one topic. When the experimental data set has document categories, we can assign a Topic Label to every term and can compute Topical Skewness for every term. Additionally, by collecting data from a subjective evaluation done by human evaluators, I test whether the Topic Labels given by my method correlate with the labels given by the evaluators. I also check whether the Topical Skewness of each term correlates with the number of people who give a term the same label. The result shows that these tools are suitable for evaluating topic partiality. Therefore, I use Topic Label and Topical Skewness to compare TNG with other term-weighting methods. The results show that TNG can extract terms strongly related to any one of the topics contained in the retrieved documents, and term clusters generated with these terms are also strongly related to each topic.

Finally, I develop a real system using TNG to show topical term clusters which can be used for query refinement. We can use each term cluster as an additional query to the original query.

## A9. 空間データ共有のためのピアツーピアシステムに関する研究

魏 新法

### A Study of Peer-to-Peer Systems for Spatial Data Sharing By Xinfa Wei

This thesis is about peer-to-peer systems for sharing spatial data. In recent years, tremendous improvements in data gathering techniques have contributed to an unprecedented growth of available spatial data at geographically distributed locations. This has created a strong motivation for the efficient sharing of such data. While peer-to-peer systems becomes an important approach of massively distributed systems not only for file transfers but also for searchable data network, in this thesis we study the methods of sharing geographically distributed data with P2P networks. By now, there are a number of P2P protocols proposed, but most of them are based on distributed hashing tables, such as CAN and Chord which support exact match only and have limited number of search predicates support. When we consider a set of peer nodes as a massively geographically distributed database, several types of

search predicates should be provided in addition to exact match search. So in order to efficiently support spatial data sharing peer-to-peer application, we need to design new peer-to-peer systems that broaden the types of query processing, improve the performance and are of fault-tolerance. This thesis first presents the design and evaluation of GNet, an early work of exploring the possibility of geographical peer-to-peer protocol that targets supporting wide area location-based service. The GNet protocol uses hierarchical geographic address as the identifiers of peer nodes. By combining domain-progressive routing mechanism like plaxton mesh with geographical domain hierarchy, this protocol has the advantages of efficient routing, locality preserving, etc. It supports position-based and especially geographically scoped operations efficiently. Though implementation prerequisites limits its application area, analysis and evaluation results demonstrate its scalability, query efficiency and load balancing features, which makes it adaptable to certain applications.

As the main contribution of this thesis, DHR-Trees protocol is then presented with its design, multidimensional query method and performance, maintenance method and cost analysis, structure fault-tolerance and query fault-tolerance under churn. DHR-Trees structure is the first peer-to-peer structure that supports region-based multidimensional search predicates, such as range queries and nearest neighbor queries as in R-Trees structure, the predominant indexing structure in spatial databases.

The thesis presents the structure of DHR-Trees and multidimensional query support mechanism. Instead maintaining a global centralized R-Trees index, each peer owns a semi-independent partial region tree structure, which makes it possible to keep correctness of structure even under dynamic network changes. Each geographically distributed peer node is identified by its value on Hilbert space filling curve, which maps Euclidean space into one-dimensional identifier space. Peer nodes self-organize into a virtual ring, sorted by the value of the identifier. For routing purpose and query supporting purpose, each peer maintains a routing table which contains pointers to a number of nodes in the network and region information of underlying entries in the DHR-Trees. The routing cost is logarithmical to network size. The spatial query evaluation results show that queries can be efficiently supported with less traffic than its competitor, the Squid P2P protocol. Furthermore, the nearest neighbor query, which is not supported in Squid, can also be efficiently executed.

The thesis then provides analysis of DHR-Trees peer-to-peer systems under network churn, including scalability, robustness and resilience. To keep the structure correct as nodes join, leave, and fail, peer node in the network periodically run two stabilization processes, i.e. ring stabilization and routing table stabilization. Our analysis and evaluation result shows that the overhead of updating routing tables when a new node joins increases logarithmically to the network size. This demonstrates the scalability of DHR-Trees. By introducing successor lists to the entries in the routing table, robustness

and resilience are greatly improved. Moreover, to eliminate the frequent updating requirements of the region information in harsh churn environment, we introduce the usage of adaptive bounding rectangle as the replacement of minimum bounding rectangle. This approach decreases the updating overhead and greatly improves the quality of query result under churn.

Through this thesis, two new novel peer-to-peer protocols are provided. Both GNet and DHR-Trees are designed to be architectures for sharing geographically distributed spatial data. In particular, the DHR-Trees can not only index spatial data as in centralized R-Trees, but also be able to handle dynamism in the peer-to-peer network. We believe our approaches can help realization of certain distributed spatial data sharing applications. We hope our works will stimulate more research interest in both peer-to-peer structures and spatial data sharing applications.

## A10. ロボットによるプレゼンテーション及び音声インタラクションの実現に関する研究

西村 義隆

### A system for humanoid robot presentation and speech interaction

By Yoshitaka Nishimura

Research in robotics is growing and many humanoid robots are being produced. The humanoid robots are remarkable media because they have many modalities and can act in the real world like humans. Humanoid presentations are effective in a real environment, because they can move and look around at the audience similar to a human presenter. Thus, in this paper, I propose a humanoid robot's presentation system that includes the speech interaction.

There are many tools to make multimodal contents using animated agents, but there are no tools for humanoid robots. Thus, I have utilized the technology developed for animated agents. MPML (Multimodal Presentation Markup Language) is a medium-level scripting language allowing many non-specialists to easily write multimodal presentations with life-like animated agents. Like HTML for making Web pages, MPML is expected to serve as a core for describing and producing multimodal contents. I have developed a new MPML version called MPML-HR (MPML for humanoid robots). Using MPML-HR it is easy to write and thus generate a set of humanoid robot behaviors.

A parallel execution mechanism of action, speech and autonomous head motions has been introduced in the presentation system to make the presentation more life-like. The system will have two threads when the sequent two commands are action and speech; these two commands are executed simultaneously. The autonomous head motions are evoked when there is only utterance and no action. The angle of the head motion is generated at random.

While the first version of MPML-HR allows everyone to make presentation contents with humanoid robots, it doesn't support interaction functions with audiences. Furthermore, although several markup languages for interactive systems have been

developed, their interaction functions in presentation have been weak or insufficient. Therefore, I introduced an interaction function to the robot's presentation system. It enables to describe speech interaction in MPML-HR. This interactive function of MPML-HR has been realized so as to make use of the merit of MPML-HR, i.e., the easiness of description. In the interaction, the presentation system can deal with audiences' utterances such as requesting to repeat previous explanations or to skip some contents. In order to cope with such interruptions, MPML-HR needs to be extended so that the content designer can specify interruption utterance patterns for speech recognition and the destination point the presentation should move to for each type of interruption. To make it possible to specify the point to move to, the presentation content needs to be divided into short pieces so that the robot can move to the head of one of such short pieces. To divide the contents, the page tag in MPML-HR scripts is used. Each part embraced by the page corresponds to one slide on the screen. Since each slide can be considered to be one topic in the presentation, this tag is suitable for indicating the point to move to when an audience interrupts.

One issue in handling audience interruptions is that there can be speech recognition errors. If the robot reacts to an erroneous speech recognition result, the presentation will move to an unintended point. Therefore two functionalities are incorporated into MPML-HR. One is to ask the audience back what he/she said or ask the audience back the recognition result is correct or incorrect when the speech recognition confidence is low. The other is to go back to the original point in the presentation when the presentation moved by a speech recognition error and to allow the audience to correct an utterance.

In the presentation, the humanoid should listen to the user's speech by using its own microphones, because it is not realistic to assume that the user always wears a headset in a daily environment. In such a humanoid, "noise" generated by its actuators becomes a crucial problem. The humanoid is basically a highly redundant system, so it includes a lot of motors as well as cooling fans for humanoid-embedded processors to realize human-like behaviors autonomously. These noises can be easily captured by the humanoid's microphones because the noise sources are closer to the microphones than the target speech source. Thus, the SNR (signal-to-noise ratio) of input speech becomes quite low (sometimes less than 0 dB). However, it is possible to estimate these noises by using information on the humanoid's motions and gestures. I have proposed a method to improve ASR (Automatic Speech Recognition) for a humanoid with motor noises by utilizing its motion/gesture information. The method consists of noise suppression and MFT-ASR (missing-feature-theory-based ASR). The proposed noise suppression technique is based on spectral subtraction, and white noise is added to blur distortion of suppression. MFT-ASR improves ASR by masking unreliable acoustic features in the input sound. The motion/gesture information is used for obtaining the unreliable acoustic features.



Furthermore, I also evaluated with the acoustic model adaptation technique called MLLR (Maximum Likelihood Linear Regression). Un-supervised MLLR was used for the adaptation. I evaluated the proposed method through recognition of speech recorded by using Honda ASIMO in a room with reverberation. The noise data contained 34 kinds of noises: motor noises without motions, gesture noises, walking noises, and so on. The experimental results show that the proposed method outperforms the conventional multi-condition training technique.

The aforementioned system has been realized with Honda ASIMO, the most famous humanoid robot in the world.

#### **A11. 放送型暗号と高機能公開鍵暗号方式のための統一的枠組みに関する研究**

アッタラパドゥン ナッタポン

##### **Unified Frameworks for Practical Broadcast Encryption and Public Key Encryption with High Functionalities**

**By Attrapadung Nuttapong**

In this thesis, we study encryption schemes with various “high functionalities” including one specific focus on broadcast encryption. As for the main contributions, we propose a framework for constructing practical broadcast encryption schemes and a unified framework for public-key encryption with various functionalities.

The first focus of the thesis is on a special but important kind of encryption schemes, namely broadcast encryption. Such a scheme has many useful applications; the most important one to be mentioned is the digital right management. More precisely, broadcast encryption enables the protection of digital contents such as copyrighted DVD. Such a technology is “inevitable” nowadays as modern advancements in communication infrastructure and digital storage technologies have, on one hand, enabled pervasive digital media distribution, but on the other hand, also allowed the spread of “pirate” contents to be done easier than ever before.

There are some broadcast encryption schemes available in the literature; however, as the number of all users in the system tends to be increased, these existing solutions tend to be quite inefficient, and eventually cannot be used in the real-world application. Our focus is then to construct practical broadcast encryption schemes, which can be “scalable”, in the sense that the efficiency of scheme will not be affected by the increasing number of users. As a result of the research, we achieve this goal by constructing the first schemes whose the main two parameters, namely the ciphertext size and the private key size, are independent of the number of all users, while the computational cost is semi-scalable (namely, the cost is increasing but slowly as logarithmically). Behind this scheme, we proposed a theoretical framework that can be used to construct efficient schemes in a systematical way.

The second topic shifts the research focus from the practical point of views to more theoretical ones and looked beyond to

more general encryption schemes with “high functionalities”. The motivation came from the fact that in recent years, there have been many cryptographic primitives which extend the normal public-key encryption to achieve useful functionalities such as ID-based encryption, Key-insulated encryption, Forward-secure encryption, Certificate-less encryption, and many more. Each functionality is proved to be useful in different scenarios and applications thereof. Although being seemingly related primitives, there was no unified framework for defining or constructing them.

In this work, we proposed a unified framework called Directed Acyclic Graph Encryption (DAGE) that unifies these highly-functional encryption primitives into a unified syntax, a unified security notion, and unified generic/specific constructions. More precisely, we reduce a specification of such a primitive to its necessary and sufficient information, which is turned out to be its underlying graph: by specifying a graph, the definition and constructions will be automatically induced by the framework. We also give a primitive implication theorem which gives a simple criterion whether a primitive implies another.

In the theoretical point of view, the merits of the proposed framework are direct. It helps understanding the theoretical essences of the encryption schemes with high-functionalities from our unified characterization. This result simplifies the previous complicated researches into one piece. The result on the primitive implication theorem gives an automated verification of relations among primitives. This reduces the proof of relations which has to be performed based on complexity-theoretic approaches in the previous individual researches, which is quite complicated and can be verified only by human, to the logical-based approach, which is much simpler and can be verified automatically by computer.

The proposed generic construction implies the possibility result for arbitrary graphs. This has merits not only in the theoretical point of view but also in the practical point of view where the protocol designer can just specify a “tailor-made” graph for the on-purposed application and the implementation of the scheme will be prompted to use. Furthermore, any esoteric scheme featured with many combined functionalities can be directly implemented; for example, a forward-secure certificate-less public-key encryption with keyword-searchability. This is also something that previous works cannot achieve, particularly since there was no unified framework to cope with.

For the third main topic, we focus on the combination of the above-mentioned two previous results: public-key broadcast encryption schemes that are simultaneously practical and feature high functionalities. To be able to attain such practical broadcast schemes, it is unavoidable to focus on more specific functionalities (not generic as in the second topic above). We focused on some most useful functionalities, namely forward-security and keyword-searchability. Forward-security enables the private-key updating and guarantees the security of the previously-encrypted ciphertexts even when the present-time private key is exposed. We presents the most

practical and scalable forward-secure broadcast encryption so far in the literature. Keyword-searchability enables the search over encrypted data. It has a killer application of encrypted file sharing systems over public database. We presented the first such scheme in the literature.

#### **A12. 同一場面映像の照合による大規模映像アーカイブ構造化**

瀧本 政雄

##### **Indexing of Video Archive Based on Identification Method for Video Shots of the Same Scene By Masao Takimoto**

A semantic indexing approach for huge video archive is proposed in this paper. Nowadays, large amount of accumulated videos are available but there is no definitive way to deal with them based on their contents. Although metadata annotated by humans has useful semantic information, it is not satisfactory for every person and manual annotation needs high const. Therefore, some method to extract semantic information automatically from video data is supposed to be needed.

Typically in TV video archive, an identical scene could be used in many video shots in various TV programs. For example, a speech about a big event by famous person might be broadcasted in most of TV news programs. We can guess the semantic relationship between such shots by the identification of them. Because scenes broadcasted repeatedly often have remarkable contents, detection of the relationship from video archive can lead to the semantic indexing. In this paper, those shots are called "identifiable shots".

For the identification, there are mainly 2 problems to be solved. First one is the existence of difference in appearances even between identifiable shots because they can be taken by different cameras and edited in different way. Second problem is temporal offset between identifiable shots which is caused because different TV programs use different period in an identical scene. Proposed method can solve these problems by using temporally changing pattern of image features as the criteria of the identification: occurrence of flash lights and inconsistency of object motion. They are relatively invariant to the difference of cameras or editions, and temporal offset is estimated by shifting it and selecting the offset which yields the best similarity between patterns.

There is another problem in order to apply the method to huge video archive: the computation cost. Most of existing image/video analysis methods didn't discuss the problem so much, but it becomes much more important as the environment for digital videos is developed. Proposed method in this research tackles the problem by avoiding the direct comparison between video shots. Shots are represented with some features and they are compared in feature space. This approach greatly improved the efficiency of the identification.

#### **A13. 人体動作と音楽の解析に基づく舞踊動作生成**

白鳥 貴亮

#### **Synthesis of Dance Performance Based on Analyses of Human Motion and Music By Takaaki Shiratori**

Recently, demands for synthesizing realistic human motions are rapidly increasing in computer graphics (CG) and robotics fields.

One of the easy solutions to this issue is to use a motion capture system.

However, it still remains difficult to capture the motion data that animators really want, and most prior work aimed to solve this problem by editing motion capture data, seamlessly blending or connecting motion capture data sets, or modifying them according to physical properties.

In most cases, human movements, however, are induced by external signals: people first receive visual information such as environmental obstacles from eyes, or audio information such as speech or music from ears, and then recognize essential information or feel some emotions from the obtained information, and finally perform movements.

Considering these aspects makes it possible to automatically synthesize more human-like motion, and, despite this possibility, only a few methods considering these aspects have been developed.

To meet this need, we are focusing on dance performance as an experimental subject.

Dance performance strongly depends on musical features such as tempo, rhythm, mood, intensity, or genre of played music recognized by dance performers, and is well-suited to the issue.

The ultimate goal of our study is to realize dancing-to-music ability for CG characters and humanoid robots.

This dissertation describes three novel studies.

The first study is to analyze the relationship between motion and musical rhythm.

According to observation of human dance motion, motion rhythm is represented with stop motion called a "keypose", at which dancers clearly stop their movements, and the motion rhythm is synchronized with musical rhythm to perform dance performance.

The proposed method aims to reveal the relationship and consists of music analysis step that estimates musical rhythm, and motion analysis step that extract keypose candidates.

By integrating these information, keyposes that are very similar to dancers' understandings are extracted.

The second study is to model how to modify upper body motion based on the speed of played music.

When we observed structured dance motion performed under normal music playback speed and motion performed under faster music playback speed, we found that the detail of each motion is slightly different while the whole of the dance motion is similar in both cases.

This phenomenon is derived from the fact that dancers omit the details and perform the essential part of the dance in order to follow the faster music speed.

To prove this, we analyzed the motion differences in the

frequency domain, and obtained two insights on the omission of motion details: (1) the keyposes mentioned in the first study are preserved, and (2) high frequency components are gradually reduced depending on the musical speed.

Based on these insights, we modeled the motion modification using musical rhythm and kinematic constraints that humans have.

We show the effectiveness of our algorithm through experimental results.

Additionally, we also developed some applications for CG character animation and humanoid robot motion generation.

The third study is to automatically synthesize dance performance that is well matched to input music.

People feel various emotions depending on musical mood. For example, people feel quiet and relaxed when listening to relaxing music such as a ballad, and they feel excited when listening to intense music such as hard rock music.

We observed dance performance, especially original dance, and found that the same is often true for dance performance.

Based on this, we designed an algorithm to synthesize new dance performance by assuming the relationship between motion and music rhythm mentioned in the first study, and the relationship between motion and music intensity.

As for motion synthesis step, we propose two methods: a globally optimal method and a locally optimal method.

Users can select one of them depending on their purposes. Our studies have many advances over prior work on human motion analysis and synthesis.

They contribute to not only entertainment systems of CG animation and humanoid robots, but also applications for digital archive of our intangible cultural heritages.

#### A14. 公開鍵暗号の効率的構成法および証明可能安全性に関する研究

崔 洋

##### Efficient Constructions and Provable Security of Public-Key Encryptions By Yang Cui

Public-key encryption is playing a crucial role in modern cryptography and information security, for the confidentiality of the secrecy and privacy. This dissertation considers the efficient design and provable security of public-key encryptions. We present new algorithms and motivating applications, with rigorous proofs based on well-known cryptographic assumptions. All schemes we presented are efficient and practical.

In particular, our approach is focusing on the following areas.

1). Generic conversions for public-key encryptions: The confidentiality of public-key encryptions is required to satisfy the strongest security, however, most of current public-key encryptions are only fulfilling with relatively weak security. Although there were some generic conversions had been proposed for enhancing the security of the original public-key encryptions including some distinguished schemes,

unfortunately, there does not exist such a scheme that could generically transform many public-key encryption schemes to the strongest security, with the theoretically minimal overhead. Optimal Asymmetric Encryption Padding (OAEP), as its name, was considered to be able to transform a specific public-key encryption to the strongest security with optimal message overhead, but finally found to have a flaw if without additional overhead. Thus, it loses the optimal result. We present here a generic conversion which is the first one to achieve the optimal message overhead while keeping the strongest security. It bases on a well-known cryptographic assumption, and its proof has a tight reduction cost compared to the previous schemes, which usually implies a better performance under the same security level.

On the other hand, a number of public-key encryptions currently used are subject to quantum algorithms if quantum computer could be built. Concerning that long-term security, it is essential to take account of post-quantum public-key encryptions as soon as possible. Among many candidates, a kind of promising public-key encryptions has recently been broken by a decryption error based attack. We present here a generic and efficient solution to thwart the underlying attack, so that the public-key encryption with decryption errors may still immune to the quantum algorithm based attack.

2). Efficient hybrid encryption: Since we have achieved the optimal result when solely public-key encryption scheme is used, we also intend to construct efficient schemes in other cases. One of the most important applications of public-key encryptions, is to transfer session key for the symmetric encryption to encrypt the lengthy data in a fast way. A combination of public-key encryptions and symmetric-key encryptions works in tandem, which is called hybrid encryption. We show that in hybrid encryption scenario, the efficiency could be further enhanced while keeping the security as the same. We present two schemes in hybrid public-key encryption setting, which are based on a recently presented advantageous framework in a number of aspects. One of the schemes is quite simple and nearly optimal since only one cryptographic hash function and one key derivation function are needed in addition to the original public-key encryption. Astonishingly, a distinguished scheme proposed more than 10 years ago could be actually taken as a special case of our very efficient scheme. Therefore, our result can be considered as a generalization solution, and several significant public-key encryptions are possibly adapted to our new scheme in order to guarantee the strongest security. The scheme is secure as long as a well-known mathematical assumption holds, and the security proof is built in the so-called “random oracle” model.

Although the random oracle model is a powerful tool widely use in the design and analysis of cryptography, sometimes it is not desired to assume such an ideal cryptographic hash function in practice. The other scheme we presented here, has achieved the best security in the standard model (i.e. without requiring the random oracles). We take advantage of

identity-based encryption to construct a hybrid public-key encryption in the strongest sense. The resulting scheme is a lot more efficient than the previous one both in computation and communication cost.

More interestingly, the second scheme is naturally functional in the threshold cryptography, which has numerous applications in E-commerce and E-voting. Basing on our new scheme, we also present a threshold hybrid encryption and an identity-based threshold hybrid encryption in the standard model, with pretty good efficiency. The technique we used may have an independent meaning in cryptography.

3). Lightweight public-key encryptions: Public-key encryptions have plenty of applications in theory and in practice. We are motivated by the security requirement in wireless environment, where the problem is hard to tackle because of the restricted computation and communication sources. Although it is difficult to achieve a full-fledged public-key encryption in the best security level, we point out that some lightweight solutions are still available. We present two secure authentication protocols by using a partial public-key encryption, and prove the protocols are effective and efficient. Summarizing another work where we find successful attacks against a distinguished lightweight authentication based on a similar assumption, we conclude that our protocols are very promising for protecting wireless security in practice.

Finally, this dissertation summarizes the methodology of design and analysis of public-key encryptions. We wish that it will contribute to the research of cryptography and information security, for protecting the information technology as well as personal secrecy and privacy.

#### **A15. 学習者状態とインタラクションする共感的教育キャラクターエージェントの研究**

王 化

##### **Empathic Tutoring Character Agents Interacting with Learner's States** By Hua Wang

This thesis describes the research work on e-learning interface with multiple tutoring character agents to improve the learning process with learners.

The character agents use eye movement information to facilitate empathy-relevant reasoning and behavior. Eye Information is used to monitor user's attention and interests, to personalize the agent behaviors, and for exchanging information of different learners. The system reacts to multiple users' eye information in real-time and the empathic character agents owned by each learner exchange learner's information to help to form the online learning community.

In the system, the learner's facial information, voice information, as well as mouse movement, is obtained in real-time and the character agents give the feedback to learners based on these kinds of information. Each type of the data is a modular which makes the system easy to integrate and update. The system provides the platform for communicating and

exchanging the information during the learners' learning process. The interface is customizable.

Based on these measures, the interface infers the focus of attention of the learner and responds accordingly with affective and instructional behaviors. The thesis will also report on the usability test results concerning how users respond to the empathic functions and interact with other learners using the character agents.

#### **A16. 複数文書自動要約における情報の集約と統合に関する研究**

岡崎直観

##### **Research on Information Aggregation and Integration for Multi-Document Summarization** By Naoaki Okazaki

This thesis addresses methodologies for aggregating information and knowledge across documents, focusing on three research topics essential to an MDS system: sentence extraction, sentence ordering, and acronym recognition. This thesis consists of seven chapters. The first chapter addresses the background, motivation, and goal of this study. The subsequent chapter (Chapter 2) provides a review for automatic text summarization. Chapter 3 presents the task definition and evaluation methodology of the 3rd Text Summarization Challenge (TSC). Chapter 4 describes a method for sentence extraction in an MDS system. Chapter 5 addresses two approaches to text structuring for extracts from multi-documents: a novel method to refine the conventional method for arranging sentences; and a machine learning approach to aggregate the multiple criteria for further improvement. Chapter 6 presents a methodology for building an abbreviation dictionary from a large corpus. Chapter 7 remarks future directions of this work and concludes the thesis.

Chapter 4 of this thesis presents a methodology for sentence extraction. This study assumes that: a human reader breaks a sentence into a set of information fragments to which the sentence is referring; an information fragment is independent from each other; and an information fragment has its importance score. Among various sentence representations such as bag-of-words, bi-gram, tri-gram, n-gram, FrameNet, this study proposes the use of the dependency relations of terms in a sentence. Based on the sentence representation, the problem of sentence extraction is formalized as a combinational optimization problem that determines a set of sentences containing as much important information fragments as possible. Because source documents often contain redundant information, the algorithm reduces the importance of information fragments that has been included in the sentences chosen previously.

