Faculty of Engineering
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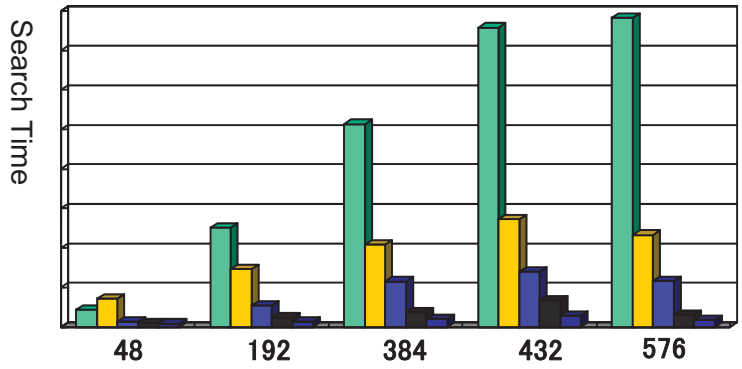
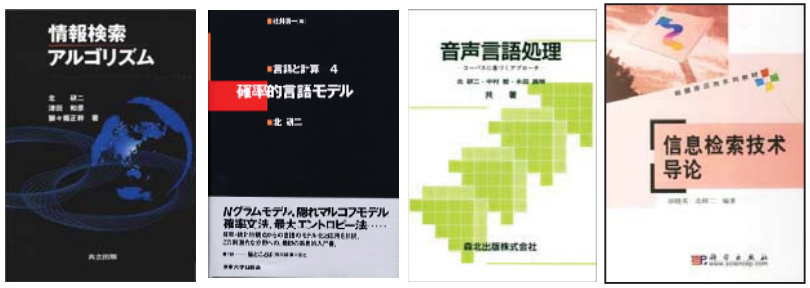
Efficient Multimedia Information Retrieval

Professor Kenji Kita



Development of the Fastest Multidimensional Search



Selected Professional & Technical Books by K.Kita

Content:

With the increasing size and complexity of multimedia databases, the problem of getting fast access into those large-scale databases has become immensely important.

We are concerned with the development of efficient search algorithms for a variety of multimedia formats, and have succeeded in developing novel methods as follows:

- The world's fastest multidimensional nearest search algorithm,
- A fast algorithm for computing the earth mover's distance (EMD) between a pair of histograms , and
- A fast Hamming space search algorithm for audio fingerprinting systems.

We are also interested in developing flexible, intelligent, and efficient technology for multimedia contents as follows:

- Semantic and emotional search,
- Cross-media information retrieval, and
- EEG-based multimedia information retrieval.

Keywords : multimedia contents, information retrieval, search algorithm

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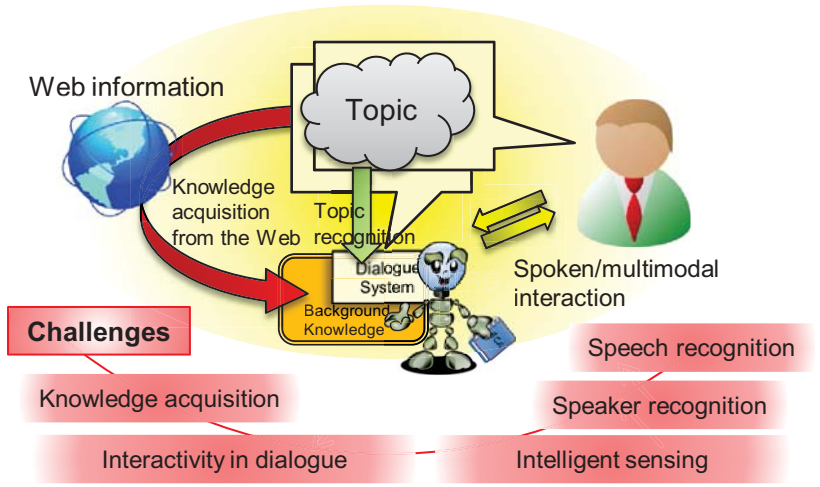
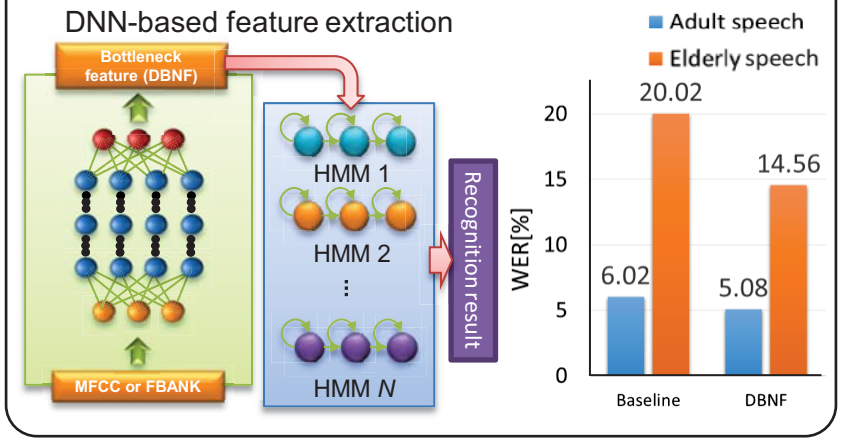
Research on spoken/multimodal information processing

Professor Norihide Kitaoka

Intelligent dialogue system structure



Speech recognition – robustness against ages -



We are engaged in the research on spoken/multimodal dialogue system based on speech information processing.

Robustness against the speech variety such as noises and age differences is a big topic. Adoption of neural networks based on deep learning (Deep Neural Network; DNN) is a promising way to tackle this problem. We achieved high performance using DNN-based feature extraction.

We also proposed a timing control method for system response generation. Such timing control enables novice users to use spoken dialogue system comfortably.

Integrative recognition method of speech and gesture is also proposed, to achieve integrative understanding of users' intent.

Based on these background technologies, we also study dialogue technologies and systems, for example, systems for elderly people and interfaces for semi-autonomous vehicles.

Keywords : speech recognition, multimodality, dialogue system

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Heterogeneous Wireless Network

Professor Kazuhiko Kinoshita

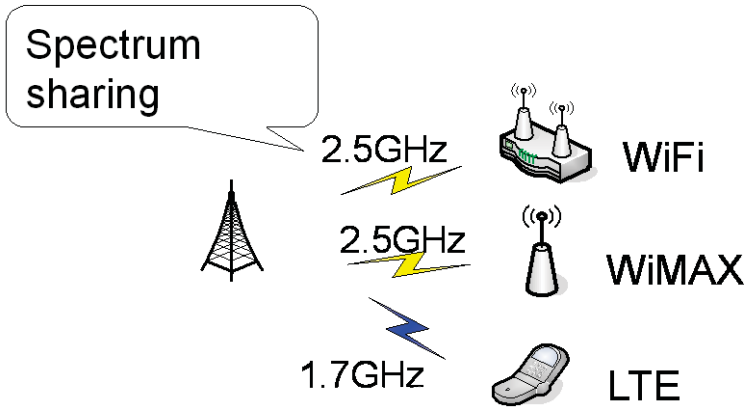

Fig.1 Spectrum Sharing

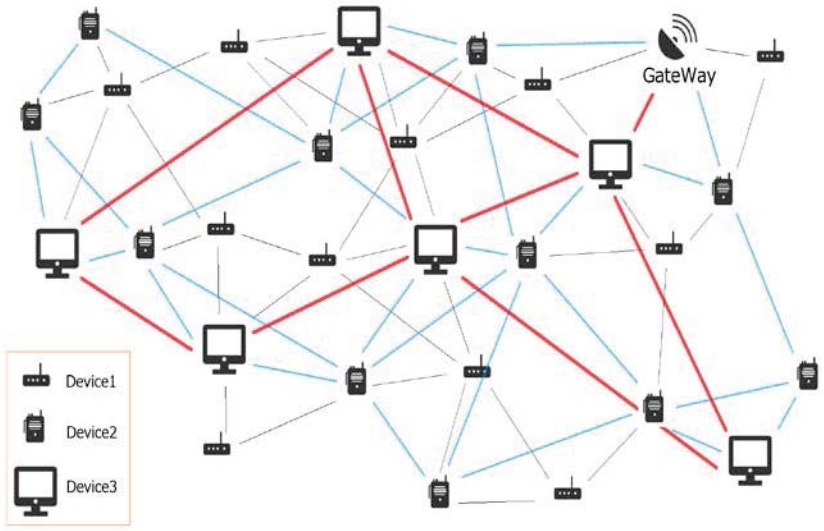

Fig. 2 Wireless Multihop Network for M2M/IoT Services

The number of wireless network users has remarkably grown by recent advances in wireless communication technologies such as WiFi and WiMAX. This has led to a lack of spectrum resources, which has therefore become an important issue. To overcome this problem, spectrum sharing technology, whereby a WiFi system temporarily uses a spectrum band of a WiMAX system, is receiving much attention. We propose a dynamic spectrum sharing method for ultimate utilization of wireless communication resources.

