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Heterogeneous Wireless Network

Professor Kazuhiko Kinoshita

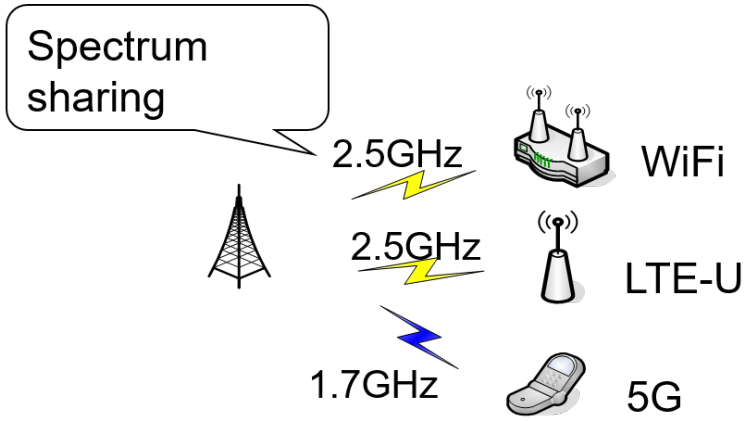

Fig.1 Spectrum Sharing

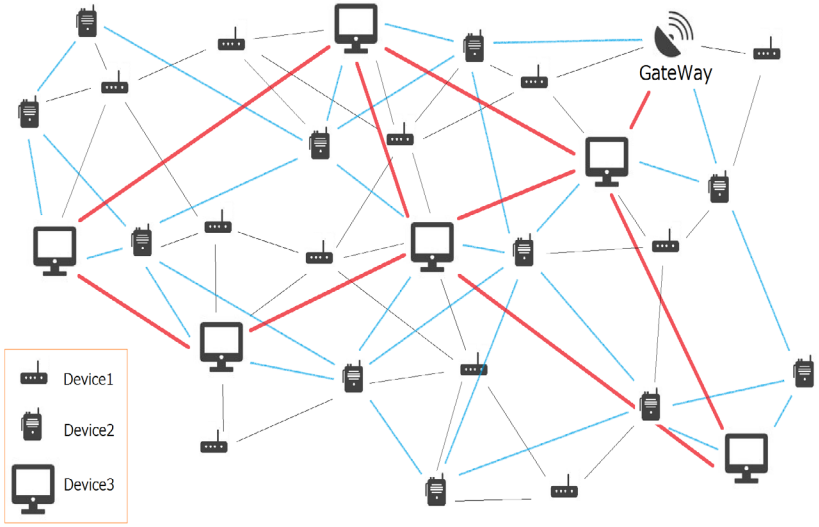

Fig. 2 Wireless Multi-hop Network for M2M/IoT Services

The number of wireless network users has remarkably grown by recent advances in wireless communication technologies such as Wi-Fi and 5G. 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 Wi-Fi 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 multi-hop networks

Keywords：wireless network, spectrum sharing

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Content-based Multimedia Information Retrieval Systems