The presented system achieved a good result on TSC-3 evaluation corpus. For both high and low summarization ratios, the system extracted relevant sentences and hardly included redundant information. The comparison among sentence representation demonstrated that the proposed representation using pair-wise dependency relations performed better than

bag-of-words and co-occurrence representations.

Chapter 5 examines a method to arrange sentences that are extracted by important sentence extraction. The most common strategy for sentence ordering is chronological ordering, which arranges sentences in the order of their publication dates. However, some sentences may lose the presupposition assumed in their original documents. In order to deal with the problem case with chronological ordering, the proposed method improves chronological ordering by resolving precedent information of arranging sentences. This study also proposes an evaluation metric that measures sentence continuity and an amendment-based evaluation task. The proposed method achieved good results in a rating task, raising poor chronological orderings to an acceptable level by 20%. Amendment-based evaluation outperformed an evaluation that compares an ordering with an answer made by a human. The sentence continuity metric, when applied to the amendment-based task, showed good agreement with the rating result.

Although several strategies to decide a sentence ordering have been proposed in the previous work, the appropriate way to combine these strategies to achieve more coherent summaries remains unsolved. This chapter also formalizes four criteria to capture the association of sentences. These criteria are integrated into a criterion by a supervised learning approach. Our experimental results showed a significant improvement over existing sentence ordering strategies.

Chapter 6 addresses abbreviation recognition for MDS. In practice, no generic rules or exact patterns have been established for dealing with abbreviation creation. Thus, abbreviation recognition aims to extract pairs of short forms (acronyms or abbreviations) and long forms (their expanded forms or definitions) occurring in text. Except for a few studies, most studies focus on parenthetical expressions and locate a textual fragment with an abbreviation definition by using a letter-matching algorithm. However, the letter matching approach cannot deal with a long form whose short form is arranged in a different word order, e.g., water activity (AW). In addition, the letter matching approach is not applicable to Japanese acronyms, which does not necessarily share the same letters between a short/long-form pair because of its foreign origin, e.g., Yakan Ri-chakuriku Kunren (NLP).

This study assumes a word sequence is a possible long-form if the word sequence co-occurs frequently with a specific abbreviation and not with other surrounding words. Satisfying a validation rule for being a long form, the word sequence is stored in the abbreviation dictionary. This approach detects the starting point of the long form without using letter matching. In order to validate a short/long-form pair in English, this study uses a refined letter-matching algorithm that can recognize shuffled abbreviations. This study examines the number of paraphrase instances in the source documents for validating short/long-form pairs in Japanese. The proposed method outperformed the base-line systems, achieving 99% precision and 82-95% recall on MEDLINE evaluation corpus (biomedical English text). The proposed

method could also detect Japanese acronyms at high accuracy.

#### A17. インバースサウンドレンダリング: 内部空間の表面の音響特性推定を目的とした音響逆問題解析

パブロ ナバ ガブリエル

##### **Inverse sound rendering: In-situ estimation of surface acoustic impedance for acoustic simulation and design of real indoor environments** **By Pablo Nava Gabriel**

When acoustic engineers make analyses of the sound propagation with numerical methods, they use values of the acoustic properties of the objects to describe the behavior of a given object when a sound wave hits its surface. In other words, these numerical methods often require the specification of boundary conditions that characterize the acoustic properties of the materials. For example, once the acoustic properties of the materials are known, numerical analysis such as boundary or finite element methods can be applied to predict and control the sound field by manipulation of the analyzed materials. In the present work, of particular interest is the development of a method to measure the acoustic property called “normal acoustic impedance” of the surface an object (in what follows it will be referred as to simply “impedance”). It is considered here the special case when the objects to be measured are contained in the interior of an enclosed space, for example a room. On the other hand, once the impedances of the surfaces inside the interior space are known, we can now use them to make predictions of the sound response of that interior space (a room for example) by employing numerical simulations. Moreover, since the 3D model of the room is assumed to be known, we may use it together with the estimated impedances to simulate modifications of the room, for example insertion of new objects (with known acoustic impedance), or changes of the materials in the walls, or placing a carpet on the floor, and then make predictions of the sound response that we would hear if we did the actual modifications in the real room. This is important for example in the early stages of the acoustic design of concert halls, seminar rooms, audio studios, etc. where an optimum acoustic design should be determined in advance before making costly expenses.

As mentioned before, the measurement method proposed here is to be used in real situations where the materials cannot be taken to the acoustic laboratory so one can obtain their acoustic impedance with specialized devices. Therefore, if the impedance of those materials is desired, in-situ measurements must be performed. In this point, a number of in-situ measurement methods have been proposed since around seven decades ago, but it was not until recent years that in-situ measurement techniques based on inverse acoustic numerical methods attracted the interest of researchers due to their applicability to arbitrary geometries. In such inverse methods the underlying idea is that it is possible to reconstruct the boundary values (such as vibration strength and sound

pressure) at the surface of a vibrating body if there is a transfer function or a propagation model that relates the sound in the propagation field with the sound at the boundaries (or the surface of the vibrating object in this case). The reconstruction is then achieved by solving the inverse formulation of the propagation model, in a least-squares sense, using samples of sound taken at reference points in the field. In the present work two algorithms for the estimation of acoustic impedance are presented. Both algorithms are based on the solution of the Helmholtz Integral Equation (HIE) of the wave propagation in a homogeneous media. Hence, the underlying theory of these algorithms is the Boundary Element Method (BEM) and the Inverse Boundary Element Method (IBEM). Similar approaches based on these theoretical frameworks have been proposed for the identification of noise sources in a vibrating system. However, the present work represents a first attempt to estimate the acoustic impedances in the interior of large-scale objects (such as rooms).

The basic idea for a system of the inverse estimation of acoustic impedances is therefore as follows: in an interior space (e.g. an office, a conference room, a hall, etc.) a sound source (e.g. a speaker) is placed in a known position and a harmonic tone is emitted into the space; as the sound travels and reflects in the interior surfaces, a microphone is moving freely in the interior and recording samples of sound; after a number of samples are recorded the sound source stops. Then the problem is: given the 3D model of the interior space, the strength of the sound emitted by the source, and the set of recorded samples of sound, the objective is to estimate the acoustic impedance of the surfaces in that interior space. That is achieved by discretizing the geometric model into  $N$  elements and using the measured sound samples. Then applying the IBEM theory, a large system of equations is constructed. The unknowns of this linear system are the boundary values of the HIE that happen to be precisely the parameters that define the impedances at the surfaces. Therefore the solution of this linear problem leads to the sought acoustic impedance values.

However, the solution is not achieved straight forward since this kind of inverse problems are usually ill-posed, meaning that if one wants to find a solution to the linear system in the least-square sense, there exist many vectors in the solution space that minimize the residual. In other words, the system is not uniquely solvable and there maybe an infinite number of minimizing vectors near the desired solution. Moreover, the matrix of our system of equations is highly ill-conditioned making the linear problem sensitive to the noise introduced in the measurements. And because of these reasons, extra information of the sought solution should be given in the form of constraints to the linear system (this process is known as Regularization). A number of regularization methods have been proposed in the literature, being Tikhonov regularization the most widely used; other regularization techniques are based on the singular value decomposition (SVD) of the linear system. Although the application of existent regularization methods improves the accuracy of the solutions, the

calculation of the amount of regularization is usually a complex work resulting in extra computational cost. And as the dimensionality of the problem becomes large, as large as that of the problems addressed in the present work, the limitations imposed by the regularization step are more predominant. As an alternative to overcome these difficulties, the methods proposed here attempt to solve the ill-conditioned linear system by exploiting a priori knowledge of the geometrical segmentation of the surfaces and introducing it as a physically-meaning constraint. In one hand, a non-linear Least-squares optimization approach aims to find the sound pressure and the particle velocity (parameters that define the acoustic impedance) at each discrete element of the 3D model. This method has the advantage that gives a good approximation, in terms of geometric resolution, to the distribution of the impedance values over the surfaces, however the solutions turn more unstable as the dimensions of the geometry grows. On the other hand, a second approach is an iterative optimization process that estimates directly the sought impedances assuming that the interior surfaces have homogenous impedance values. This assumption allows in addition a dramatic reduction of the dimensionality of the optimization problem, and therefore being able to keep an acceptable accuracy for large-scale problems. Another advantage of this method is its robustness to the perturbations in the measured data, due to the fact that the inversion of the ill-conditioned matrix is not required. A drawback of this second approach is its slow convergence.

In the evaluation part, the performance of the methods proposed here is investigated by means of numerical simulations with basic geometrical shapes (such as a unitary cube) and with realistic 3D models (an office room). In addition to the simulations, validation experiments are realized by attempting to estimate the acoustic impedance of the interior walls of a reverberation chamber. With respect to the experimental measurement system, the use of video cameras to perform 3D real-time tracking of the position of the microphone is also introduced. The 3D tracking with video cameras makes it possible to perform mass data acquisition of the sound samples in the interior space. Results of the simulations and the experiments are presented and discussed.

In summary, the contributions of the research work presented here are as follows:

- A first attempt to estimate the acoustic impedance of all the interior surfaces in a real room.
- The introduction of two optimization methods for the solution of ill-posed inverse problems for estimation of acoustic parameters in large-scale models.
- The elimination of the restriction of complex microphone arrays and the possibility to use sound samples measured at random points inside the enclosed space.
- The concept of Inverse Sound Rendering as a new paradigm in the area of inverse acoustic problems. |

## A18. 空間構造上の協力行動に関するエージェントベースモデル

小野 真裕

**An agent base model about the cooperation action on space structure**  
**By Masahiro Ono**

In the history of the science, the influence of the reductionism that starts from Rene Descartes is very large. The reductionism is a theory that asserts that the nature of complex things is reduced to the nature of sums of simpler or more fundamental things. This theory implies that we can understand the complex things if we understand allfundamentals. Physics and the chemistry, etc. according to this notion have developed greatly in these centuries.

However, the assumption that the whole is the sum of all elements is not always right. Life and intelligence may be typical examples for the case. Though the life and the intelligence emerge as a whole, we cannot discover a straight life and intelligence even if we observe an atom or a cell.

On the other hand, the research area of complex systems science generically has appeared in recent years. It is an attempt of clarifying the phenomenon with a difficult explanation in the reductionism. The one of the centers of the discussion in this area of investigation is a phenomenon that is called emergence. The interaction among those elements indicates the phenomenon to invent behavior as the whole that cannot be explained from each element. This idea assumes the computer simulation to be a powerful weapon, and becomes active with the development of the computer in recent years.

It is very important to know a property common to a general system in the world in the sense of engineering as well as science. The root of this study includes a purpose finding a basic law of an emergence phenomenon. However, because we have a difficulty to achieve this purpose at present, the purpose of this study is to get knowledge from limited phenomena to contribute to understand the general system in the future.

In this study, I specifically intend to extend knowledge of cooperation in the population in the case of the decision making on the spatial structure. The constructive approach is performed in this study. This approach is as follows. One system which consists of many elements is built, and the many elements are operated according to a micro rule. Then we can deepen an understanding of a macroscopic emergent phenomenon by observing them.

I specifically assume an agent performing decision making as an element of system and simulate an evolutionary multi-agent system. An agent plays the prisoner's dilemma game that is one of the famous games in the game theory which treats decision making mathematically. The feature of this study is the spatial structure which limits contacts between agents.

The decision making of the agents has an influence each other, and they pile up to a population characteristic. I observe the behavior of an agent and the population characteristics to get knowledge with respect to an emergence phenomenon. In addition, the proposed agent models help us to investigate the influence of the spatial structure on learning

of an agent and the utility of estimating ability of intention of an opponent in this study.

In chapter 1, the background and the purpose of this study is described. In chapter 2, the game and the position of the game in the society and the history are described. Then, this study is placed in the story. In chapter 3, a basic behavior of the agents that played the prisoner's dilemma game is investigated. Conventional knowledge in the ecology is supported quantitatively. In chapter 4, network formation in the case that the agents can operate their own links is studied. It is shown that some agents have many links in the stable state. In chapter 5, a learning agent model is proposed and the influence of the spatial structure on learning process is investigated. The strength of the relation among agents makes influence on trustiness. In chapter 6, the control possibility of the population is discussed. A control method that takes advantage of the spatial structure is proposed and the effect is examined. In chapter 7, the agent model that guesses the other agent's intention is proposed. Strength of the agent who guesses the intention to an agent is examined. Finally, this thesis is summed up and the problem in the future is referred.

**A19. 言語情報と映像情報の統合による作業教示映像の構造的理解**

柴田 知秀

**Structural Understanding of Instruction Videos by Integrating Linguistic and Visual Information**  
**By Tomohide Shibata**

To perform real-world information processing, such as intelligent robotics, multimodal dialogue system and video processing, it is essential to integrate several media processing techniques such as natural language processing, speech recognition and image analysis. From the viewpoint of natural language processing, since language in real world strongly depends on the scene, it is important to understand utterances in accordance with the scene.

This thesis focuses on handling video contents. Among several types of videos, in which instruction videos (how-to videos) about sports, cooking, D.I.Y., and others are the most valuable, we focus on cooking TV programs. In realizing flexible utilization/access of video contents, the crucial point is the structural understanding of their contents, which requires the interpretation of utterances based on wider contexts including the scene.

Chapter 2 describes basic linguistic analysis of cooking instruction utterances (closed caption texts). First, we perform anaphora resolution, which is inevitable to detect discourse structure or make linguistic information correspond with visual information. We build an anaphora resolution system based on large-scale case frame. Next, we detect utterance type of a clause of each utterance. In cooking instruction utterances, while explanations of actions are dominant, there are several types of utterances such as declaration of beginning of series of actions, tips of actions, notes, etc. We classify cooking instruction utterances to recognize utterance types using clause-end patterns. Then, we analyze discourse structure of

instruction utterances. This analysis is performed by integrating the anaphora resolution result, utterance type and generalized discourse structure rules, which consider cue phrases and word chaining.

Chapter 3 proposes an unsupervised topic identification method integrating linguistic and visual information based on Hidden Markov Models (HMMs). Identified topics are used for video segmentation/summarization and for automatically acquiring object models described in Chapter 4. We employ HMMs for topic identification, wherein a state corresponds to a topic and various features including linguistic, visual and audio information are observed. This study considers a clause as a unit of analysis and the following eight topics as a set of states: preparation, sauteing, frying, baking, simmering, boiling, dishing up, steaming. The basic linguistic feature is a case frame, which is a generalization of utterances referring to an action, such as "ireru" and "kuru". In addition to the case frame, we utilize domain-independent discourse features such as cue phrases, noun/verb chaining, which indicate topic change/persistence. We utilize visual and audio information to achieve robust topic identification. As for visual information, we can utilize background color distribution of the image. As for audio information, silence can be utilized as a clue to detecting a topic shift.

Chapter 4 presents a method for automatically acquiring object models from large amounts of video for performing object recognition. We first collect sets of a close-up image and a keyword. Close-up images are extracted with edge detection and, in the close-up image, region segmentation is performed and an attention region is determined considering the following points: area, center of gravity and variance of pixels in a region. A keyword is extracted from instructor's utterances when the close-up image appears. In the case of cooking, objects (i.e. ingredient) change their shape/color along with the progress of cooking. Consequently, good examples for object acquisition cannot be collected from video segments whose topic is sauteing or dishing up. Therefore, a keyword is extracted only from segments whose topic, which is identified by the proposed method, is preparation. The important score of each word is calculated according to the linguistic analysis result, such as the discourse structure analysis and utterance type recognition, and the word that has the maximum score is extracted as a keyword. After collecting sets of a close-up image and a keyword, for each keyword, its object model is acquired by summing RGB histograms in the attention region. Next, we perform object recognition based on the acquired object models and the discourse structure. We can acquire the object models of around 100 foods and achieve an accuracy of 0.778. The accuracy of object recognition is 0.727. Then, a method for improving anaphora resolution by integrating visual information with linguistic information is presented.

Chapter 5 describes our video retrieval system. In this system, a user can ask a query in natural language and can enjoy the search result, which is similar to the user's query. To provide an accessible mean to the video, we generate a summary of the

video. This analysis is based on topic segmentation, important utterances extraction, topic identification result, object recognition result.

Chapter 6 concludes this thesis and addresses the future work.

## **A20. GMPLSピアモデルに基づく全光ネットワークの実用性に関する研究**

アハマド スフィアン モハマド

### **Feasibility Investigations of GMPLS Peer Model in All-Optical Networks**

**By Ahmad Suffian Mohamad**

Generalized Multi-Protocol Label Switching (GMPLS) is a promising candidate for a unified control plane technology. GMPLS is being defined within the Internet Engineering Task Force (IETF), and intended to offer an advanced and unified control plane for a variety of network technologies from packet switching networks, to lambda and fiber switching. GMPLS refers to a set of protocols that will provide interoperable end-to-end provisioning of optical networks as well as other devices.

This thesis describes the feasibility test of GMPLS based all-optical network for scalable network. We deployed GMPLS peer model and evaluate the effective use of unified control plane in order to realize optical quality control of label path and dynamic optical resource management for traffic engineering. In the feasibility test, we demonstrate real implementation of GMPLS based control plane, evaluate limitations of current equipment and we finally prove the possibility of GMPLS based control plane to be used in next generation networks.

In the feasibility investigation tests, we have implemented the full scale of GMPLS protocol suites and we also have demonstrated the integration of multi-vendor devices on GMPLS common control plane. We focused on GMPLS based Path Protection and Restoration, GMPLS Quality Control, and GMPLS Traffic Engineering.

#### **GMPLS All-Optical Path Rerouting:**

In the field test, we have integrated PXC, IP router, and WDM, with GMPLS unified control plane. We succeeded in optical path rerouting by interoperating four vendors equipment including two vendors PXCs. All-optical end-to-end path rerouting has been successfully demonstrated. Test by using two PXCs and three PXC was carried out and it was confirmed that end-to-end path rerouting was completed in about 6.8 second and 4.2 seconds respectively.

Relatively, longer restoration time was obtained, due to excess message exchange for fault detection occurs. In our field test, fault localization functions defined in the GMPLS protocol suite was not fully implemented. The GMPLS signaling message time may be suppressed by appropriate fault localization. To the best of our knowledge, this is the first field test in terms of interoperating different PXCs based on GMPLS protocols.

#### **GMPLS Quality Control:**



**By Masatoshi Sekine**

We applied an automatic CD compensation system to the network. A field test for 40 Gbps wavelength path protection using PXC and GMPLS control over 240 km installed fiber was carried out. From the results of the field test, we have confirmed that 40 Gbps wavelength path service with GMPLS photonic network control is feasible with the applications of automatic CD compensation systems. We could conclude that, automatic CD compensation and path protection/restoration as the key technologies to maintain the quality of transmission, to reduce operational cost as well as to facilitate the enhancement of network capabilities.

GMPLS multilayer integration is effective to manage networks generally and is essential for all-optical network. As conclusion, GMPLS peer model could integrate the path resource management, topology control, re-allocation of existing IP transmission flows, and CD control.

GMPLS based Dynamic Optical Link Preemption:

We have reported the successful field test results of dynamic optical link preemption operation in photonic network by GMPLS protocols. We have made sure that the latency of the prioritized traffic can be drastically reduced by the procedures in this work. In the field test, when high priority traffic suffers from high latency, the traffic preempts the optical link between the photonic cross-connect (PXC) equipment with low latency that has previously been used by low priority traffic using GMPLS protocols.

The optical link between the PXC is optically transparent, so the link can provide a path that is independent of the bit rate and frame format. The field test results have shown that the latency of high priority flow has been drastically reduced from over 100 ms to less than 1 ms by the preemption operation. To the best of our knowledge, this is the first field test of optical link preemption using the optically transparent link between the PXC based on GMPLS protocols. GMPLS peer model enables coordination between control plane and resource management system, which is essential in all optical network. Conclusion: GMPLS based all-optical network is the key to maintain the quality of transmission, to reduce operational cost as well as to facilitate the enhancement of network capabilities. The deployment of peer model for GMPLS based control plane enables extension of peer elements, such as optical devices to take place in direct control through control plane. It also enables the use of monitoring equipment to detect traffic condition and quality condition of dedicated flow.

Our feasibility tests prove that the possibility of GMPLS based unified control plane to be effectively use in future all-optical networks. As conclusion we could say that by using GMPLS peer model unified control plane, flat network management over optical infrastructure to provide flexible and reliable end-to-end services could be achieved.

## **A21. センサネットワークにおける高効率分散型制御に関する研究**

関根 理敏

### **A Study on Efficient Distributed Control for Sensor Networks**

With the recent advances in micro-electro-mechanical systems (MEMS) and wireless technologies, many small sensor nodes connected by wireless links with each other are deployed in ad-hoc manners. In ubiquitous computing, sensor network has become suitable technology for collecting a lot of information from the physical world. Moreover, it is assumed that the local wireless sensor networks are connected with the Internet. Sensor data are obtained from not only restricted places such as a home and an office, but also wide areas such as a city and a natural environment.

Our research primarily aims to realize that a lot of information from the physical world is gathered effectively by distributed controls in sensor networks. We discuss solutions for technical problems. We assume both wired and wireless sensor networks. We propose an energy-efficient and traffic adaptive media access control protocol and a synchronization protocol with active/sleep schedule in wireless sensor networks. This is because it is very important to prolong the lifetimes of nodes with severely restricted batteries. In internet-scale sensor networks, update overhead can not be ignored because the rate of content changes in sensor networks is generally high. Therefore, we propose a technique for sensor data management with load balancing and overhead reduction in both data updates and data searches in internet-scale Peer-to-Peer (P2P) networks.

Our first proposal is a light-weight and traffic adaptive medium access control (MAC) protocol. In designing MAC protocols in sensor networks, traffic-adaptive controls are important because the traffic of packets dynamically changes in many applications. We propose an energy-efficient media access control protocol with adaptive slot reservation for wireless sensor networks. Our primary goal is to achieve an energy-efficient and traffic adaptive TDMA-based MAC protocol using a low-overhead operation in slot reservation. In our protocol, each slot is assigned by exchanging information within one-hop neighbors on the basis of the traffic to reduce the overhead of control packets for slot reservation. In addition, the length of an active period for slot reservation is also changed dynamically based the traffic. Furthermore, our protocol keeps throughput by a slot assignment using traffic information of senders and extending active period in slot reservation. Our performance evaluation by simulation shows that our proposal is more energy-efficient than traditional works.

Our second proposal is an adaptive protocol for active/sleep schedule synchronization. In general wireless sensor networks, sensor nodes generally switch between active and sleep modes in the MAC layer to reduce energy consumption. In previous synchronization protocols, each node begins to synchronize the active/sleep schedule with other nodes at the network setup phase, and maintains the synchronization even if it has no packet to send. Therefore, the control overhead and energy consumption during synchronization can not be ignored under low traffic. We propose an energy-efficient active/sleep

schedule synchronization protocol for wireless sensor networks. In our protocol, each node synchronizes with its neighbors only when a transmission request is generated. In adjustment of the active/sleep schedule, each node considers not only the offset of two clocks which is the actual time difference between them, but also the clock skew for the long maintenance of synchronization. The clock skew means the difference in clock frequency between two nodes. These operations can reduce energy consumption especially under low traffic. Our proposed method is based on transmission request from upper layers and maintenance of long synchronization by using information on clock skew. The results obtained from our performance evaluation show that our proposed method reduces the overhead of control packets and is more energy-efficient than the synchronization protocol in S-MAC under low traffic. Our protocol is effective especially in applications where nodes detect and report events that unpredictably happen because of the traffic adaptation.

Finally, we discuss a technique for scalable and efficient sensor data management with load balancing and reducing overhead in both updating and searching real-time sensor data which change frequently in structured P2P networks. In P2P networks, it is necessary to manage content properly in terms of efficiency, robustness, load balancing, etc. When we share sensor data in P2P networks, overhead in data updates may be large because sensor data frequently change in general. However, traditional works mainly assume load balancing and overhead reduction in the amount of data that each node manages and in data searches, while these measures are not considered in data updates. We propose a technique for adaptive management of data that change frequently when performing range queries in structural P2P networks. In our proposed method, nodes avoid concentration of load in data updates by using data update rates. They also avoid concentration of load in data searches by deploying replicas of their data. Moreover, they reduce overheads in both data updates and data searches by using following methods: history information, query shortcut by deploying of pointers to destination nodes, and adaptive deployment of data and metadata. By using computer simulation for performance evaluation, we show that our proposed method is effective for load balancing and overhead reduction in data updates and data searches.

## A22. 低解像度画像から視線方向の推定

小野 泰弘

### Gaze Estimation from Low Resolution Images By Yasuhiro Ono

Much research has been done on image-based gaze tracking techniques. Gaze direction is an important cue for understanding human activities since they indicate our focus of attention. Image-based gaze tracking techniques that do not constrain human activities and do not require the mounting of special devices could be widely used in practical applications. However, such gaze tracking techniques have not been

developed.

To aid the development of these gaze tracking techniques, we discuss a method of estimating gaze direction by using images of human bodies, for instance, images captured by a surveillance camera already installed in a public space. In that situation, the resolution of the eye region is low because the camera is far from a subject. Therefore, we discuss a method of estimating gaze direction from low-resolution images.