In addition, new services based on M2M (Machine-to-Machine) and/or IoT (Internet of Things) communications are also attractive. In such a network, tremendous number of terminals including sensors, actuators, etc. are connected, so that traditional networking technologies does NOT work well. We propose a new network platform to support M2M/IoT services in a unified manner.

Specifically, we research on the following topics.

Efficient spectrum sharing

Dynamic cell area optimization

Routing, buffer control, and channel assignment method in heterogeneous wireless multihop networks

Keywords : wireless network, spectrum sharing

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Content-based Multimedia Information Retrieval Systems

Professor Masami Shishibori

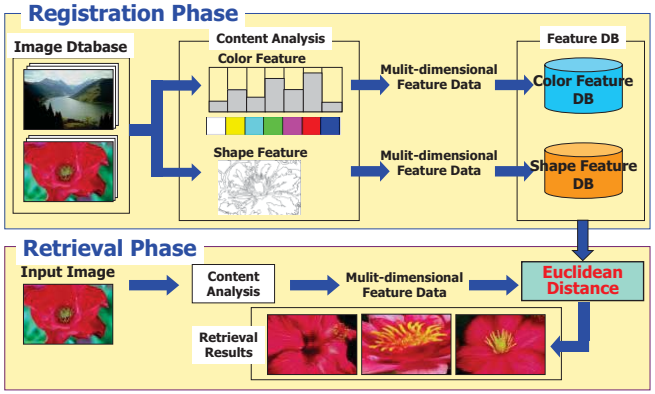

Fig.1 An example of content-based image retrieval systems

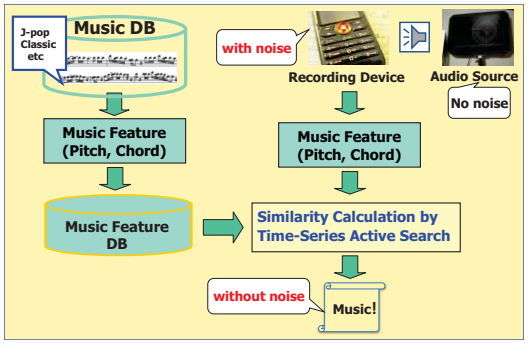

Fig.2 Noise robust music retrieval system

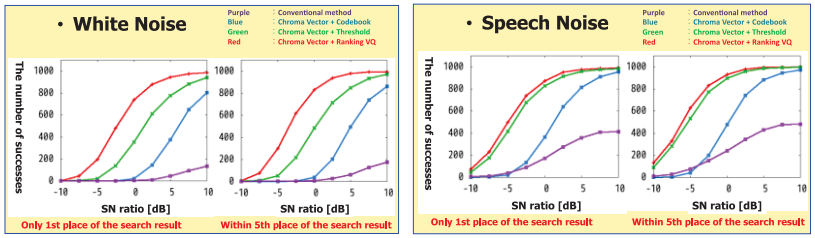

Fig.3 Experimental results on music retrieval systems

Content:

Multimedia Information Retrieval (MMIR) is one of active research fields of the computer science. An example of Content-based Image Retrieval systems (CBIR) is shown in Fig.1. CBIR can be organized in two important modules: Content analysis module extracts semantic features from images and affects the search accuracy. Feature indexing module classifies the similar features into the same category and affects the retrieval speed. Our research group developed the fast search engine as the feature indexing module.

As for video data, our group has participated the TREC Video Retrieval Evaluation (TRECVID) since 2005. Some content-based video retrieval systems were developed for the Instance Search task of the TRECVID.

As for music data, conventional systems use text data as the query, such as song titles, singer names, and so on. Our systems can search the similar music to humming and noisy data. On the noise robust music retrieval system (Fig.2, Fig.3), the user inputs the part of music data with white and speech noise, and then this system can search the similar music without the noise.

Keywords : search engine, intelligent systems, image retrieval, video retrieval, music retrieval

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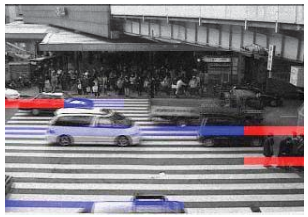
Image Sensing of Complicated Motion and Indistinct Shape Objects

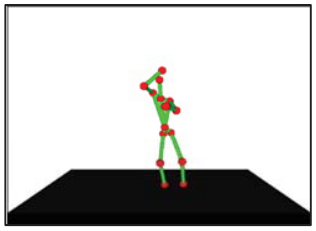
Professor Kenji Terada

■Fire Detection

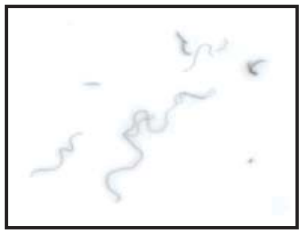
■ITS



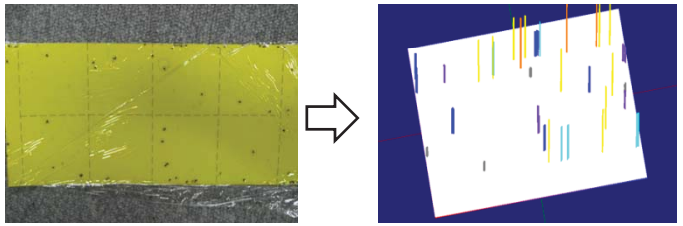
■Quality of Skill



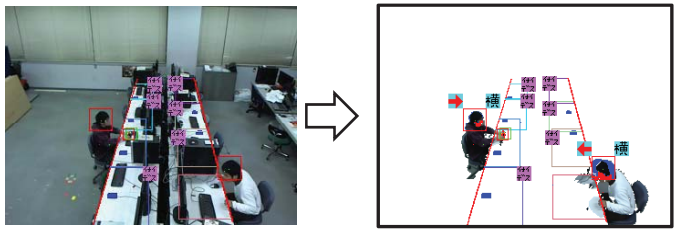
■Environmental Preservation



■Agriculture Application



■Human Behavior Observation



Content:

Image Sensing of Indistinct Shape Objects

Image Sensing of Complicated Motion Objects

■Fire Detection

e.g. Detection of smoke and fire frame by image processing

■ITS(Intelligent Transport Systems)

e.g. Crosswalk observation by image processing

■Environmental Preservation

e.g. Dust counter system by image processing

■Evaluation of Quality of Skill

e.g. Evaluation of quality of AWA dancing skill by image processing

■Agriculture Application

e.g. Insect counter system by image processing

■Human Behavior Observation

e.g. Observation of computer room by image processing

Keywords : Computer Vision, Image Processing, Image Sensing, Image Recognition

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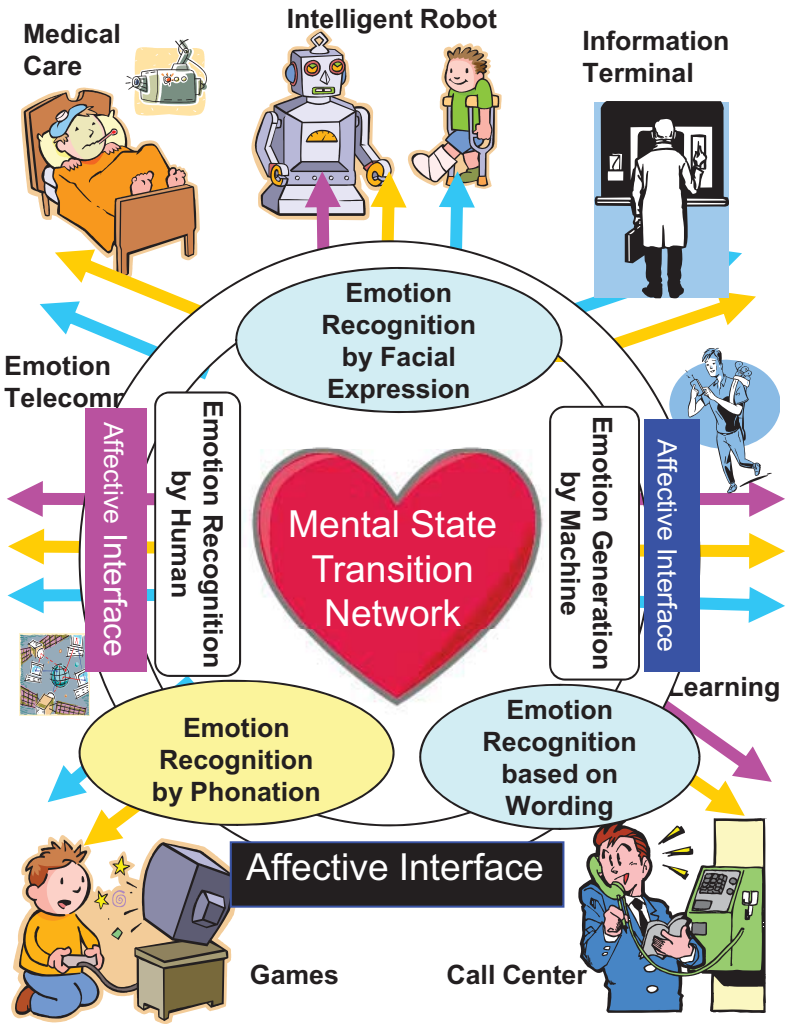
Constructing Evolutionary Robot to Have Human IQ and EQ

