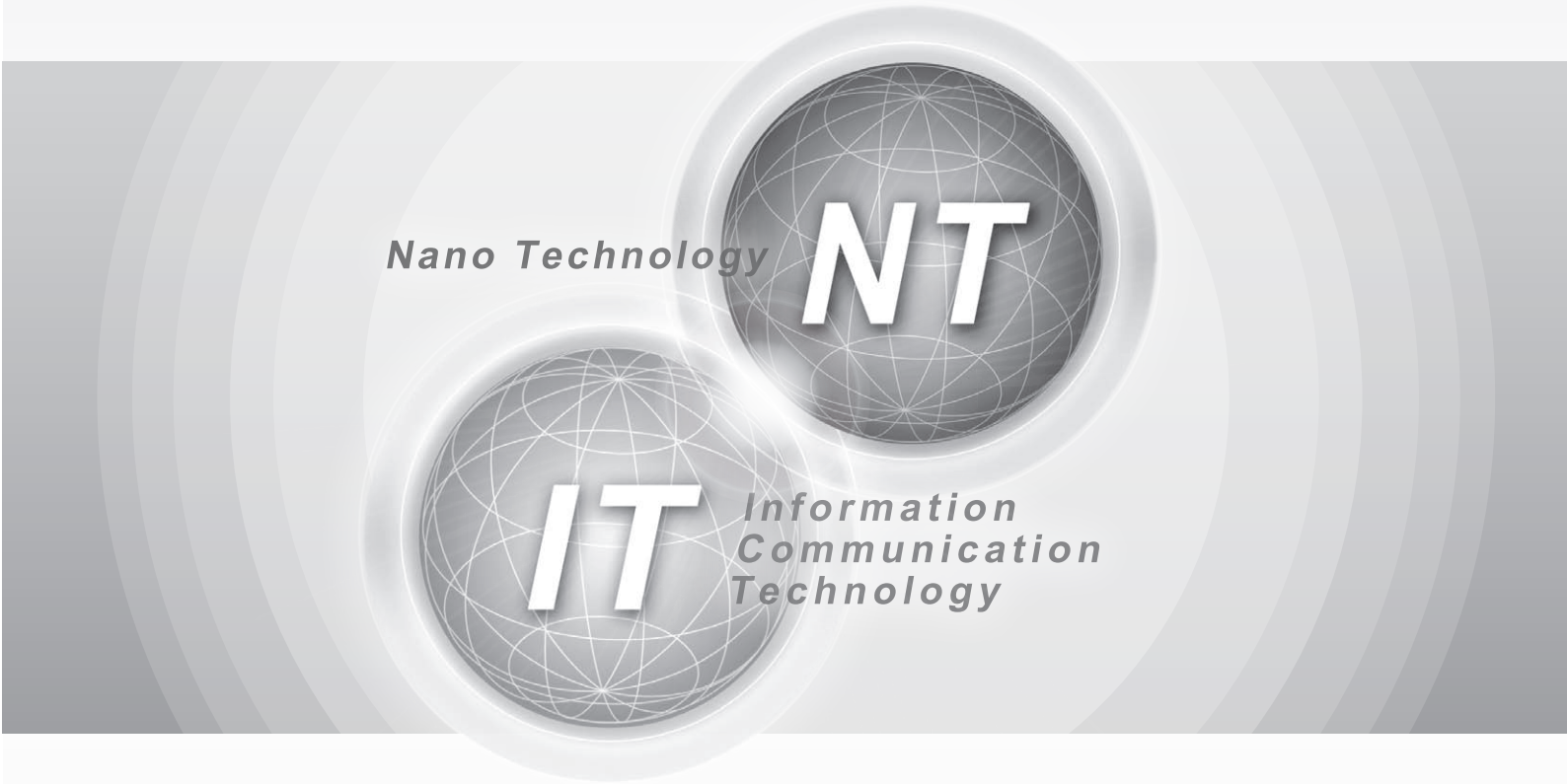
Advance Program

CERIES-GCOE/SOIM

Center of Education and Research for Information Electronics Systems Tohoku University



The 5th International Symposium and the 4th Student Organizing International Mini-Conference on Information Electronics Systems

February 22-24, 2012
The Westin Sendai 2F, Sendai, Japan
http://www.ecei.tohoku.ac.jp/gcoe/

Global COE NT IT CERIES

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The 5th International Symposium and the 4th Student Organizing International Mini-Conference on Information Electronics Systems,
The Westin Sendai, February 22nd to 24th, 2012

Program at a Glance

Wednesday, February 22nd, 2012

9:00-9:30	**Opening Session (Conference Room A : Take(竹))**		
		Opening Remarks	Nei Kato
		Opening Remarks	Akihisa Inoue (President, Tohoku University)
		GCOE Activities for Five Years	Fumiyuki Adachi
		v-QI School Outcomes	Masayuki Kawamata
9:30-10:20	1A-1	Strategic Research and Innovation in Optical Communications: An Excited-State Lifetime of Forty Years at AT&T Bell Lads (Keynote)	Tingye Li (Emeritus AT&T)
10:20-10:40		**Break**	
10:40-11:20	1A-2	Vehicular Communication Networks: Opportunities and Challenges (Invited)	Weihua Zhuang (University of Waterloo)
11:20-12:00	1A-3	Sensitive Superconducting Detectors at Terahertz and Optical Wavebands (Invited)	Jian Chen (Nanjing University)
12:00-13:20		**Lunch**	
13:20-13:50	2A-1	Challenge to Ultrafast and High-Spectral-Density Optical Communications Systems	Masataka Nakazawa
13:50-14:20	2A-2	Reflectarray Development for Elimination Blindness Propagation Channel	Kunio Sawaya
14:20-14:50	2A-3	Recent Advances in Gigabit Wireless Technology	Fumiyuki Adachi
14:50-15:20	2A-4	A Robust Optimization of Designing P2P System with Attack and Fault	Nei Kato
13:20-13:50	2B-1	Recent Progress in Spintronics Technology for Nonvolatile VLSIs	Hideo Ohno
13:50-14:20	2B-2	Tailor-Made Nano Structured Material for Highly Qualified Spin Related Devices	Migaku Takahashi
14:20-14:50	2B-3	Perspective of 10 Tbitt/inch^2 Information Storage	Hiroaki Muraoka
14:50-15:20	2B-4	Scanning Nonlinear Dielectric Microscopy	Yasuo Cho
15:20-15:40		**Break**	
15:40-16:20	3A-1	Constrained Nonnegative Matrix Factorization for Recognition Tasks from Facial Images (Invited)	Chiou-Ting Hsu (National Tsing Hua University)
16:20-16:40		**Break**	
16:40-17:10	3A-2	New VLSI Platform for Real-World Intelligent Integrated Systems based on Algorithm Selection	Michitaka Kameyama
17:10-17:40	3A-3	Wire-Fault-Tolerant Delay-Insensitive Asynchronous Communication Link with Current-Level Monitoring	Takahiro Hanyu
17:40-18:10	3A-4	Higher-Order Model Checking and its Applications	Naoki Kobayashi
16:40-17:10	3B-2	Nanocarbon-Nanoelectronics Oriented Nanoscopic Plasma Control	Rikizo Hatakeyama
17:10-17:40	3B-3	Self-ordered Nano-tubular Structures: Formation and Applications	Michio Niwano
17:40-18:10	3B-4	Application of the Ultrasonic Micro-spectroscopy Technology to Next-Generation Functional Glasses	Jun-ichi Kushibiki
18:10-19:40		**Welcome Reception (Hermitage 3F)**	All

Thursday, February 23rd, 2012

9:00-9:50	4A-1	Spin Based Quantum Computation with Quantum Dots: Qubit, Qubit Gate and Scale-up (Keynote)	Seigo Tarucha (University of Tokyo)
9:50-10:30	4A-2	Nanostructured Semiconductor Layers Grown on Oxidized Si Surfaces (Invited)	Alexander A. Shklyaev (The Institute of Semiconductor Physics)
10:30-10:50		**Break**	
10:50-11:20	4A-3	Multi-Photon Quantum Optics and Quantum Information	Keiichi Edamatsu
11:20-11:50	4A-4	Atomically Controlled Processing for Future Si-based Devices	Junichi Murota
11:50-13:10		**Lunch**	
13:10-15:00	Short Presentation I & II	**(Conference Room A: Take(竹)) (14:00-14:10 Break)**	All RAs
15:00-17:00	Poster Session and Exhibition	**(Conference Room B: Suzume (雀) & Sakura(桜))**	All Members and RAs
17:00-19:00		**Banquet (Hermitage 3F)**	All