Professor Masami Shishibori

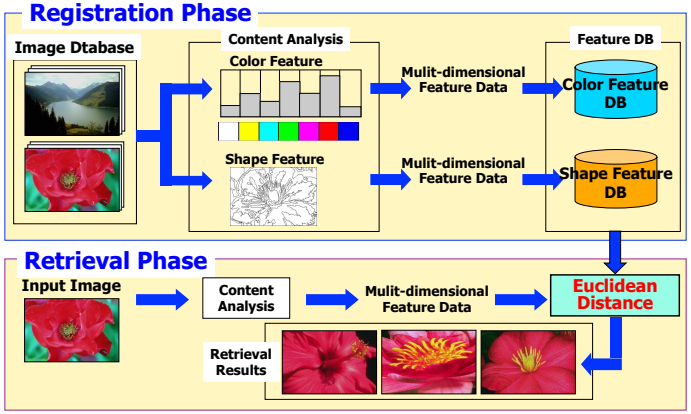

Fig.1 An example of content-based image retrieval systems

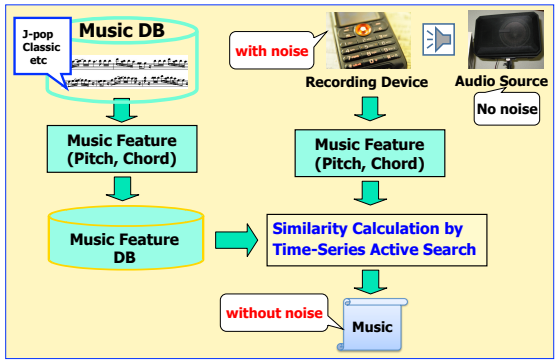

Fig.2 Noise robust music retrieval system

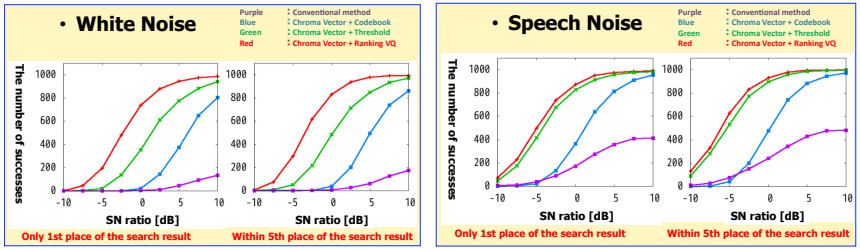

Fig.3 Experimental results on music retrieval systems

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

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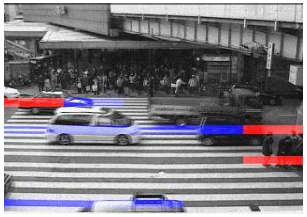
Image Sensing of Complicated Motion and Indistinct Shape Objects

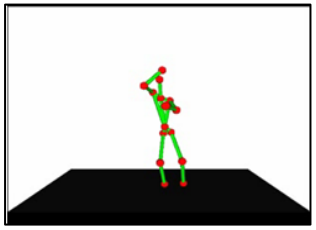
Professor Kenji Terada

■Fire Detection

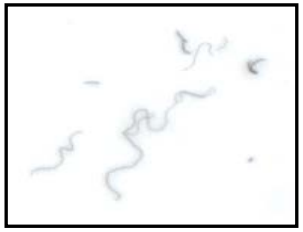
■ITS



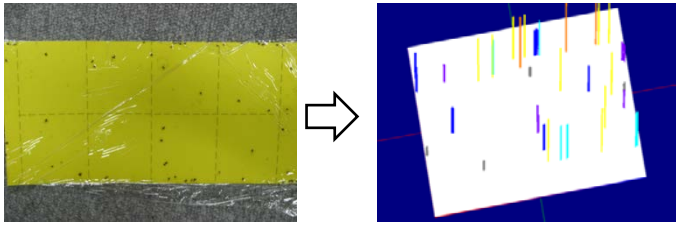
■Quality of Skill



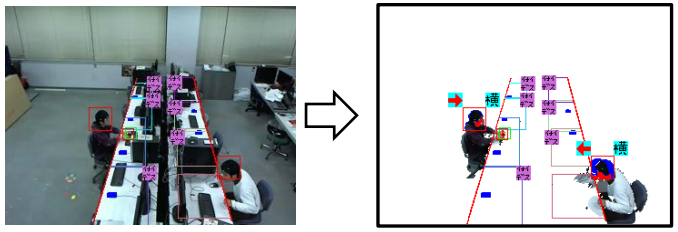
■Environmental Preservation



■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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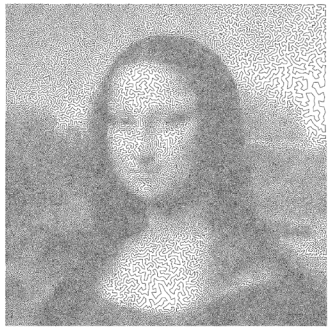
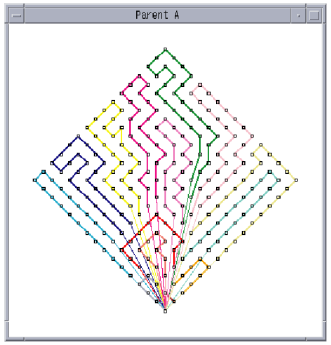
Metaheuristics for large combinatorial optimization problems

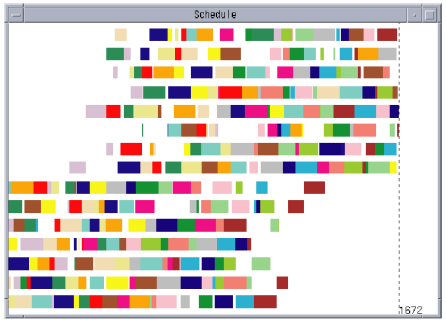
Professor Yuichi Nagata



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.