Little research has been done to estimate gaze directions from low-resolution images. Existing gaze tracking techniques can be classified into two approaches, i.e., model-based methods and appearance-based methods. Model-based methods usually require high resolution images of human faces to estimate gaze direction accurately. This is because gaze directions are determined from the eye's geometric features localized in images.

By contrast, appearance-based methods do not require localizing geometric features of the eye, but they use deviation of pixel values of eye region images to estimate gaze direction. Thus, we conclude that the appearance-based method is more suitable for estimating gaze directions from low-resolution images than the model-based method.

In appearance-based methods, gaze estimation accuracy is degraded by appearance variations because of positioning errors of an eye region, subject identity, and head poses. Therefore, we discuss these three problems in this research. Previous research on gaze tracking techniques by using the appearance-based method has not addressed the problems of positioning errors and subject identity. Our research is the first to discuss these problems.

When we estimate gaze direction from low-resolution images, a positioning error of an eye region causes an essential problem. It is difficult to position an eye region accurately in a low-resolution image. The inevitable positioning error seriously degrades the accuracy of gaze estimation.

Our approach to solve this problem is to perform training by using images with appearance variation due to a variety of gaze directions and a variety of positioning errors. In addition, to separate the variation due to gaze directions from that due to positioning errors, we extract the gaze feature, which cannot be easily influenced by eye region positioning errors. In order to do this, we model eye images with appearance variations due to gaze directions and positioning errors by using the multi-linear model. Experimental results have demonstrated that the accuracy of the proposed method is better than that of the Principal Component Analysis (PCA) based method.

Appearance variation due to subject identity causes an essential problem in practical application. The problem is that the gaze estimation accuracy of the subject whose training images have not been obtained is worse than that of those whose training images are available.

Our approach to solve this problem is that we treat the appearance variation due to gaze directions, due to positioning errors, and due to identity separately as three different modes in the framework of the multi-linear model. In addition, to extract gaze feature accurately from eye images with 3-mode

appearance variations, we model eye images based on a multi-linear model that considers non-linearity.

In the ordinary multi-linear model, we suppose that the relationship between pixel values of an image and the feature of each mode is linear. However, when we use eye images, the linearity assumption is not correct in a mathematical sense. Therefore, in order to extract gaze features accurately, we consider the non-linearity. Via a number of experiments, we have demonstrated the advantage of the proposed method over the method that does not consider the non-linearity.

Since the variation of a head pose affects the appearance of an eye image, head pose variation can seriously degrade the gaze estimation accuracy. To solve this problem, we separate the appearance variation due to the gaze directions from that due to the head poses in the framework of the multi-linear model.

To do that, it is necessary to extract the gaze feature and the head pose feature from the image with a small eye region. However, it is difficult to do that accurately. To extract the head pose feature accurately, we use the information of a head pose that can be measured by a head pose tracking system based on facial features. Experimental results have demonstrated the merit of the proposed method.

## 電子工学専攻

### A23. 低電カスタティック CMOS デジタル設計におけるノイズ耐性に関する研究

モハマド アバス

#### Study on Noise Immunity of Low-Power Static CMOS Digital Design By Mohamed Abbas

In the past, noise was not such a big issue in digital integrated circuits. However, the continuous progress in semiconductor technology put the noise issue among the major concerns of digital CMOS IC designers. This study concerns with the noise immunity of static CMOS low power digital design by investigating the noise immunity of the current low power static CMOS design schemes and presenting a fast and accurate methodology to evaluate the noise sensitivity of the different nodes in a design during the design phase. In addition, for the modeling/characterization of noise in digital circuits, techniques to measure the non-periodic noise and sensing the peak minimum/maximum fluctuation on-chip have been presented. The study is presented in five chapters in addition to conclusion.

The first chapter includes a background about the power consumption and noise issues in current and future VLSI/ULSI digital design. It also includes the objectives of the study and thesis organization.

In chapter two, we present the effect of noise on the performance of a selected group of low power as well as traditional digital design techniques. First, we present a model for the different noise sources in the digital circuits. Then we

applied the model to a selected group of low power and traditional designs as testing circuits. The noise immunity of the tested schemes has been reported in terms of logic error and delay error. At the end of the chapter, we present a methodology for leakage power saving and at the same time has high noise immunity. One of the ways to increase the noise immunity of a digital circuit is to give special strengthen considerations to the soft (weak) parts (nodes) against noise. Since it is time consuming to analyze the noise-sensitivity of different nodes in a big design using transistor level simulators, an analytical (fast and accurate) method is required.

In chapter three, we present a methodology to evaluate the noise-induced logic error probability in a given CMOS digital design in terms of supply voltage, threshold voltage, noise level and circuit configuration. At first, we modeled the noise immunity of the different logic gates in terms logic error probability including the effect of supply and threshold voltage, which is called electrical masking. Then, time masking has been modeled to include the variation of the spurious pulse width and generation time in the overall logic error probability. Moreover, the logic masking effect has been also considered. The electrical, timing and logic masking have been combined to form the overall logic error probability model. The model has been used to evaluate the logic error probability caused by the noise at the different nodes in digital circuit examples. The model results have been compared with results obtained from HSPICE simulation. The results reveal that the model fit with the expected simulation results achieving speedup factor of more than 1000 over HSPICE. Moreover, the calculation time of the methodology is linearly proportional with the number of gates in a design, and hence, the method is suitable for investigating the noise immunity of the big circuits. The model can be used to identify the weak parts against the noise in a given design during the design phase and hence it helps the designer in giving specific design considerations to strengthen the weak nodes. The methodology is based on hypothetical noise distribution. So that, for more accurate results, a real noise distribution should be provided.

In chapter four we present, first, an overview on the previous works regarding the on-chip noise measurement has been given. To avoid the problems attached with the previous designs, an on-chip noise detector has been designed and fabricated using 0.18um technology. The detector can detect the single-event or the non-periodic signals within the measurement time window. It is equipped with a programmable voltage divider to be able to detect high-swing signals having maximum theoretical frequency of 5GHz. The bandwidth of the output signal can be controlled by the user to fit the monitoring tools capability off-chip and to avoid the effects of the on-chip parasitic elements and hence conventional equipments can be used to measure the signal off-chip. Moreover, the detector is synthesizable and the designer can flexibly adjust its main parameters. A test chip is fabricated and tested successfully. The detector's design has been modified to increase the sampling rate. Upon the simulation results, the modified version is capable to measure

signals of frequency (theoretically) up to 10GHz. Chapter five includes the description of a CPU-interfaced system to monitor the minimum/maximum fluctuation in both VDD and ground in a design. In addition to the magnitude information, the system has the ability to report the timing and spatial information of the spurious pulse. The system is designed using Rohm 0.18 $\mu$ m technology. The fluctuation is detected by comparing with a reference voltage supplied from off-chip, and the fluctuation information is sent off-chip in digital format. The detector is simple, therefore, it can be replicated within a design to detect the fluctuations on VDD/Ground net at different spots and hence, safe operation can be guaranteed. The detector is interfaced by a CPU and hence it is suitable for future VLSI/ULSI circuits.

Finally, we conclude the study in chapter six.

#### A24. 任意位相シフト光ファイバブラッグ回折格子に基づいた高性能光フィルタ

王 徳翔

##### High-performance Optical Filters based on Fiber Bragg Gratings with Arbitrary Phase Shifts By Dexiang Wang

As optical communication systems have been developed for larger capacity (>10 Tb/s per fiber) and bandwidth efficiency (>1 bit/s/Hz), optical filters play more and more important roles that perform functions of multiplexing different wavelength channels and demultiplexing them, background noise suppression, spectral filtering, dispersion compensation and optical signal processing. Among various optical filter techniques, fiber Bragg grating (FBG) has attracted much interest due to its all-fiber geometry, low insertion loss, potentially low cost, and easy fabrication. But the most distinguishing feature is the flexibility they offer for achieving desired spectral characteristics.

Although FBG technologies have been developed well in recent years, making FBG with arbitrary phase shifts by using general phase masks is unavailable, which limits the possibility to obtain more high performance FBG based optical filters. This project focuses on solving this problem to make high performance FBG based optical filters with arbitrary phase shifts.

Multilevel phase-shifts phase sampling has been shown numerically to have higher diffraction efficiency than binary phase-shifts phase sampling. In order to fabricate grating structures with arbitrary phase shifts, displacing phase mask method has been proposed. Two kinds of phase sampling functions have been designed and corresponding FBG reflection spectra have been calculated numerically. Then, two kinds of phase sampled-FBGs (PSFBGs) have been fabricated to show the flexibility of displacing phase mask method for inducing phase change. The first has several binary phase shifts either 0 or  $\pi$  within a sampling period. The second has continuous phase variation between 0 to  $2\pi$  within a desired sampling period. Experimental results verify that the developed fabrication method is suitable for making complex

grating structures.

Multi-channel optical filters are cost effective for processing and manipulating optical signal in optical communication systems. Among various available technologies, phase-sampled FBGs have many advantages such as low insertion loss, all fiber geometry, compact and typically low cost. With the improved FBG fabrication method, two kinds of multilevel phase-sampled FBG (PSFBG) have been made with general uniform or chirped phase masks. Two applications based on fabricated multilevel phase-shifts PSFBGs are demonstrated. One is an 8-channel tunable dispersion compensator. The other is pulse repetition rate multiplier from 40 GHz to 160 GHz.

Conventionally, FBG-based optical filters are bandstop filters and need to be used conjunctionally with optical circulators, thus increasing the cost of devices. Although FBG-based tunneling filters with a flat passband have been demonstrated by inducing multiple  $\pi$ -phase-shifts along a uniform FBG, the stopband of uniform FBGs is generally narrower than 2 nm and such filters are still not suitable for many applications. We propose and demonstrate that direct-coupled resonators could be fabricated on LCFBGs, and that desired transmission characteristics could be designed by the amount and position of phase shifts. Since the stopband of LCFBGs can be very wide, bandpass filters based on LCFBGs are suitable for practical applications. In addition, center wavelengths of bandpass filters can easily be controlled inside the wide stopband.

In high-speed optical communication systems, relative timing drift between signal pulses and clock pulses severely affects the performance of optical switching. By shaping the signal pulse waveform into rectangular shape, this issue can be solved. Rectangular short pulse generation by using strong unchirped FBG has been demonstrated. The grating structure is synthesized by using inverse-scattering algorithm. With this improved FBG fabrication method, the FBG is fabricated and the measured reflection spectrum coincides with target reflection spectrum very well. From experimental results, it can be seen that ~18 ps rectangular pulses are generated successfully. We also propose a scheme to generate rectangular short pulses by using two linearly chirped FBGs (LCFBGs): one is used for pulse reshaping and the other is for dispersion compensation. As an example, the grating structure of the pulse reshaping LCFBG has been designed to generate 4-ps rectangular output pulses, and numerical calculations confirm the feasibility of the proposed scheme.

The current emphasis on optical communication systems is on increasing the spectral efficiency. One of the techniques that is used for achieving high spectral efficiency in WDM systems is vestigial sideband (VSB) filtering. VSB filtering increases spectral efficiency (the number of bits per unit bandwidth) and improves fiber dispersion tolerance. FBG based optical VSB filters for 40 Gb/s bit rate application have been studied. The principle of VSB optical filters and available techniques for realizing VSB optical filters are introduced. A FBG based VSB filter with a 3-dB bandwidth of 0.32 nm has

been designed and fabricated. The fabricated VSB filter has been used in 40 Gb/s optical transmission system and experiment results have been analyzed in detail.

Several high-performance FBG based optical filters with arbitrary phase shifts have been realized by using developed fabrication method with just general phase masks. It is anticipated that these high performance optical filters will play important roles in contemporary optical communication systems.

## **A25. 電界吸収非線型効果を用いた波長変換器およびモノリシック集積型全光スイッチ**

周小平

### **All-optical Wavelength Converter and Monolithically Integrated Switch Based on Electro-absorption**

#### **Nonlinearity**

**By Zhou Xiaoping**

The tremendous development of the internet or other wide band access technologies such as DSL、FTTH has driven the development of the high-capacity optical networks from research laboratories into commercial deployment such as Synchronous optical networks or Synchronous digital hierarchy. In the first generation, optics is used only in transmission, and all switching and other intelligent functions are handled in electronics. Now people are seeing the deployment of the 2nd generation optical networks, where some of the routing, switching and intelligence are handled optically. In this network, data is carried from its source to its destination in optical form, without undergoing any optical-to-electrical conversion so that the electronic devices will not limit the speed. In this network, both of the two current primary techniques for data multiplexing i.e. wavelength-division multiplexing (WDM) and time-division multiplexing (TDM) are used including all optical devices such as wavelength converters, all optical switches, optical add/drop multiplexer, 2R, 3R and etc..

This thesis introduces two novel devices for all optical processing by using multiple quantum well (MQW) electroabsorption modulators (EAM) for high-speed telecommunication: wavelength converters and all optical switches. The reasons why the EAM is used to replace the traditional semiconductor optical amplifier (SOA) are short recovery time under reverse bias (possible to be <10ps), high stability, no amplified-spontaneous emission (ASE), and easy integration with other devices, especially, lasers. Moreover, we chose InGaAlAs as the core layer material in our devices due to its merits of large refractive index ratio between waveguide and cladding layer, large conduction band offset suitable for uncooled operation, and large spectral range.

The proposed wavelength conversion is based on the optical nonlinear polarization rotation in an EAM. Nowadays, most of the EAM-based wavelength conversion is using cross-absorption modulation (XAM) due to its simple configuration. However, XAM suffers from the large input power, typically larger than 15dBm. In order to reduce the

input power, we investigated the cross-phase modulation (XPM) for TE mode and TM mode, and the polarization rotation. In the static wavelength conversion experiment, we demonstrated that the input powers for p phase shift are only 5dBm for upward conversion (from 1555nm to 1560nm) and 8dBm for downward conversion (from 1555nm to 1550nm), and the extinction ratios are 34dB and 31dB respectively. 10Gb/s dynamic wavelength conversion has also been demonstrated. Further simulation shows that the narrowing of the quantum well and compressive strain of MQW enhance the polarization rotation, thus reducing the required input power for saturation state. Higher speed operation is also possible by using higher reverse and optimizing the RF response.

For all optical switches, a Mach-Zehnder interferometer (MZI) configuration with EAM on the MZI arms is proposed. On account of the low relaxation time of EAM, no push-pull operation is needed. Moreover, compared to SOA, EAM has no current injection, so lower heating and low power consumption can be achieved.

The main challenge of our MZI-EAM device is the monolithic integration of the EAM and other passive waveguide. Due to large insertion loss of EAM and no gain devices in the whole structure, etch and regrowth method is chosen to reduce the total insertion loss by optimizing the active and passive regions individually. Till now, etch and regrowth technology has been well developed for InGaAsP material, but for Al-containing material, it still remains a challenge, especially for ex-situ cleaning procedure. The difficulty arises from the formation of stable Al-Oxides due to the often inevitable air-exposure of the InGaAlAs core layer during device processing, which degrades the crystal quality grown at the interface and causes large scattering loss. We optimized the growth conditions by MOVPE and processing procedures for both one-step regrowth and two-step regrowth and obtained good connection at the interface of the passive waveguide and active EAM region, with high coupling efficiency and low coupling loss (0.21dB/facet).

Another big issue of the EAM-based all optical switch is the large insertion loss. This is mainly due to the large absorption of EAM and scattering in the waveguide. High mesa structure is superior for small size, but suffering from the significant scattering loss at the sidewall. Ridge structure has much lower loss, but has longer S-bend and multimode interferometer (MMI). Moreover, the doping profile in the cladding layer has also influence on the total loss.

## **A26. 大規模集積回路におけるスタンダードセルレイアウトの最適自動合成手法**

飯塚 哲也

### **Optimal Layout Synthesis of Standard Cells in Large Scale Integration**

**By Tetsuya Iizuka**

This thesis focuses on the optimization methods for standard cell layouts. Standard cells are the most fundamental components of VLSI, and provide the building blocks for

creating large complex functions in both application-specific and semi-custom domains. Therefore, their performance has significant effects on the final performance of the synthesized VLSI. We propose a minimum-width transistor placement and an intra-cell routing via Boolean satisfiability to optimize the area of the cell layouts. We also propose a comprehensive cell layout synthesis method and a cell layout de-compaction method for yield optimization.

Chapter 2 proposes a minimum-width layout synthesis method for dual CMOS cells via Boolean Satisfiability (SAT). Cell layout synthesis problems are first transformed into SAT problems by this formulation. The proposed method guarantees to generate minimum-width cells with routability under our layout styles. This method places complementary P and N type transistors individually during transistor placement, and can generate smaller width layout compared with the case of pairing the complementary P and N type transistors. The experimental results indicate that our cell layout styles defined for the SAT formulation is practical enough to generate the layout of dual CMOS cells quickly with a little area overhead.

Chapter 3 describes a hierarchical extension of the cell layout synthesis method proposed in Chapter 2 for the cell layout synthesis of large dual CMOS cells. This method partitions a given transistor-level netlist into blocks considering the transistor connections by diffusions. Intra-block placement uses the exact transistor placement method proposed in Chapter 2, and hierarchically generates the transistor placement with routability. The comparison results with the flat cell layout synthesis method show that the proposed hierarchical method reduces the runtime for cell layout synthesis drastically with little width increase. The experimental results show the effectiveness of the proposed method as a quick layout generator in the area of transistor-level circuit optimization such as on-demand cell layout synthesis.

Chapter 4 shows flat and hierarchical approaches for generating a minimum-width transistor placement of CMOS cells in presence of non-dual P and N type transistors, whereas the cell layout synthesis methods proposed in the previous chapters are only for dual cells. This chapter targets the minimum-width transistor placement, and does not take the intra-cell routings into consideration. Our approaches are the first exact transistor placement methods which can be applied to CMOS cells with any types of structure, whereas almost all of the conventional exact transistor placement method is applicable only to dual CMOS cells. Experimental results show that the proposed method is not only applicable to CMOS cells with any types of structure, but also more effective even for dual CMOS cells compared with the transistor placement method proposed in Chapter 2. The hierarchical single-row approach is shown to be effective to reduce the runtimes drastically. This chapter also shows the generalization results of the single-row transistor placement method into the multi-row placement. The proposed exact minimum-width multi-row transistor placement method

generates more area-efficient placement than the conventional method by using the gate connection style which is more suitable for multi-row transistor placement than the conventional style.

Chapter 5 introduces a cell layout synthesis technique to optimize the yield. The yield cost metric used in this chapter is the sensitivity to wiring faults due to spot defects. The sensitivity to faults on intra-cell routings is modeled with consideration to the spot defects size distribution and the end effect of critical areas. The impact of the sensitivity reduction on the yield improvement is also discussed in this chapter. The minimum-width cell layout of CMOS logic cells are comprehensively generated using the transistor placement method proposed in Chapter 2 and the comprehensive intra-cell routing method proposed in this chapter. The yield optimal layouts are selected from the exhaustively-generated layouts by using the proposed sensitivity to wiring faults as a cost metric. The experimental results show that the fault sensitivity is effectively reduced by selecting the minimum-sensitivity layouts rather than selecting the minimum-wire-length layouts.

Chapter 6 proposes a timing-aware cell layout de-compaction method for yield optimization using Linear Programming (LP). The proposed method performs a de-compaction of the original layout in order to improve the yield by minimizing the critical area inside the cell. This yield improvement procedure is executed under given timing constraints. To formulate the timing constraints into LP, a new accurate linear delay model which approximates the difference from the original delay is proposed. Using the proposed timing-aware yield enhancement method, we can explore the trade-off between performance and yield, and can pick up the yield/performance variants from the trade-off curve. The effectiveness of the proposed method for OPC mask data volume reduction is also shown in this chapter. This timing-aware de-compaction framework is extended to the redundant contact insertion adjacent to the original single contacts to minimize the yield loss due to contact failure. To take the parametric yield into account, the proposed method is also extended to the gate layout pattern regularity enhancement to reduce the systematic variation of the gate critical dimensions.

We are sure that these results in this thesis such as the exact minimum-width cell layout synthesis techniques, the comprehensive cell layout synthesis method, and the cell layout de-compaction method for yield optimization will be used for standard-cell layout optimization in terms of area, delay, and yield, and contribute to the VLSI performance and reliability improvements.

## **A27. 基板バイアス係数可変完全空乏型 SOI MOSFET**

大藤 徹

**Variable-Body-Factor Fully-Depleted SOI MOSFETs  
for High-Speed, Low-Power VLSIs  
By Tetsu Ohtou**

A variable body-factor fully-depleted (FD) silicon-on-insulator (SOI) MOSFET is proposed and characterized by the measurements and device simulations.

Over the three decades, integrated circuits have obtained higher-speed operations and more functions by the transistor-scaling; the exponential increase of the number of MOSFETs in VLSIs. Power consumption in VLSIs becomes one of the serious issues and is expected to become more severe in the future. Due to the lower limit of sub-threshold swing at room temperature, the suppression of the power consumption by the conventional way, lowering the supply voltages in VLSIs while keeping circuit speed, is getting more and more difficult. In addition, due to a large number of MOSFETs in a VLSI, variation of MOSFETs' characteristics also becomes a severe problem. Fine tunings of MOSFETs in VLSIs after fabrication are required in order to secure the process yield of VLSIs in the future. Thus, the ability for adaptively adjusting their characteristics in operating times after the fabrication is strongly favorable.

Back-bias scheme, which is also called VTCMOS or adaptive body bias, can be a possible candidate for solving the problem, where body effect of MOSFETs is exploited for adaptive control of MOSFETs' characteristics. Exploiting the body effect, the characteristics of VLSIs can be adaptively optimized to the target, realizing the decrease of power consumption while keeping the circuit speed, and realizing the suppression of characteristics variations among VLSIs.

One important factor on the back-bias scheme is body-factor. The body-factor is defined as  $\frac{\Delta V_{th}}{\Delta V_b}$  where  $\Delta V_{th}$  is a change in threshold-voltage and  $\Delta V_b$  is a change in the back-bias. Large body-factor exhibits better controllability to the characteristics. To obtain flexibility for adaptive control, a large body-factor is favorable. However, at the same time, a large body factor has several disadvantages such as small transconductance, large sub-threshold swing and stack effect in series circuits. Because the body-factor of the conventional MOSFETs is determined by its structure, thus it cannot be modified after the fabrication. Therefore, if MOSFETs are designed for a large body-factor, such degradation in device performance has to be accepted.

A fully-depleted SOI MOSFET is a promising candidate for future scaled devices because of a small parasitic capacitance and better immunity to short-channel effects over conventional bulk MOSFETs. However, their body-factor is extremely small because of a thick buried-oxide (BOX). If extremely thinner BOX is used, their body-factor can be made large so that their threshold-voltages are well adjustable by the body effect, leading to a severe increase of parasitic capacitance as well as intrinsic disadvantages thanks to a large body-factor.

The objective of this study is proposing an optimized device for the back-bias scheme. To achieve the objective, the author proposes "variable-body-factor fully-depleted SOI MOSFETs". Ideally, in the active-state, body-factor should be as small as possible so that high-speed operation is realized, and in the standby-state, a large body-factor is favorable in

order to realize a high threshold-voltage for leakage-current suppression. This proposed device scheme provides two body-factors in each device, namely active-body-factor (small value) and standby-body-factor (large value), whereas only one type of body-factor is provided with each conventional MOSFET. Active-body-factor is optimized for the active-state and is used only for compensation of characteristic variations. Thus, not so large value is needed. Standby-body-factor is optimized for the standby-state and is used to raise the threshold-voltage to a large extent for leakage suppression.

To realize those functions, the proposed device scheme utilizes fully-depleted SOI MOSFETs with an extremely thin BOX and a substrate with a low impurity concentration. Thin BOX is for obtaining a large body effect. Substrate with a low impurity concentration is for obtaining a wide depletion layer in the substrate. By using the structure, two body-factors are realized. Two body-factors are switched by changing the substrate conditions: depletion, inversion, and accumulation. When the substrate is depleted, body-factor becomes small thanks to small depletion capacitance in the substrate. On the other hand, accumulation or inversion of substrate leads to a large body-factor thanks to the large capacitance of BOX and the absence of substrate capacitance. This study focuses on the inversion-type variable-body-factor fully-depleted SOI MOSFETs, where inversion of substrate is utilized for obtaining a large body-factor.

The characteristics of long-channel and short-channel inversion-type variable body-factor fully-depleted SOI MOSFETs including circuit performance are verified with device simulations and measurements. Large threshold-voltage controllability by the back-bias, realization of two types of body-factor for the active- and standby-state, and advantages in terms of circuit performance over conventional fully-depleted SOI MOSFETs under the back-bias scheme are examined by simulations and measurements.

The variable body-factor fully-depleted SOI MOSFET provides the sole solution to realize the threshold-voltage controllability under the back-bias scheme operation without the sacrifice of device performance in the active-state. Thus, the device proposed in this thesis is promising for future high-speed, low-power VLSIs.