Friday, February 24th, 2012

9:00-9:50	5A-1	Symbolic Interaction in Sound and Music (Keynote)	Gérard Assyag (IRCAM, CNRS, UPMC)
9:50-10:30	5A-2	High-Accuracy Design and Implementation of All Pass-Based Hilbert Transformers and Fractional Delay Filters (Invited)	Georgi Stoyanov (Technical University of Sofia)
10:30-10:50		**Break**	
10:50-11:20	6A-1	Toward Realizing High Sense-of-Presence Communications with 3D Spatial Sound Systems	Yôiti Suzuki
11:20-11:50	6A-2	Efficient Image Segmentation Algorithms with Flexible Shape Control	Takeshi Tokuyama
11:50-12:20	6A-3	Toward Machine Vision Technology Overcoming the Pixel Resolution Limit --- From 3D Vision to Medical Imaging ---	Takafumi Aoki
10:50-11:20	6B-1	Development of the Next Generation Highly Functional Display Systems	Tatsuo Uchida
11:20-11:50	6B-2	The Class of Digital Filters with All Second-Order Modes Equal	Masayuki Kawamata
11:50-12:20	6B-3	Probabilistic Computational Models for Statistical Inference and Learning Based on Bayesian Analysis and Belief Propagation	Kazuyuki Tanaka
12:20-12:40		**Break**	
12:40-13:20	7A-1	What Future Robots Will Understand by Analyzing Human Movements and Biological Signals (Invited)	Adrian Stoica (Jet Propulsion Laboratory)
13:20-13:30		**Closing Remarks**	Nei Kato
13:30		**Adjourn**	

Location of Session A: Conference Room A (Take:竹), Location of Session B: Conference Room B (Suzume:雀)

9:00--9:30 **Opening Session**

Opening Remarks	**Nei Kato**
Opening Remarks	**Akihisa Inoue** (President)
GCOE Activities for Five Years	**Fumiyuki Adachi**
ν -QI School Outcomes	**Masayuki Kawamata**

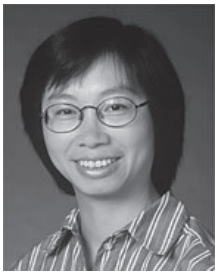
9:30--10:20 **1A-1: Strategic Research and Innovation in Optical Communications: An Excited-State Lifetime of Forty Years at AT&T Bell Labs (Keynote)**

Tingye Li, Emeritus, AT&T Bell Laboratory, USA

Strategic research may be regarded as that mission-oriented work which is focused on producing significant advances and innovations in a particular field. It can be fundamental or applied, but always involves having realistic goals in mind, a deep understanding of physical principles and a good appreciation for applications issues. It is often associated with a vision that could launch a new technical direction and spawn innovations that would engender significant industrial and societal impact. Innovation, on the other hand, is the process by which novel ideas or concepts are created and translated into viable applications. The innovation process can initially be a one-person or small-group effort, but later would evolve into a large-scale, institutionally-supported, mission-driven team endeavor, motivated by significant and measurable operational and economical gains. In this talk, I shall relate my experiences and observations as a participant of strategic research and innovation in the field of optical fiber communications at AT&T Bell Laboratories over a professional career of four decades.

10:20--10:40 **Break**

10:40--11:20 **1A-2: Vehicular Communication Networks: Opportunities and Challenges (Invited)**



Weihua Zhuang, University of Waterloo, Canada

Vehicular ad hoc networks (VANETs) are envisioned to be a cornerstone for road safety, intelligent transportation, mobile Internet access, and many location dependent commercial applications. The growing importance of inter-vehicular communications has been recognized by governments, academia, and industry. VANETs have unique features that provide opportunities for optimizations, but also have complex aspects that challenge the system design and implementation. This presentation will provide an overview of the state-of-the-art in the development of VANETs, discuss research challenges, and identify some open issues for resource allocation, network control, and service provisioning in VANETs.

11:20--12:00 **1A-3: Sensitive Superconducting Detectors at Terahertz and Optical Wavebands (Invited)**

Jian Chen, Nanjing University, China

This report will focus mainly on the recent progress in RISE on the research and development of sensitive superconducting detectors at terahertz (THz) and optical waveband, including superconducting hot electron bolometer (HEB) THz mixer and superconducting nanowire single photon detector (SNSPD) For the HEB THz mixer, the double sideband receiver noise temperature of 1135 K at 2.5 THz has been obtained at 4.2 K without corrections. It is about 8.5 times of the quantum limit noise temperature and same with the performance of the HEB used in the Herschel Satellite. For the SNSPD, the maximum system detector efficiency of 32% for 404 nm photons, 21% for 660 nm photons and 10% for 1310 nm photons have been achieved. Its applications will be discussed.

12:00--13:20 **Lunch**

Session 2 (A): Wednesday, February 22nd, 13:20--15:20

Optical/Wireless Technology and Networking

13:20--13:50

2A-1: Challenges to Ultrafast and High-Spectral-Density Optical Communications Systems

Masataka Nakazawa, Tohoku University, Japan

We present our recent progress toward the realization of ultrahigh-speed coherent optical transmission using ultrashort pulse technology and an advanced modulation format. We first describe 2.56 Tbit/s/ch optical time division multiplexing (OTDM) transmission using an ultrafast optical Fourier transformation technique. We then focus on coherent optical transmission using quadrature amplitude modulation (QAM) with a multiplicity of 512~1024, which aims at a spectral efficiency approaching the Shannon limit. Finally, we demonstrate an ultrafast, spectral-efficient transmission with an OTDM-RZ/QAM scheme, in which 800 Gbit/s, 32 RZ/QAM signal was successfully transmitted over 225 km using a novel RZ-CW conversion technique.

13:50--14:20

2A-2: Reflectarray Development for Eliminating Blindness in Wireless Propagation Channel

Kunio Sawaya, Tohoku University, Japan

An approach using reflectarray to eliminate blindness in wireless propagation channel and to increase the multipath richness for MIMO (Multiple Input Multiple Output) communications is studied. Theoretical and numerical approaches are shown to design the reflectarray which scatters the incident wave to a desired direction at dual frequency band. The reflectarray having characteristics such as the dual-polarization control and broad bandwidth is also studied. An outdoor experiment is demonstrated to show the performance of the reflectarray in improving propagation channel of wireless communications.

14:20--14:50

2A-3: Recent Advances in Gigabit Wireless Technology

Fumiyuki Adachi, Tohoku University, Japan

Gigabit wireless technology that can achieve data transmissions of higher-than-1Gbps is demanded. However, unfortunately, the available wireless bandwidth is limited. Particular attention is paid to frequency-domain multi-input/multi-output (MIMO) multiplexing to significantly increase the throughput without expanding the signal bandwidth. Besides the gigabit wireless signal processing, another important issue exists. Gigabit data services need prohibitively high transmit power if the present network architecture is employed. A new wireless network that can significantly reduce the transmit power is required. An introduction of distributed antenna network architecture is a promising solution to this issue. In this talk, we will overview the state-of-the-art gigabit wireless technology.

14:50--15:20

2A-4: A Robust Optimization of Designing P2P Systems with Attack and Fault

Nei Kato, Tohoku University, Japan

Distributed networks have attracted much attention due to their scalability and inexpensiveness as compared to traditional centralized networks. While distributed networks are appropriate to construct large-scale networks, insuring the tolerance to both attacks and faults is still an unresolved issue. In this paper, we classify and evaluate the existing distributed networks based on their degree distributions. We also propose a method to construct a network based on bimodal degree distribution, which is tolerant to attacks and network faults.