Content:

Metaheuristics are approximate methods used for solving 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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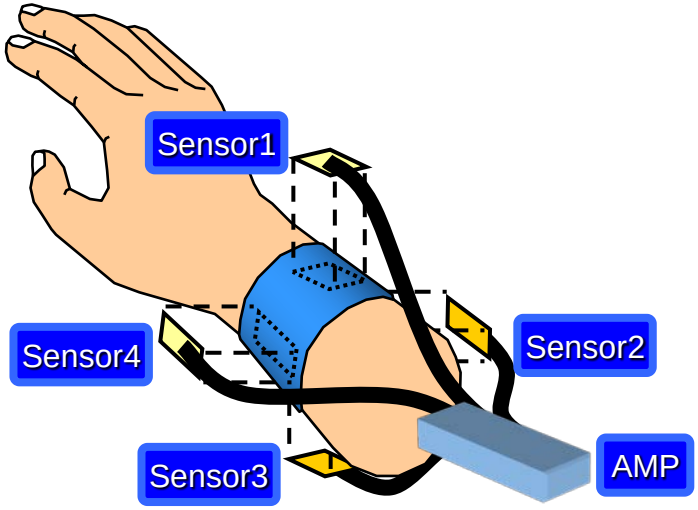
Hand motion recognition using wrist EMG

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), 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, including the use of deep learning.

Keywords : EMG, Simple-FLDA, Statistical learning

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

Professor Masao Fuketa

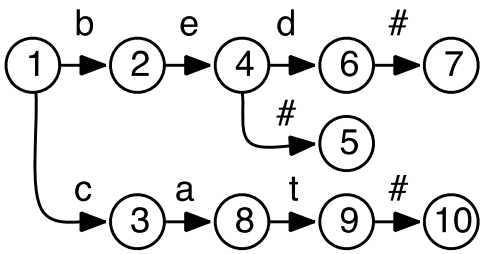

Figure 1 Example of a trie

	1	2	3	4	5	6	7	8	9	10
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 structure

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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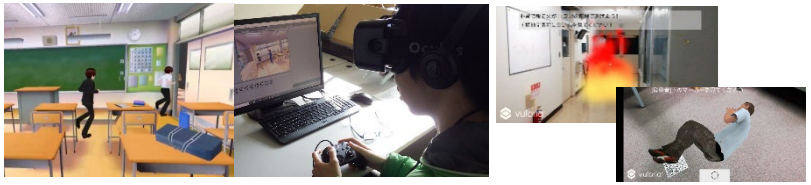
ICT-based Disaster Education Systems

Professor Hiroyuki Mitsuhara

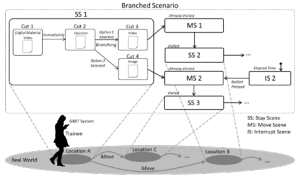
VR/AR-based Evacuation Training Systems

Enhancing interactivity and reality of evacuation training



Evacuation Training System using LBG

Mainly training school students to be survivors



LBG-based System for Learning Local Disaster Management

Applying Pokémon GO's idea to disaster education

AR-based System for Visualizing Disaster Situations

Superimposing virtual disaster situations (CG) onto the real-time vision

Content:

(1) Background and Motivation

Anyone can encounter disasters. People should learn how to survive disasters and recognize that disasters are not someone else's problem. However, traditional disaster education has not yet been established. For example, in traditional evacuation training, participants simply follow a fixed route in a normal situation. Disaster education should be improved by ICT to be more interactive and realistic.

(2) Overview

My research team aims to develop new disaster education systems using ICT (e.g., VR/AR, digital game, and mobile systems) and practice the systems mainly in schools.

Projects:

- VR/AR-based Evacuation Training Systems
- Evacuation Training System using LBG (Location-based Game)
- LBG-based System for Learning Local Disaster Management
- AR-based System for Visualizing Disaster Situations

Keywords：VR/AR, digital game, and mobile systems

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Gap based Analysis of Subspace Identification Method