Professor Fuji Ren



Affective Interface which can Recognize Human Emotion and Create Artificial Emotion

Content:

Information recognition and extraction of human emotions are necessary for machines to communicate smoothly with humans. We focus on human psychological characteristics to develop general-purpose agents that can recognize human emotion and create machine emotion. We are constructing a new evolutionary robot to have human IQ and EQ based on Advanced Intelligence and Mental State Transition Network, and we are applying it to some applications shown in the left figure. We have built an emotional robot (the avatar of Prof. Ren) and succeeded in developing novel technologies as follows:

- Emotion Corpus Ren-CMCps
- Method to recognize human emotion based on phonation, facial expressions, and speech usage
- Recovery support and detection of depression
- Nursing care robot and ability support robot
- Cloud robot and robot school

Keywords: Affective Computing, Language Understanding, Intelligent Robotics

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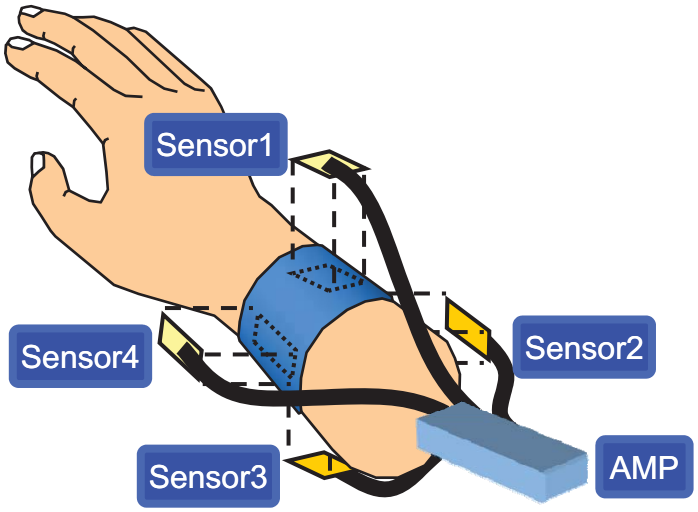
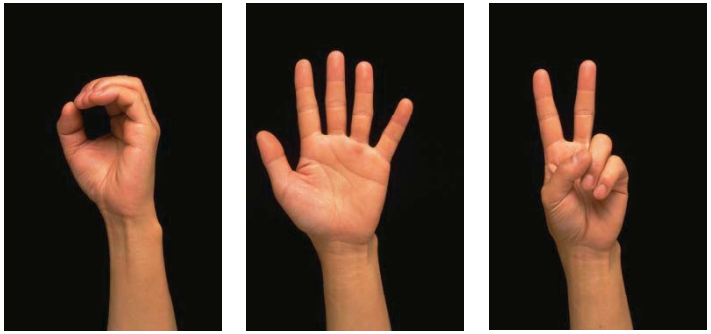
Hand motion recognition using wrist EMG

Professor Minoru, Fukumi



(a) Wrist EMG measurement



(b) On-line recognition of rock-paper-scissors

Content:

In this research, finger motions are recognized by EMG (electromyography) signals measured using dry-type electrodes attached to wrist. Target behaviors to be recognized are four finger motions that the Janken, “rock”, “paper”, “scissors” and when not doing anything “neutral”. EMG signal measured in wrist is unstable and noisy compared to forearm and upper arm. However wrist EMG can be applicable to control of wearable devices.

On the one hand, we developed the Simple-FLDA (approximated version of Fisher linear discriminant analysis, FLDA), which resolved three drawbacks in matrix-type FLDA. This algorithm allows a statistical on-line learning of approximated eigenvectors for the high-dimensional EMG signals. We can obtain a high recognition accuracy for hand motions using these eigenvectors.

In the next step, we try to recognize every wrist and finger motion and develop a total control system for wearable devices using wrist EMG.

Keywords : EMG, Simple-FLDA, Statistical learning

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Bifurcation and Control on Hybrid Systems

Professor Tetsushi Ueta

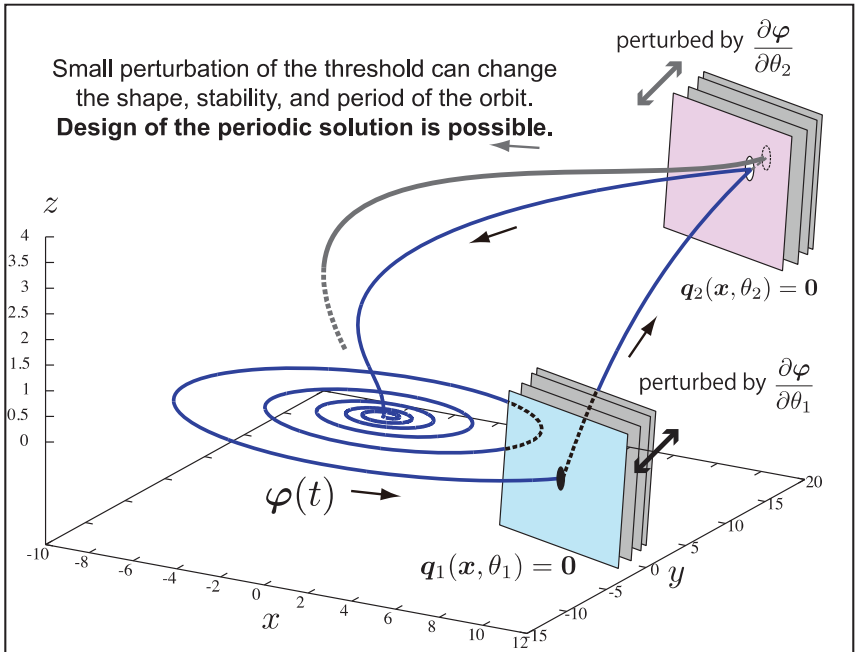

Fig. 1: Generation of attractors by threshold perturbation control

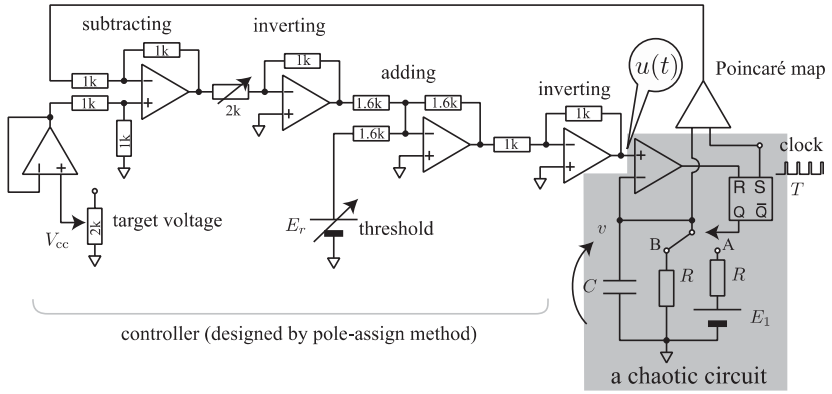

Fig. 2: Controlling chaos by threshold perturbation control

Content:

Nonlinear electric circuits including switching devices (e.g., multiplexer, relay, diode) are composed by both continuous flows and discrete events. These hybrid systems often specify bifurcations of periodic attractors and exhibit chaotic motions. We have developed a numerical analysis methodology for bifurcations in such systems for threshold values by computing variations about it. Bifurcation diagrams of periodic solutions can be obtained accurately. As an application of this technology, we demonstrate generation of periodic attractors (Fig. 1) by combining several switching manifolds, and controlling chaos in hybrid systems (Fig. 2) by using the perturbation of a switching threshold value. The key points of these trials are: (1) all required information is given by numerical integration of variational equations, (2) threshold perturbations are realized by less control energy compared with the conventional control technologies.