15:20 --15:40 **Break**

Session 2 (B): Wednesday, February 22nd, 13:20--15:20

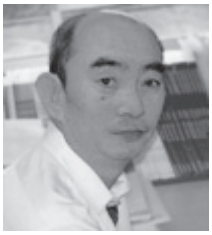
Memory-related Technology and Systems

13:20--13:50 **2B-1: Recent Progress in Spintronics Technology for Nonvolatile VLSIs**

Hideo Ohno, Tohoku University, Japan

Nonvolatile VLSIs, which embedded spin-transfer torque magnetic tunnel junctions (MTJs) with perpendicular magnetic anisotropy electrodes, have attracted much attention due to the expectation of reduction of power consumption and of interconnection delay. We found out that the perpendicular magnetic anisotropy in CoFeB/MgO stack structure resulting from interfacial anisotropy. The perpendicular anisotropy CoFeB/MgO MTJs (p-MTJs) exhibit high potential to achieve the high tunnel magnetoresistance (TMR) ratio, high thermal stability $\Delta=E/kBT$ and low switching current down to the junction size as low as 40 nm in diameter, simultaneously. These p-MTJ technologies will be a promising building block for spintronics based nonvolatile VLSIs.

13:50--14:20 **2B-2: Tailor-Made Nano-Structured Material for Highly Qualified Spin Related Devices**



Migaku Takahashi, Tohoku University, Japan

Highly qualified spin related devices such as ultra-high density hard disk drive (HDD), magnetic random access memory (MRAM), motor/generator, and antenna for high frequency use are inevitable requirements for future IT technology in sustainable and/or low-carbon society. Tailor-made spin nano-structured materials by precisely controlled fabrication technology with nano-scale in each devices and understanding their nanomagnetics are essential from the view point of material, process, and physics. Within the frame work of the present paper, correlation between tailor-made nano-structured material and magnetic properties developed for each categorized research items mentioned above will be widely discussed in connection with spin related devices.

14:20--14:50 **2B-3: Perspective of 10 Tbit/inch^2 Information Storage**

Hiroaki Muraoka, Tohoku University, Japan

Worldwide created information quantity is rapidly growing as 10 times per 5 years. The demand of areal density of HDD is therefore strong. Hard disk drives reached to the areal density of 1 Tbit/inch^2, where the bit area is only 625 nm^2. Several challenges are still remained to go beyond the terabit recording. In order to achieve 10 Tbit/inch^2, a narrow bit length of 8 nm is required. For such tiny bit writing, the first challenge is writing resolution, or writing head field gradient. Magnetic fluctuations such as switching field distribution or grain size dispersion must be also satisfied. Next challenge will be at around 3 nm or 100 Tbit/inch^2, where we will confront thermal and granular limit.

14:50--15:20 **2B-4: Scanning Nonlinear Dielectric Microscopy**

Yasuo Cho, Tohoku University, Japan

Scanning nonlinear dielectric microscopy (SNDM) is reviewed. First, experimental results on the detection of ferroelectric domains are shown following a presentation about the theory and principle of SNDM. Next, a noncontact scanning nonlinear dielectric microscopy (NC-SNDM) is proposed. Using NC-SNDM, we clearly resolve the electric dipole moment distribution of Si atoms on a Si(111)7x7 surface. We also succeeded to resolve a fullerene (C_{60}) molecule. Since the technique is applicable not only to semiconductors but also to both polar and non-polar dielectric materials, $SrTiO_3$ and TiO_2 surfaces were observed. Finally, we characterize an ultrahigh density ferroelectric data storage system using SNDM.

15:20--15:40 **Break**

15:40--16:20 **3A-1: Constrained Nonnegative Matrix Factorization for Recognition Tasks from Facial Images (Invited)**

Chiou-Ting Hsu, National Tsing Hua University, Taiwan

Nonnegative matrix factorization (NMF) tends to characterize local feature variation and has been shown to be more interpretable on facial images. In this paper, we focus on three problems of facial image analysis, including facial age estimation, age-invariant face recognition, and expression recognition. To solve the above recognition tasks, we propose to extract task-specific features by using a supervised NMF (SNMF). In addition, since different persons usually have very different appearance changes with respect to age or expression, it is not easy to find a set of good features feasible for all individuals. To overcome this difficulty, we further include a person-independent constraint and propose a new approach called person-independent SNMF (PI-SNMF) to characterize local face appearance. We conduct PI-SNMF on two kinds of face databases for the recognition tasks. Our experiments show that the derived facial bases indeed characterize the task-specific local variations and are successfully extended to tackle age-invariant face recognition, which is still an open problem among existing facial image analysis.

16:20--16:40 **Break**

16:40--17:10 **3A-2: New VLSI Platform for Real-World Intelligent Integrated Systems Based on Algorithm Selection**

Michitaka Kameyama, Tohoku University, Japan

A real-world intelligent system consists of three basic modules: environment recognition, prediction or estimation, and behavior planning. We propose a VLSI platform that is universal for every application and that includes an intelligent algorithm framework. The main reason for the VLSI platform is the requirement for high-speed processing to provide the best results as well as low-cost implementation. However, real-world information is highly complex and cannot be reliably analyzed using a single algorithm. Thus, a mechanism, that for any of the three computational stages select the best possible algorithm is developed. This selection mechanism is based on machine learning and uses features extracted from the real-world information. The resulting selection mechanism guarantees the most suitable algorithm usage in the recognition and behavior planning while selecting the best context for the estimation stage. To develop a low-cost, high-performance and low-power VLSI platform, we present a novel dynamic reconfigurable VLSI processor for real-time adaptation of the algorithm selection. The new architectures include a logic-in-memory architecture to solve data transfer bottleneck, an intra-chip packet routing scheme to reduce the size of the configuration memory, and power gating with asynchronous control to achieve low power.

17:10--17:40 **3A-3: Wire-Fault-Tolerant Delay-Insensitive Asynchronous Communication Link with Current-Level Monitoring**

Takahiro Hanyu, Tohoku University, Japan

A wire-fault-tolerant delay-insensitive asynchronous communication link with current-level monitoring is proposed for a highly reliable asynchronous Network-on-Chip system. Since current is cut off when open faults on interconnection wires between transmitter and receiver occur, the current level is getting increased at the transmitter. The current-level monitoring allows us to detect the interconnect fault with maintaining delay insensitivity. The efficiency of the proposed link is compared under 0.13μm CMOS with a Triple Modular Redundancy (TMR)-based asynchronous communication link. As a result, the energy consumption and the number of wires of the proposed link are reduced to 57% and 33%, respectively, in comparison with those of the conventional TMR-based one.

17:40--18:10 **3A-4: Higher-Order Model Checking and its Applications**

Naoki Kobayashi, Tohoku University, Japan

This paper gives an overview of our project on higher-order model checking and its applications. Model checking is a technique for automatically checking whether a given mathematical model satisfies a specification, and has been successfully applied to hardware and software verification. Higher-order model checking is a generalization of traditional model checking, where models are described as higher-order programs. Despite its extremely high worst-case complexity, we have recently developed a practical higher-order model checking algorithm that works well for typical inputs, and applied it to software verification. We summarize our recent and ongoing work in the paper.

18:10--19:40 **Welcome Reception** **Hermitage 3F**

16:40--17:10

3B-2: Nanocarbon-Nanoelectronics Oriented Nanoscopic Plasma Control

Rikizo Hatakeyama, Tohoku University, Japan

Based on nanoscopic plasma process control, we have created the following nanoelectronically-functional fullerenes, carbon nanotubes, and graphene. Firstly, the overwhelmingly-highest synthesis purity around 0.5% of atomic-nitrogen encapsulated C_{60} ($N@C_{60}$) is achieved toward a novel quantum-computer application. Secondly, an n-type thin film transistor is fabricated with Cs-encapsulated single-walled carbon nanotubes (Cs@SWNTs), which is very stable even in air, after long time soaking in water, and high temperature heating (<400℃). Thirdly, Au nanoparticles are decorated with their size and distance controlled on the surface of SWNTs toward novel applications of plasmonics-related nano and bio electronics. Fourthly, a transfer-free method for growing graphene directly on a SiO2 substrate is realized, and room-temperature selective edge functionalization and doping of graphene is developed toward its practical applications.