Associate Professor Kenji Ikeda

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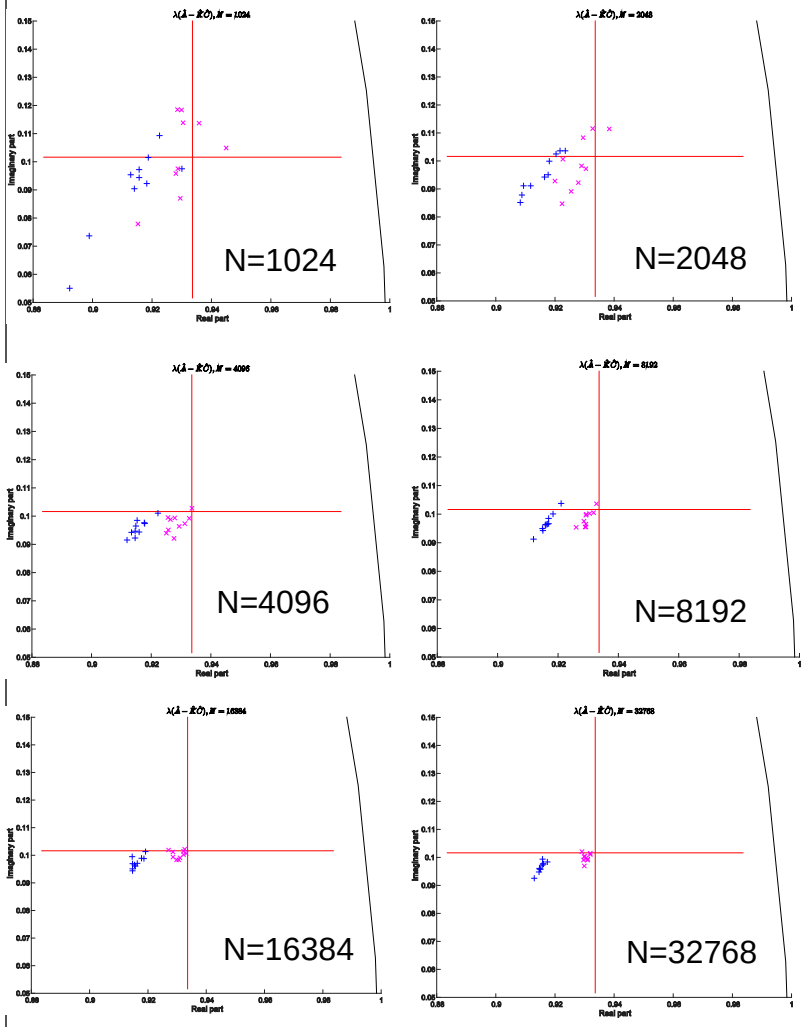

Content:

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 fields in the control engineering which estimates the plant model systematically from 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 are not sufficient.

We have proposed a variance analysis method based on the gap between the singular subspaces spanned by some data matrix which enables us to compare several subspace methods and determine optimal design parameters, etc.

We are now proposing consistent estimates of Kalman gain and the covariance matrix of the innovations process. Only asymptotically consistent estimates of them are proposed in the conventional methods. So, more accurate variance of the estimates will be evaluated.

Keywords：System Identification, Subspace identification, Variance analysis

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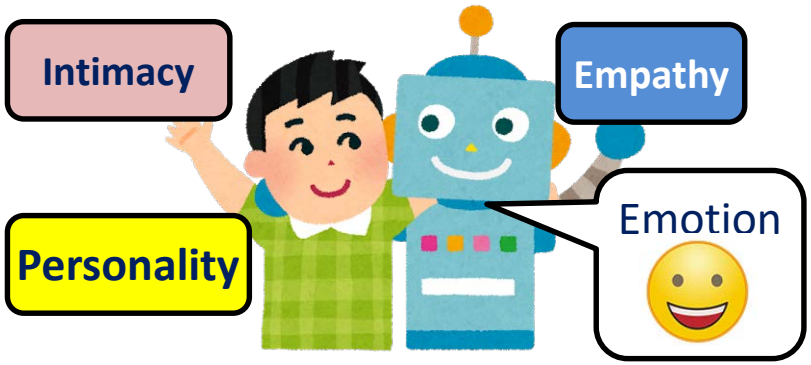
Research on Kansei Information Processing and Kansei Robotics

Associate Professor Kazuyuki, Matsumoto

Human-Friendly Kansei Robot

Understand human emotions, personalities and relations



- Emotion Estimation
- Reputation Analysis
- Personality Analysis
- Conversion of Slang to Standard Word
- Intimacy Estimation
- Analysis of Non-verbal Expression on Web

Application to nursing and caring

Content:

In order to construct human-friendly kansei robots, my research mainly focuses on kansei estimation from language and reputation analysis. Individual messages on Social Networking Sites (SNS) are effective to find out latest trends or public opinions. However, we might miss important information in the analysis due to the words that are not included in the existing dictionaries. Considering that such newly-coined words are often representing personal emotions or the trends of the times, it would be important to construct a dynamic and effective dictionary for reputation/opinion mining analysis. The meanings or frequency of use of the newly-coined words also change depending on the communities in which they are used, and their meanings or tendency of usage receive a lot of influence from the times. Therefore, it would be necessary to adjust the information regarding their sensitivity, usage, degree of importance, etc. properly according to the environments in which they are used. My study deals with how to effectively extract knowledge to automatically construct an effective dictionary that can be updated automatically according to analysis purposes. If the proposed method is realized, more accurate analysis of reputation or flame based on SNS would be possible.