## A28. 設計固有セルライブラリの最適生成手法

吉田 浩章

### Optimal Generation of Design-Specific Cell Libraries By Hiroaki Yoshida

This dissertation focuses on optimal generation of design-specific cell libraries. In cell-based integrated circuit design, a cell library defines the final quality of a design. Hence, use of a general-purpose cell library may lead to a poor quality. We address various issues regarding optimal

generation of design-specific cell libraries, targeting high-performance digital circuit design.

The goal of the first part of the dissertation is to provide the key components required to successfully realize the automatic generation of design-specific cell libraries, which consists of cell logic type selection and drive strength type selection.

Chapter 2 addresses feasibility issues on transistor-level optimization. During transistor-level optimization, cell layout synthesis and characterization steps are the major bottlenecks with respect to runtime. To resolve this drawback, we present a fast and accurate prelayout estimation technique of cell characteristics. Our estimation technique is based on quick transistor placement. Given a transistor-level circuit of a cell, layout parasitics are estimated using quick transistor placement. Then, the cell is characterized by simulating an estimated circuit which is built according to the estimated layout parasitics.

Experimental results on a 0.13 $\mu$ m industrial standard cell library demonstrate that the proposed technique estimates the cell characteristics with a reasonable accuracy in a negligibly small amount of time.

Chapter 3 addresses a cell logic type selection problem for design-specific cell libraries. Our methodology consists of two steps: logic-rich cell library generation and cell logic type count minimization. We propose a cell logic type count minimization method which minimizes the logic type count iteratively under performance constraints. Experimental results on the ISCAS 85 benchmark suite in an industrial 90nm technology demonstrate that it is feasible to find the minimal set of cell logic types under performance constraints.

Chapter 4 addresses a performance-constrained cell count minimization problem for continuously-sized circuits. After providing a formal formulation of the problem, we propose an effective heuristic for the problem. The proposed hill-climbing heuristic iteratively minimizes the number of cells under performance constraints such as area, delay and power. Experimental results on the ISCAS 85 benchmark suite in an industrial 90nm technology demonstrate its effectiveness. We also discuss several implementation issues towards a practical application of the proposed method to large-scale circuits.

The second part of the dissertation focuses on transistor-level topology synthesis, which is an important component in the manual generation phase where portions of a circuit are manually identified and cells for the portions are synthesized at the transistor level. We present three transistor-level topology synthesis methods. Although their objectives are to minimize the transistor count, they have different solution spaces. Combining these methods, the minimum solution in larger solution space can be obtained.

Chapter 5 presents a method for synthesis of minimal static CMOS circuits where the solution space is restricted to the circuit structures which can be obtained by performing algebraic transformations on an arbitrary prime-and-irredundant two-level circuit. The circuit structures are implicitly enumerated via structural transformations on a single graph structure, then a dynamic-programming based

algorithm efficiently finds the minimum solution among them. Experimental results on a benchmark suite targeting standard cell implementations demonstrate the feasibility of the proposed procedure. We also demonstrate the efficiency of the proposed algorithm by a numerical analysis on randomly-generated problems. It is also shown that the proposed procedure sometimes generates significantly smaller circuits compared to conventional approach.

Chapter 6 presents an exact method for minimum logic factoring which can be viewed as the synthesis of a static CMOS compound gate. We first introduce a novel graph structure, called an X-B (eXchanger Binary) tree, which implicitly enumerates binary trees. Using this X-B tree, the factoring problem is compactly transformed into a quantified Boolean formula (QBF) and is solved by general-purpose QBF solver. Experimental results on artificially-created benchmark functions show that the proposed method successfully finds the exact minimum solutions to the problems with up to 12 literals. Chapter 7 studies the synthesis of read-once switch networks in which every variable appears only once. The proposed procedure is based on the notions of prime implicants and unateness, which establish a basis for Boolean expression synthesis. We also propose a pruning technique for an efficient search. Experimental results on randomly-generated problems with up to 20 switches demonstrate that the proposed procedure successfully solves about 90% of the problems in 10 minutes each and the resulting read-once switch networks are up to 78% smaller compared to series-parallel switch networks.

Chapter 8 conducts an experimental study using a circuit consisting of C432 and C499 from the ISCAS 85 benchmark suite as a design example. We compare the circuits synthesized with a typical cell library and optimal design-specific libraries in an industrial 90nm technology, and demonstrate that using the design-specific cell libraries, the area-delay tradeoff curve is shifted to the left-bottom from that using the typical library. Comparing between the area-optimal circuits, the area is improved by 27.3%. And, comparing between the delay-optimal circuits, the maximum delay is improved by 22.4%. These results clearly prove the effectiveness of the flow and the key components for optimal generation of design-specific cell libraries.

## A29. 概念音声合成の枠組を用いた音声対話システムにおける応答生成手法の構築

八木 裕司

### Generation of reply speech for spoken dialogue systems through concept-to-speech conversion By Yuji Yagi

As the most basic and intrinsic way of realizing human communications, speech is highly required to be used in man and machine interface. Therefore, a number of efforts were



conducted to realize spoken dialogue systems. When realizing these systems, technologies on speech processing, such as speech recognition, speech synthesis, and those on natural language processing, such as dialogue control, sentence generation, need to be unified. Supported by the recent developments of these technologies, spoken dialogue systems showed outstanding advancements and have been offered in particular and practical uses, such as for guidance robot in an event hall.

One of the most important issues to realize spoken dialogue systems for common use is to realize an efficient method of recognizing/understanding dialogue speech: dialogue speech may include a number of phenomena which are rather rare in read speech. They are utterance irregularities, such as re-statements, incomplete sentences, filled pauses, and para- and non-linguistic information, such as intention, emotion. Researches are mostly devoted from this viewpoint, and those on another important issue, generation of reply sentence/speech, are rather rare.

In most spoken dialogue systems, text-to-speech conversion devices are used for reply speech generation. However, use of such devices makes it difficult to well reflect higher-level linguistic (and para-/non- linguistic) information obtainable during sentence generation process on reply speech. This situation degrades the reply speech quality mainly from the aspect of prosodic features. A method is necessary to directly converting content of reply into speech. This method, known as concept-to-speech conversion, is required for the reply speech generation in spoken dialogue system. From this viewpoint, I have realized the concept-to-speech conversion.

The thesis consists of 5 chapters. After showing the background and the aim of the thesis in Chapter 1, existing spoken dialogue systems are surveyed in Chapter 2.

In chapters 3 and 4, spoken dialogue systems developed for the thesis are introduced with detailed explanation on the reply sentence/speech generation and its evaluation.

Chapter 3 is for the agent spoken dialogue system. In the system, a method of concept-to-speech conversion was realized. The method is consisted of two parts; reply sentence generation from concept and prosodic control in speech synthesis. Reply sentence generation was conducted by pasting words at tag positions of a sentence template, which was prepared in a tag-LISP form. In order to realize the concept-to-speech conversion, syntactic structure of input sentences is kept and utilized for the sentence generation. Words conveying important information are decided by referring to the tags and the preceding user utterance. The conjugation form of each content word in a sentence can be decided by the succeeding particle identity. Therefore, the conjugation form can be controlled in a simple way when concatenating words according to the syntactic structure.

As for the prosodic control, the method of reflecting “importance of word” on the prosody of output speech is proposed. Emphasis on the “important word” placed by controlling prosody is helpful for users to understand what the system wants to say. A listening experiment was conducted

to evaluate the reply speech generated by the above process from the viewpoints of “understandability” and “naturalness.” The result showed the validity of the proposed method.

Chapter 4 is for the spoken dialogue system of road guidance. Reply sentence/speech from the agent system in Chapter 3 has very limited variety and, therefore, the system is not appropriate for the detailed examination on the sentence generation and the prosodic control methods developed. Responding to this requirement, a spoken dialogue system on road guidance was further constructed, and in the system, the reply sentence/speech generation method in chapter 3 was improved. As for reply sentence generation, the method in chapter 3 can generate a sentence only in the style designated in the frame template. This situation largely increases necessary templates of sentences when increasing styles in reply sentences. To solve this problem, the template unit is changed from sentence to phrase. The total process of reply sentence generation is as follows; first generate phrases by inserting words to tag position of the phrase template and then concatenate them as designated in the sentence template, which is also represented in the tag-LISP form. Flexibility of sentence generation is realized by making a tag be acceptable phrases not only words. Through this improvement, various styles of reply sentences are realized, not limits to simple sentences, but also to complex/compound sentences.

As for the prosodic control, some rules are newly added to the method in Chapter 3. A listening experiment was conducted for evaluating the validity of newly adopted rules, and the result showed the validity of these rules. Further listening experiments were also conducted to evaluate the proposed method from the viewpoint of reflecting syntactic structure and discourse information on the prosody of output speech.

Chapter 5 concludes the thesis.

### **A30. 自己形成量子ドットの超低密度化と異方的シュタルク効果の研究**

大森 雅登

#### **A study on ultra-low density self-assembled quantum dot and their anisotropic Stark effect**

By Masato Ohmori

A zero-dimensional exciton confined in a single self-organized InAs quantum dot (QD) has been extensively investigated because of its importance both in fundamental physics and applications, including QD-based single photon emitters and detectors. Earlier works have shown that the electron-hole pair in such a QD is often polarized, as the built-in strain and/or the local accumulation of In atoms around the dot modify the confining potential. Hence, one needs to clarify why and how such an exciton is polarized and establish ways to control the spatial separation of electron and hole. Here we report our attempt to control the polarization state of a QD exciton by placing a single InAs QD in the central region of a novel GaAs mesa structure of about 1 micron in width, where two pairs of

Schottky electrodes are formed; note that the top-to-bottom electrode pair enables one to apply an electric field  $F_z$  along the growth direction, while a bias voltage  $V_s$  applied across the side electrode pair modifies an in-plane field  $F_x$  along the base plane of a (truncated) pyramidal QD.

### A31. Cベースシステムレベル設計言語におけるAMS領域への拡張に関する研究

劉 宇

#### AMS Extensions for C-Based System-Level Design Language By Yu LIU

Recently, system-level design languages (SLDLs), which can describe both hardware and software aspects of the design, are receiving attentions. However, most of SLDLs focus on digital systems. Analog mixed-signal (AMS) extensions to SLDLs enable current discrete-oriented SLDLs to describe and simulate not only digital systems but also digital-analog mixed-signal systems.

C/C++ based SLDLs such as SpecC and SystemC have been gaining greater attentions because uniform languages for hardware and software description can make system-level design more efficient. In this research, we work on the analog and mixed-signal extensions to the C-based system-level design language, such as SpecC.

SpecC language is a C-style language for the system-level design. It focuses not only on the system's simulation but also on the system's synthesis. With SpecC methodology, the system design starts from the capture of system's functionality in specification model, then, by the architecture exploration, the specification model is partitioned, allocated and scheduled into architecture model with the more detailed information contained, and then, by implementing the communications among the behaviors in architecture model, the architecture model is detailed into communication model having the detailed communication implementations, finally, the communication model is synthesized to implementation model by mapping the implementation model with RTL IP and RTOS IP. In the methodology of SpecC, the specification model is usually untimed, i.e., there is only execution order defined in the specification model. With introducing more detailed information of implementation during the design phases, the time of the behaviors is estimated and cycled, so called it is timed.

The AMS extended language of SpecC, named as SpecC-AMS, has the same syntax style with original SpecC. It supports the models of both continuous and discrete behaviors, data and time which are needed in the mixed-signal system-level design with software and analog, digital circuits. It also supports the hierarchy with which a complex system can be decomposed into a set of interconnected pieces.

SpecC-AMS captures the functionalities of continuous specification in an extended class named as con behavior. Con behaviors communicate with each other via the ports of extended continuous variables. The con behaviors that are

chained with a same network of continuous variables are grouped into a CNT. The CNT exchanges data with discrete behavior through the extended class named ms channel. The synchronization between CNTs and discrete behaviors are via the extended event type named as AD Event and DA Event.

SpecC-AMS models the continuous functionality with the solver-based method. The solver-based descriptions can provide flexibilities and conveniences for user to specify the functionalities of continuous behavior. The continuous solvers of SpecC-AMS are divided into built-in and built-out solvers. We integrate two of the most generally used continuous solvers in current version of SpecC-AMS. They are linear state-space equation solver and transfer function solver, which are widely used for modeling the continuous functionalities of time-domain and frequency-domain respectively.

SpecC-AMS code is executable with the extended compiler and simulation library. We extend the simulation kernel of SpecC so as to synchronize the continuous solver and discrete simulator processing concurrently in the distinguish natures. The synchronization is performed upon a new synchronization mechanism, so called transaction-blended synchronization method. Comparing with the traditional optimistic and lock-step synchronization method, transaction-blended method has the features as: 1) accommodation of both timed and untimed discrete description, 2) unlike optimistic concept, no backtracking is needed, and 3) less disturbance than in the lock-step concept.

We evaluate the SpecC-AMS with serial examples. The evaluation results show the extensions work well under both the timed/untimed system-level description, and have many attractive advantages than traditional design languages.

### A32. 選択 MOVPE によるモノリシック集積化低密度波長分割多重 DFB レーザーアレイに関する研究

ダルジヤジェッシー

#### Monolithically Integrated DFB Laser Array by MOVPE Selective Area Growth for Coarse WDM Systems By Jesse Darja

With increasing network traffic in metropolitan and access networks, carriers are seeking cost-effective solutions to meet their transport needs. Coarse wavelength division multiplexing (CWDM) systems offer lower power dissipation, smaller size, and lower cost compared to dense wavelength division multiplexing (DWDM) systems. Monolithically integrated distributed feedback (DFB) laser diode arrays with simultaneous multichannel operations are key device for CWDM systems. Compared to hybrid integrated laser array modules consisting of discrete DFB lasers, monolithically integrated DFB laser arrays can potentially lower packaging cost per laser due to its compact size. In this study, two key techniques, namely wide-stripe MOVPE selective area growth and e-beam lithography, are used to fabricate integrated four-channel  $1.55 \mu\text{m}$  DFB laser array for CWDM systems.

Compared to other monolithic integration schemes, this method is superior in terms of simplicity and scalability, which is particularly advantageous for fabricating laser arrays.

### **A33. 実時間認識システムのための画像処理 VLSI 回路技術**

山崎 英男

#### **Image Processing VLSI Circuits for Real-Time Recognition Systems By Hideo Yamasaki**

Real-time object recognition is becoming increasingly important in various applications such as security systems as well as in establishing more robust and flexible human-computer interfaces. In image recognition, a target image is firstly converted to a reduced format called a feature vector, then being recognized using some sorts of classifiers. Feature extraction from an image involves a series of filtering operations, which, in general, are repeated pixel by pixel to scan the entire image. Therefore, it is computationally very expensive. In order to achieve a real-time performance in image recognition, software processing running on general-purpose processors is not sufficient in terms of speed and power dissipation. Therefore, for the purpose of real-time image recognition with high power efficiency, developing dedicated processors is quite essential.

Being inspired by the biological principle, a directional edge-based feature vector representation algorithm was proposed and has been successfully applied to medical radiograph analysis as well as to handwritten pattern recognition. Other representations also developed based on the directional edge information have been proven very robust in face detection and face identification. However, the directional edge detection costs a lot for computation. This is because the processing needs be repeated pixel by pixel to cover the entire area of the "recognition window", the sectioned image defined for partial image recognition. Furthermore, in the object search in a scene the recognition window itself must scan a large search area also pixel by pixel in the scene, making real-time processing unrealistic.

In order to realize the high-speed image recognition, seamless feature vector generation coherent to the continuous scanning movement of the recognition window is quite essential in carrying out objects search and recognition in a large scenery image. In this work, an arrayed-shift-register architecture has been employed in conjunction with a pipelined directional-edge-filtering circuitry. Four-directional edge information is detected from a 5x5-pixel block input image in coherent with the threshold determination for edge filtering. The detected edge flags are temporarily stored in a 64x64 two-dimensional array of shift registers directly linked to summation units to construct feature vectors. With this architecture, it has become possible to scan an image, pixel by pixel, with a 64x64-pixel recognition window and generate a 64-dimensional feature vector in every 64 clock cycles.

In the edge-based image vector generation, determining the threshold value for edge detection adaptive to local luminance variances is of paramount importance to perform robust image recognition. In our system, all 40 absolute-value differences between two neighboring pixels are calculated in both vertical and horizontal directions in a 5x5 filtering kernel and the median value is employed as the threshold.

Median filter is known as a very powerful rank-order filter but computationally very expensive, making the threshold determination the bottleneck of our system. This is because it requires in principle the sorting of a large number of numerical data. In order to expedite the processing, small-latency VLSI median filters have been developed using both digital and analog circuit technologies. In the digital approach the circuit is configured as a sorting network composed of a number of comparators, thus consuming a lot of chip area. In addition, power dissipation due to the long interconnects with repeaters and buffer circuitries also presents a problem. In the mixed-signal approach, on the other hand, the median filter is implemented based on binary search algorithm. The circuit is composed of majority voting circuits and simple logic circuits. In order to establish high-speed and low-power median search, high-performance majority voting circuits have been developed employing the floating-gate MOS technology.

My dissertation research has resulted in feature-extraction and vector-generation VLSI circuits for real-time image recognition. By employing arrayed-shift-register architecture, seamless scanning of the recognition window has been achieved. In order to determine the threshold for edge-filtering operation adaptive to local luminance variances, a binary median search algorithm has been implemented using high-precision majority voting circuits working in the mixed-signal principle. The prototype chip was fabricated in a 0.18-um CMOS technology. A high-speed feature vector generation in less than 9.7 ns/vector has been experimentally demonstrated using the fabricated chip. It has become possible to scan an entire VGA-size image using the 64x64-pixel recognition window at a rate of 5 frames/sec., thus generating as many as 1.5 million feature vectors in a second for recognition. This is more than 10,000 times faster than software processing running on a 3-GHz general-purpose processor.

### **A34. 微傾斜 GaAs 基板上への InGaAs 結合量子細線および量子ドット構造の形成とその電子伝導特性の研究**

秋山 芳広

#### **Formation of InGaAs Coupled Quantum-Wire and Quantum-Dot Structures on Vicinal GaAs Substrates and Their Electron-Transport Properties By Yoshihiro Akiyama**

Abstract of this thesis:

Low-dimensional electronic systems confined in semiconductor nanostructures possess unique properties and can be used not only to improve device performances but also

to create novel device functions. In fact, two-dimensional (2D) electrons confined in 10 nm-scale films or quantum wells are now used in a variety of core devices such as field-effect transistors (FETs) and lasers. In contrast, device applications of 1D electrons and/or 0D electrons in “quantum wires (QWRs)” and “quantum dots” have not yet been well established mainly because of difficulties in their fabrication, although interesting and attractive functions have been predicted.

In this thesis, we describe first the epitaxial growth of InGaAs coupled QWR structures by molecular beam epitaxy (MBE). Specifically, QWR structures have been formed by depositing a thin InGaAs layer on multi-atomically corrugated surface of GaAs. We report also on our discovery that InGaAs coupled “quantum-dot” structures have unexpectedly been formed by depositing a thin InGaAs layer with a higher In content. Low-dimensional electron transports through InGaAs coupled QWR and quantum-dot structures have been experimentally investigated in macroscopic or local measurements.

This thesis consists of six chapters, as follows.

In Chapter 1, the historical background and significance of this research work are briefly reviewed.

In Chapter 2, the formation of InGaAs coupled QWR and quantum-dot structures by MBE on vicinal (111)B GaAs substrates are described. We prepared first GaAs multi-atomic steps with the typical period of 20 nm, and then deposited  $\text{In}_x\text{Ga}_{1-x}\text{As}$  layers of various thicknesses and In contents, so as to study their surface morphologies by atomic force microscopy (AFM); an almost flat surface was found to be formed when a nominally 3 nm-thick  $\text{In}_x\text{Ga}_{1-x}\text{As}$  was deposited with In content  $x$  is 0.1, whereas a high-density array of 3D islands (namely self-assembled quantum dots) aligned along multi-atomic steps were formed when  $x$  is 0.3.

In Chapter 3, a series of  $\text{In}_x\text{Ga}_{1-x}\text{As}$  layers with various In contents  $x$  and nominal layer thicknesses  $d$  were grown and their surfaces were studied by AFM, in order to clarify growth mechanisms of such an InGaAs quantum-dot array. On the basis of these experiments, the accumulation and release processes of strain energy in deposited InGaAs layers are discussed to suggest a model for the aligned dot formation.

In Chapter 4, results of macroscopic studies of transport are described. Transport properties of electrons through  $\text{In}_{0.1}\text{Ga}_{0.9}\text{As}$  coupled QWR structures were measured at low temperatures (below 4.2 K), using Hall-bar-shaped FET samples, where current flowed parallel or perpendicular to the GaAs multi-atomic steps. Similar studies were made on  $\text{In}_{0.3}\text{Ga}_{0.7}\text{As}$  coupled quantum-dot structures. When the gate voltage  $V_g$  was sufficiently high, usual quantum Hall effects were found in magnetoresistance curves, indicative of quasi-2D natures of electrons, although their mobilities were anisotropic. As  $V_g$  was lowered, especially in  $\text{In}_{0.3}\text{Ga}_{0.7}\text{As}$  coupled quantum-dot structures, the deviations from ordinary 2D transport properties became prominent; anomalies such as “the remarkable reductions of conductance” and “quenched Hall resistances” were observed. Transport data were also

analyzed to determine quantum scattering times (single-particle lifetimes) as well as classical scattering times (transport lifetimes). In addition, effects of quasi-periodic potential modulations are discussed.

In Chapter 5, we describe unique transport studies to clarify electron transport through single or a small number of self-organized InGaAs QWRs. For this purpose, conductance parallel to the multi-atomic steps was measured in a novel quantum-wire FET fabricated by constricting lithographically the corrugated  $\text{In}_{0.1}\text{Ga}_{0.9}\text{As}/\text{GaAs}$  “quantum-well” channel (namely,  $\text{In}_{0.1}\text{Ga}_{0.9}\text{As}$  coupled QWR structures). Measurements at temperatures between 4 and 0.3K have demonstrated unique transport properties of quasi-1D electrons. In particular, the conductance at a given gate voltage decreased sensitively as temperature was lowered until it got nearly constant below a critical temperature. These tendencies are found out to be qualitatively consistent with a theory for dirty Tomonaga-Luttinger liquids, or 1D electronic systems where impurity scattering and Coulomb interaction are important. The power-law-like behavior of conductance experimentally observed above the critical temperature is found to fit quantitatively with the mathematical formula in the theory. These agreements suggest that the effect of Coulomb interaction on backward scattering is actually far more prominent in our disordered but quasi-ballistic 1D system, than in very lightly disordered 1D systems.

In Chapter 6, key findings in this work are summarized, and conclusions are made.

### A35. III 族窒化物半導体微小共振器型光源の作製と評価に関する研究

有田 宗貴

#### Fabrication and Characterization of III-Nitride Semiconductor Nanocavity Light Emitters By Munetaka Arita

This thesis describes III-nitride semiconductor nanocavity light emitters from the viewpoints of both fabrication technologies and their optical characteristics. Recent experimental progress in quantum cryptography has brought a growing demand for high-efficiency single-photon emitters operating at moderately high temperature. Being potential high-temperature single-photon sources, III-nitride quantum dots deserve consideration as possible candidates to meet such a demand when combined with optical nanocavities, which can improve performances of single-photon emitters. In order to realize such III-nitride nanocavity light emitters, here the author describes two different approaches: vertical microcavity surface-emitting diodes and two-dimensional photonic crystal nanocavities.

In Chapter 2, Basic principles of crystal growth of III-nitride semiconductors by metalorganic chemical vapor deposition (MOCVD) are presented. Details on experimental setups for the growth as well as fundamentals on MOCVD growth of nitride quantum dots are also given. Special efforts are made to improve crystal quality of thin AlN layers requisite to

construct photonic crystal slab structure. Alternate supply of source gases is revealed to be effective to control surface morphology and relaxation process in the initial stage of AlN epitaxial growth. Utilizing that, thin AlN layer with sufficient quality is able to be grown. GaN QDs are grown on the thin AlN layer and characterized.

In Chapter 3, MOCVD growth of electrically conductive AlGaIn/GaN DBRs is discussed. Structural, optical and electrical properties of the DBRs are studied systematically. From Si doping concentration dependence of structural and optical properties of n-DBRs, it can be concluded that reasonable reflectivity can be maintained with uniform carrier concentration profile of  $1 \times 10^{18} \text{ cm}^{-3}$ . The author shows that the carrier concentration in n-AlGaIn layers can be increased up to  $3 \times 10^{18} \text{ cm}^{-3}$  while that of n-GaN is kept at constant value,  $1 \times 10^{18} \text{ cm}^{-3}$ , without further degradation of optical properties. Using such modulated doping profiles, electrical properties of the n-DBRs can be improved. As a result, it is possible to obtain near 99 % reflectivity in electrically conductive n-type nitride DBRs. Further improvement in both structural and electrical characteristics can be achieved by introducing n-AlGaIn/n-GaN short-period superlattice into the n-DBRs.