17:10--17:40

3B-3: Self-ordered Nano-tubular Structures: Formation and Applications

Michio Niwano, Tohoku University, Japan

It is well-known that on anodization in a suitable electrolyte, the so-called “valve” metals such as aluminum, tantalum, zirconium and titanium, undergo formation of porous anodic oxides with self-ordered nano-tubular structures. Those self-ordered nanostructures may be applied to various types of nano-electronic devices. We have fabricated low-power single-electron-transistors (SETs), organic and dye-sensitized solar cells (SCs), gas- and bio-sensors, by using a hybrid process in which anodization (bottom-up process) for formation of nano-tubular anodic oxides is combined with the conventional photolithographic technique (top-down process). We demonstrate that self-ordered nano-tubular anodic oxides have the potential to be used for high-performance nano-electronic devices.

17:40-018:10

3B-4: Application of the Ultrasonic Micro-spectroscopy Technology to Next-Generation Functional Glasses

Jun-ichi Kushibiki, Tohoku University, Japan

We applied ultrasonic micro-spectroscopy (UMS) technology to characterization of next-generation functional glasses, viz., TiO_2-SiO_2 ultra-low-expansion (ULE) glasses and synthetic silica (SiO_2) glasses. We developed a method of evaluating temperatures at which a coefficient of thermal expansion (CTE) of TiO_2-SiO_2 ULE glasses becomes zero. We demonstrated that TiO_2-SiO_2 ULE glasses with zero-CTE temperature ranging from -70°C to 140°C will be available. We also developed a method of evaluating the fictive temperature, parameter of glass structure related to the thermal history, of SiO_2 glasses. We applied UMS technology to homogeneity evaluation of TiO_2-SiO_2 and SiO_2 glasses.

18:10--19:40 **Welcome Reception** **Hermitage 3F**

Session 4 (A): Thursday, February 23rd, 9:00--11:50

Quantum Technology and Advanced Si Device

9:00--9:50

4A-1: Spin Based Quantum Computation with Quantum Dots: Qubit, Qubit Gate and Scale-up (Keynote)

Seigo Tarucha, University of Tokyo, Japan

Electron spin qubits with quantum dots have been demonstrated using various techniques. These achievements have motivated further effort to implement two-qubit gates and multiple qubit systems. I will review recent progresses in this direction. We have developed a micro-magnet technique to make spin qubits with quantum dots and then combined the spin rotation with inter-dot spin exchange coupling in a double quantum dot to realize a two-qubit gate to control spin entanglement. Concerning the scale-up, I will discuss a straightforward approach of making multiple quantum dots, and as an alternative of transferring a qubit state between distant quantum systems.

9:50--10:30

4A-2: Nanostructured Semiconductor Layers Grown on Oxidized Si Surfaces (Invited)

Alexander A. Shklyaev, The Institute of Semiconductor Physics, Russia

The growth of Ge and Si on the oxidized Si surfaces proceeds by the nucleation of three-dimensional islands with a concentration of the order of 10^{12}-10^{13} cm^{-2}. The islands can be epitaxial or non-epitaxial with respect to the Si substrate, depending on the growth temperature. These nanostructured surfaces are used for the growth of structures with dense arrays of quantum dots, as well as dislocation-free and dislocation-rich layers. Their growth mechanism, surface morphology, bulk structure and luminescent properties are discussed.

10:30--10:50 **Break**

10:50--11:20

4A-3: Multi-photon Quantum Optics and Quantum Information

Keiichi Edamatsu, Tohoku University, Japan

Efficient generation of multiple photons in a spectro-temporally pure state is important for novel multi-photon quantum optics and quantum information technology. We present our recent activities to develop such multi-photon sources by use of spontaneous parametric down-conversion with the extended phase-matching technique. We also show our experiments on multi-photon quantum interference and multi-photon entanglement.

11:20--11:50

4A-4: Atomically Controlled Processing for Future Si-Based Devices

Junichi Murota, Tohoku University, Japan

The concept is based on atomic-order surface reaction control by CVD. Si-based epitaxial growth on B or P atomic layer formed on Si(100) or $Si_{1-x}Ge_x$(100) surfaces is achieved at below 500 °C. The tensile-strained Si epitaxial growth suggests that the low electrical activity is caused by B clustering as well as the increase of interstitial B atoms and that tensile-strain enhances P surface segregation and reduces the incorporated P amount around the heterointerface. These results open the way for group IV semiconductors with high mobility as well as high carrier concentration by strain control for ULSIs using atomically controlled processing.

11:50--13:10 **Lunch**

PR-01

Toward Voltage-Controlled Magnetic Tunneling Junctions with ZnO-related Materials as Tunneling Barriers

Mohamed Belmoubarik, Sahashi Laboratory

Magnetic tunnel junctions (MTJs), composed of two ferromagnetic electrodes separated by a thin insulating barrier layer, are currently used in spintronic devices, such as magnetic sensors and magnetic random access memories. Recently, driven by demonstrations of ferroelectricity at the nanoscale, thin-film ferroelectric barriers were proposed to extend the functionality of MTJs. Due to the sensitivity of conductance to the magnetization alignment of the electrodes (tunneling magnetoresistance) and the polarization orientation in the ferroelectric barrier (tunneling electroresistance), these multiferroic tunnel junctions (MFTJs) may serve as multi-state resistance devices controllable by external electrical field. In this paper we propose another probe allowing the control of magnetoresistance (MR) with external electric field using ZnO-related materials as barriers.

PR-02

Manetotransport Properties of Current-perpendicular-to-plane Exchange Biased Spin Valves Based on Alternate Monatomic [Fe/Co]n Superlattices and Ag with Fe Insertion Layer

JinWon Jung, Sahashi Laboratory

The bulk and interface spin scattering asymmetric coefficients, ßF and γF/N, respectively, as well as the interfacial specific resistance, AR*F/N, contribute to the total resistance change-area product, ΔRA, in current-perpendicular-to-plane (CPP) geometry. The ßF is related to spin polarization in the conductance of the F materials, while γF/N is related to spin asymmetric scattering of the spin-up and spin-down electrons at interface between the ferromagnetic (F) and non-ferromagnetic (N) layers. Improved ΔRA values can be also be achieved by increasing the AR*F/N ,which is crucial factor in influencing spin transport and magnetoresistance, respectively, are large when compared to the band match between the F and N interfaces as a spacer layer. We report the effect of the insertion of a 1 nm Fe layer into F/N interfaces on the spin dependent transport properties. Using the Valet-Fert theory based on the two-current model in which ΔRA is obtained as a function of thicknesses of the ferromagnetic layer (3, 4, and 5 nm), we experimentally deduced the values of ßF, γF/N, and AR*F/N of exchange-biased spin valves (EBSVs) for an artificially ordered B_2 state $Fe_{50}Co_{50}$ alloy as a magnetic layer and an Ag spacer layer.

PR-03

Dependence of Tunnel Magnetoresistance Properties on Sputtering Conditions and Stack Structures in CoFeB/MgO Based Perpendicular Anisotropy Magnetic Tunnel Junctions

Kotaro Mizunuma, Ohno Laboratory

CoFeB/MgO based perpendicular anisotropy magnetic tunnel junctions (p-MTJs) have attracted much attention from the possibility to reach high density nonvolatile memory cell and logic chips. We investigated the effect of sputtering conditions on the tunnel maganetoresistance (TMR) ratio in the CoFeB/MgO p-MTJs. The maximum TMR ratio of 205% at RT was obtained in the p-MTJ with a 1.2 nm-thick MgO which deposited at high Ar gas pressure of 20 mTorr and a 1.3 nm-thick bottom CoFeB electrode which deposited at high sputtering power density of 0.88 W/cm^2.

PR-04

Magnetic Anisotropy Modulation in Ta/CoFeB/MgO by Electric fields: Annealing Temperature and Composition Dependences

Shun Kanai, Ohno Laboratory

We investigate the magnitude of the modulation of magnetic anisotropy in Ta/CoFeB/MgO with various annealing temperatures and compositions. The perpendicular anisotropy field is enhanced (reduced) by applying negative (positive) gate electric field, and the magnitude of modulation depends on annealing temperature. The largest modulation is observed when annealing temperature is around 225℃ in all CoFeB-compositions. The ratio of 65 mT per 1 V/nm is obtained for $Co_{20}Fe_{60}B_{20}$ annealed at 250℃.