Keywords : Affective Computing, Kansei Information Processing, Kansei Robotics

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Construction of Impression Knowledge from Words

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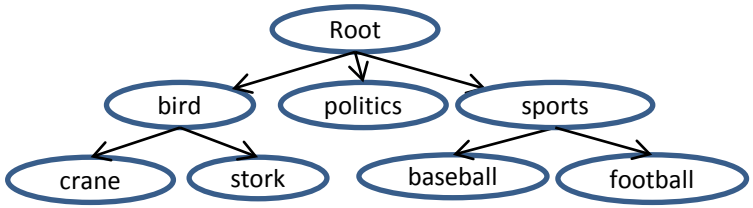
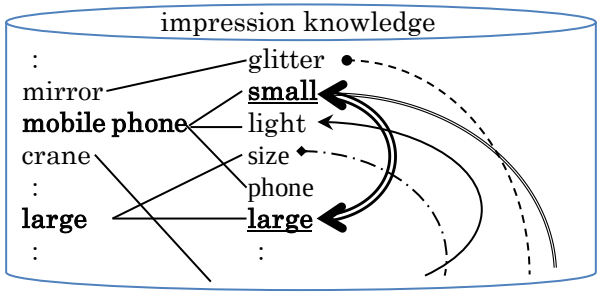
Associate Professor Kazuhiro, Morita



(a) Example of the usual conceptual knowledge



(b) Example of constructed impression knowledge

Fig. 1 Outline of impression knowledge

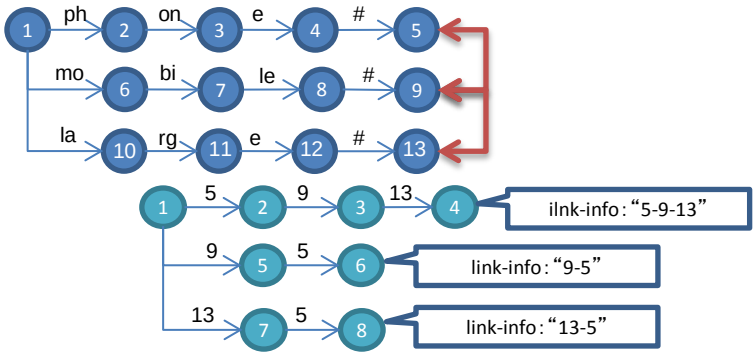


Fig. 2 Dictionary structure of impression knowledge

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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Electroencephalogram Analysis Considering Personality

Associate professor Shin-ichi Ito

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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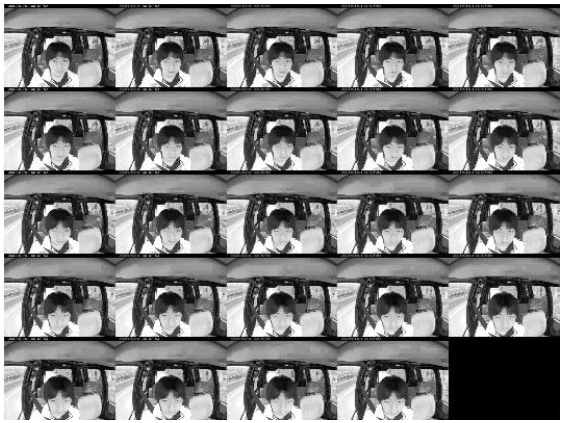
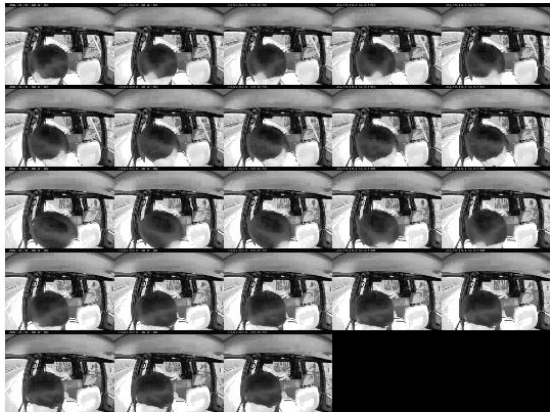
Safety Driving Assistance System using Driving Behavior