In Chapter 4, Developments of fabrication processes for nitride vertical microcavity light emitting devices are presented. Because at least one of cavity mirrors is made by insulating materials in practical device structures, it is reasonable to utilize transparent intracavity contact to overcome design issues concerning efficient hole current injection. For this purpose, indium tin oxide (ITO) is used in this study. Rapid thermal annealing of sputtered ITO films under nitrogen ambient can improve both electrical and optical properties of the films. To improve process yield in photolithographic liftoff, new double-layer resist technique is developed. Undercut resist profile favorable for liftoff as well as good adhesion onto nitride (and ITO) surface is available with this new method. Substrate preparation method to prevent thick AlGaIn/GaN DBR to crack is also established.

In Chapter 5, the author describes fabrication and characterization of InGaIn vertical microcavity LEDs. Magnetron-sputtered, transparent ITO film is employed as a p-contact. After the LED mesas is defined by Cl<sub>2</sub>-based plasma etching, a 10.5 pairs of SiO<sub>2</sub>/ZrO<sub>2</sub> top mirror is evaporated and wet-etched, followed by formation of an Al n-contact. EL spectra of these LEDs have reduced linewidth, exhibiting clear effects of microcavity. The angle dependence of EL reveals blue shift of main mode due to DBR resonance. Furthermore, directionality of the microcavity LED is dramatically improved to half angle of around 10 degree, compared to that of conventional one. The results are promising for developing blue/ultraviolet VCSELs and high performance LEDs, as well as electrically-pumped single photon emitters.

In Chapter 6, Developments of fabrication processes for AlN photonic crystal nanocavities are described. Preliminary calculations reveal technological requirements for the

fabrication. In addition to the requirement for fine patterns as small as 150-nm-period, the substrate must be removed in order to obtain sufficient optical confinement in the nanocavities. To this end, photoelectrochemical etching is employed to fabricate AlN photonic crystal nanocavities. Due to accumulated photogenerated holes, lateral etching of 6H-SiC substrate occurs just below the AlN/SiC interface, and partial lift-off of AlN epitaxial layer results in a convex-shaped air-bridge structure.

In Chapter 7, experimental results are given on optical characterization of AlN photonic crystal nanocavities with GaN quantum dots. Microscopic photoluminescence measurements are performed to investigate the optical properties of the nanocavities. For the lowest-order cavity mode of a 150-nm-period nanocavity with seven missing holes, luminescence linewidth of 0.16 nm corresponding to the Q-factor of more than 2,400, which is the highest Q for nitride-based PC nanocavities ever reported, was obtained. Discussions on the results are also presented.

In Chapter 8, summary of this thesis is presented. Future prospects of this research is also given.

The author believes these experimental results facilitate further development of nitride-based ultraviolet quantum optoelectronic devices such as single photon emitters.

### A36. 紫外光描画石英系平面導波路によるブラッググレーティングとカーボンナノチューブ集積デバイス

柏木 謙

#### Integrated Bragg Grating and Carbon Nanotube Devices Using UV-Written Silica-Based Planar Waveguides By Ken Kashiwagi

Silica-based optical planar waveguide technology is promising to realize various functional devices. Recent requirements for optical devices are flexibility and cost effective fabrication. UV-written silica-based planar waveguide device is alternative option which may meet these requirements. However, silica-based waveguide devices are not suitable for realizing ultrafast tunable devices. Recently, carbon nanotubes (CNTs) for optical device applications are attracted much attention because of their ultrafast recovery time, third order high optical nonlinearity, etc. Structures of conventional devices based on CNTs have been all bulky, and they have a difficulty in integration. Another difficulty in CNT-based optical devices is handling of CNTs. In this thesis, we propose and realize a hybridization of silica-based optical waveguides and CNT devices to combine their advantages and compensate their disadvantages, and propose a novel handling method of CNTs based on optical tweezers.

Principle of fabrication technique of UV-written silica-based waveguides is photosensitivity. Photosensitivity, or UV-induced refractive index increase appears in Ge-doped silica-glass. By this refractive index increase, core-cladding refractive index contrast can be formed and desired

waveguides patterns can be fabricated without any patterning masks. There have been realized various devices by this technique such as power splitters, directional couplers, etc. However, structures of UV-written waveguides have not been enough investigated compared with silica-based waveguides fabricated by Si-LSI fabrication technology. We measured cross sectional refractive index profiles of UV-written waveguides by refracted near field method, and found that refractive index distributions are Gaussian horizontally, and almost uniform vertically.

One of the advantages of UV-written waveguides is that the refractive index distributions can be easily formed by simply changing irradiation intensity of UV beam. Bragg gratings and sampled Bragg gratings are important elements which can be realized by refractive index perturbations in optical waveguides. We fabricated silica-based optical channel waveguides containing sampled Bragg grating using phase mask method. With 9mm-long sampled grating, we achieved 100GHz channel spacing and 98% reflectivity. Densification of channel spacing of sampled Bragg gratings for dense wavelength division multiplexed systems was conventionally achieved by elongating the total device size. Shortening device length is important especially for planar waveguide type devices because total device size directly determines the device cost. We introduced multiple phase shift technique to the sampled Bragg grating waveguides, and doubled the channel spacing to be 50GHz without elongating the total device length.

CNTs are attractive materials for photonic device applications because of their ultrafast recovery time, high nonlinearity, etc. Conventional CNT devices are all bulky and not integratable. We proposed planar waveguide-type CNTs devices. As a first step, we investigated a waveguide-type saturable absorber utilizing interaction between CNTs and evanescent wave. Planar waveguide-type saturable absorbers were realized by spraying purified CNTs onto over-cladding less silica-based optical waveguides fabricated by UV beam irradiation. We confirmed saturation of absorption by 3% when light from high power pulsed laser was incident. The device shows polarization dependence originated from the asymmetric structure, and polarization dependent loss over 15dB was observed. By using the saturable absorber, passively mode-locked fiber laser with pulse width as short as 187fs was realized. Another attractive characteristic of CNTs is their high optical nonlinearity which can shorten the sizes of optical nonlinear devices. All optical switching using CNTs' strong third order nonlinearity in nonlinear optical loop mirror (NOLM) configuration is investigated. Splitting ratio contrast of 20% using 1cm-long over-cladding-less CNTs-loaded planar waveguide was realized. This result indicates the possibility of integrated CNTs-based all optical switches realization.

Finally, we propose and demonstrate a novel fabrication technique of CNT devices. Handling the CNTs is one of the problems for device applications, and easy and cost effective handling technique of CNTs is required. Optical tweezer is the

technique to manipulate micro-, nano-sized objects by focused light spot. By this technique, for the first time, CNTs were successfully deposited area selectively on the core region of end facets of optical fibers, and area selective deposition was confirmed by both Raman spectroscopy and field emission scanning electron microscopy (FE-SEM). We realized passively mode-locked fiber ring laser using the CNTs deposited fiber by optical tweezers. For precise control of CNT layer and estimation of CNT layer thickness and uniformity, we also developed an in-situ monitoring technique of CNT deposition process using optical reflectometry, and FE-SEM images supported the results. We also found that stable CNT sphere structure can be formed by optical tweezers, which may be useful for many applications.

### A37. 形式文法の確率的一般性と応用に関する研究 柴田 剛志

#### A Study on Probabilistic Generalization of Formal Grammars and Its Application By Takeshi Shibata

Recently, some non-regular subclasses of context-free grammars have been found to be efficiently learnable from positive data.

In order to use these efficient algorithms to infer probabilistic languages, one must take into account not only equivalences between languages but also probabilistic generalities of grammars.

The probabilistic generality of a grammar  $G$  is the class of the probabilistic languages generated by probabilistic grammars constructed on  $G$ .

We introduce a subclass of simple grammars (SGs), referred as to unifiable simple grammars (USGs), which is a superclass of an efficiently learnable class, right-unique simple grammars (RSGs).

We show that the class of RSGs is unifiable within the class of USGs, whereas SGs and RSGs are not unifiable within the class of SGs and RSGs, respectively.

We also introduce simple context-free decision processes, which are a natural extension of finite Markov decision processes and intuitively may be thought of a Markov decision process with stacks.

We propose a reinforcement learning method on simple context-free decision processes,

as an application of the learning and unification algorithm for RSGs from positive data.

### A38. エピタキシャル強磁性 MnAs ソース・ドレインを有するスピン MOSFET: 成長、ショットキー接合特性、トランジスタ特性およびスピン依存伝導現象

By 杉浦 邦晃

#### Si-based spin MOSFETs with epitaxial ferromagnetic MnAs source and drain : Growth, Schottky

## junction, transistor, and spin-dependent transport properties

Kuniaki Sugiura

Recently, Si-based spin electronics has attracted considerable attention, because it can lead to a variety of spin-electronic devices, which utilize spin degrees of freedom and well-established Si technologies. In this respect, recently proposed Si-based spin MOSFETs, which consist of a MOS gate capacitor and ferromagnetic source and drain (S/D), are promising. Previous theoretical studies showed that the spin MOSFETs can be potentially used for reconfigurable logic gates and nonvolatile memory, since the output characteristics can be controlled by both the gate voltage and magnetization of the S/D. One of the most practical devices is a spin MOSFET with ferromagnetic metals for the S/D, which can be simply realized by substituting ferromagnetic metals for the S/D of an ordinary Schottky MOSFET.

To realize both high electrical performance and spin-dependent characteristics in spin MOSFETs, thermally stable ferromagnetic metal/Si junctions with low Schottky barrier heights are strongly needed. It is well-recognized that spin injection from a ferromagnetic metal into a semiconductor is the most important issue for spin MOSFETs, and that the spin injection efficiency is considerably affected by the ferromagnet/semiconductor interface quality, its Schottky barrier height, and the spin-polarization of the ferromagnet. Furthermore, like the ordinary Schottky MOSFETs, low Schottky barrier height is required for high-performance electrical output characteristics of the spin MOSFETs. From the viewpoint of device fabrication processes, high thermal stability of the ferromagnetic metal/Si junction is also needed, since there are usually thermal annealing processes at a few hundred degree centigrade. CoFe and CoFeB, which are widely used in spin-valve devices, would not be suitable for S/D of spin MOSFETs, since the formation of intermixing layer can proceed easily, in spite of their high spin polarization of  $\sim 0.5$ .

Ferromagnetic MnAs is a good candidate for S/D of spin MOSFETs, because it has high spin-polarization of  $\sim 0.5$ , and epitaxial MnAs/Si(001) junctions with an atomically flat interface can be fabricated by molecular beam epitaxy (MBE). On the other hand, there are no reports evaluating the thermal stability and the Schottky barrier height of MnAs/Si junctions. The aim of this thesis is to fabricate Si-based spin MOSFETs with MnAs S/D and clarify their characteristics. Crystalline properties, thermal stability, and the Schottky barrier height of MnAs/Si(001) junctions are evaluated, and their influence on the device characteristics are examined. Spin MOSFETs with MnAs S/D are fabricated on silicon-on-insulator (SOI) substrates, and their transistor performance and spin-dependent transport are investigated.

In chapter 2, fundamental properties of epitaxial MnAs films were described. Growth was performed by low temperature molecular beam epitaxy (LT-MBE), and Si(001) wafers were used as substrates. In order to obtain good

magnetic properties and crystalline quality, the growth condition was optimized by the in-situ reflective high energy electron diffraction (RHEED) observations, the ex-situ atomic force microscopy (AFM) observations, and their ferromagnetic properties were measured by a superconductive quantum interference device (SQUID) magnetometer. Furthermore, in order to examine the thermal stability of the MnAs films, the magnetic properties were measured after post-growth annealing at 400°C, 500°C, and 600°C. The ferromagnetic behavior was preserved when the annealing temperature were 400°C and 500°C whereas it disappeared when the annealing temperature was 600°C. As a result, MnAs films on Si substrates were found to have sufficiently high thermal stability in thermal processes up to 500°C.

In chapter 3, the Schottky barrier height of the MnAs/Si junction was evaluated comparing with that of  $\text{Co}_{90}\text{Fe}_{10}/\text{Si}$ , and  $(\text{Co}_{90}\text{Fe}_{10})_{70}\text{B}_{30}/\text{Si}$  junctions. From current-voltage (I-V) measurement in the temperature range of 300 K to 450 K, MnAs/Si junctions found to have a low Schottky barrier height of 0.16 eV for electrons, while the  $\text{Co}_{90}\text{Fe}_{10}/\text{Si}$ , and  $(\text{Co}_{90}\text{Fe}_{10})_{70}\text{B}_{30}/\text{Si}$  junctions have mid-gap Schottky barrier heights of 0.73 eV and 0.75 eV for electrons, respectively. Thus, MnAs is a promising material for ferromagnetic S/D in spin MOSFETs. A further evaluation of the MnAs/Si interface through secondary ion mass spectroscopy (SIMS) revealed that a substantial amount of As atoms ( $^{1018} \sim 10^{19} \text{ cm}^{-3}$ ) are likely to be present near the interface. It is a possible origin of the low Schottky barrier height of the MnAs/Si junction.

In chapter 4, a spin MOSFET with epitaxial MnAs S/D were fabricated on thin-film silicon-on-insulator (SOI) substrates, and measurements of the transistor characteristics were performed. A spin MOSFET with  $(\text{Co}_{90}\text{Fe}_{10})_{70}\text{B}_{30}$  S/D was also fabricated for comparison. From the drain current  $I_{\text{DS}}$  - drain voltage ( $I_{\text{DS}} - V_{\text{DS}}$ ) characteristics, the spin MOSFET with MnAs S/D exhibited  $\sim 100$  times higher in current drivability than the spin MOSFET with  $(\text{Co}_{90}\text{Fe}_{10})_{70}\text{B}_{30}$  S/D. From the drain current  $I_{\text{DS}}$  - gate voltage ( $I_{\text{DS}} - V_{\text{GS}}$ ) characteristics, the spin MOSFET with MnAs S/D showed the high on-off ratio of  $\sim 10^8$ , which is comparable to that in conventional MOSFETs with pn junction S/D. High electrical performances of the spin MOSFET with MnAs S/D, which were expected in the chapter 3, have been demonstrated. Postgrowth annealing effect on the transistor performance was also investigated. It was found that the  $I_{\text{DS}} - V_{\text{DS}}$  and  $I_{\text{DS}} - V_{\text{GS}}$  characteristics were not degraded, but rather improved, when the postgrowth annealing temperature was done at 500K. In chapter 5, the spin-dependent transport properties of the spin MOSFET with MnAs S/D was explored in the temperature range of 2.8 K  $\sim$  50 K. At 2.8 K, the drain current  $I_{\text{DS}}$  - magnetic field ( $I_{\text{DS}} - H$ ) characteristics exhibited hysteresis behavior depending on the gate voltage  $V_{\text{GS}}$  and temperature. This phenomenon could be explained by theoretical studies by other reports. The maximum of the obtained magnetocurrent ratio was  $\sim 1.6\%$ , and the hysteresis of  $I_{\text{DS}} - H$  loops were preserved up to 20 K at high  $V_{\text{GS}} > 100$  V. Since the magnitude of the magneto-current signal is larger

than that of the estimated signals of various parasitic magnetization-dependent signals, such as anisotropic magneto-resistance (AMR) of the MnAs film, the magneto-resistance of the non-magnetic Si layer, and local Hall effect (LHE), this signal probably originates from the spin-dependent transport of the spin MOSFET.

### A39. 伝搬光・近接場光変換素子の開発

野村 航

#### Development of optical far/near-field conversion device

By Wataru Nomura

Future optical transmission and data processing systems will require advanced photonic devices, and their integration, in order to increase data processing rates and capacity. Consequently, these devices will have to be significantly smaller than diffraction limit of light. To meet this requirement, nanometer-scale photonic integrated circuits (nanophotonic ICs) that are composed of nanometer-sized elemental devices (nanophotonic devices) were proposed by our laboratory.

To drive this device, the signal light must be converted from conventional far-field light to near-field light. The goal of this thesis is to develop optical far/near-field conversion device that acts as an input terminal of the nanophotonic device.

First we proposed metallic optical far/near-field conversion device that consists of a surface plasmon condenser and a nanodot coupler and I fabricated and confirmed it. The Surface Plasmon Polariton (SPP) was focused with a spot size as small as 400 nm at  $\lambda = 785$  nm by surface plasmon condenser. When the focused SPP was incident into the nanodot coupler, its transmission length through the nanodot coupler was confirmed to be  $4.0 \mu\text{m}$ , which is three times longer than that of a metallic core waveguide owing to the efficient near-field coupling between the localized surface plasmon of neighboring nanoparticles. Furthermore, the transmission length through a zigzag-shaped nanodot coupler was as long as that through a linear one owing to the efficient coupling between the TM and TE localized surface plasmon modes at the corners.

Next, I checked the relation between resonant size effects of Au nanoparticle and energy transmission efficiency of a nanodot coupler. Comparing the nanodot couplers that consist of Au nanoparticles in height of 50nm and diameter range of 150-300nm, we found the highest efficiency in the nanodot coupler in diameter of 200nm, which was resonant for irradiated  $\lambda = 785$ nm light. Also I checked the wavelength selectivity of the nanodot coupler that was expected from this result. I compared the transmission efficiency of nanodot couplers by irradiating  $\lambda = 785$ nm and  $\lambda = 633$ nm SPP. A nanodot coupler that consists of resonant size nanoparticles performed the highest transmission efficiency at each wavelength. From this result, it is concluded that a nanodot coupler is not only efficient nanoscale optical transmission channel but also has a function of frequency selector.

Furthermore, we proposed a semiconductor nanodot coupler which consists of an array of closely spaced quantum dots (QDs). It is expected as having low energy loss and efficient connection to nanophotonic device because the mechanism of energy transfer among semiconductor nanodot coupler is similar to that of nanophotonic device. I used CdSe/ZnS core shell QDs as material of semiconductor nanodot coupler for operating check. I confirmed that the energy transfer among the same size quantum dots in room temperature. And I linearly arranged quantum dots along self assembled pattern of DPPC monomolecular film. The time evolution of luminescence from two arrays of quantum dots was taken. One consisted of the same size QDs and another consisted of two sizes of QDs whose resonant energy level. By comparing these two time evolutions, the energy transfer between resonant exciton levels of QDs was found, and the operation of a semiconductor nanodot coupler was confirmed. From these results, I successfully developed an optical far/near-field conversion device for an input terminal of nanophotonic devices.

In appendices A-D, I described results of studies related to optical far/near-field conversion devices.

A. I tried to fabricate an InAs semiconductor nanodot coupler by using epitaxial growth and Stranski-Krastanov mode. I proposed to use selective area growth of GaAs buffer layer by using patterned SiO<sub>2</sub> mask and arrange InAs QDs along the wedge of GaAs buffer. This is the most promising way to connect a semiconductor nanodot coupler to a nanophotonic device.

B. I approached shape-, size-, and position-control of self assembling DPPC line & space patterns. By optimizing the coating parameters of DPPC film, I made vertically crossing space to normal line & space, and minimized the space width to 15nm. Furthermore, I arranged a photoresist on the substrate and coated DPPC line & space. The line & space pattern was aligned along the photoresist threshold.

C. I performed near-field optical imprint. Using a thin metallized mold, I obtained 50nm width pattern at the edge of the mold where an optical near-field was excited efficiently. I also irradiate pulse laser to imprinted pattern with the same metallized mold. Due to the strong optical energy, the stamped resist pattern was higher than 200nm, which was depth of the mold.

D. I developed self assembling method for forming a metallic nanoparticle chain with optical near-field. I irradiate  $\lambda = 532$ nm laser to scratched SiO<sub>2</sub> substrate during Al sputtering. By this process, an Al nanoparticle chain (100nm diameter and 125nm center-to-center separation) was formed along the scratch on the substrate with the length of  $300 \mu\text{m}$ . I observed fabricated Al nanoparticle chain and the substrate by AFM. By using FDTD simulation, we found that the nanoparticle chain was formed at the area where the optical near-field intensity was sufficiently high.

### A40. ウェアラブルシステムによるライフログの取得と処理



タンチャロエン ダチャコーン  
**A Study on Capture and Retrieval of Life Log by a  
Wearable System**  
By Datchakorn Tancharoen

Experience is valuable in our life time. Nowadays, many people like to record their experiences by using digital media devices which is more efficient than ordinary writing a diary. We can capture digital media to keep in digital memory directly. In order to record personal experiences effectively, we attempt to create a wearable system to capture our experiences continuously. Due to the development of personal computer and digital media devices, we have implemented the wearable video system to record our experiences from the user's view point. The system is able to capture continuous video contents by a wearable video camera and record environmental contexts including location by GPS receiver, movement by motion sensors and physiological data by body sensors which we called this system as a "life log system".

In this research, we focus on capture and retrieval of personal experiences by a wearable system. We develop a life log system which acts as a personal digital memory for capture and retrieval of personal experiences. The system has two stages including capture and retrieval. In the capture stage, life log data is captured by using the wearable life log system which includes a wearable video camera, a microphone, motion sensors, a GPS receiver and body sensors. We apply these wearable sensors to record some useful features for processing in the retrieval stage.

In the experiments, the wearable system has been used to capture our experiences in daily life for more than two years. The system is used in various situations such as working, shopping, meeting, traveling, dining, etc. We could find many interesting parts of our experiences from the life log video. Video data is recorded in MPEG format that its capacity is about 1 GB/hour. Totally, we record the video data almost 500 GB and keep them in a server. In real life, it takes a long time and it is almost impossible to watch all these video experiences. Thus we attempt to find the efficient retrieval techniques to recall these experiences from life log video.

In the retrieval stage, we develop the video retrieval and navigation system to extract the key events from the life log video. Since the life log video is recorded continuously and has no shot or scene as other structured videos. We have to consider the practical methods to retrieve and navigate the experiences from life log data. User interfaces are designed to help people to recollect some desired events more comfortable than ordinary approach by key frame extraction and indexing techniques as a navigation system. We propose the retrieval techniques based on life log contents and contexts including audio visual and environmental data from wearable sensors. Firstly, we apply GPS data to extract some key events in traveling scenes including spatiotemporal sampling based on distance and time, speed detection and directional change detection. We find that these methods are useful to extract some key events in traveling scenes such as slowing down the

speed and changing the direction. However, it has a limitation to use GPS data alone that the signal cannot be received inside the building and some obstructive location. Secondly, audio visual contents from life log video are analyzed to extract the key events with user's voice. It is advantage to acquire some information such as scenes with voice annotation and talking scenes. In the experiments, we assume that talking scene should contain some faces during talking period. We identify the talking scene by a basic face detection based on skin color. Body media armband, including physical and physiological sensors, can examine some physical activities. We also employ the body sensors to analyze physical and physiological data to extract the key events in life log video. The environmental change detection is proposed by using features from body sensors. Physiological features including heat flux, skin temperature and motion data are analyzed to detect the environmental change. Image processing based on histogram difference is used to ensure the accuracy. This technique is benefit to separate life log video into different environments that we can observe the scenes when user is moving from one place to another place.

To extend the scope of experience representation, we also develop a media integration system to represent personal experiences. The retrieval scheme is flexible to retrieve personal experiences in form of wearable video, ordinary digital video, digital photo, physiological data, and electronic document in hierarchical order. We evaluate the system using subjective and objective evaluation. Each function is evaluated individually to see its efficiency. The overall system is evaluated by comparison with the other system in various aspects.

Additionally, we realize Memex which was predicted by Vannevar Bush in 1945. We demonstrate an integration of our life log system and MyLifeBits system for continuous and discrete recording and retrieval of personal experiences. SenseCam, a passive capture camera is used to capture some parts of experiences. We also apply SenseCam sensor data to index the key frames of life log video. The relationship of life log video and SenseCam image is demonstrated. The system integration shows that our life log platform can gain the advantages for capture and retrieval of personal experiences.

**A41. 探査ロボットの行動計画のための環境理解に関する研究**

江尻 理帆

**Environment Understanding for Behavior Planning  
of Exploration Robots**  
By RihoEjiri

Humans are flexible because they can adapt to changing environments and respond to different situations. However, robots do not have such flexibility and each robot is designed to comply with the environment which had been expected in advance. Therefore, when developing robots, it is imperative that the operating environments be well-defined so that the robots can adapt to them for achieving their goals.

When humans recognize their surrounding environments, most of the information is obtained from their eyes. The brain processes the visual information to decide upon a course of actions, and decide what they are going to do next. Then how do humans understand their environment? What is environment understanding? To consider these questions, this thesis aims at identifying what environment understanding is from the aspect of behavior planning of robots.

The operating environment of a robot can be characterized into unknown, known, natural and artificial environment. In unknown and natural environments, robots require the ability to sense and recognize their surroundings. This thesis focuses on mobile robots operating in unknown and natural environments.