PR-05 **Electrons Spin Relaxation Anisotropy in Modulation-doped GaAs/AlGaAs Wires**

Jun Ishihara, Ohno Laboratory

We investigated the electron spins relaxation of quasi-one dimensional electron gas in modulation doped GaAs/AlGaAs quantum well by optical time-resolved Kerr rotation measurement. It was shown that the spin dephasing time of electrons in a [110] oriented wire structure is longer than 1 ns, while that of the electrons in a [-110] oriented wirestructure is 60 ps at a magnetic field 1 T and the temperature 5 K. This strong anisotropy of the spin relaxation time indicates that the effective magnetic field due to the spin-orbit interaction is mostly cancelled for electrons moving along [110] orientation.

PR-06 **Excitonic Rabi oscillations in Self-assembled Semiconductor Quantum Dot Utilizing Photon Echo Spectroscopy**

Kenta Asakura, Edamatsu Laboratory

Semiconductor quantum dots (QDs) are promising candidates for solid-state quantum logic devices since excitons in QDs have atom-like optical properties due to the three dimensional confinement effects of the carriers. In this paper, we report on the experimental observation of the excitonic Rabi oscillations in self-assembled QDs by photon echo spectroscopy. The observed oscillations showed anomalous behavior which was unexpected in two-level systems. We successfully reproduced the observed curves by a numerical calculation including the local field effect (LFE). The agreement of the experimental and calculated curves implies the importance of LFE on the coherent manipulation of the excitons in QDs.

PR-07 **Optical Response of Biexcitons in CuCl Microcavities**

Shinpei Matsuura, Edamatsu Laboratory

We studied the optical response of biexcitons in CuCl thin film embedded in a microcavity by spectrally resolved four-wave-mixing (FWM). We measured the biexciton dispersion relation in the microcavity by observing the incident-angle dependence of the FWM spectra. The obtained biexciton dispersion did not follow the theoretically-expected strong coupling between the biexciton and the cavity photon. We also found that the dephasing time of the biexciton in the microcavity was faster than that of a bare CuCl thin film, indicating that the biexciton-photon coupling is in a weak coupling regime.

PR-08 **Generation and Characterization of Polarization Entangled Photon Pairs Using Two-period Quasi-phase Matched $LiNbO_3$**

Wakana Ueno, Edamatsu Laboratory

Entanglement is one of the key resources in quantum information technology. Spontaneous parametric down-conversion (SPDC) is the main method so far used to generate entangled pairs of photons. Quasi-phase matching (QPM) technique enhances the ability of SPDC. We have designed and fabricated periodically poled $LiNbO_3$ (PPLN) crystals having two poling periods and demonstrate the generation of polarization-entangled photon pairs at telecommunication wavelengths. The generated two-photon polarization state was analyzed by the quantum state tomography. We also design PPLN waveguides with two-period QPM to obtain higher conversion efficiency and applicability to extended phase matching.

PR-09 **Activation of Bound Entanglement in a Four-Qubit Smolin State**

Fumihiro Kaneda, Edamatsu Laboratory

Entanglement has an essential role in quantum information and communication technology (QICT). The entanglement thus far applied to QICT has been pure and distillable entanglement. Yet there is anothertype of entanglement, called “bound entanglement”, which is not distillable by local operations and classical communication. We demonstrate the experimental “activation” of the bound entanglement held in a four-qubit Smolin state, unleashing its immanent entanglement in distillable form, with the help of auxiliary two-qubit entanglement. We anticipate that it opens the way to a new class of QICT applications that utilize more general classes of entanglement than ever, including bound entanglement.

PR-10

Bottom Gate Polycrystalline Si Thin Film Transistors Prepared by Pulsed-plasma Chemical Vapor Deposition under Near Atmospheric Pressures

Yohei Inayoshi, Suemitsu Laboratory

Si thin film prepared by pulsed-plasma chemical vapor deposition (CVD) under near atmospheric pressures. The Si thin films were deposited at low temperature (< 150 °C), which showed high crystallinity without additional recrystallization processes. As the gate insulator layers, not only SiO_x films by sputtering but also SiN_x films formed by the same pulsed-plasma CVD were applied. The obtained TFTs show an on/off current ratio of more than 104 and an electron mobility of ~0.03 cm^2/Vs.

PR-11

Comparison between VARIOT and Crested Tunneling Barriers in Nonvolatile Memory Using High-k Charge Trap/Blocking Layer

Goon-Ho Park, Suemitsu Laboratory

Charge trap flash memory devices with modified tunneling barrier were fabricated using the tunneling barrier engineering technique. Either Variable oxide thickness (VARIOT) barrier or crested barrier, both consisting of thin SiO_2 and Si_3N_4 dielectric layers, were used and compared. Furthermore, high-k dielectrics were used as the charge trapping and blocking oxide layer to improve the program/erase speed. The VARIOT type tunneling barrier using oxide-nitride-oxide (ONO) layers revealed a long retention time and superior endurance characteristic while the crested tunneling barrier using nitride-oxide-nitride (NON) layers showed degraded retention and endurance characteristics.

PR-12

Behavior of N Atoms after Thermal Nitridation of $Si_{1-x}Ge_x$ Surface

Tomoyuki Kawashima, Murota Laboratory

Behavior of N atoms after thermal nitridation of $Si_{1-x}Ge_x$ (100) surface in NH_3 at 400°C was investigated. Angle-resolved XPS measurements shows that there are N atoms not only at the outermost surface but also beneath surface especially in a deeper region around a few atomic layers for the nitrided Si(100), $Si_{0.3}Ge_{0.7}$(100) and Ge(100), which indicates that penetration of N atoms occurs during nitridation. Moreover, it is found that bonding between N and Si atoms for nitrided $Si_{0.3}Ge_{0.7}$(100) dominantly form Si_3N_4 structure which stably remains during heat treatment in H_2 (400°C), while amount of N atoms bonded with Ge atoms decreases.

PR-13

A Read and Half Select Disturb Free SRAM Cell with Stacked Vertical MOSFET

Hyoungjun Na, Endoh Laboratory

In this paper, a read and half select disturb free compact SRAM cell with the stacked vertical MOSFET is proposed. The proposed SRAM cell has a small cell size, because of its stacked vertical MOSFET structure. It realizes a read and half select disturb free SRAM operation; therefore, a larger SNM is achieved than the conventional SRAM cell. Furthermore, it suppresses the degradation of the write margin and write time. The proposed SRAM cell is a suitable SRAM cell with a small cell size, immunity to the read and half select disturb, wide write margin and fast write time.

PR-14

Performance of the 3-D Vertical FG NAND Memory Using the Separated Sidewall Control Gate

Moon-Sik Seo, Endoh Laboratory

In order to reduce the bit cost of the NAND memory, 3-dimensional (3-D) vertical cell stacked technologies mainly have been researched. Last year, we proposed novel the 3-D vertical Floating Gate (FG) NAND with Separated Sidewall Control Gate (S-SCG). In this paper, we successfully demonstrate the excellent operation performance of the 3-D vertical FG NAND with S-SCG in comparison with the conventional 3-D FG NAND cells by using the cylindrical device simulation. Above all, the proposed cell array has good potential for Terabit 3-D NAND cell array with highly reliable multi level cell (MLC) operation.

PR-15 **Design and Evaluation of a Long HTS Tri-axial Transmission Line**

N. Hu, Hamajima Laboratory

By the advantage of more compact structure, small leakage field, and low heat loss, tri-axial cable become to be mainstream design in recently HTS practical project. Since there is no existent standard for the HTS tri-axial cable insulation design yet, in this paper, a method of insulation design is proposed. The cable current imbalance ratio due to imbalance capacitance distribution is evaluated as a function of length. A discussion of fabrication error is carried out.

PR-16 **Basic Examination of Eddy Current Loss Estimation in PM Motor Based on Electric and Magnetic Networks**

Yukihiro Yoshida, Ichinokura Laboratory

This paper presents a method for calculating eddy current loss in a permanent magnet (PM) of the PM motor. First, an electric network model for calculating eddy current is described. Next, modeling of the RNA of the PM motor is presented. The validity of the proposed model is proved by comparing with a finite element Analysis (FEA).

PR-17 **Formation of an Anodic Titanium Oxide Nanotube Film on a Transparent Conductive Oxide Layer for a Dye-sensitized Solar Cell**

Ryota Kojima, Niwano Laboratory

Titanium oxide nanotube films draw attention as a negative electrode for a dye-sensitized solar cell (DSC) because of their properties of high charge transport, high structure controllability, and large surface area. Anodization of titanium is a promising method to directly fabricate a vertically oriented titanium oxide nanotube film on a transparent conductive oxide (TCO) layer. In this study, a titanium film deposited on a TCO layer by the DC magnetron sputtering method was anodized in an ethylene glycol solution containing ammonium fluoride. In addition, DSCs using the anodic titanium oxide nanotube film as a negative electrode were fabricated and characterized.