Associate 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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Faculty of Science and Technology
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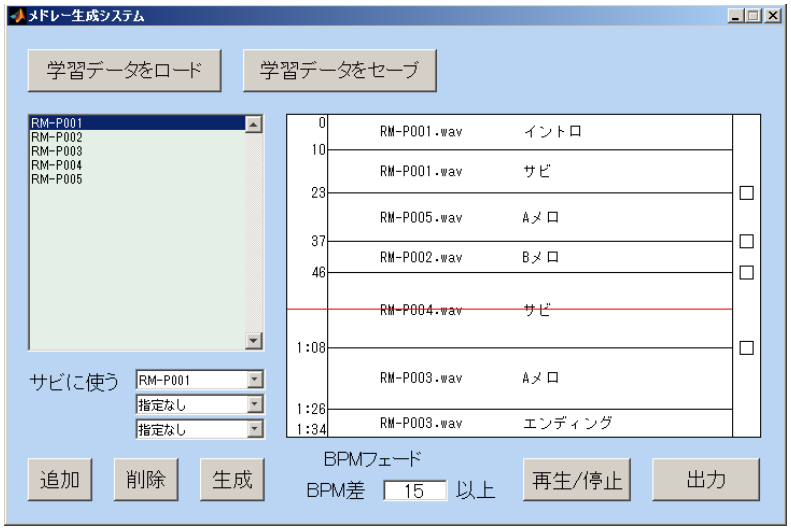
Research of Intelligent Music Information Processing System

Lecturer Masaki Oono



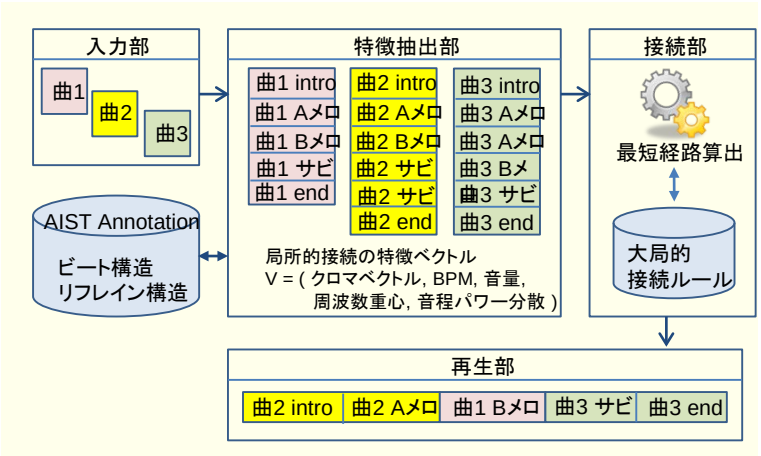


Figure 1 Medley song genaration system

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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Studies on Personal Area Wireless Networks and Virtual Reality Assisted Network Simulations

Assistant Professor Alberto Gallegos Ramonet

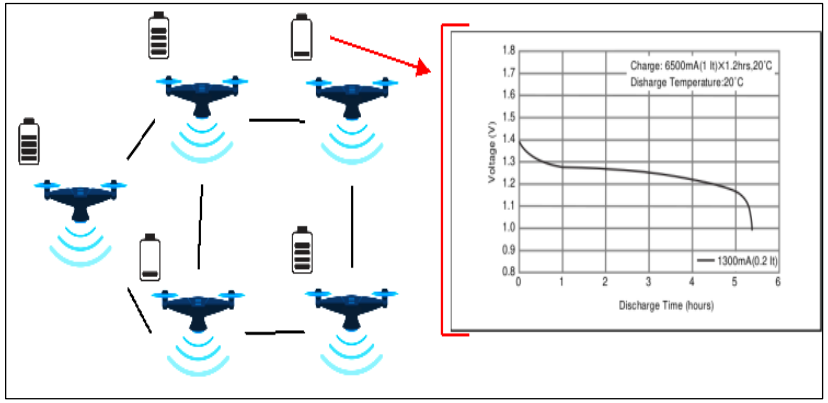

Fig 1. Multi-hop wireless network set on drones. Drones autonomous navigation and communication considers de battery discharge status of each individual drone.

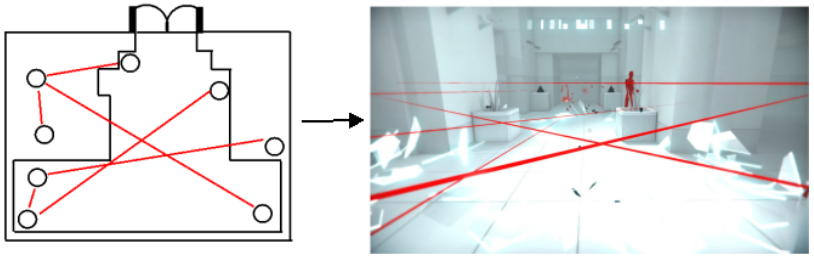

Fig 2. Simulation of a realistic personal area wireless network using the help of a Virtual Reality environment.