Keywords: hybrid systems, bifurcation, chaos, control

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Variance Analysis of Subspace Identification Methods

Associate Professor Kenji Ikeda

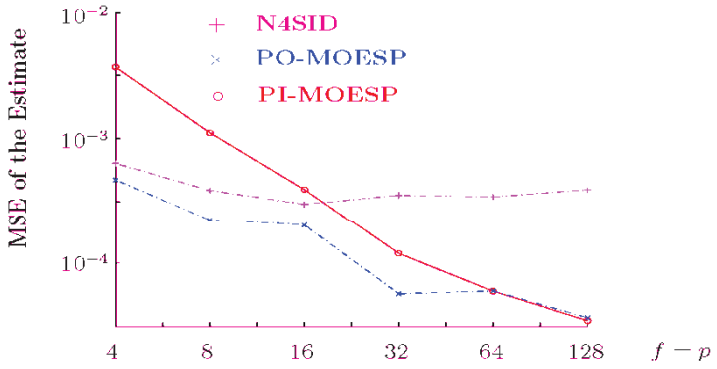

Fig.1 Mean squared error (MSE) vs $f = p$.

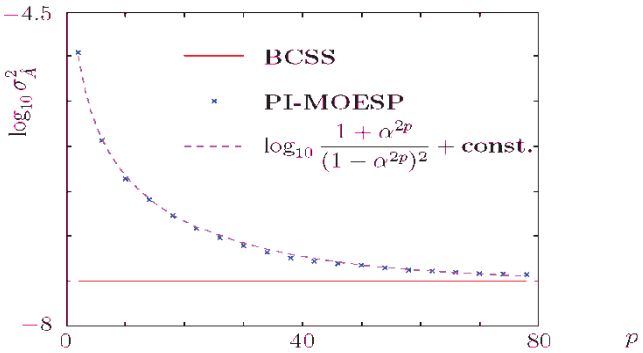

Fig.2 Comparison of BCSS(Bias Compensated State Space Model Identification Method and PI-MOESP method (when f is fixed to 2)

Content:

Control engineering is a highly developed fundamental discipline of the engineering, in which systematic design methods of control systems are developed based on the optimization by using mathematical models of the plant. System identification is one of the control engineering fields which estimates the plant model systematically from the input/output data of the plant. Subspace identification is a comparatively new method and has attracted attention from the middle of the 1990s. However, we have to say its analysis on the mathematical characteristics such as the variance of the estimate is not sufficient.

We have proposed a variance analysis method which enables a comparison of some subspace identification methods, analysis on the relation between the design parameters and the variance, etc.

In the subspace identification methods, singular value decomposition(SVD) of a matrix is utilized and it makes difficult to analyze the perturbations on the estimates. In this research, instead of analyzing the perturbations on the singular vectors, analysis of the perturbation on the singular subspace is adopted and this makes it easy to analyze the variance of the estimates.

Keywords: System idenfitication, Subspace identification method, Variance analysis

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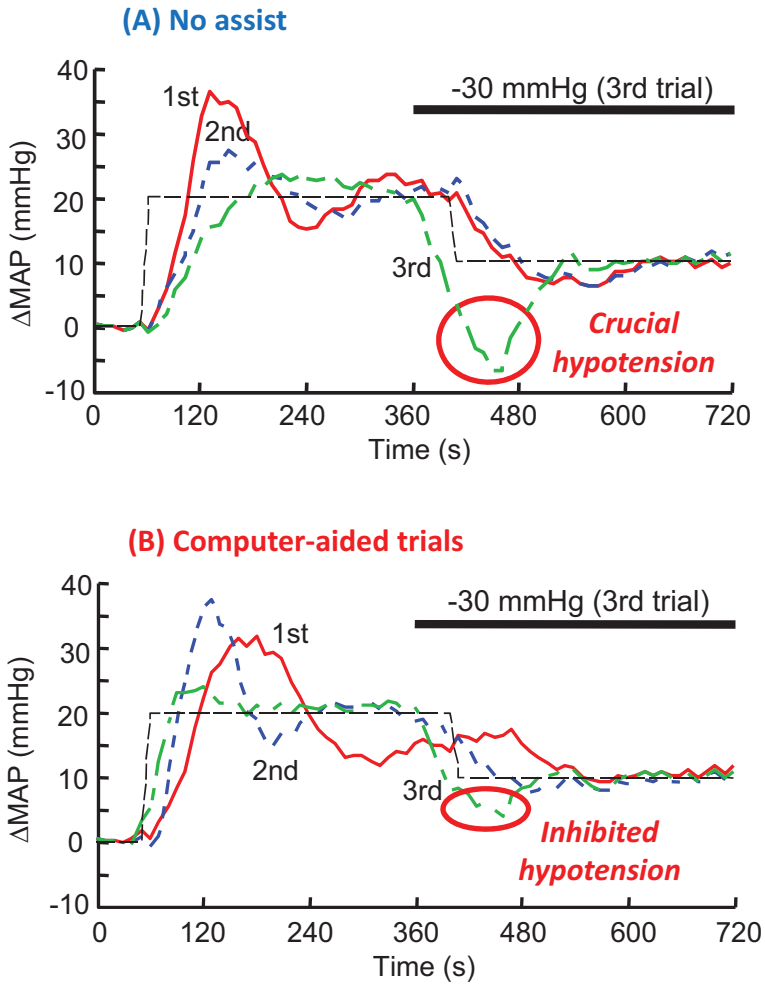
Computer-Aided Drug Delivery System with Adaptive Predictive Control

Associate Professor Koji Kashihara



Content:

A computer-aided drug delivery system with adaptive predictive control was proposed to support the judgment of operators.

This assistant system can predict future drug responses of a patient and calculate optimal drug infusion rates. The predicted values are presented on a monitor screen.

Regardless of sudden disturbances such as bleeding, the operators using the computer-aided system were able to regulate arterial blood pressure.

To improve the computer-aided system, the method for emergent warning or the correspondence to multiple drug infusions must be considered.

Keywords : intelligent system, human interfaces
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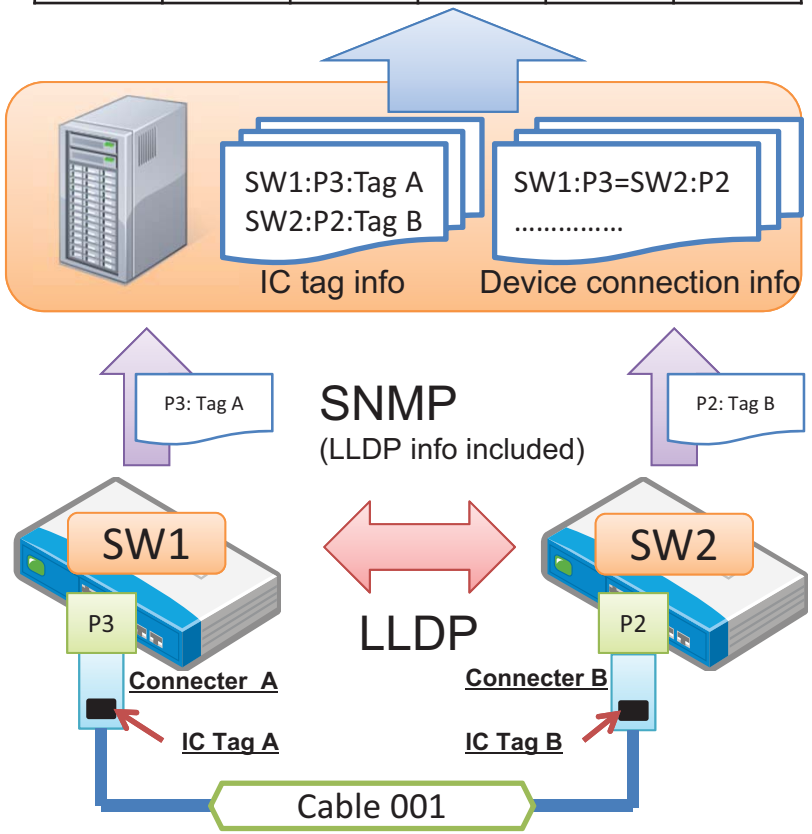
Automation of network cabling management with high security

Associate Professor Masahiko Sano

<Cables information table>

CABLE NO.	TAG PAIR FROM	TAG PAIR TO	DEVICE PORT FROM	DEVICE PORT TO	STATUS
001 002	TAG A TAG ...	TAG B ...	SW1:P3	SW2:P2	ACTIVE NA



Content:

In general, the physical cabling information of LAN in a building is managed by the databases or documents described their interconnection information. However, the management cost, for example updating their data, increases in the large network configurations. In addition, the safety of the information system is essential for the information society of today.