PR-18 **Simulations of Pharmacological Actions in the Basal Ganglia Circuit**

Ichiro Sakurai, Niwano Laboratory

We have carried out computational simulations to investigate pharmacological effects in the basal ganglia (BG). Results of our simulations showed that dopamine depletion induces a time delay of the saccade eye movements and an oscillatory behavior of the neuronal activity in the BG. We also suggest that the oscillatory behavior is originated from formation of closed loop circuits in the BG.

PR-19 **A High Efficiency Si-CMOS Power Amplifier for Millimeter Wave Broadband Wireless Communication Employing Optimized Transistor Size**

Tuan Thanh Ta, Suematsu Laboratory

For small size and low cost mobile terminals on millimeter wave radio communication, we design and fabricate 60 GHz-band broadband power amplifier (PA) using a 90 nm silicon complementary metal oxide semiconductor (Si-CMOS) process. In designing high linear gain PA, transistor size optimization method of PA is used. Target output power is 10 dBm in push-pull structure. With the transistor size optimization method, unit gate width is 2 μm and a number of gate fingers are 32, so total optimal gate width is 64 μm. The push-pull PA has achieved P1dB of 10.2 dBm, Psat of 12.9 dBm, linear gain of 13.1 dB, peak PAE of 25.4% at 63 GHz, and a bandwidth over 10 dBm of 10 GHz. These measurement results show the potentiality of high efficiency Si-CMOS PA for 60 GHz band broadband wireless communication applications.

PR-20 **A 60-GHz Band Planar Dipole Array Antenna in 3-D System-in-Package Modules**

Satoshi Yoshida, Suematsu Laboratory

We propose a new concept of 60-GHz band planar array antenna configuration which is suitable for 3-D SiP (System-in-Package) modules. Conventional planar array antenna uses only one substrates, hence main beam direction is orthogonal to the substrate. Our proposal uses multiple substrates in 3-D SiP modules, and antenna elements located each substrate. Therefore, main beam direction is horizontal to the substrate. To achieve high gain, we extend a dielectric substrate to main-beam direction.

PR-21 **A Proposal of Mutually Coupled 60 GHz Beam Forming Antenna for Miniaturization**

Yosuke Sato, Kato Laboratory

In order to further improve millimeter wave (60 GHz) beam forming antenna size for portable terminals applications, this paper proposes a mutually coupled double slot antenna which adopts “two-tenths wave length antenna element separation” instead of conventional “half a wave length separation”. The computer simulation shows that the proposed mutually coupled double slot antenna which introduces mutual couplings between antenna elements intentionally, reduces about 60 % size of the double slot antenna (patent pending) while achieving almost the same antenna electrical performance, a 10 dBi antenna gain which is good enough for most of portable terminal applications.

PR-22 **Simultaneous Measurement Method of Complex Electromagnetic Field Using Modulating Probe Array**

Toru Mizukami, Sawaya Laboratory

A measurement method using a modulating probe array for phase and amplitude of electromagnetic field is proposed. The profile of measured phase versus propagation distance is investigated to verify the validity of the proposed method. The measured phase almost agrees with theoretical values and the validity of the proposed method is confirmed. Simultaneous phase measurements of radiation field of monopole antenna and a directional antenna are also performed by a modulating probe arrays confirming that the modulating probe array can be used for practical measurements.

PR-23 **Analysis of Antenna in Vicinity to Dielectric Object by CBFM with Optimum Block Division**

Keisuke Konno, Sawaya Laboratory

Characteristic basis function method (CBFM) is applied to solve volume integral equation (VIE). For fast and accurate analysis of antenna in vicinity to dielectric object, number of blocks is analytically optimized and various patterns of block division in the CBFM are numerically investigated. It is demonstrated that polarization current of dielectric object in vicinity to the antenna should be allocated in the same block with the antenna. It is also shown that all antenna segments should be allocated in the same block as much as possible for accurate analysis.

PR-24 **160 Gbit/s Demultiplexing Using Nonlinear Optical Loop Mirror for Ultlrahigh-speed Transmission at 1.1 μm**

Kengo Koizumi, Nakazawa Laboratory

We demonstrate the generation and demultiplexing of a 160 Gbit/s optical time-division multiplexed (OTDM) signal using a 10 GHz mode-locked Yb fiber laser in the 1.1 μm wavelength region. A nonlinear optical loop mirror (NOLM) was employed to demultiplex the 160 Gbit/s OTDM signal to 10 Gbit/s. Error-free performance was achieved for all 16 channels.

14:00--14:10 **Break**

PR-25

400 Gbit/s Frequency-Division-Multiplexed and Polarization-Multiplexed 256QAM-OFDM Transmission over 400 km with a Spectral Efficiency of 14 bit/s/Hz

Tatsunori Omiya, Nakazawa Laboratory

We demonstrate a 400 Gbit/s frequency-division-multiplexed and polarization-multiplexed OFDM transmission over 400 km (5 x 80 km SSMF) with 256 QAM subcarrier modulation using an optical PLL. A record spectral efficiency of 14 bit/s/Hz was successfully achieved.

PR-26

A Precise OPLL Circuit Employing Narrow Linewidth LDs and its Application to Coherent Optical QAM Transmission

Yixin Wang, Nakazawa Laboratory

We report a precision optical phase-lock loop (OPLL) based on narrow linewidth laser diodes (LDs) and its application to multi-level coherent transmission. By employing a C2H2 frequency stabilized external laser diode with a linewidth 4 kHz and a relative intensity noise (RIN) of -135 dB/Hz, a stable and a low phase noise OPLL was achieved. With the OPLL, a 120 Gbit/s, 64 QAM signal was successfully transmitted over 150 km.

PR-27

ASIC Design and Implementation of Single Carrier Frequency Domain Equalization

Kazuhiro Komatsu, Suematsu Laboratory

Single-carrier (SC) transmission using frequency domain equalization (FDE) is one of the candidates for the next generation mobile communication systems expected to deliver high-speed and high-quality packet data services. Moreover, SC-FDE with minimum mean square error (MMSE) operates at lower peak to power ratio (PAPR) than OFDM. In this paper, the SC-FDE receiver is designed and implemented on TSMC 180 nm CMOS and its performance is analyzed through experimental data.

PR-28

Joint MMSE-FDE & Spectrum Combining for Antenna Diversity Reception on Single-carrier Transmission

Tatsunori Obara, Adachi Laboratory

Frequency-domain equalization (FDE) based on minimum mean square error (MMSE) criterion is a powerful equalization technique for the broadband single-carrier (SC) transmission. However, the presence of timing offset produces the inter-symbol interference (ISI) and degrades the bit error rate (BER) performance. As the roll-off factor of the transmit filter increases, the performance degrades more. Recently, we proposed joint MMSE-FDE & spectrum combining which can achieve the frequency diversity gain while suppressing the negative impact of timing offset for the SC transmission. In this paper, we extend the joint MMSE-FDE & spectrum combining to include the antenna diversity reception.

PR-29

Adaptive Inter-agent Communication Scheme for Large-scale Multi-sink Sensor Network in Ubiquitous Computing Environment

Taishi Ito, Kinoshita Laboratory

In this paper, we describe a multi-sink sensor network communication scheme for agent-oriented middleware in the ubiquitous computing environment. We propose an adaptive communication mechanism between agent platforms, which can select dynamically communication schemes and communication protocols according to properties of the computational resources and situations of the network that is relying on agent platforms. We introduce the design of the proposed mechanism, and we show an evaluation to confirm the effectiveness of the mechanism based on sensor network environment.

PR-30

Identity-based Key Management From Pairings with Clique Certificate Authorities

Qing Chen, Kato Laboratory

Due to the lack of a centralized infrastructure, it is difficult to provide authentication services in the wireless ad hoc network. In this paper, we utilize both Certificate Graph (CG) and identity-based security in designing a key management scheme for wireless ad hoc network. We first use one-hop message exchange to build CG at each wireless node. Then we select maximum clique nodes in CG as distributed Certificate Authorities. We use identity-based key agreement from pairings to protect each session. We also prove the security by Canetti Krawczyk model-based analysis. We use computer simulations to demonstrate the effectiveness and feasibility of our protocol.