During the past few years, the interconnectivity between small devices have rapidly increased. These devices communicate with one another through networks used in appliances in our homes, medical equipment, security and monitoring devices. The networks used by these small devices are often limited and impose many challenges. Furthermore, these networks may or may not be connected to the Internet. While these type of networks are often overlooked, they are one of the pillars that supports IoT (Internet of Things) and the development of future networks. In these research, the following topics are studied:

- Development of new communication protocols for personal area and body area networks (IEEE 802.15.4 & IEEE 802.15.6).
- Measurement of energy consumption and development of energy efficient algorithms used in radio transceivers and vehicles (e.g. drones)
- Development of simulation tools that support the development of these networks: (A) Simulated networks using virtual reality environments. (B) Simulated energy models for batteries and radio transceivers.

Keywords: Personal Area and Body Area Wireless Networks, Network Protocols, Energy efficient Networks, Network Simulation tools, Networks on Virtual Reality Environments.

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Multimedia Data Pattern Recognition

Asso.Prof. Stephen Karungaru

- **Human behavior recognition**

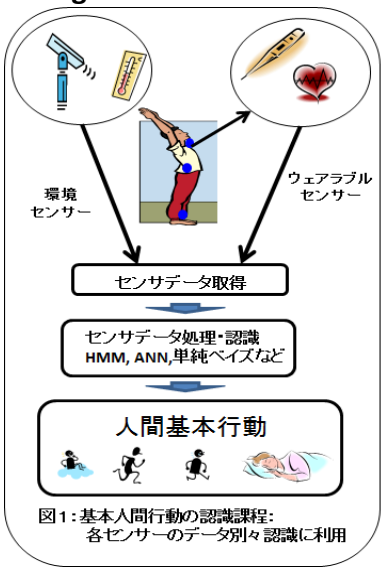

図1：基本人間行動の認識課程:
各センサーのデータ別々認識に利用

- **Intelligent Transportation Systems**

Content:

- **Research Topics**
- **Road signs recognition/ safe driving assist technology**
- **Vehicle recognition and tracking using surveillance cameras**
- **Human Action recognition using wearable sensors**
- **QR code analysis using smart phone**
- **Surveillance camera based human action recognition**
- **Kanji character recognition using smart phone**
- **Human tracking and recognition suing an Air-drone**
- **Sports skill assisting technology**

Keywords：Pattern recognition, Wearable sensors

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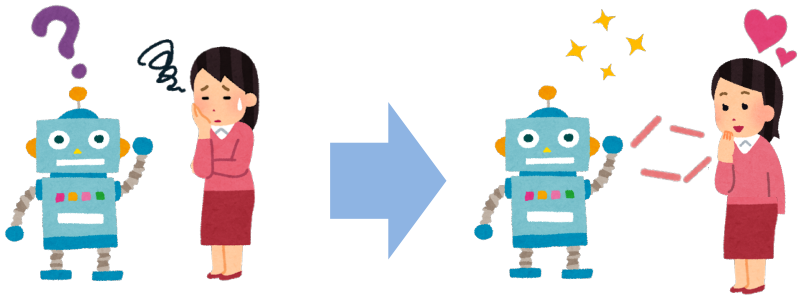
Spoken Dialog System based on Real-time Control of Dialog Tempo for Smooth Dialog

Associate Professor Ryota NISHIMURA



Probrem:
Robots can't interact as naturally as humans

Solution:
Focus on conversation tempo and make it smoother

Basic module configuration of spoken dialog system

data

(A)speech	(B)sentence	(C)semantics	(D)semantics	(E)sentence	(F)speech
	How is the weather in Kyoto?	Topic :Weather Date :Today Place :Kyoto	Topic :Weather Date :Today Weather :fine	It looks fine	

Improve the performance of each part

- Introduction of deep learning
- Response timing control
- select response content

- Daily conversation voice data
- large conversation data

Mutual cooperation

- Use info from each part
- Exchange information
- In real time
- Mutual use of interim results

1) Research background

In recent years, **spoken dialog systems** such as Apple Siri have become widespread. However, **a smooth conversation** like a conversation between humans **cannot be performed**. To achieve this, the control of other elements is indispensable.

2) Research method

In this study, we **focus on the tempo** of the dialog (volume, pitch, speed, timing). The purpose of this research is to clarify the elements necessary for the user to use the spoken dialog system naturally and enjoyably.