The purposes of this research are to allow the automatic construction of physical wiring database described above, to detect (malicious material or due to work) replacement of physical wiring. The former reduces the manpower of administrative tasks, the latter to improve the information security by the detection of malicious attacks and the mistake of wiring on the maintenance.

In this research, we are trying to embed a low cost IC tag in each cable connector. The physical port connection relations collected with LLDP and the IC tag information collected with SNMP are able to pair both ends of the cable automatically.

Keywords: lan cable management, security

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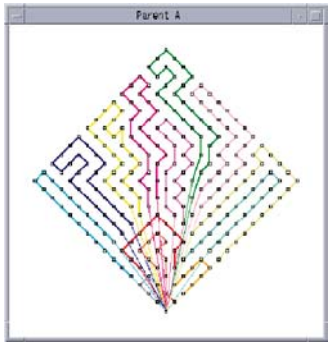
Metaheuristics for large combinatorial optimization problems

Associate Professor Yuichi Nagata

A best-known solution of the well-known Mona-Liza TSP benchmark (n=100,000) found by our genetic algorithm.



A best-known solution of one of the well-known benchmarks of the VRP found by our memetic algorithm.

A best-known solution of one of the well-known benchmarks of the JSP found by the proposed algorithm.

Metaheuristics are approximate methods used for solving instances of hard combinatorial optimization problems. The field of metaheuristics for the application to combinatorial optimization problems is a rapidly growing field of research. This is due to the importance of combinatorial optimization problems for the scientific as well as the industrial world. In our research, we develop very powerful approximate methods for many combinatorial optimization problems.

1. The traveling salesman problem (TSP) is one of the most cited NP-hard combinatorial optimization problems. We have developed a very powerful genetic algorithm (GA) for the TSP, finding very high-quality solutions on instances with up to 200,000 cities. A similar approach also shows a very good performance for solving vehicle routing problems.

2. Job shop scheduling problem (JSP) is one of the most studied scheduling problems in the OR community. We have developed a very powerful approximation algorithm for the JSP. The proposed algorithm is base on a new metaheuristic framework, which incorporates constraint propagation techniques into a local search framework.

Keywords: Metaheuristics, combinatorial optimization

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High speed and compact methods for string retrieval by a double array

Associate Professor Masao Fuketa

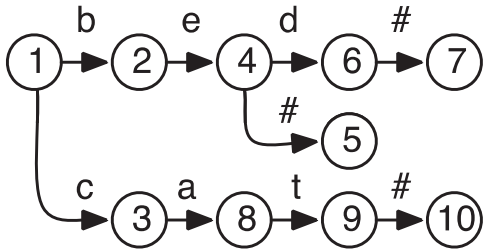

Figure 1 Example of a trie

BASE	1	1	2	1	-1	3	-2	1	6	-3
CHECK		1	1	2	4	4	6	3	8	10

	#	a	b	c	d	e	t
CODE	4	6	1	2	5	3	7

Figure 2 Example of a double array

Content:

Retrieving strings is used in many applications and a very important technology. Retrieval speed and saving memory are required for string retrieval. A trie (Figure 1) is one of data structures to retrieve strings, and a double array (Figure 2) is one of retrieval methods by using the trie. As large string sets are frequently used due to development of Internet, compact data structures such as LOUDS are used. The speed of the compact data structure is very slow compared with the double array.

Hence, my research is to save memory with maintaining the high speed of the double array. By constructing the double array for each depth of trie, values of BASE and CODE are determined for each depth, and then reduction of number of bits representing BASE values and saving memory of double array are achievable. Moreover, a method to reduce number of bits representing CHECK values is under investigation.

Furthermore, this research applies to similar string retrieval and DNA sequence retrieval .

Keywords : trie, data compression, dababase

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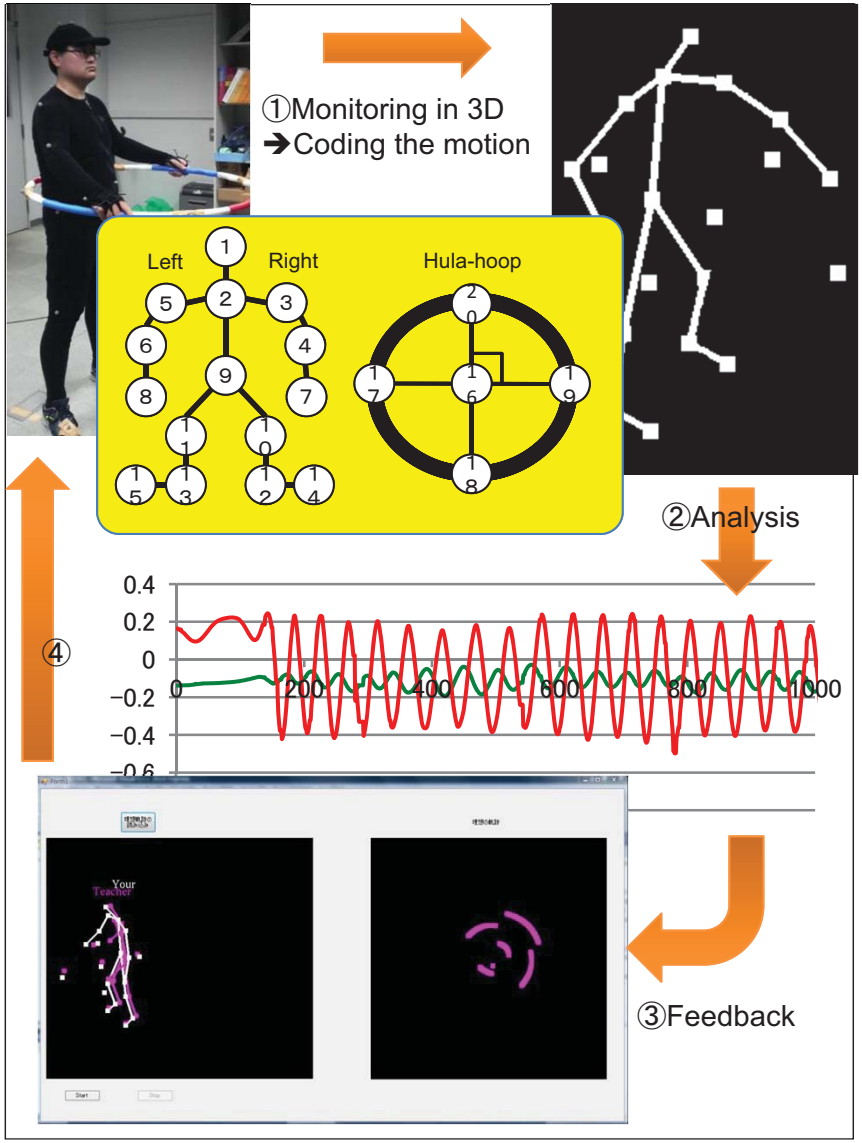
Research on skill development of repeating motion

Associate Professor Kenji Matsuura



Content:

The research focuses on a supporting framework that contributes motor-skill learners of repeating motions. The concrete target of repeating motion is “hula-hoop” at beginning. It has several characteristics such as manipulating an object, in room, simple motion.

The supporting process we have in mind is shown as in the left figure. To start, the system monitors the 3D motion and create a series of motion-code. Then, it will automatically analyses the coded motion in a wave form. There several types of wave form based on our initial discussions. After this process, the system makes the feedback model and give the visible feedback image. The learner can identify which point should be arranged from the origin.

In fact, the supporting process described above is associated with the assumption about the human process of motor-skill learning. The process includes cognition, motion selection, actual motion and storing result. We have to discuss the human process deeply and design the framework based on the discussion. We will also implement the total system including the whole process mentioned above.