PR-31 **Reference Image for Flicker Parameters Estimation and Blotch Detection in Old Film Sequences**

Koki Shoji, Kawamata Laboratory

This paper proposes an estimation method of a common reference image for flicker parameters estimation and blotch detection in a digital restoration system of old film sequences. In order to improve the accuracy of flicker and blotch removal, it is necessary to reduce flicker and blotch in the reference image. The proposed method employs the characteristics that flicker and blotch are Gaussian noise and impulsive noise in temporal direction at each pixel respectively. The experimental results show that the proposed method can reduce flicker and blotch in the reference image and estimate a reference image for flicker parameters estimation and blotch detection.

PR-32 **Fusion of Satellite Imagery Using IHS Transform**

Naoko Tsukamoto, Omachi Laboratory

Image fusion is a process for generating a synthesized image with high spatial resolution that has an appropriate spectral contest from a set of images with different spatial and spectral resolutions. Many methods based on intensity-hue-saturation (IHS) transform, PCA transform and wavelet transform have been proposed. However there is still a tradeoff between spatial and spectral enhancements. In this paper, we propose a method for estimating a correction coefficient of color image corresponding to panchromatic image from a relative spectral responsively, and present a new image fusion method based on the HIS transform.

PR-33 **Image Recognition and Retrieval by Using Distance-based Shape Invariant**

Natsuda Kaothanthong, Tokuyama Laboratory

We propose an image retrieval system which applies the shape invariants and the geometric matching method. An image retrieval framework which retrieves a set of similar objects using pattern matching is proposed. Instead of comparing the shape similarity to every object, the query in our algorithm only compares with objects in a candidate set which is selected according to the distance-based shape invariant via hashing. Moreover, a new shape invariant is proposed to improve the accuracy of the candidate set. The advantage of using such method is also discussed in this paper.

PR-34 **Statistical Performance Analysis of Image Inpainting Based on Bayesian Image Modeling**

Shun Kataoka, Tanaka Laboratory

Inpainting is the process of reconstructing missing or deteriorated parts of images. This approach can be regarded as one of inference problems based on Gaussian Markov random fields and its efficient algorithms has been proposed by means of the Gauss-Seidel method. We propose a scheme for evaluating statistical performances of the inpainting algorithm by Gaussain Markov random fields. The scheme can be reduced to the problem solving simultaneous integral equations for distributions of light intensities at missing pixels. We give some numerical experiments for our Gaussian inpainting algorithms as well as the statistical performance analysis of them.

PR-35 **An Accurate Registration Technique for Medical Volume Data Using 3D Phase-Only Correlation**

Yuichiro Tajima, Aoki Laboratory

Volume registration is an essential technology for comparing medical volume data acquired in different days and for combining different types of volume data from various imaging devices. In this paper, we propose a novel volume registration technique based on 3D Phase-Only Correlation (POC). Our method achieves an accurate and fast registration by employing POC-based block matching (with small volume blocks), which can find dense voxel correspondence with sub-voxel accuracy between the given two volume data. The proposed approach exhibits higher accuracy and lower computational cost compared with conventional methods, and is effective even for multimodality cases such as CT-MRI registration.

PR-36 **Corpus Analysis for Automatic Semantic Role Labeling of Japanese**

Yuki Hashimoto, Inui Laboratory

In this paper, we discuss a model for predicate-argument structure analysis. In the field of natural language processing, fundamental techniques such as morphological analysis or parsing have progressed to a usable level. As a result, much of the research in recent years is related to the analysis or processing of more abstract information of the text such as semantic or discourse analysis. Predicate-argument structure analysis, a central topic in the field of semantic analysis, is the task of specifying the predicate-argument pairs in a given text. A predicate is a word that express a event, and an argument is a indispensable word to use with the predicate such as subject or object. The analysis of predicates called "event nouns", which share properties with predicates yet have drastically different syntax, is challenging, particularly for the Japanese language. In this paper, we discuss a model for Japanese predicate-argument structure analysis that focuses on co-reference relations between arguments.

PR-37 **Quantitative Information Flow - Verification Hardness and Possibilities**

Hirotoshi Yasuoka, Kobayashi Laboratory

Researchers have proposed formal definitions of quantitative information flow based on information theoretic notions such as Shannon entropy, min entropy, guessing entropy, and channel capacity. This research investigates the hardness and possibilities of precisely checking quantitative information flow. In particular, we studied the comparison problem of Shannon entropy based quantitative information flow. We prove that the comparison problem is not a k-safety property for any k. And, we show that the comparison problem with its distribution universally quantified is a 2-safety problem.

PR-38 **A Higher-Order Distributed Calculus with Name Creation**

Adrien Pierard, Kobayashi Laboratory

Higher-order distributed systems, i.e. distributed systems with the transfer of programs, are nowadays pervasive but methods for reasoning about them are underdeveloped. In this paper we introduce a new model: the higher-order pi-calculus with passivation and name creation. Passivation is a convenient language construct for modelling higher-order behaviours like failure or migration. Name creation means the generation of a fresh name instead of hiding one, which arguably enables more realistic modelling. We then define for this model a sound and complete theory of environmental bisimulation for proving correctness of higher-order distributed systems.

PR-39 **Verification of Higher-order Programs with Recursive Data Structures**

Ryosuke Sato, Kobayashi Laboratory

Higher-order model checking has been studied recently, and applied to verification of higher-order functional programs. In previous work, we have developed an automated verifier for functional program with only integers and booleans. In this paper, we extend the verifier to deal with recursive data types (e.g., lists and trees), which is necessary for practical functional languages. Our approach is to translate a target program into a program with integers, and verify the translated program with our previous verifier.

PR-40 **Thesis Defenses Scheduling Method by Using the Network with Third-order Connections**

Takahiro Sota, Nakajima Laboratory

Thesis defenses are held on each year, and scheduling the defenses is also required at each year. However, it is not easy to schedule the defenses to all examiners' satisfaction. We have proposed the method of using the neural network with third-order connections to solve the combinatorial optimization problems and shown that the network state indicate only desirable states if the network reaches the stable states. Hence, this method may also solve the scheduling problem of the thesis defenses. In this paper, we propose the scheduling method of the thesis defenses by using the network with third-order connections.

PR-41 **Energy-Efficient Threshold Circuits Computing Mod Functions**

Akira Suzuki, Zhou Laboratory

We prove that the modulus function MODm of n variables can be computed by a threshold circuit C of energy e and size s = O(e(n/m)^(1/(e−1))) for any integer e ≥ 2, where the energy e is defined to be the maximum number of gates outputting "1" over all inputs to C, and the size s to be the number of gates in C. Our upper bound on the size s almost matches the known lower bound s = Ω(e(n/m)^(1/e)).

PR-42 **Information Leakage from the Unintentional Emanation of an Integrated RC Oscillator**

Masahiro Kinugawa, Sone Laboratory

Recently, it has been shown that electromagnetic radiation from electrical device leaks internal information. Some investigations have shown that information leaks through the clock frequency and higher harmonic waves. Thus, previous studies have focused on the acquisition of information from the change in the amplitude of the clock signal or its harmonic signal. In this paper, we focus on the clock frequency of the integrated RC oscillators that is changed by phase noise and clarify the impact of the frequency shift on the acquisition of information.

PR-43 **Loop Design Optimization of 4th-Order Fractional-N PLL Frequency Synthesizers**

Lee Jun Gyu, Masui Laboratory

Loop design optimization method is proposed for 4th-order fractional-N PLL featuring 5□sec settling time. The optimized design flow overcomes inaccuracy between the real settling time and loop bandwidth by using MATLAB Control System Toolbox with circuit robustness. Also the tradeoff between the phase noise and area is considered. The optimization process consists of 1) relationship between the settling time and loop bandwidth with PVT variations, 2) relationship between phase noise and area, and 3) derivation of all loop filter components. The designed result is compared with simulations using 1.8V 0.18μm CMOS technology, and the error is less than 5.3% (0.2μsec).