When mobile robots traverse over a long distance under constraints such as total power, exploration period, transmission delay, and unknown environments, robots need the ability to navigate efficiently. Conventionally, robots in unknown and natural environment are navigated by laser range finder (LRF) or stereo vision. However, the measurement range of LRF and stereo vision are several meters wide. A robot equipped with a navigation sensor with a much wider measurement range would be better suited for long distance traverses.

This thesis proposes an environment understanding method vision-based approach for robots in unknown and natural environment. This thesis also proposes a behavior planning method based on the result of environment understanding. In chapter 2, the strategy of these proposed methods is discussed. Images obtained by a camera, which provides environmental information from a wider measurement range than LRF and stereo vision, are used in the proposed method. Firstly, "gazing areas" - regions in an image with potential landmarks - are extracted. The terrains in these areas are then categorized based on the knowledge about the terrain characteristics of natural environment. A new environmental map is built from the result of this terrain estimation. A robot would continuously update its environmental map as it moves towards its destination. The proposed method in this thesis is targeted at robotic exploration on lunar and planetary environment, where the environments are natural and unknown. As such, grayscale images are used, because images of the lunar and planetary landscapes do not exhibit a wide range of hues.

Chapter 3 describes the process of constructing an environmental map. Regions with high variations in shades and bounded by edges are of particular interest in images of lunar and planetary landscapes. These are selected as gazing areas, and the terrain in them are estimated based upon the knowledge about lunar and planetary environment characteristic. Estimated terrains are classified into five categories: rocks, craters, concavities, convexities and complexes. Environmental map is formed tabularly from the gazing areas using their positions in the image, sizes, terrain estimation results and likelihoods of being landmarks.

A method to updating a robot's environmental map as it

traverses its environment is proposed in chapter 4. In the process, each data in the new map is compared against its representation in the previous map. As an environmental map is updated, the reliability of terrain estimation increases and the ambiguity between images decreases.

A behavior method based upon the results of environment understanding is proposed in chapter 5. The proposed method includes route planning and sensing planning. In route planning, the route to the destination of the robot is planned roughly using the environmental map. In sensing planning, sensing strategy is planned following the planned route.

The remaining part of this thesis discusses the concept of environment understanding. A way to apply the proposed method to other environments is explained, and environment understanding from the aspect of the robotic behavior planning is described.

#### **A42. 超電導コイルを用いたフォーメーションフライト衛星の相対位置制御に関する研究**

金田 良介

#### **A Study on The Relative Position Control in Formation Flying Satellites using Super-Conducting Magnets**

By Ryosuke Kaneda

This paper denotes a unique proposal for a control method of formation flying (FF) satellites using electromagnetic force generated by super-conducting magnets (SCM). Coils' current would be sinusoidal, in order to eliminate the disturbance torque build-up caused by the earth magnetism. Relative position control has been designed by on the basis of the phase difference of the coil's sinusoidal current. We used the resonance of the SCM and a capacitor as a sinusoidal electromagnetic force generator. A phase control circuit, that shifts the phase of driving SCM's sinusoidal current, is designed and confirmed its performance by experiments. We conducted some experiments using relative position control simulator on a computer, which includes real phase control circuit in the simulation loop and suggested the efficiency of the proposed method.

1st section describes problems of the conventional control system for FF satellites. FF is a novel flying method, consists of several satellites working together in a coordinated manner. FF is expected to carry out some missions impossible and difficult for a single satellite. For example, FF satellites can construct a large telescope virtually dividing it into a lens-loaded satellite and a detector-loaded satellite. This reduces launch load dramatically compared to real-telescope launch at one time. The problem of virtual telescope is, of course, relative position control and relative attitude control of the satellites. FF requires some control force in order to keep the relative position constant against each one's Keplerian orbit. Conventionally, we've been using thrusters considering its propulsion mass and its limits all the time.

2nd section introduces our proposal of control method for

FF using Scams on satellites and discusses its advantage compared to the conventional one; thruster using method. The proposed method is much reliable when the mission lifetime is several years or more. While the total mass increases exponentially with required mission lifetime in thruster using method, the proposed method needs no propulsion that the total mass is constant. There is few research in this point of view and no thesis digs into proposal of real circuit or actual control method. Existing FF missions order the satellites' space from ten meter to several kilometers. In order to generate powerful electromagnetic force, we planned to load SCM on the satellite. The problem of using coils is the disturbance torque by an interference of earth magnetism and SCMs. Coils' current would be sinusoidal in our system and eliminate the disturbance torque in long term. The phase difference of each coil would determine the strength of the control force for FF.

3rd section explains how to realize the relative position control by sinusoidal electromagnetic moment. Parameters of controller and driving frequency of sinusoidal current are arranged considering control accuracy. Numerical simulation of designed control system is also conducted including earth magnetism model and other physical models.

The 4th section describes the design of the relative position control system. The controller was designed with 'Coefficient Diagram Method' in order to the disturbance. And the conversion equations were derived from the electromagnetic force equation.

5th section is about the phase control of the sinusoidal magnetic moment, that is, the phase control of the current that excite the SCM. In our system, a capacitor and a SCM consist of resonance circuit that generates sinusoidal magnetic moment. The lost energy in resonance circuit would be provided by the external D.C. voltage and it also provides the phase shift of the current. This section explains how to achieve energy supplement (amplitude control) and phase shift (phase control). Numerical simulations are also conducted and it demonstrated that the proposed amplitude and phase control are available.

The 6th section informs the simulation of the whole control method included. The simulation results cleared some environmental conditions of driving circuit and also proved that our proposal is really useful, valid and actual. This thesis reports the relative position control method of FF satellites using electromagnetic force. It points out that the magnetic force should be sinusoidal and tells its appropriate frequency under the required control accuracy. We proposed a driving circuit that provides sinusoidal magnetic force and also proposed how to realize amplitude and phase control of the current. Simulations and experiments have been greatly conducted and it confirms our proposal is reliable and effective.

#### **A43. マイクロ波衛星観測データ解析システムの構築 とそれに基づく地震・火山噴火探知の研究**

前田 崇

#### **Study on Composition of Analysis System for**

### **Microwave Data by Satellite Observation and Detection of Earthquakes and Volcanic Eruptions By Takashi Maeda**

Microwaves at 300MHz, 2GHz and 22GHz emitted on the occasion of rock failures were confirmed for the first time in the world.

This result suggests similar microwaves are emitted in natural phenomena with rock failures (e.g. earthquakes and volcanic eruptions).

Especially about earthquakes, it is reported that various anomalies of the electromagnetic field in the atmosphere or ionosphere have been observed before their occurrence.

However, such electromagnetic emissions are not confirmed in laboratory environments well.

In this circumstance, we established an emission model of earthquake-associated microwaves based on the result of our rock fracture experiments, and found these microwaves can be observed from satellites.

In this study, we extract features of earthquake-associated microwaves from the data of microwave receivers loaded on satellites and verify the result obtained with this emission model. This is the first purpose of this study.

Generally, since the scale of satellite data is very large, they are analyzed by a computer system.

Formerly, the construction of the computer system became very complex and it demanded very high costs to develop the system.

However, considering the recent remarkable progress of computer technologies, even if we develop the satellite data analytic system on a personal computer with open-source and license-free softwares, we can realize advanced data processings by this system. Moreover, the development costs of this system are suppressed dramatically.

In this study, through the practice of this policy, we accumulate technology and know-how to establish the satellite data analytic system which realizes advanced data processings at low cost.

This is the second purpose of this study.

In this paper, we describe the current status of studies on electromagnetic emissions associated with earthquakes (seismo-electromagnetic phenomena) at first.

We can classify studies on seismo-electromagnetic phenomena into mainly four fields as follows:

observations of a ground potential, an earth magnetism in ULF band,

a natural radio wave emission from VLF to HF band and an ionosphere disturbance.

In each field, lots of case studies guess the association between observation results and earthquakes.

However, since the results obtained in each study are not allied enough, the big picture of these phenomena is far from understood.

Recently, some models to explain the mechanism of these phenomena are suggested, but each is no more than a tentative. Since it is difficult to identify the site of an earthquake in

advance, satellites are applied to observe seismo-electromagnetic phenomena. This enables us to observe electromagnetic emissions globally. However, since frequencies treated in traditional satellite observations are lower than VLF band, subjects of observations are not earthquake-associated electromagnetic emissions but ionosphere disturbances by these emissions. This ionosphere disturbance is not also understood perfectly.

Therefore, seismo-electromagnetic phenomena far from understood are observed through ionosphere disturbances not understood perfectly. This increases the uncertainty of the association between observation results and earthquakes.

On the other hand, we have the remote sensing technology. We can obtain much information from subjects of observations with sensors loaded on aircrafts or satellites. Frequencies of radio waves used in the remote sensing by satellites range from VHF to UHF, SHF (microwave region) and EHF (milliwave region). Infrared and visible light are also used.

These radio waves enable us to observe phenomena occurred under the ionosphere directly. In other words, by remote sensing satellites, we can observe earthquake-associated electromagnetic emissions themselves globally. We have already confirmed the microwave emissions on the occasion of rock failures and found these microwaves can be observed from satellites based on the emission model of earthquake-associated microwaves.

The microwave radiometer, AMSR-E loaded on the remote sensing satellite Aqua is operated by Earth Observation Research Center (EORC), JAXA.

In the data analysis of AMSR-E, in order to detect earthquake-associated microwaves more efficiently, we develop three analysis policies shown below:

1. We give priority to the analysis of an earthquake which has a bigger magnitude and a shallower seismic center.
2. We extract the data observed during night (in the descending orbit) selectively, and use for the analysis.
3. We place an emphasis on the data observed at the frequency with the highest possibility of detecting earthquake-associated microwaves.

Although, in fact, there are various difficulties to guess microwave emissions from the ground surface by the actual observed data.

This is because microwaves emitted from the ground surface surge by effects of various natural phenomena(e.g. soil moisture, cloud vapor and precipitation) by the time they reach AMSR-E.

In this circumstance, after much trial and error, we develop the data analysis method and succeed in the feature extraction from the observed data in the connection of some earthquakes and volcanic eruptions.

We can extract the local fluctuation of the emissions from land territories by this data analysis method.

These emissions from land territories are not treated in the traditional remote sensing.

This data analysis must contribute to the further progression of

the remote sensing technology.

## 基盤情報学専攻

### A44. 光パケット交換ネットワークの構成と制御に関する研究

松本 延孝

#### A Study on Architecture and Control Mechanisms for Optical Packet Switching Network By Nobutaka Matsumoto

Rapid growth and spread of the Internet has brought the increase of network traffic, while the transmission capacity of routers is coming to be saturated due to the limitation of electrical packet processing. However, optical switching mechanism is still to be researched. Optical circuit switching is simple and commercialized, but link utilization is relatively low and control granularity is coarse. Optical burst switching lacks compatibility to current IP packet switching network because burst assembling causes unexpected delay and jitter on end-to-end communications.

Therefore, optical packet switching is expected to be one of the possible solutions for large capacity network. In optical packet switching network, packets are forwarded in optical domain so that high link utilization, fast switching, compatibility to current internet will be realized.

Issues for realizing optical packet switching network are as follows:

- How data packets are treated in optical domain
- How optical packet switching network and nodes are controlled

Functions and operations offered by optical devices are limited compared to electrical devices. Especially, lack of optical RAM disables flexible buffering and complex computation in optical domain. Conventional packet switching demands those functions since nodes store packets, recognize destination, and search on routing table during packet forwarding. Optical header processing is obviously challenging, and even if the header is processed in electrical domain, table lookup time is unfixed and sometimes large, which makes it difficult to control for keeping cut-through packet waited in optical domain. It follows that new optical packet switching network architecture is desired for its realization.

The target of this research is to study practical architecture for optical packet switching network considering available functions of optical devices. In addition, technologies composing the architecture are developed. Through the investigation of those technologies, direction of future optical network technologies is explored.

To solve the problem that some functions for packet forwarding is not suitable for optical packet switching, a concept that intermediate nodes are concentrated on forwarding packets and edge nodes take charge of routing is adopted.

As an approach to realize optical packet switching network based on the concept, self-routing switch is employed so as to eliminate routing table lookup from packet forwarding.

Core technologies addressed in this research are following four technologies: label processing mechanism for self-routed optical packet switching network, switched fiber-delay-line buffers for contention resolution, route information exchange for constructing self-routing label, route selection for reducing contention probability. The former two are technologies for operation on packets forwarded in optical domain; the later two are for controlling optical packet network.

[Simple optical label processing using preamble-shift-based label stripping]

When self-routing switches are used for end-to-end multi-hop forwarding, reduction of label length and a method to detect the position of recognized information are coming to be problems. In the proposed mechanism, optical packet is composed of preamble, safety-gap, label (the sequence of the output-interface identifiers of the intermediate nodes), and payload. Each nodes forwards packet by recognizing label header, and label update is operated by delaying preamble using a delay-line with the same length of recognized part of label in the node, so that label header is set to the position of the output-interface ID of the next node. This mechanism provides simple label recognition, simple label update. It is evaluated that label length of the proposed mechanism is shorter than that of other self-routed optical packet switching due to reutilization of preamble and safety-gap.

[Evaluation of fiber-delay-line-based contention resolution mechanism]

Packet contention is unavoidable in packet switching network, however, lack of optical RAM makes it difficult to operate contention resolution in optical domain. Wavelength conversion, deflection routing, FDL buffer have studied as optical contention resolution schemes. In this research, FDL buffer is taken because of feasibility. Since delay time of buffered packets is fixed dependent on the length of FDL, structure of FDL buffers affects the performance. Relation between FDL structure and packet loss rate, delay, jitter is evaluated.

[Route information advertisement scheme for constructing self-routing label]

In proposed optical packet switching network, label is constructed as the sequence of the output-interface identifiers of the intermediate nodes. Since each label is unique even if the destination node is same, scalable route information advertisement is necessary. A path-vector routing information advertisement scheme for interface-based source routing is described and scalability was evaluated.

[Priority-based route selection for contention reduction]

In optical packet networks, utilizable contention resolution technologies at the contention occurred nodes and their performance are limited. Thus, it is important to reduce the contention probability itself by distributing traffic. A route selection method to reduce packet loss rate in the optical packet source routing network is described. It selects routes

according to the priority learned from the transmission results. From simulation results, it is clarified that the proposed method reduced packet loss rate compared to other distributed route selection schemes.

#### **A45. 方向性エッジに基づく画像の特徴表現アルゴリズムとそのVLSI顔画像認識システムへの応用** 鈴木 康文

##### **A Directional Edge-Based Feature Representation Algorithm for Facial Image Perception VLSI Systems**

**By Yasufumi Suzuki**

A huge number of studies have been devoted to revealing the mechanism of human brain processing in diverged fields of research. Among them is an approach from the engineering point of view, in which a variety of research has been conducted aiming at realizing human-like perception systems using VLSI technologies. The development of VLSI image perception systems, in particular, is quite important since image perception plays essential roles in the activity of human brains. However, in spite of the remarkable progress in the VLSI technologies according to the Moore's law, it is still a challenging task to realize human-like perception systems since the principle of human visual perception is not well understood yet. In addition, it is difficult to achieve the robustness under various circumstances.

For robust image perception, feature representation algorithms which extract essential features from images and represent them in vector formats are quite important. Since the discovery by Hubel and Wiesel in the study of visual cortex of animals, it is well known that the directional edge information in visual inputs plays an essential role in early visual processing. Namely, biological systems rely on the spatial relationship among edges in various directions for image perception. In order to establish VLSI hardware systems mimicking the principle of such biological mechanisms, the Projected Principal-Edge Distribution (PPED) has been developed for image feature representation. The feature representation of PPED is based on the spatial distribution of four directional edges (horizontal, +45 degrees, vertical, and -45 degrees) extracted from an image. The PPED has already been applied to hand-written pattern recognition and medical X-ray analysis successfully. And a dedicated VLSI chip which generates PPED feature vectors at a rate of 1,000,000 vectors/sec has already been developed.

Facial image perception is one of the most important capabilities in the human perception system. It is still debated by psychologists whether the face perception is a specialized function in the human brain or not, although the human certainly has a special skill in facial image perception as an essential ability to survive. Therefore, face perception, I believe, is an appropriate application test vehicle for evaluating the capability of image feature representations. In addition, there are a variety of applications of facial image perception such as intelligent human-computer interfaces,

security systems, and so forth. In the facial image perception, there are two main issues, i.e., the face detection and the face identification. In the face detection, facial images must be correctly localized in an input image without prior information about illumination, scales, numbers of faces, and so forth. In the face identification, the localized faces are identified as individuals. By achieving both face detection and identification system, an automatic face recognition system which searches for and identifies faces in the target image can be realized.

The purpose of this research is to further extend the capability of the directional edge-based feature representation algorithm by applying to the face detection and identification systems. These systems have been chosen as appropriate test vehicles for developing human-like robust image perception systems based on the directional edge-based image representation algorithms. The PPED representation is not sufficient to carry out face detection since the dimensionality reduction employed in the PPED discards some essential features and makes it difficult to make discrimination between faces and various background patterns. In order to solve the problem, new directional edge-based feature representations compatible with the dedicated VLSI have been developed and the concept of multiple-clue criteria has been introduced. Namely, several feature representations in addition to PPED are employed for the template matching and the multiple clues derived from each of the feature representations are utilized for the classification. Using various clues, which are derived from different feature-representation schemes, has enhanced the performance of face detection and has enabled us to successfully detect all face candidates without false negatives. In order to validate the face candidates detected in the segmentation stage, the face verification scheme confirming the existence of facial parts has been developed. Furthermore, the robustness against various scales and rotations in facial images has been achieved by including such variations in the face templates. As a result, a robust nature of the face detection system against the variations in illumination, focus, scale, rotation conditions has been demonstrated.

The directional edge-based feature representations have also been applied to the face identification system based on pseudo-two dimensional hidden Markov models (HMM's). The robustness of the identification system against illumination conditions has been improved as compared with the system using the DCT-based feature vectors. In order to realize the real-time responding systems, a hardware architecture of pseudo-2D hidden Markov models have been proposed and implemented on a Field Programmable Gate Array (FPGA). In order to reduce the area, the mixture of Laplace distributions has been utilized for an observation probability function in the place of widely-used mixture of Gaussian distributions. The proposed pseudo-2D HMM architecture has shown the performance of identifying 200 facial images per a second, thus realizing a real-time responding system.

In this research, the directional edge-based image feature

representation algorithm has been developed and successfully applied to building a face detection system and a face identification system. The proposed algorithm has enabled us to build real-time responding systems using the dedicated VLSI chips developed for the processing. The capability of the directional edge-based feature representation algorithm in performing robust visual perception has been thus verified.

#### **A46. ユーザエクスペリエンスを考慮した無線センサネットワークに関する研究**

猿渡 俊介

##### **A Study on Wireless Sensor Networks Considering User Experiences**

**By Shunsuke Saruwatari**

Semiconductor technology not only boosted computer's performance, but also had many effects on various domains. The semiconductor's lithography enables us to develop MEMS that is ultra-small, high sensitivity, low-power sensors and actuators. SoC technology integrates a computer and a radio frequency module into a single integrated circuit, and contributed to birth of RFID and wireless sensor networks. By combining semiconductor technology and MEMS, it is going to get possible to integrate a computer and a radio frequency module, and sensors/actuators into a chip. The chip will be embedded to various objects in the near future.

The object, which embedded the sensors or actuators, can input and output several information. This paper defines sensors as "functions to acquire information from environment", and actuators as "functions to act on environment". For example, we treat not just a 3D accelerometer that is embedded to a chair, but an input device such as a switch on a wall, as a sensor. We also treat not just a motor that controls a curtain, but an output device like an ambient light, as an actuator. We will be able to create unprecedented services if we combine the sensors and the actuators dynamically.

Focusing attention on possibility of wireless sensor networks, the author studied on wireless sensor network technology in a comprehensive view that is from lower level, such as communication protocols, to higher level, such as applications. Especially, because user experience is very important when utilizing new technology, the author studied an operating system that enable users to develop software easily, and a framework that enables us to create services on-demand by combining wireless sensors/actuators embedded to daily objects.

TinyOS is currently used as a standard operating system for wireless sensor networks. The author has been studying wireless sensor networks since 2001, and examined to use of TinyOS. However, TinyOS has two shortcomings to us: one is difficulty of writing program on TinyOS, the other is not supporting hard-realtime transaction. Hence, we have decided to develop an original operating system for wireless sensor nodes.

A name of the operating system is PAVENET OS. With

thread-model, PAVENET OS enables user to write program easier than TinyOS, and supports hard real-time transaction. PAVENET OS has hybrid task scheduler: pre-emptive and co-operative. The pre-emptive task scheduler realizes row overhead hard real-time transaction by making use of CPU functions that are dynamic priority interruption, and fast interruption. The co-operative task scheduler reduces overheads, such as context switch and exclusive control, with user's execution of the system calls that release CPU explicitly. The system calls are `os_yield`, `sleep`, and so on. Additionally, PAVENET OS provides wireless protocol stack. The wireless protocol stack realizes each layer's modularity with hiding exclusive controls in APIs.

PAVENET OS can be implemented in the same amount of computational resources as TinyOS: Blink program's footprint size is RAM 74 bytes, ROM 1700 bytes in TinyOS, RAM 60 bytes and ROM 1600 bytes in PAVENET OS. PAVENET OS also can be implemented in the same performance as TinyOS. On the contrary, PAVENET OS can support hard real-time transaction that is not supported in TinyOS. Therefore, PAVENET OS can transact precise 100 Hz sensor acquisitions and rf phy transaction in the same moment, while TinyOS can't. The author designs and implements ANTH using PAVENET OS described previously. ANTH assumes wireless sensors/actuators are embedded into daily objects. Since ANTH provides a user-friendly human interface for device cooperation, users can create various services with combining the sensors/actuators. The characteristics of the services are event-driven, because sensors acquire changes of environment that are caused with some events. In addition, it is important that flexibility of object-to-object connectivity and easiness to develop new objects, since a number of daily objects around us is huge.

The author develops ANTH based on Bind Control Model that is simplified event driven programming. General event driven programming decides a relation between an event and a callback function statically, because the event passes the arbitrary typed data to the callback function. On the other hand, Bind Control Model unifies the interface of callback functions to zero argument. The zero argument interface realizes flexible connectivity between sensors and actuators, and easiness to develop caller and callee objects without concerning each other. However, Bind Control Model has two shortcomings: one is that services tend to be static because of the simplicity, the other is that users have to control many connections between sensors and actuators. ANTH expands feasible services with a virtual machine on sensor nodes. The virtual machine provides a dynamic loadable module for the functions of sensors and actuators. ANTH provides an intuitive human interface to reduce user's burden. Furthermore, ANTH realizes low power wireless communication by longitudinally concerning from the mac layer to the application layer.

#### **A47. 高度画像処理のための並列処理 VLSI アーキ**

テクチャ

伊藤 潔人

### **Parallel-Processing VLSI Architecture for Intelligent Image Processing By Kiyoto Ito**

In the era of multimedia and information, real-time image processing plays essential roles in various applications, such as image recognition, robotics control, security surveillance, and so forth. In such applications, intelligent image processing which takes expensive computational cost is utilized even at a pixel level. As a result, software solutions running on general-purpose microprocessors cannot attain real-time response capability even when the state-of-the-art VLSI technologies are introduced. Therefore, a new VLSI design paradigm is in demand in order to realize efficient execution of image processing for real-time applications.

The purpose of this thesis is to develop parallel VLSI architectures for real-time intelligent image processing. Especially, the thesis is focused on image filtering because it is the most fundamental function in various image-processing algorithms. For instance, spatial-convolution filtering plays an important role in a number of image-processing algorithms since it realizes various early visual processing such as noise reduction, feature detection, and so forth. For another example, temporal convolution determines time derivatives of intensity at each pixel location, which is important information in motion-related algorithms. Although operations in image filtering at each pixel are simple, image filtering is computationally very expensive because the operations must be conducted pixel-by-pixel across the entire image. Therefore, it is essential in various intelligent image processing to implement a not only high-speed but also low-power VLSI architecture for image filtering operations. Therefore, parallel-processing architectures and circuit designs based on logic-in-memory architecture and smart image sensor have been developed in this study.

Firstly, a VLSI image filtering processor capable of performing various kernel convolution processing in a single clock cycle has been developed based on the logic-in-memory architecture. In order to eliminate redundant memory accesses and complicated memory address control for partial image acquisition, pixel data are rearranged in the buffer memory according to the quaternary-tile pixel-mapping scheme developed in the present work. As a result, a fast and low-power operation has been achieved. In addition, the kernel size is variable up to 5x5 pixels, thus making the processor compatible to a number of advanced image-processing algorithms. The concept has been verified by a test chip fabricated in a 0.18-um 5-metal CMOS technology. Without pipelining, the processor operates at 50MHz under a 1.8-V power supply, which outperforms the software processing running on a 2.2GHz MPU.