Keywords : Skill development, motor-control

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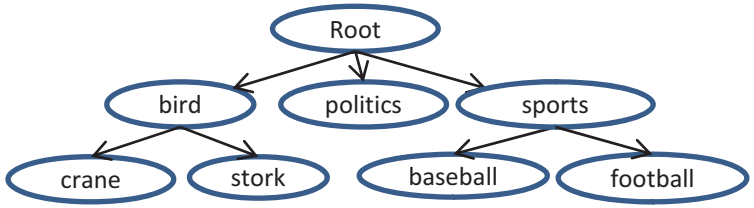
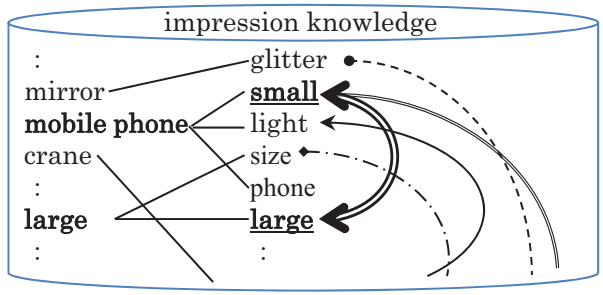
Construction of Impression Knowledge from Words

Faculty of Engineering
Tokushima University

Associate Professor Kazuhiro Morita



(a) Example of the usual conceptual knowledge



(b) Example of constructed impression knowledge

Fig. 1 Outline of impression knowledge

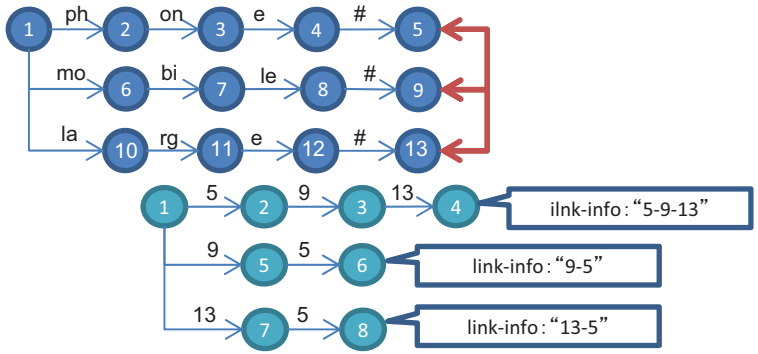


Fig. 2 Dictionary structure of impression knowledge

Content:

The technology that correctly understands the demand of human is important for the achievement of a man-machine interface with kindness to the person. The semantic understanding is processed by constructing the knowledge of the concept base, ontology and so on in the field of natural language processing. For example, "The stork carries" becomes "<bird>+(carry)" by acquiring the semantic concept, however, in this case, it is thought that "{happiness}+(carry)" is correct understanding. Thus, an interpretation different from the meaning of the surface is needed to understand the meaning from metaphor, metonymy, onomatopoeia and so on. The sensibility and the impression should be stored as knowledge.

This research aims to understand the intention by constructing the impression felt from words as impression knowledge. The constructed impression knowledge connects with words and the impression as shown in Fig. 1(b). To store these in the dictionary as the indexes, the dictionary structure shown in Fig. 2 is constructed.

Keywords: impression knowledge, knowledge dictionary

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Research of Intelligent Music Information Processing Systems

Associate Professor Masaki Oono

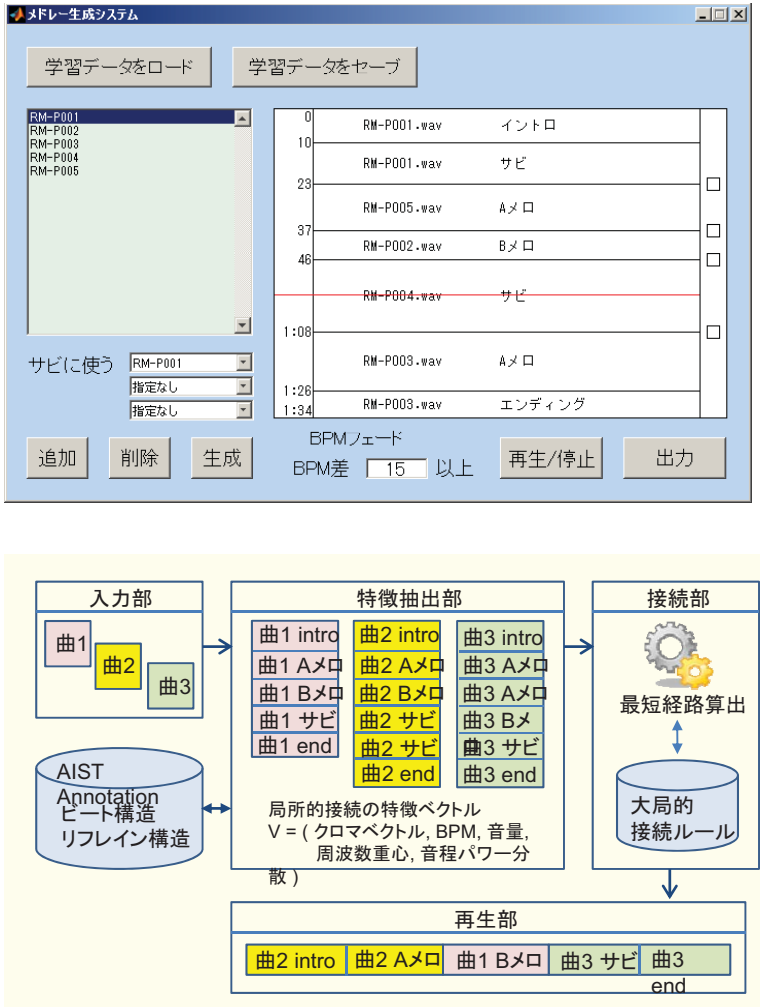

Figure 1 Medley generation system

From the point of view of engineering, my research is focused on music information processing to search music efficiently, to manage music easily, and to enjoy music more and more.

(1) Music information retrieval system based on audio fingerprint

An audio fingerprint is condensed digital summary, deterministically generated from an audio signal that can be used to identify and audio sample or quickly locate similar items in an audio database. We research an algorithm to extract audio fingerprint and to retrieval music efficiently.

(2) Audio synthesis system for music appreciation

We research audio synthesis techniques to listen music interactively. For example, medley generation system and music summarization system.

(3) Structural analysis of music

We research signal processing techniques such as beat tracking system, chord recognition system, structural segmentation system.

Keywords: Music information processing
Music information retrieval

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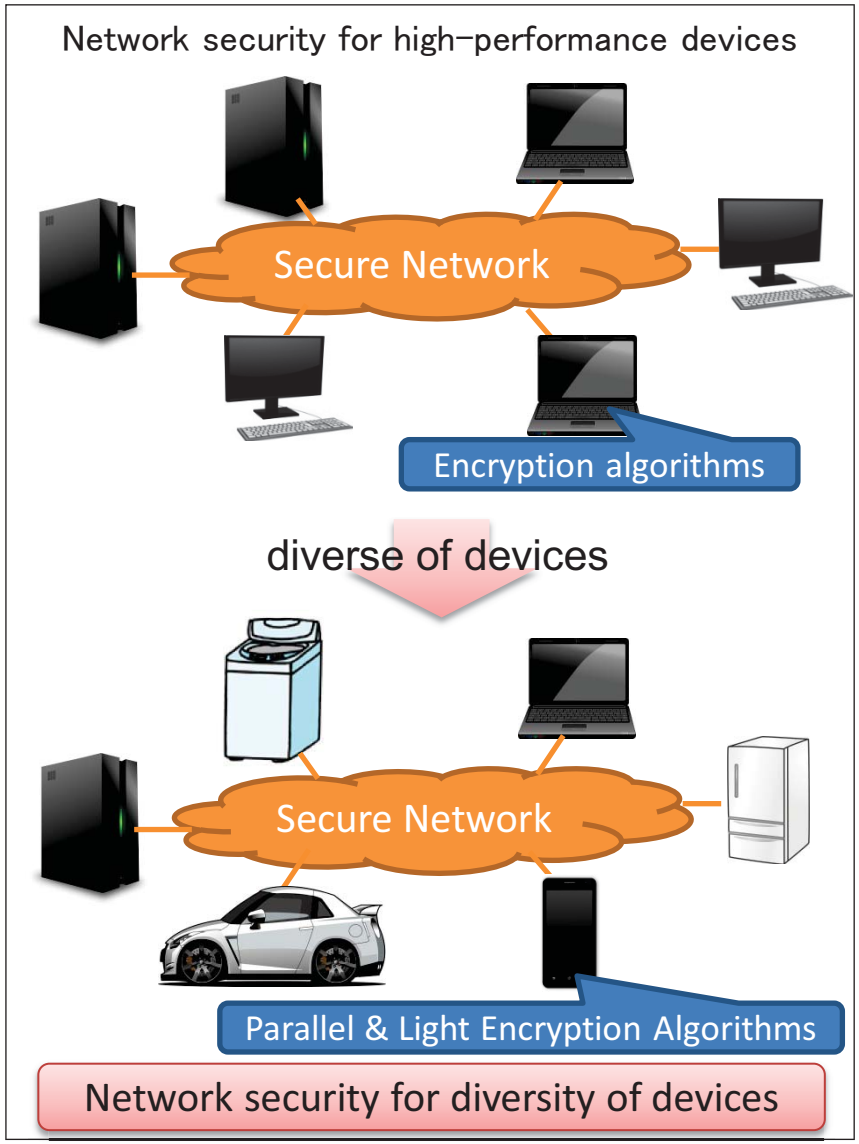
Cryptography for Parallelized & Low-performance Devices

Associate Professor Akinori Kawachi



The information communication technology, which gave deep impacts to modern society, such as the Internet is entering a new phase. Most of devices in networks were supposed as devices which have high performance with sufficient memory. Nowadays, devices in networks are being diversified, and a lot of lower-performance devices such as smartphones, home electrical appliances, etc., are connected with the networks. Moreover, even such small devices utilize multi-core processors inside them.