3) Application

As a result of this research, it is **possible to realize a robot that can have more fun and smooth interaction** by being able to perform conversations with good tempo.

Not only that, this technology is indispensable as a means for inputting information to a spoken dialogue system, robot, and device.

Keywords: spoken dialog system, speech recognition, tempo, real-time

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Interactive Text Mining on a Corpus

Lecturer Minoru Yoshida

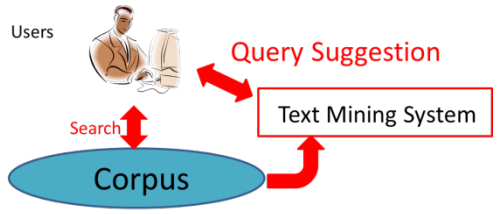

Fig.1: Workflow: Query Suggestion by Text Mining

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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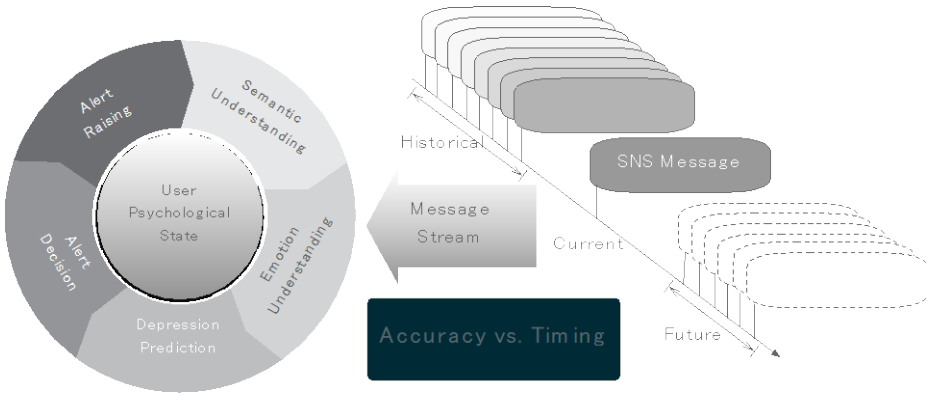
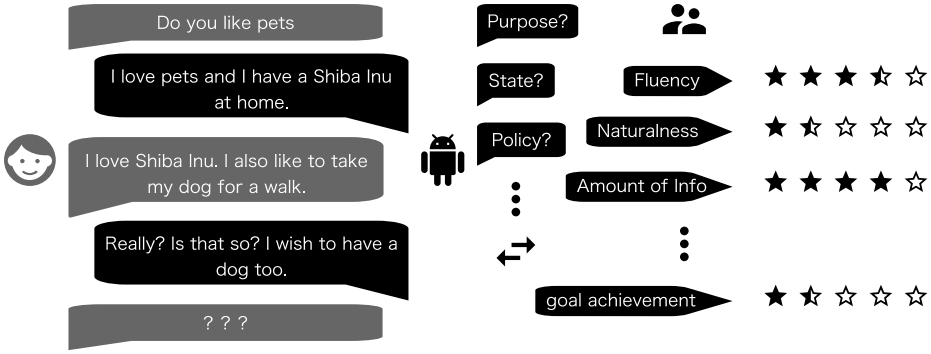
Research of Early Depression Detection & Research of Dialogue Quality Evaluation and Domain-Specific Dialogue Generation

Assistant Professor Xin, Kang

Early Detection of Depression



Dialogue quality evaluation & Domain-Specific Dialogue Generation



Early detection of psychiatric disorders has become an important issue for psychological treatment and rehabilitation. In this research we use semantic and emotion understanding modules for analyzing message streams of SNS users and propose a model for predicting their depression probabilities while learning a policy for raising the alert of depression as soon as possible. Alerts can be provided to SNS users or to the medical and hygiene institutions for further treatments. In this study, we examine various machine learning methods in order to resolve the contradiction between two important targets, that is, the detection accuracy and the alert raising time.

The rise of voice assistants such as Siri and Alexa is inspiring new researches for developing human-like dialogue systems. However, as the conversation scenario or purpose varies, uniformly defining “humanity” in the generated dialogues still challenges the academic society. Without clear constraints such as “humanity” to the learning target, dialogue systems tend to generate semantically conflicting or even ethically violating utterances, which are unacceptable in many real-world use cases. This research focuses on service counter conversation and psychological counseling conversation and experimenting psychological theories with various machine learning methods for automatically evaluating the humanity of dialogue systems while improving the quality of generated dialogues.

Keywords : NLP, Early Risk Detection, Dialogue Quality Evaluation, Dialogue Generation

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