A computational digital-pixel-sensor (DPS) VLSI with on-chip image processing circuits has been developed. Block-readout architecture is employed in memory

configuration at each pixel in order to resolve an interconnection bottleneck between a DPS array and processing units. The data from sensor array are read out in block and processed on the chip. As a result, this architecture enhances the performance of bit-serial digital signal processing, and pixel-parallel seamless scan of filtering operations has been successfully realized. A proof-of-concept chip including 64x48 DPS array and rank-order-filtering circuits has been designed and fabricated, and the concept has been verified by measurements.

For high-speed execution of motion-related image-processing algorithms, a time-domain gradient detection architecture of analog motion sensors has been developed. In this architecture, a compact gradient detector circuit calculates temporal and spatial gradients of photodiode signals at each pixel location, converting the gradients to pulse widths, i.e. to time-domain signals. The time-domain signals are then converted to digital format using on-chip binary counters, thus allowing us to carry out various algorithms by external digital imaging systems. A proof-of-concept chip of 31x31 pixels has been designed and fabricated using 0.35-um CMOS technology, and the optical flow estimation at the rate of 400 frames/sec with 3.3V supply has been experimentally demonstrated.

A mixed-signal focal-plane image processor for real-time spatiotemporal convolution has been developed based on time-domain computation technique. This allows us to build a compact pixel processing element having programmability. The concept was verified by a prototype chip fabricated in a 0.18-um CMOS technology, demonstrating over 78,000 convolutions/sec with 1.0V supply. In addition, an enhanced version of the focal-plane image processor is also designed, where digital arithmetic operations are realized by simple logic circuits based on the time-domain technique. This enhanced version enables us to implement more compact design of pixel unit and to achieve more flexibility in the processing.

In this study, the parallel-processing VLSI architectures executing spatial and temporal image filtering operation in real time have been developed. The architectures would make contributions to the advanced image processing algorithms since they carry out various image-filtering operations in real-time, and elemental circuits in the architectures would enhance performance or efficiency in various intelligent image processing.

#### **A48. Memetic アルゴリズム を用いた遺伝子制御ネットワークの推定**

ノマン ナシムル

##### **A Memetic Algorithm for Reconstructing Gene Regulatory Networks from Expression Profile By Noman Nasimul**

With increasing number gene expression data being available, the field of the systems biology is targeting the genome-wide identification of the structure of biomolecular interactions. However, the limited amount of gene-expression data and the

significant amount of noise from the measurement technology place the greatest challenges for such reconstruction processes. This dissertation addresses the challenges of reverse engineering molecular pathways of gene regulation from gene expression data using the decoupled S-system model. Again, modeling gene regulatory networks using S-system imposes additional difficulties for the reconstruction algorithms such as identifying the sparse network architecture and efficient learning of the model parameters. This work also deals with these issues.

In order to design an efficient and robust optimizer, first, the standard Differential Evolution (DE) algorithm was hybridized with a crossover based local search operation to improve its neighborhood exploration capability. This improved optimizer was used in the core of the reconstruction algorithm for inferring the transcriptional regulations in a biochemical network. Besides, a hill-climbing local search method was embedded in the developed algorithm for obtaining the sparse network structure efficiently. For identifying the skeletal structure of the target network, enhancements of the conventional Mean Squared Error (MSE) based fitness function and a new Information Criteria based fitness function have been proposed.

The suitability of the method is tested in gene circuit reconstruction experiments, varying the network dimension and/or characteristics, the amount of gene expression data used for inference and the noise level present in expression profiles. The reconstruction method inferred the network topology and the regulatory parameters with high accuracy. The proposed fitness functions have been found more suitable for evaluating the candidate network models compared to the existing ones. The proposed algorithm ascertained higher computational efficiency compared to other algorithms. Finally, the methodology was applied for analyzing two real gene expression profiles to reconstruct the underlying networks.

#### **A49. ユビキタスホームにおける体験情報処理と検索 デシルヴァ ガムヘワゲ チャミンダ**

##### **Multimedia Experience Retrieval in a Ubiquitous Home**

By DE SILVA GAMHEWAGE CHAMINDA

Automated capture and retrieval of multimedia experiences at home is interesting due to the wide variety and personal significance of such experiences. However, this is a difficult task with several challenges in different aspects. The number of sensors required for complete capture of experiences taking place in a home-like environment is quite large. Continuous capture is necessary to prevent missing experiences that residents are not prepared for, resulting in a large amount of multimedia content that is much less structured compared to those from any other environment. Processing the data to obtain higher level results actions, events and experiences is extremely difficult. Queries for retrieval will be at high semantic level, and at different levels of granularity, calling for well designed interaction between the automated retrieval



system and its users.

In this research, we focus on capturing and retrieval of personal experiences in a ubiquitous environment that simulates an entire house, with the objective of creating an electronic chronicle that enables the residents to retrieve the captured video using simple and interactive queries. A large number of cameras and microphones are used to continuously record video and audio at desired areas of the house. Pressure based sensors, mounted on the house floor, record context data corresponding to the footsteps of residents.

Our approach to achieve efficient multimedia retrieval from this large collection of data is based on adaptive source selection using both context and content analysis. Data from floor sensors are analyzed to segment footstep sequences of different persons, which are then used for the creation of video clips while automatically changing cameras and microphones to keep the person in view and hear the sounds in his/her surroundings. These videos are further summarized into sets of key frames, allowing the users to view a compact and complete summary of their content. Audio data from the microphones are segmented and classified into different categories of sounds, to retrieve the sounds and video showing the locations where the sounds are heard. Basic analysis of image data facilitates the detection of selected events that take place inside the house. Floor sensor data are analyzed in combination with other sensory modalities, for recognition of some common actions inside the house. The results are written to a central database, where they can be fused for accurate detection of activities. The users, who are also the residents, retrieve their experiences from the database through a graphical user interface by submitting interactive queries. This interface was designed based on the concepts of hierarchical media segmentation and Interactive retrieval, to facilitate effective retrieval with a small amount of manual data input using only a pointing device. Visualizations of different types of data at various levels of detail were included to help the user to retrieve required media and understand the results.

We evaluated the system using a two-pronged approach. Each functional component was evaluated individually, to ensure that it provides accurate results to the user and the other components using the results. We used standard accuracy measures and experiments where available, while designing experiments and defining new accuracy measures where necessary. We conducted a user study for the purposes of gathering system requirements and evaluating the overall system. A family who actually lived in ubiquitous home was selected as the subjects for this study.

Hierarchical clustering of floor sensor data followed by video handover enabled the creation of personalized video clips using a large number of cameras. It was possible to dub this video with reasonably good quality, using audio handover. An adaptive algorithm enabled retrieval of more than 80% of the key frames required for a complete summary of the video. Silence elimination and false positive removal from audio data produced results with a high accuracy of 98%. The scaled template matching algorithm we propose is able to achieve

generally accurate sound source localization despite the absence of microphone arrays or a beam-forming setup. The accuracy of audio classification using only time domain features is above 83%, suggesting that high accuracy of classification is possible at the expense of further analysis using features from multiple domains. Basic image analysis facilitated detection of events that are useful in understanding the activities that take place inside the house. Action detection using multiple sensory modalities yielded an average accuracy of approximately 78%.

The residents who evaluated the system found it useful, and enjoyed using it. They found the system easy to learn and usable. The requirements they identified and the feedback they provided were valuable in improving the system.

## A50. マルチエージェント協調作業のための経路プランニングに関する研究

神尾 正太郎

### Path Planning Algorithm for Multi-agent Cooperation Tasks By Shotaro Kamio

The cooperation of multiple robots enables complex tasks. If the task is complicated, an operator will be forced to send many instructions to the robots in order for the task to be achieved. It is necessary to be able to control the robots easily. Path planning algorithms will reduce the burden for this purpose.

This paper proposes a path planning framework for the sake of the multi-agent cooperation tasks. In the multi-agent cooperation tasks, some robots are assigned a sub-task and its sub-goal. But the other robots cannot be assigned the sub-task nor the sub-goal. Therefore, the path planning algorithms with a sub-goal and without a sub-goal are proposed in this paper. In addition, sub-goal generation algorithm is presented. These algorithms are based on the Rapidly-exploring Random Trees (RRT) method. The algorithms are realized with a centralized planner. Its applicability is shown in two tasks: a multi-agent object rearrangement task and a cooperative object transportation task. Moreover, the cooperative object transportation task is realized using two humanoid robots in a real world environment.

The multi-agent object rearrangement problem is the task that multiple robots carry objects from their initial positions to their goal positions. A robot transfers one object at a time. The path planning for multiple robots requires large amount of computation. The proposed algorithms reduce the complexity. Therefore, the computation time will gradually raise even if the number of robots increases. The result is compared with the dynamic programming (DP) approach. The proposed method can acquire comparable result in shorter execution time than that of the DP approach.

The cooperative object transportation task is the task of having robots cooperate in carrying an object from a start position to the specified goal position. In this task, each robot is in separated rooms with windows. Two robots have to

cooperate and transfer the object from one to the other through the windows. The proposed algorithm can produce robots' paths by using small amount of information. The effectiveness of the algorithm is shown by simulation results. The result is compared with the normal RRT method. The proposed algorithm is more faster than the normal method in complex problems.

In addition, the passing order searching is investigated in the cooperative object transportation task. The objective is to determine the order in which the object passing should be executed. This is a difficult task to find an optimum solution. Two algorithms are discussed that use the best-first search with a cost to go to the goal position. The algorithms reduce the amount of the required information that the operator has to give to the robots and it makes robot operations easy. The effectiveness of the algorithms is verified through simulation.

The application to a real world problem is also presented. When realizing our path planning using actual robots, noise coming from the environment needs to be dealt with. The position of a robot is affected by the noise arising from slipping and deviation of robot movements. As a result, the robots cannot achieve the task by simply executing the planned path. Therefore, the re-planning algorithm is necessary for accomplishing the task. This paper describes the algorithm and the control system. When the robot's location significantly differs from the intended path, the planning is redone based on the current location. The robot acquires their locations using the cameras with Monte Carlo Localization. The experiment is performed with the cooperative object transportation task using two humanoid robots. The result confirms the applicability of the proposed method.

**A51. 進化論的計算を用いたマイクロアレイデータの分類とガン関与遺伝子群の検出**  
ポール トポン クマル  
**Cancer Class Prediction and Biomarkers Detection Using Microarray Data with Evolutionary Computation**  
By Topon Kumar Paul

Cancer diagnosis based on the morphological appearance of tumor is sometimes difficult or impossible because tumors of different cancers may have identical appearances and show unequal responses to the same initial treatment. Recently many researchers are investigating whether gene expression profiling, coupled with class prediction methodology can be used to classify different types of tumor samples more reliably. Though different machine learning approaches have been proposed in this context, their success is limited due to smaller number of available samples compared to huge number of genes and due to many redundant genes.

The aim of this work is to develop a reliable and robust computational model for gene expression based diagnosis of cancer and identification of potential biomarkers of cancer. For this purpose, we propose two methods: random probabilistic

model building genetic algorithm (RPMBGA), and majority voting genetic programming classifier (MVGPC). RPMBGA, a variant of genetic algorithm, is a gene selection method and requires a classifier. Therefore, its accuracy as well the selected genes is dependent on the classifier used to calculate the goodness of a gene subset.

MVGPC is based on genetic programming (GP) and majority voting technique and improves the classification accuracy of GP. It uses an ensemble of GP rules and predicts the label of a sample by employing majority voting technique. For identification of potential biomarkers, we propose that classifier be first devised, which will obtain higher classification accuracy, and then the evolved rules be analyzed to determine the most frequently occurring genes, i.e. first classification, then gene selection. To get a more stable frequency distribution of selected genes, MVGPC should be repeated several times on the microarray data. The ways the optimum ensemble size be determined, the label of a test sample be predicted using the ensemble, and the potential biomarkers be extracted from microarray data are our main contributions in MVGPC.

By performing experiments on microarray data sets, we have found that MVGPC is more reliable than RPMBGA, and the test accuracies obtained with MVGPC are significantly better than those with other competitive methods of gene selection and classification including AdaBoost+GP, and some of the more frequently selected genes in the ensemble of MVGPC are known to be associated with the types of cancers being studied in this dissertation.

**A52. 非線形構造・材料を組込んだファイバブラッググレーティングを利用したDWDMシステムのための機能フォトニックデバイス**  
ディンチュンキエン  
**Novel Functional Photonic Devices for DWDM Systems Based on Fiber Bragg Gratings Incorporating Nonlinear Structures/Materials**  
By Dinh Trung Kien

This thesis is a study of sampled fiber Bragg gratings for the device applications in dense WDM communication systems. Multi-channel devices with dense channel spacing, broad bandwidth, in-channel dispersion compensation function, as well as the tunability are proposed and realized using sampled fiber Bragg gratings incorporating nonlinear materials/structures.

The rapid growth of the Internet has raised the demands for more transmission bandwidth and speed, WDM systems continue to grow in complexity and sophistication with increasing numbers of channels, longer transmission distances and higher bit rates. Thus, WDM devices with novel functions are required to meet the demands: dispersion compensation ability for higher bit rates and longer distances; broad bandwidth, dense channel spacing for more numbers of channels; tunability for managements and reconstructions of more and more complicated systems in changing

environments.

On the other hand, fiber Bragg grating is one of technologies that greatly enhance the performances of high density WDM systems. The filtering capabilities combined with the great design flexibility of fiber Bragg grating make it an ideal candidate for high channel count components such as multiplexers/demultiplexers, add/drop filters, as well as spectrally-designed complex filters and dispersion compensators. In today networks, fiber Bragg gratings have found applications in which they stand out from all other technologies, in both performance and cost.

However, realization of fiber Bragg gratings to meet the requirements of new specifications is difficult. Conventionally, gratings with broader bandwidth, denser channel spacing requires longer length and higher maximum refractive index changes, which both are physically limited. Gratings for multi-channel dispersion compensators are difficult to realize due to the unbalanced parameters or complicated experimental setups. Besides, grating design is in lack of flexibility due to the device restraints and high cost, conventional tuning methods are also in lack of quality.

This thesis addresses these problems. We study the effects of parameters on dispersion as well as channel spacing characteristics, and realize chirped sampled FBGs with both comb-like reflection spectra and dispersion compensation function with optimal values. Then, we show that by interleaving different grating sections and trimming relative phase shifts among them, reflection spectra of sampled fiber Bragg gratings can be broadened and densified simultaneously. For the tunability issue, we show that the channel spacing can be dynamically controlled by applying the gradient strain along the grating length, and desired dispersion values can also be realized by simply controlling the duty ratio, which enables great flexibility in design and low cost in fabrication. Finally, we design and demonstrate the potentials of novel switching devices based on fiber Bragg gratings incorporating nonlinear materials/structures such as carbon nanotubes and tapered structure.

### **A53. 無線トランシーバ用ミリ波 CMOS の設計とモデリングに関する研究**

ライ チェー ホン イワン

#### **Design and Modeling of Millimeter-wave CMOS for Wireless Transceivers**

**By LAI CHEE HONG IVAN**

Millimeter-wave wireless transceivers operate beyond 30 GHz to provide air links for next-generation communications. Modeling for design, and designing with physical implementations of integrated circuit (IC) chips using commercial silicon-based 90nm CMOS technology are the focus of this research. The circuit designs emphasize low power consumption, size reduction and achieving high frequency for possible applications towards portable hand-held and high-speed applications such as high-definition video. In this research, advanced high-frequency precision measurement

equipments are employed to further the performance up to 110 GHz.

## B. 大学院修士課程論文リスト

### Masters' Dissertations

#### 電気工学専攻

氏名	論文題目	Name	Title
中田 宗樹	光駆動型MEMS スキャナの医療内視鏡応用に関する研究	Muneki Nakada	A Study on Optically Actuated MEMS Scanner for Medical Endoscope Applications
澤島 公則	ワッシャーガンを用いた低メンテナンス低電圧大電流型中性粒子ビーム入射装置の開発	Masanori Sawahata	Development of Low-maintenance/ Low-Voltage/ High-Current Neutral Beam Injection System by Washer gun.
中村 則仁	Self Servo Track Writer の実用化へ向けた制御手法に関する研究	Nakamura Norihito	Research on Controller Design for Self Servo Track Writer toward Practical Use
吉田 憲吾	二関節同時駆動機構を備えたロボットアームの実現と筋の粘弾性を生かした制御に関する研究	Yoshida Kengo	Realization of Robot Arm with Bi-articular Driving Mechanism and its Control Using Muscular Viscoelasticity
大江 英輝	MOVPE 成長した InGaAlAs 多重量子井戸における逆バイアス時の位相変調特性の測定とキャリア空乏効果の解析	Hideki Ooe	Measurements of phase modulation characteristics under reverse-biased conditions and analysis of carrier depletion effects in MOVPE grown InGaAlAs multiple quantum wells
趙 莉	電気自動車におけるドライバの意図に沿ったリアルタイム速度パターンの生成	Li Zhao	Realtime Speed Pattern Generation for EVs according to Driver's Intention of Traveling
益田 泰輔	UPFC を用いた最適潮流制御による過渡安定度を考慮した ATC 拡大手法および供給信頼度評価に関する研究	Taisuke Masuta	ATC Enhancement and Supply Reliability Assessment Considering Transient Stability by OPF Control Using UPFC
土井田 尚	2光子励起レーザ誘起蛍光法を用いた大気圧コロナ放電下での酸素原子ラジカルの挙動観測	Hisashi Doita	Observation of Atomic Oxygen Radical in Atmospheric Pressure Corona Discharge by Using Two-Photon Absorption Laser-Induced Fluorescence Spectroscopy
有田 征史	大容量風力発電が導入された 2 地域系統における蓄電池を用いた周波数・連系線潮流制御および蓄電池容量評価	Masashi Arita	Evaluation of Battery Capacity for Frequency and Interline Power Flow Control in Interconnected 2-area Power System with a Large Penetration of Wind Power Generation
森崎 大介	気体中及び誘電体沿面上を進展するストリーマのシミュレーション	Daisuke Morisaki	Simulation of streamer propagation in gas with dielectric barrier
川沼 岳明	中長波帯電磁界パルスによる雷放電位置標定精度向上の研究	Takeaki Kawanuma	Improvement of Location Accuracy in Lightning Detective by EMP of MF/LF Ranges
松本 洋和	シャック・ハルトマン型レーザ波面測定法による気体放電中の電子密度計測	Hirokazu Matsumoto	Electron Density Measurement in Gas Discharge by Shack Hartmann Laser Wavefront Method
都留 大和	電力系統における電力貯蔵設備の費用便益評価	Hirokazu Tsuru	Cost Benefit Analysis of the Power Storage Facilities in Power System

伊藤 晃太	MEMS ピンセットを用いた HBC ナノチューブの機械的特性評価	Kota Ito	Mechanical Characterization of HBC nanotube using MEMS tweezers
吉田 遼太郎	マイクロ波照射による PCB 類脱塩素反応促進機構の解明	Ryotaro Yoshida	The Reaction Promotion Mechanism of PCBs Dechlorination by Microwave Irradiation
都島 良久	知能化空間における情報提示システムの提案 -RT ミドルウェアを用いた分散デバイスの統合	Yoshihisa Toshima	Information Display System in Intelligent Space -Integration of distributed devices based on RT-Middleware
シーサムラー スサックダー	MEMS 技術による VLSI 基板素材変更法とその応用	Srisomrun Sakda	A VLSI Substrate Material Alteration Method and Applications by MEMS Technology
ハイレジ ユ ネス	分散復号と軟判定を用いた協調無線通信に関する研究	HAIREJ Younes	Distributed Decoding and Soft Decision in Cooperative Wireless Communications
ブンヨン タ ッサボン	競争環境下におけるハイブリッド型電力取引モデルを考慮した電力系統の供給信頼度評価	BOONGNONG Thatsaphone	Power System Reliability Assessment in Competitive Environment Considering Hybrid Power Transaction Models
松本 淳平	高温超電導ケーブル絶縁における部分放電計測	Junpei Matsumoto	Partial Discharge Measurement in High Temperature Superconducting Cable Insulation
守末 奨	YBCO 薄膜を用いた超電導限流器の基本特性と設計に関する基礎的考察	Susumu Morisue	Measurements of characteristics of SFCL using YBCO thin film and its conceptual design
仲島 祐樹	金対シリコン異種 MEMS 針端の接触による金原子移動の実時間観察	Yuuki Nakajima	Real Time Observation of Au Atom Transport in Au/Si Hetero Contact between MEMS Sharp Tips
福正 博之	生体の拮抗二関節筋を模擬する電磁駆動系の開発と制御	Hiroyuki Fukusho	Development and Control of an Electromagnetic Actuator to Approximate an Antagonism Bi-articular Muscle of Life
タルハン・メ フメット・チ ャータイ	分子認識と直接輸送による分子ソーティングデバイス	Mehmet Cagatay TARHAN	Molecular Sorting Device Based On Molecular Recognition and Direct Transportation
山口 瑛史	車両駆動用リニア誘導モータのベクトル制御のための端効果を考慮した等価回路の同定法と性能評価	Terufumi Yamaguchi	Identification Method of Equivalent Circuit for Vector Control of Linear Induction Motor Considering End-effect and Its Dynamic Performance Evaluation
肖 利民	低電力 VLSI 実現に向けた細粒度パワーゲーティングの研究	Limin Xiao	Research on Fine-grained Power-gating for Low-power VLSI
松山 知弘	自律分散 MEMS を目指したマイクロアクチュエータと情報処理 VLSI との集積化に関する研究	Tomohiro Matsuyama	Research on Integration of Microactuators and Information Processing VLSI for Autonomous Distributed MEMS
今澤 良太	磁気中性点と合体を用いた高ベータ球状トカマク生成装置 UTST の開発	Ryota Imazawa	Development of high beta spherical tokamak device UTST by use of magnetic field null and plasma merging
大平 晃三	マルチエージェントモデルによる流通設備拡張事業を考慮した電力市場のシミュレーション解析	Kozo Ohhira	Simulation Analysis on Electricity Markets considering Transmission Capacity Expansion using a Multi-Agent Model

## 電子情報学専攻

氏名	論文題目	Name	Title
細羽 啓司	アプリケーションレベルマルチキャストストリーミングの品質向上のための遅延ゆらぎ低減手法	Keishi Hosoba	A Method for reducing delay jitter in Application Level Multicast Streaming
楊 鵬	ID ベース暗号の安全性評価および強化	Peng Yang	Security Evaluation and Enhancement for Identity Based Encryption
劉 薇	日本企業調査に基づく情報セキュリティ投資に関する実証分析	wei LIU	An Empirical Analysis of Information Security Investment Based on a Japanese Enterprise Survey
大畑 真生	LDPC 符号を用いた BB84 量子鍵配送プロトコル	Maki Ohata	BB84 Quantum Key Distribution Protocol Using LDPC Codes
角谷 直樹	センサネットワークによる交通状態遷移モデルに関する研究	Naoki Sumiya	Study on Traffic State Transition Modes by Sensor Networks
黒岩 久人	画像センサネットワークによる次世代交通信号制御システムに関する研究	Hisato Kuroiwa	Future Traffic Signal Control System based on Vision Sensor Network
黒岩 龍	日本語音声合成のためのアクセント結合規則の改善とデータベースに基づく統計的アクセント処理	Ryo Kuroiwa	Improvement of Accent Sandhi Rules and Statistical Learning of Accent Sandhi for Developing Japanese Text-to-Speech Systems
中澤 敏明	構造的言語処理を指向する用例ベース機械翻訳システム	Toshiaki Nakazawa	Example-based Machine Translation Pursuing Fully Structural NLP
劉 浩	長文分割を用いた決定性の中国語依存構造パーサに関する研究	Hao Liu	A Chinese Deterministic Dependency Parser Augmented by Sentence Division
上野 裕也	省電力型データベース問い合わせ実行方式の研究	Yuya Ueno	A Study on Power Conscious Database Query Execution
ボッレーガラ ダヌシカ タルパティ	複数文書自動要約における要約文の並び順による一貫性向上に関する研究	BOLLEGALA DANUSHKA TARUPATHI	IMPROVING COHERENCE IN MULTI-DOCUMENT SUMMARIZATION THROUGH PROPER ORDERING OF SENTENCES
真川 純	Free-Form Deformation と局所的な位置合わせを用いた三次元形状解析	Jun Sanagawa	3D Shape Analysis by using Free-Form Deformation and Local Alignment Methods
栗田 弘之	動的なインフォメーションフロー制御による情報漏洩防止手法	Hiroyuki Kurita	Dynamic Information Flow Control for Preventing Information Leakage
金 攀嶸	日韓機械翻訳システムにおける敬語翻訳に関する研究	Nayoung Kim	Research on Honorific Translation in Japanese-Korean Example-based Machine Translation
オニク アシフ アフメド	テンプレートをを用いたウェブログの検出と分析	Anik Asif Ahmed	Detection and Dissection of Weblogs through Template Manipulation
中島 亮	レイヤ 2 転送を用いたレイヤ 3 アドホックネットワークの構成法	Ryo Nakajima	Layer 3 Ad-hoc Network using Layer 2 Transmission Capability
澤村 正	IEEE802.11 フレーム拡張機能を用いた無線アクセスポイント選択手法の提案	Tadashi Sawamura	Selecting Wireless Access Points Using IEEE802.11 Frame Extension
田中 隆浩	アドホックネットワークを利用したシームレスな位置情報の取得に関する研究	Takahiro Tanaka	A Study on Seamless Localization using Ad-Hoc Networks

井上 博司	階層間アルゴリズム協調によるトラッキング技術の高度化に関する研究	Hiroshi Inoue	Advancement of Vehicle Tracking based on Coordination of Hierarchized Algorithm
加藤 紀雄	2つの結像系を用いた複合現実型空間立像ディスプレイの研究	Norio Kato	A Study on Floating Image Display with Dual Imaging Optics for Mixed Reality Environment
菅野 裕介	不特定多数の人物を対象とした顔変形を含む3次元頭部姿勢の実時間推定	Yusuke Sugano	User-Independent Techniques for Real-Time Estimation of Non-Rigid 3D Head Motion
小林 大祐	Webにおける自然言語投稿文の学習に基づく分類に関する研究	Daisuke Kobayashi	Classifying Natural Language Posts on Web Based on Machine Learning
岡野 諭	時空間アドレス割り当て機構の設計と実装	Satoshi Okano	Design and Implementation of the Spatio-Temporal Address Allocation System
岡部 浩司	代表表記による自然言語リソースの整備	Koji Okabe	Refinement of Language Resources Using Representative Forms
韓氷霜	ウェブにおける有向サイトグラフからのスパム発見に関する研究	Bingshuang Han	Detecting Web Spam from a Directed Graph of Web Sites
杉村 大輔	行動履歴を反映させた適応的環境属性を伴う三次元人物追跡	Daisuke Sugimura	Tracking People using Adaptive Environmental Attributes based on Long-Term Observation of Human Activities
向井 新太	MIRACLEシステムにおけるプレートマッチングとテクスチャ合成に関する研究	Arata Mukai	A Study on template matching and texture creation in MIRACLE system
羅 徳安	英語話者を対象とした日本語CALLシステムの構築と評価	Dean Luo	Development of a CALL system for Australian learners of Japanese
藤原 史隆	モット絶縁体状態のFDTD-Q解析	Fumitaka Fujiwara	FDTD-Q Analyses of a Mott Insulator Quantum Phase
河 宗玄	レンズアレイを用いた実時間自由視点画像合成システムにおける合成ぼけと光学ぼけを緩和する手法の研究	Jonghyun Ha	Suppressing Synthetic Defocus and Optical Blur in Real-time Image-Based Rendering System with Lens Array
李 鎮	社会ネットワークを利用した迷惑メール対策	Zhen Li	Leveraging Social Networks for Anti-Spam
賈 洪光	災害時の非接続アドホック・ネットワーク環境におけるコンテンツ・デリバリ・アーキテクチャー	Hongguang Jia	Contents delivery architecture for disconnected Adhoc networks in disaster case
松崎 孝大	IDベース暗号を用いたサービス妨害攻撃対策手法	Takahiro Matsuzaki	Countermeasure by Identity Based Encryption against Denial-of-Service Attacks
白井 達也	高速なトポロジー推定・ネットワークを考慮した並列処理の基盤として	Shirai Tatsuya	A Fast Topology Inference - A building block for network-aware parallel processing
清水 一人	耐ソフトウェアタンパ・プロセッサ	Kazuto Shimizu	Software-Tamper-Resistant Processor
大山 大介	列車遅延時の運行計画変更を反映した乗客行動を表現する乗客流推定法と列車運行の評価	Daisuke Ooyama	Passenger-flow estimation for expressing passengers' decision reflecting irregularity in a train operation for evaluation of timetable performance.