It is inevitable for the next-generation network technology to develop cryptographic systems that are available for low-performance devices and suitable for multi-core processors.

In this research project, we aim at constructing new fundamental cryptographic systems, such as public-key encryptions, digital signature schemes, and interactive identification schemes, that enable us to perform basic operations (e.g., encryption) with much less memory and parallelize the operations easily. For the constructions, we mathematically analyze security of the systems by techniques of mathematical sciences. We also aim at revealing theoretical limitations in term of possibility and performance of the constructions.

Keywords : Cryptography, Parallelization, Light-weight

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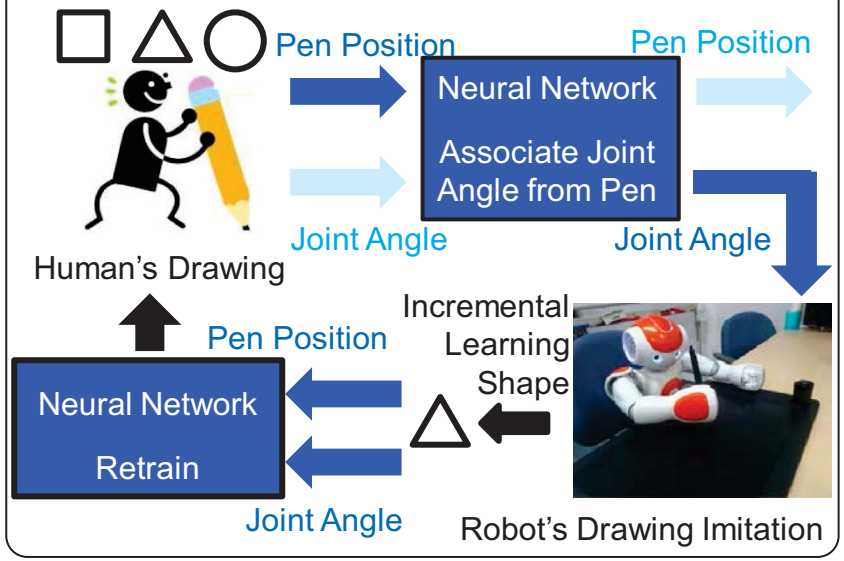
Research on Cognitive Developmental Robotics

Associate Professor Shun Nishide

Developmental Drawing Imitation Learning



Tool-Body Assimilation by Robot

Recently, studies on creating robots based on human development (known as cognitive developmental robotics) has been gaining much attention. We specifically focus on robot's knowledge/behavior acquisition based on active sensing experiences (children's toy playing) and interaction with humans (parent/infant interaction).

We utilize neural networks, which are simplified models of the brain, for robot's training model. Robot's behaviors are trained using a recurrent neural network. We have worked on creating robots based on affordance theory, creating robot's tool-body assimilation model, and human/robot drawing imitation using a developmental training model. The focus of our research is acquisition of robot's knowledge/behavior through a bottom-up approach based on primary stages of human development.

Keywords : neural network, robotics

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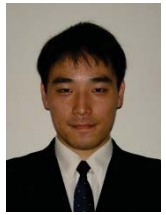

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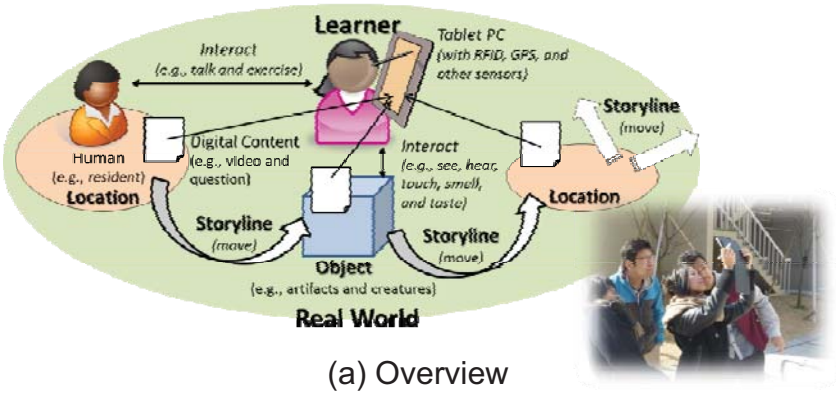
Learning Support System Enhanced by Digital Technology

Associate Professor Hiroyuki Mitsuhara

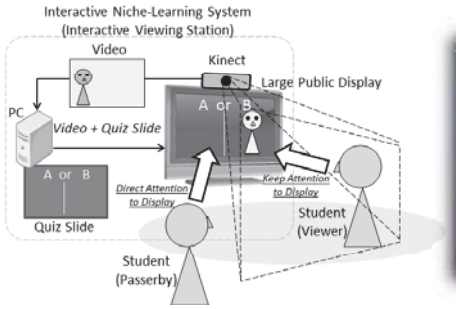


(a) Overview

(b) Main user interface

(c) Example of AR

Fig. 1 DT-based Edutainment system



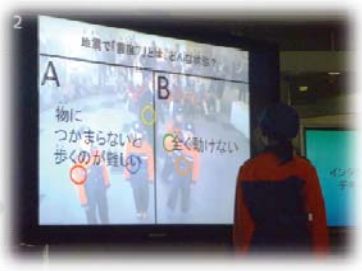


Fig. 2 Interactive digital signage

Content:

Various kinds of digital technology (DT) have been integrated into our daily life. It is no exception in learning and education. My research team focuses on learning support systems enhanced by DT such as wireless communication, intelligent sensor, and tablet computer.

In recent years, my research team has aimed at motivating people to learn disaster prevention by DT-based Edutainment (education + entertainment) systems. Figure 1 shows a mobile Edutainment system where people can learn disaster prevention based on a branched game story in the real world. This system uses AR (Augmented Reality) to increase a sense of reality. Figure 2 show an interactive digital signage system where people are superimposed on a slideshow (large public display) and can answer quiz questions in the slideshow by their simple body movement. The developed systems have been used in practical fields (e.g., elementary school.)

Keywords : educational technology, human-computer interaction, edutainment (game-based learning), augmented reality for learning, digital signage

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Interactive Text Mining on a Corpus

Associate Professor Minoru Yoshida

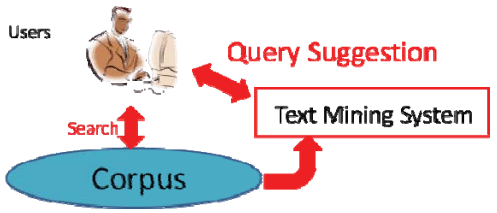

Fig.1: Workflow: Query Suggestion by Text Mining

Fig.2: Our System: Query Suggestion by Text Mining

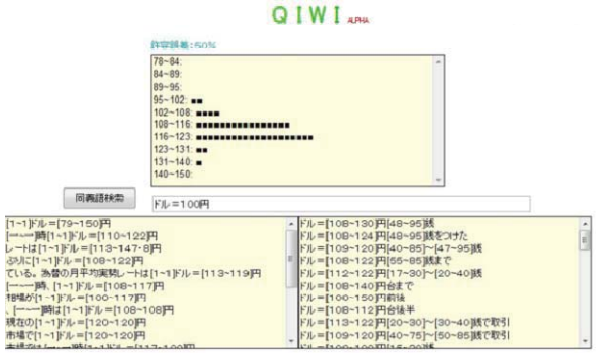

Fig.3: Mining Numbers on Text

Content:

The amount of electronic texts is rapidly growing, making it difficult to analyze them by humans. We especially focus on ``middle data'' that is not so big but not small data. Such data includes all Wikipedia pages and operation reports in call centers, etc. We propose a ``query suggestion system by real-time text mining.'' Text mining is a task to analyze how given words are used in the given corpus (i.e., set of texts). We use the index structure called ``suffix arrays'' to provide two types of text mining results, namely, usage extraction and synonym extraction, for the given query. (See Figure 2.)

We also propose a system for mining numbers in text. Many numbers are included in text, but most of existing text mining systems treat them as mere strings of digits. We propose a system that provide a function to use ``range of numbers'' as queries. (See Figure 3.)

Keywords : Text mining, Suffix arrays

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Electroencephalogram Analysis Considering Personality

Assistant professor Shin-ichi Ito

Ambient Brain Computer Interface

Medical and habilitation field
・To grasp human conditions
・To deliver appropriate service

Common field: Ambient BCI

Industrial field
・Human-centered system
・Downsizing of devices

To control exogenous stimulus using BCI

Individual Characteristic analysis Based on EEG analysis

Issues
・Intra- and inter- individual characteristic

Novelty algorithm

Solutions
・To consider human personality
・To propose methods based on gray model

【Ambient Brain Computer Interface】

・Concept;

This study constructs novel electroencephalogram (EEG) interface, which is ambient BCI, based on EEG analysis techniques. Final goal od this study is to create the assist system for therapy.

・Applications

—To detect an inclination, thinking, preference, uncomfortable feeling

— To control exogenous stimulus

【Individual Characteristic Analysis in EEG】

・Concept;

This study analyzes an intra- and inter-individual characteristic in EEG. One is affected by the influence of personality. We propose a method to analyze the EEG considering personality. Also, the proposed method employ a technique based on gray model.

・Applications

— To make new EEG interface

— To detect the human habit

Keywords：EEG, stimulus, personality

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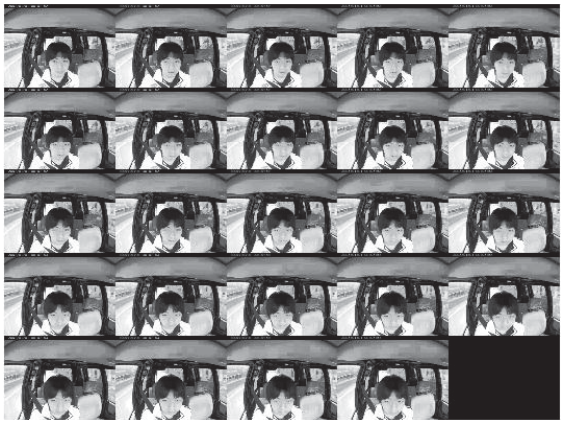
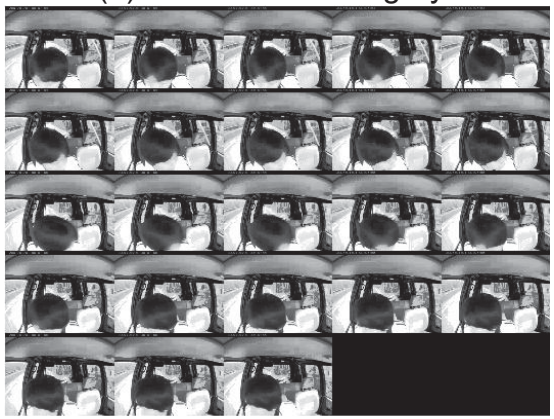
Driving Assistance System using Driving Behavior

Assistant Professor Momoyo Ito

Driver's Head Posture Categorization



(a) Frontal face category



(b) Deep head bending category

Head posture classification example..

Content

This study aims to construct a driver assistance system that is able to detect such driver deviations. The system detects deviation using time-series head motion information. We analyze driver's head posture during safety verification and propose a method for classifying head posture using two types of unsupervised neural networks: Self-Organizing Maps (SOMs) and fuzzy Adaptive Resonance Theory (ART). The proposed method has a feature based on the hybridization of two unsupervised neural networks with a seamless mapping procedure. The proposed method can generate the optimal number of cluster-generated labels for the target problem. We experimentally assess the effectiveness of the proposed method by adjusting the fuzzy ART network vigilance parameters. In addition, we indicate that driver's head posture during safety verification can be categorized according to their individual properties.

Keywords : <intelligent transport system, driving behavior analysis, machine learning>

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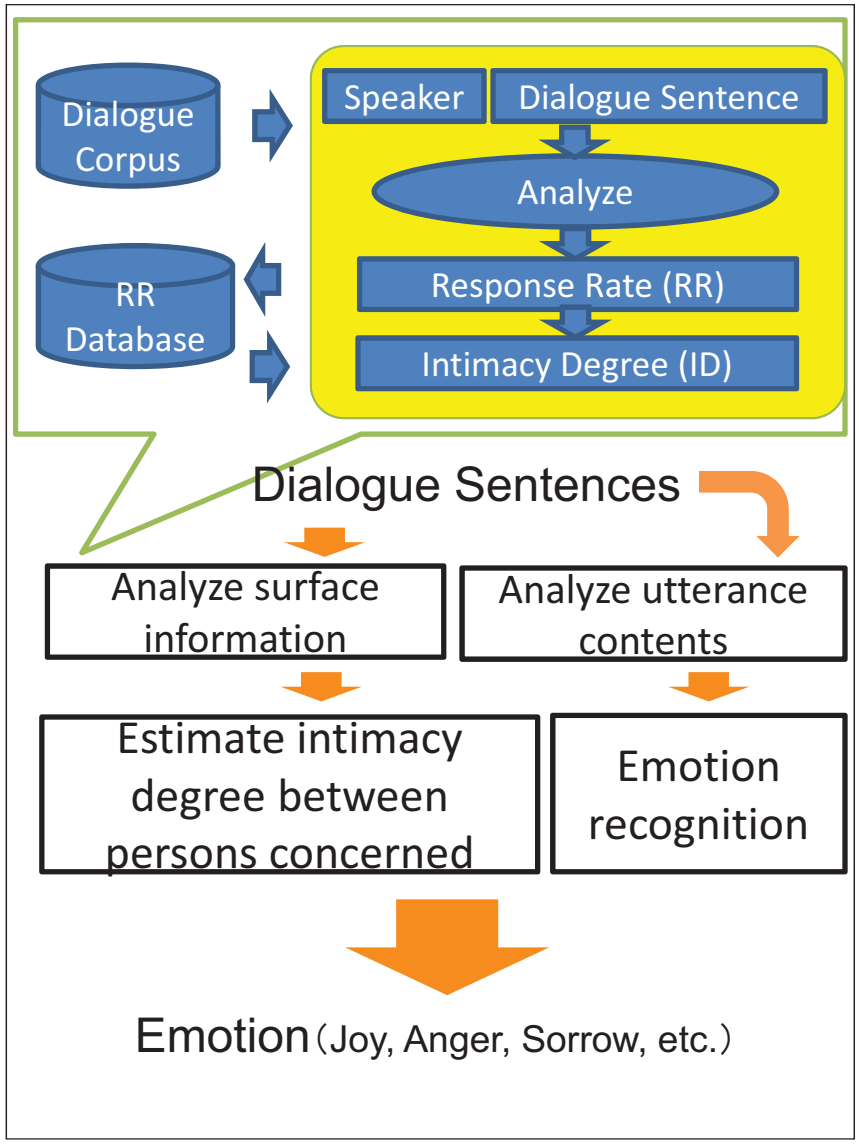
Research on Emotion Recognition by Language Information

Assistant Professor Kazuyuki Matsumoto



Content:

In our research, we focuses on language information such as wording used by the speaker and estimated his/her emotion.

Because human emotion is difficult to be recognized superficially, we consider the rhythm of the conversations, relationships/personalities of the persons concerned in the conversation and try to use these information for emotion recognition.

We extract/estimate emotion expressed by each word, sentence-end expression and speaker's intention from dialogue sentences, and use them to increase accuracy of emotion recognition.

By focusing on change of both wordings and emotions and difference of both wordings and personalities, we create dialogue data that are manually annotated such information and analyze them.

To recognize emotions from short sentences on microblog, the knowledge acquisition method from a small amount of information is also being studied.

We are also interested in how to process unknown/new words included in spoken language. Expressions that are difficult to be processed with existing methods such as onomatopeias or metaphors are also another research subject for us.

Keywords : Emotion recognition, dialogue, language information

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