細見 武郎	両眼視差の原理を用いた立体空中浮遊型映像表示ディスプレイDLFI(Display-Less Floating Image)の提案	Takero Hosomi	A Proposal of 3D floating display "DLFI(Display-Less Floating Image)" using binocular vision system
サハグン ジョナタン アンチェタ	時空間および周波数情報に基づく特徴点のクラスター解析による群集中の人物追跡	SAHAGUN, Jonathan Ancheta	Tracking People in Crowds Using Feature Point Cluster Analysis Based on Spatiotemporal and Frequency Domain Cues
石田 真一	ネットワーク分散キャッシュを用いた大規模センサ情報配信システムの提案	Shinichi Ishida	Scalable Sensing Information Delivery Using Network Distributed Cache
ウェン フック タット ダト	係り受けを用いたテキストデータからのエンティティ間関係の抽出	Nguyen Phuoc Tat Dat	Exploiting Phrase Dependency for Relation Extraction from Textual Data
丸山 和孝	話者認識技術に基づく知覚的女声度の自動推定	Kazutaka Maruyama	Automatic Femininity Estimation of MTF's Speech Based on Speaker Recognition Techniques
森本 研一	AdHoc Network におけるセキュリティ向上を目的としたルート制御の最適化	Kenichi Morimoto	A Study on Routing Optimization for Security improvement in Ad Hoc Network
坂巻 俊明	Adaptive Cardinality Counting を用いたネットワークトラフィックの分析手法	Toshiaki Sakamaki	An analysis method of network traffic by using Adaptive Cardinality Counting
吉田 康浩	wikipedia を用いた人物名の曖昧性解消	Yasuhiro Yoshida	A Study of Person Name Disambiguation using Wikipedia
マルズルフ フレデリック	量子フーリエ変換の統計的並列シミュレーション	MARZOLF Frederic	Parallel Stochastic Simulation of Quantum Fourier Transform
う けい	光源運動に伴う見えの変化に基づく物体形状復元	Yu Qiong	Reconstructing an Object's Shape from its Appearance Manifold under Moving Light

## 電子工学専攻

氏名	論文題目	Name	Title
柳内 啓司	ベイズ理論を用いた個人の興味・嗜好を反映するニュース・ウェブログ閲覧システムの構築	Keiji Yanagiuchi	News and Weblog Browser based on Personal Interest Using Bayes'theorem
金允環	CMOS イメージセンサの感度特性と評価	YunKyung Kim	Sensitivity of CMOS Image Sensor and Scaling
松尾 清隆	時分割位相シフト変調方式による光波コヒーレンス関数の合成法を用いた多点型歪センシング	Kiyotaka Matsuo	Multiplexed strain sensing by synthesis of optical coherence function with time-division phase shift modulation
生田目 慎也	AdaBoost を用いた遺伝子制御ネットワークの統合的推定	Shinya Nabatame	Integrative Estimation of Gene Regulatory Network by means of AdaBoost
吉田 剛士	カーボンナノチューブを用いた超小型モード同期光ファイバレーザの高出力化に関する研究	Takeshi Yoshida	Research on high-power mode-locked short-cavity fiber laser using carbon nanotubes
高山 伸一	CMOS イメージセンサーのスクエーリングにおけるフォトダイオード構造の最適設計	Shinichi Takayama	Design Principle of Photo Diode Structures in Scaled CMOS Image Sensors



朴澤 佐智子	磁気圏探査フォーメーションフ ライト衛星間の通信測距技術	Sachiko Houzawa	Development of Inter-Satellite Communication and Ranging Technology for Magnetospheric Exploration
西川 昌志	オゾン酸化による Ge MOS 構造 の作製と電気特性	Masashi Nishikawa	Electrical Properties of Ge MOS structures fabricated by Ozone Oxidation
瀧原 昌輝	ケルビンプローブフォース顕微 鏡による多結晶シリコン太陽電 池の局所的起電力評価	Masaki Takihara	Local Photovoltaic Characterization on Polycrystalline Silicon Solar Cells by Kelvin Probe Force Microscopy
間野 裕行	ウェアラブルセンサを併用した ユビキタスホーム内における行 動判別と映像検索	Hiroyuki Mano	Action Classification and Video Retrieval in a Ubiquitous home with Wearable Sensors
清水 健	(100)/(110)面極薄 SOI MOSFET における移動度ユニ バーサルティの実験的検証	Ken Shimizu	Experimental Study on Mobility Universality in (100)/(110) Oriented Ultra-Thin-Body SOI MOSFETs
米満 広樹	非断熱過程を利用した近接場光 リソグラフィとその応用	Hiroki Yonemitsu	Near-field Photolithography using Nonadiabatic Photochemical Reaction and Applications
武田 浩司	分布ブラッグ反射鏡を用いた多 モード干渉双安定半導体レーザ ーによる全光フリップ・フロ ップ	Koji Takeda	Multimode Interference Bistable Laser Diodes for All-Optical Flip-Flop using Distributed Bragg Reflectors
増山 惣一	Walled-LTSA array とそれを用 いたプラスチック地雷可視化シ ステム	Soichi Masuyama	Plastic Landmine Visualization System Using Walled-LTSA Array
千葉 茂生	超高速衝突に伴うマイクロ波放 射の特性と波形解析	Shigeo Chiba	The characteristics and waveform analysis of microwave emissions accompanying hypervelocity impacts
居村 岳広	無給電素子と反射板による結合 効果を利用した間引き給電型ア レーアンテナに関する研究	Takehiro Imura	Study on Partially Driven Array Antennas Using Coupling Effects with Parasitic Elements and a Reflector
水野 洋輔	強磁性半導体 GaMnAs を用いた スピンホットキャリアトランジ スタにおけるスピン依存伝導特 性	Yosuke Mizuno	Spin-Dependent Transport Properties in Ferromagnetic Semiconductor GaMnAs-based Spin Hot-Carrier Transistors
水野 雄介	正常分散エルビウム添加ファイ バ増幅と異常分散単一モードフ ァイバ圧縮を用いた 1nJ サブ 100fs 高品質パルス発生に関す る研究	Yusuke Mizuno	Generation of 1nJ, Sub-100fs High Quality Pulse by A Normal Dispersion on Erbium-Doped Fiber Amplifier and A Single-Mode Fiber-Based Compressor
サンジーワ ディサーナー ヤカ	酸化濃縮法による (110)Ge-On-Insulator(GOI)構 造の作製と MOSFET への応用	SanjeewaDissana yake	Fabrication of (110) Ge-On-Insulator (GOI) Structures by Ge Condensation Method and Application to MOSFETs
湯 京龍	低コヒーレンス干渉計による BOCDA 方式光ファイバ分布型 歪センシングの性能向上	Jinglong Tang	Performance Improvement of Brillouin Optical Correlation Domain Analysis with Low Coherent Light Source
森棟 佳陽	テーパ光ファイバとカーボン ナノチューブを用いた光デバイ スに関する研究	Keiyo Morimune	Research of optical device using tapered optical fiber and carbon nanotubes
呉 文豪	電源電圧、しきい値電圧の動的 制御による VLSI 低消費電力化 の研究	WU Wenhao	The Research on Lowpower VLSI Design Using Adaptive Control of Power and Threshold Voltages

石川 雄太	位相と振幅を利用した多値光変調信号のコヒーレント受信に関する研究	Yuta Ishikawa	Coherent detection of optical multilevel signal with phase and amplitude modulation
門馬 太平	CMOS イメージセンサのための蓄積時間・バイアス電圧自動調整システム	Taihei Monma	An Automatic Configuration System of Accumulation Time and Bias Voltage for CMOS Image Sensor
風間 大輔	システム LSI における基板雑音の能動的低減手法	Taisuke Kazama	Active Reduction Methods of Substrate Noise in System LSIs
石井 健	エラー検出可能な二線式ドミノ回路の評価	Ken Ishii	Evaluation of Dual-Rail Domino Logic with Error Detection
橋本 紘和	オンチップコイル付 MAGFET の電気的特性	Hirokazu Hashimoto	Electrical Characteristics of MAGFET With On-Chip Coil
中俣 徹	ナノフォトニックデバイス開発のための MOVPE 法による ZnO ナノロッドの選択成長	Tohru Nakamata	Selective Growth of ZnO nanorod using MOVPE method for fabrication of nanophotonic device
欧陽 慧	連続周波数変調による光コヒーレンス関数合成法を用いた多層表面測定法	Hui Ouyang	Multilayered Surface Shape Measurement by Synthesis of Optical Coherence Function with Continuous Frequency Modulation
曹溶成	三線式自己同期伝送方式の電磁干渉実験評価	Cho YongSung	EMI measurement of self-synchronous 3-phase data transmission
木野 大幹	環境半導体ベータ鉄シリサイドのフォトルミネッセンス解析	Hiroki Kino	Photoluminescence Analysis of Kankyo semiconductor beta-FeSi <sub>2</sub>
中村 壮亮	重心移動可能な車輪型ロボットにおける不整地走破性	Sousuke Nakamura	Traversability on Rough Terrain of Wheeled Robot with Movable Center of Mass
梁 志成	100nm 以下でのパラメータのばらつきに関するランダム CMOS と 2 線式 PLA のモンテカルロ解析	Zhicheng Liang	A Monte-Carlo Analysis of Random CMOS and Dual-Rail PLA for Sub-100nm Parameter Variations
田村 嘉章	画像を用いた月惑星表面への着陸航法	Yoshiaki Tamura	Image Based Navigation for Lunar and Planetary Landing
イヘリン	低密度位置制御 InAs 量子ドットの形成とその光学特性	Hearin Lee	Formation and optical properties of low-density and area-controlled InAs quantum dots
渡邊 翔太	IP 再利用のためのプロトコル変換器自動合成手法	Shota Watanabe	Automatic Protocol Transducer Synthesis Method for IP reuse
西原 佑	ハードウェア/ソフトウェア協調検証における状態遷移表現への変換に基づく形式的手法	Tasuku Nishihara	Formal Methods for Hardware/Software Co-Verification with Conversion to FSM
本良 瑞樹	低消費電力ミリ波周波数センササイズ用 CMOS 回路の設計とモデリング	Mizuki Motoyoshi	Design and Modeling of CMOS Circuits for a Low-Power Millimeter-Wave Frequency Synthesizer
久木 正晴	残留磁気モーメント推定を用いた磁気トルクのみによる小型衛星の姿勢制御	Masaharu Kugi	Fully Magnetic Attitude Control for Spacecraft with Estimation of Residual Magnetic Moment
荒木 聖人	太陽電池用多結晶シリコン材料のフォトルミネッセンス解析	Kiyoto Araki	Photoluminescence Analysis of Multicrystalline Silicon Materials for Solar Cells
酒瀬川 洋平	メタルボンディングを用いた量子カスケードレーザーの作製	Yohei Sakasegawa	Fabrication of quantum cascade lasers using metal bonding process
皆川 拓也	ナノメートル世代の低消費電力 CMOS ロジックライブラリの研究	Takuya Minakawa	Low Power CMOS Logic Library in Nanometer Era

石田 将也	ウルトラワイドバンド無線通信に向けた低消費電力 CMOS 受信回路の研究	Masaya Ishida	Low-Power Receiver Circuit for Ultra-Wide-Band (UWB) Wireless Communication
若山 雄貴	量子カスケードレーザの作製とその特性に関する研究	Yuki Wakayama	Fabrication of Quantum Cascade Lasers and Their Characteristics
鬼塚 隆祐	InGaAsP系MOVPEにおける反応炉内分布と選択成長への影響に関する研究	Ryusuke Onitsuka	Reactor-scale Distributions and its effect on Selective Area Growth in the MOVPE of InGaAsP
矢田 慎介	低温分子線エピタキシー法による Mn ドープ Ge 強磁性薄膜の成長、構造制御、および磁気特性の評価	Shinsuke Yada	Low-temperature molecular-beam epitaxy, structure control, and magnetic properties of Mn-doped Ge ferromagnetic thin films
山附 太香史	Type□GaSb 量子ドット埋め込み FET による電荷蓄積と光検出に関する研究	Takashi Yamazuki	Charge Storage and Photodetection by FETs Embedded Type□ GaSb Quantum Dots
東 佑輔	感覚運動系の遅延時間が制御性能と制御機構へ与える影響	Yusuke Azuma	Influence of delay in sensorimotor systems on the performance and mechanism of control
黄世燕	フローティングゲート MOS 技術に基づく電力解析攻撃に強い VLSI アーキテクチャ	Se Yeon Hwang	Tamper-Resistant VLSI Architecture Based on Floating Gate MOS Logic
李 大一	高誘電率ゲート絶縁膜を有する有機薄膜トランジスタの作製と評価	Daeil Lee	Fabrication and analysis of organic thin-film transistors with high dielectric constant gate insulators
永渕 誠之	マイクロ流体素子の微量液体テラヘルツ分光への応用	Masayuki Nagafuchi	Application of microfluidics to terahertz spectroscopy of liquids
チャン メル ヴィン ジェ フリー チェ ング	選択 MOVPE モノリシック集積光デバイスの受動導波路損失低減に向けた選択 Zn 拡散に関する研究	Melvin Jeffrey Cheng Chan	Study on Selective Zinc Diffusion for Reduction of Passive Waveguide's loss in Selective Area MOVPE Monolithically Integrated Photonic Devices

## 基盤情報学専攻

氏名	論文題目	Name	Title
オストルク オウグ	方向性エッジフラグ用キャッシュメモリを備えた初期視覚情報処理 VLSI	Ovgu Ozturk	An Early Visual Processing VLSI Employing Directional-Edge-Flag Cache Memory
廣松 悠介	構造化された制御フローを持つプログラムの SIMD 命令セットによるベクトル化に関する研究	Yusuke Hiromatsu	Research on the Vectorizing Structured Control Flow Program with SIMD Instruction Set
ワサンタマ ラー バダ ラワ	無線通信用ミリ波 CMOS パルス発生器	Wasanthamala Badalawa	Millimeter Wave CMOS Pulse Generator for Wireless Applications
石橋 浩二	CMOSW バンド電圧制御発振器とオンチップ楕形容量	Koji Ishibashi	CMOS W-band Voltage Control Oscillator and On-chip Comb Capacitor
中村 竜二	ジェスチャと音声による屋内型飛行ロボットの対話的航行	Ryuji Nakamura	Interactive Navigation of a Flying Robot Using Gesture and Voice Recognition
小林 直樹	ミリ波 CMOS 用受動回路の最適化	Naoki Kobayashi	Optimization of CMOS Passive Circuits for Millimeter-Wave Application
上西 康太	韻律的特徴を考慮した統計的言語モデルの高精度化	Kota Uenishi	Improvement of Statistic Language Modelling using Prosodic Features
吉田 仁	$\pi(x)$ の計算	Hitoshi Yoshida	Computation of $\pi(x)$

渡辺 哲朗	ドラム演奏のグルーブ感の解析	Tetsuroh Watanabe	Analysis of Groove Feelings of Drums Plays
七条 真人	ニ段階成長マイクロチャネルエピタキシーによる Si 基板上的 III-V-OI (III-V on insulator) 構造の作製	Masato Shichijo	Fabrication of III-V-O I (III-V on Insulator) structures on Si substrates by two step micro-channel epitaxy
矢吹 崇広	遺伝的プログラミングに基づく獲得形質を利用した探索アルゴリズムの開発	Takahiro Yabuki	A Development of Search Algorithm Using Acquired Character Based on Genetic Programming
唯野 隆一	Time-Varying Mesh における動き解析に関する研究	Ryuichi Tadano	A Study on Motion analysis for Time-Varying Mesh
張 錫振	無線センサネットワークを用いた地震モニタリングシステムの実装と性能評価	Chang Seokjin	Implementation and Performance Evaluation of A Wireless Sensor Network for Eathquake Monitoring
高橋 徳浩	自己相似演算アーキテクチャに基づく可変解像度エッジフィルタ用 CMOS イメージセンサ	Norihiro Takahashi	Multiple-Resolution Edge-Filtering CMOS Image Sensors Employing Self-Similitude Architecture
鹿野 博嗣	並列バクトル量子化アーキテクチャに基づく K-means クラスタリング・プロセッサ	Hirotsugu Shikano	A K-means Clustering Processor Based on Parallel Cector-quantization Architecture
熊谷 寛	Ge 上極薄膜 Si の低温プラズマ酸化による SiO <sub>2</sub> /Ge MIS キャパシタの作製及び特性評価	Hiroshi Kumagai	Fabrication and Characteristics of SiO <sub>2</sub> /Ge MIS Structures by Plasma Oxidation of Ultrathin Si films on Ge
上原 貴志	低温 MBE 成長による超薄層 Si/Ge/SOI 構造を用いたメタル S/D p チャネル MOSFET の試作と電気特性	Takashi Uehara	Fabrication and Electrical Properties of Metal S/D p-channel MOSFETs using Ultrathin Si/Ge/Si Structures Grown by Low Temperature MBE
鈴木 誠	動的で頑健な無線センサネットワーク構築のための仮想マシンの設計と実装	Makoto Suzuki	Design and Implementation of a Virtual Machine for Dynamic and Secure Wireless Sensor Networks
笹尾 卓宏	半構造データモデル RDF を用いた情報交換手法に関する研究	Takahiro Sasao	A Study on Information Exchange using RDF Semi-Structured Data Model
林 辰也	無線 LAN ベースのマルチカメラシステムにおける映像伝送に関する研究	Tatsuya Hayashi	Video transmission for multi-camera surveillance system using wireless LAN
伊東 和紀	動作モジュールの組合せによるヒューマノイドロボットの動作設計	Kazunori Ito	Motion Design for a Humanoid Robot by Combining Action Modules
屋比久 保史	人間の制御戦略に基づいた飛行ロボットの制御	Yasufumi Yabiku	A control method of flying robot based on human control strategy
室田 朋樹	高性能データ転送ネットワークのための観測手法	Tomoki Murota	Monitoring Method for High-Performance Data Transfer Networks
神堀 真也	高速鉄道における予測スケジューリングを用いた異種無線リンク活用手法	Shinya Kambori	Use of Wireless Links on High-Speed Railway by Predictive Scheduling
川村 泰二郎	IPv6 移行における DNS の問題に関する評価	Taijirou Kawamura	Considerations of DNS issues in IPv6 migration
圓城寺 人史	初等教育における屋外学習支援システムの設計と実践的評価	Hitoshi Enjoji	Design and Practical Evaluation of a Field Study Support System in Primary Education
柳瀬 利彦	動歩行に基づいた対話型進化計算によるヒューマノイドロボットの動作設計	Toshihiko Yanase	Design of Dynamic Motion for Humanoid Robots using Interactive Evolutionary Computation

水野 浩太郎	ハードリアルタイム処理を実現する無線センサノード用オペレーティングシステムの評価	Kotaro Mizuno	Evaluation of Hard Real-Time Operating System for Wireless Sensor Nodes
穂坂 怜	複数経路通信における経路制御に関する考察	Satoshi Hosaka	A Study on Routing Control for Multipath Communication
池西 俊介	動的スライシングとその効率化について	Shunsuke Ikenishi	Efficient Dynamic Slicing
永井 洋一	閲覧した文書中のキーワードに着目したオンライン検索支援	Yoichi Nagai	The Online Search Support Using Keywords Appeared in Browsed Documents
沈 垣甫	ウェブコミュニティ抽出に基づくウェブページの分類	Shim Wonbo	Web Page Clustering based on Web Community Extraction
阿部 崇史	コンピュータゲームプレイヤーにおける勝率を用いた探索時間最適化手法	Takashi Abe	Optimization of search time with winning percentages for computer game players
湯浅 晃	プロフィール情報に基づいたアクセス制御による電子コミュニケーションの規範的抑制効果	Akira Yuasa	Normative Effect on Computer Mediated Communication by Access Control using Profile Information
小林 弘和	中継転送ノードを利用した長距離TCPデータ転送の効率向上に関する研究	Hirokazu Kobayashi	Research on Improvement of Efficiency of a Long-Distance Data Transfer with TCP Using a Relay Node
大塚 俊範	攻撃者近隣における効率的なIP偽装パケットフィルタリング手法	Toshinori Ohtsuka	Efficient Filtering of IP Spoofed Packets Near the Attackers
金子 歩	超音波通信による高精度位置認識手法に関する研究	Ayumu Kaneko	An Accurate Positioning Technique Using Ultrasonic Communication
森川 重毅	K-means プロセッサに基づく知的画像処理アルゴリズム	Morikawa Shigetaka	An Intelligent Image Processing Algorithm based on K-means Processors
渡井 康行	インタラクティブなスケッチによるWeb ページ検索	Yasuyuki Watai	Web Page Retrieval by Interactive Sketch
神田 敦	別名SIPアドレスを用いた選択的着呼制御機構の設計と実装	Atsushi Kanda	Selective Incoming Call Control Mechanism Using Alias SIP Address
越智 景子	テキスト音声合成のための基本周波数パターン生成過程モデルを用いたコーパスベース韻律生成	Keiko Ochi	Copus-based generation of prosodic features using the generation model of fundamental frequency contours for text to speech conversion
アイデミール デニズ	ヒューマノイドロボットのためのMessy表現を用いた進化論的行動獲得	Aydemir Deniz	Evolutionary Behavior Acquisition for Humanoid Robots using Messy Representations
金 勝進	認知症介護を支援する環境適応型案内システム的设计と実装	Seungjin Kim	Design and Implementation of the Context-aware Guidance System for Dementia Care