PR-44 **Active-Gm-RC Bandpass Filter with 60MHz Center Frequency and a Combined Analog-Digital Tuning System**

Jingbo Shi, Masui Laboratory

An active-Gm-RC bandpass filter (BPF) with a combined analog-digital tuning system is presented. The active-Gm-RC BPF biquad features a positive feedback capacitor to enhance the quality factor, and its required number of OTA per filter-order becomes 0.5. A design example for the application to an on-chip equivalent SAW filter with 60MHz center frequency and 8MHz bandwidth is presented. The proposed tuning system can be enabled with a configurable active-Gm-RC BPF/LPF. Behavioral simulations present the proper tuning for the process variation of ±20% in resistors and capacitances, the power can be reduced by a factor of 18.8 over the active-RC BPF.

PR-45 **SPICE MOSFET Analog Model Parameter Verification and Re-optimization Based on gm/ID Lookup Table Design Methodology**

Takayuki Konishi, Masui Laboratory

We propose a SPICE model parameter evaluation method based on gm/ID lookup table design methodology for analog/mixed-signal circuit. The measured results of gm/ID lookup tables are obtained through the DC/RF TEG design and its characterizations. The evaluation functions representing the difference between the measured and simulation results are defined to identify gm/ID lookup table parameters to be the optimized by the SPICE model parameter modification. We propose the SPICE model modification algorithm to minimize the modification effects to original parameters.

PR-46 **High-Performance Bit-Serial Reconfigurable VLSI Using Binary-Controlled Differential-Pair Circuits**

Xu Bai, Kameyama Laboratory

A bit-serial reconfigurable VLSI based on current-mode logic is proposed. In a cell, multiple-valued signaling is utilized to implement a compact switch block, and a programmable binary-controlled three-level differential-pair circuit is introduced to implement high-performance low-power arithmetic logic operations including an arbitrary two-variable binary logic operation and a full-adder sum. Moreover, current-source sharing in a differential-pair circuit with a current-mode D-latch is proposed to reduce the current source count to reduce power consumption. These technologies are effectively employed for high-performance low-power reconfigurable VLSI computing.

PR-47 **An Architecture of a Synchronous / Asynchronous Hybrid FPGA**

Yoshiya Komatsu, Kameyama Laboratory

This paper presents an FPGA architecture that combines synchronous and asynchronous architectures. Datapath components such as logic blocks and switch blocks are designed so as to run in asynchronous and synchronous modes. Moreover, a logic block is presented that implements area-efficient First-in-first-out (FIFO) interfaces, which are usually used for communication between synchronous and asynchronous logic cores. The FPGA based on the hybrid architecture is fabricated in a 65nm process.

PR-48 **A Design Method of High-Performance Asynchronous Pipeline**

Zhengfan Xia, Kameyama Laboratory

This paper introduces a novel design method of asynchronous pipeline based on dualrail dynamic logic. The overhead of handshake control logic is greatly reduced by constructing a critical datapath, which offers the pipeline high throughput as well as low power consumption. The design targets latch-free and extremely fine-grain pipeline, where the depth of each pipeline stage is only one dual-rail dynamic logic. To evaluate the proposed design method, an array style multiplier is designed and fabricated using a 65nm design rule. The test chip works correctly, and its post-layout simulation works as high as 2.16G data-set/s. When the workload of the circuit is 50%, the proposed method reduces the power consumption by 37.9% compared to the classical synchronous pipeline.

PR-49 **Loudspeaker Arrangements for Transaural Auditory Displays Robust to Listener's Head Rotation**

Cheolsu Han, Suzuki Laboratory

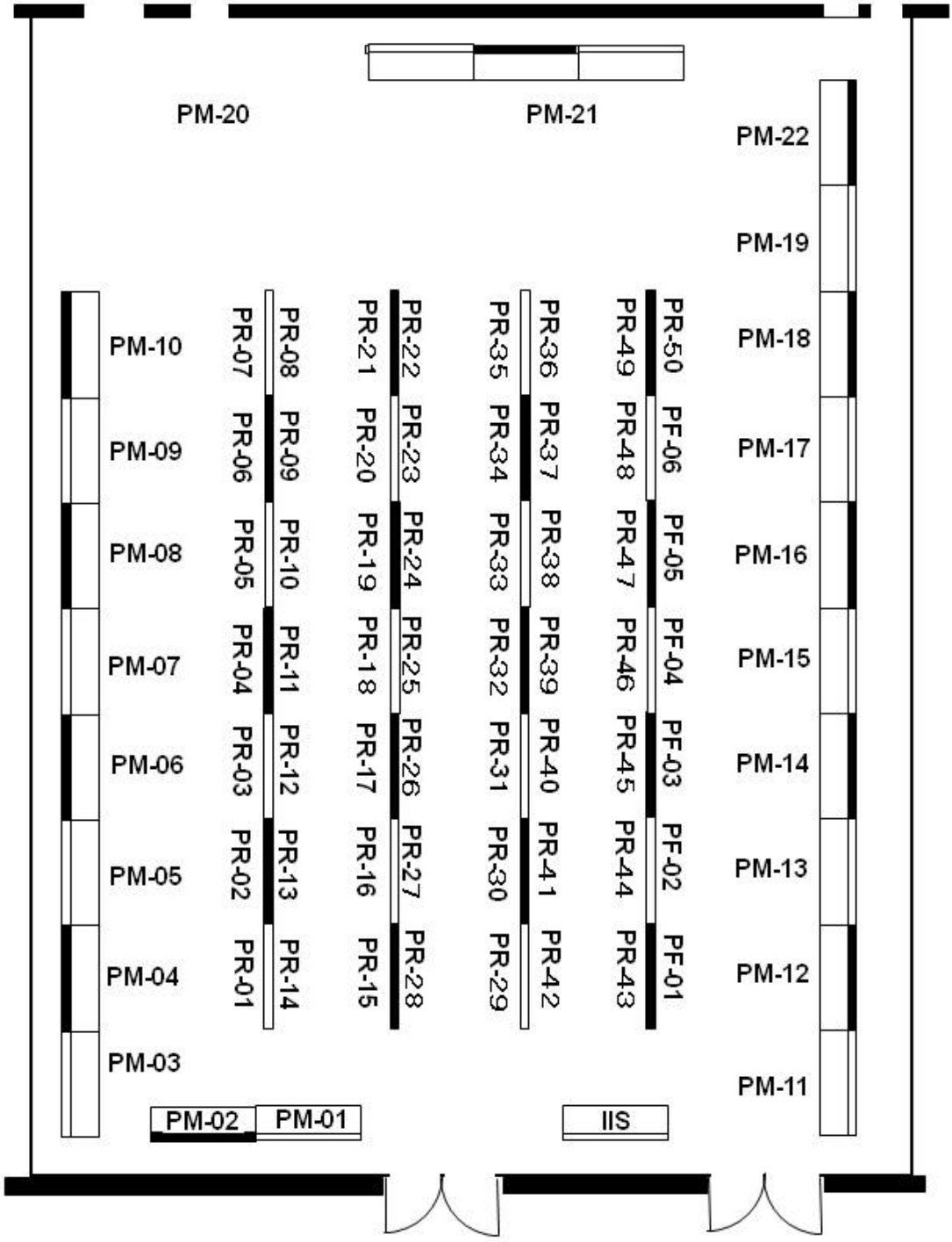
Transaural auditory displays are designed to accurately convey any input binaural signal to a listener's ears via loudspeakers. Typical approaches, however, presume that the listener's head has a fixed position and orientation. This constraint may cause large differences between the desired and presented sounds by even a small rotation of the listener's head. The present study investigates the loudspeaker distributions resulting in transaural auditory displays robust to the listener's head rotation based on a series of computer simulations. Our results show that loudspeaker arrangements above the listener generally result in transaural auditory displays that are less susceptible to head rotation.

PR-50 **Three Dimensional Auditory Display Using Ambisonics with Irregular Loudspeaker Arrays**

Jorge Treviño, Suzuki Laboratory

Virtual and augmented reality systems seek to realistically convey the presence of objects and events that are not actually part of the user’s environment. The complex task involves the precise stimulation of the user’s senses. We focus on the sense of hearing, and develop a system capable of synthesizing three-dimensional sound fields. Our system is based on a technique known as Ambisonics, which uses multi-channel loudspeaker arrays surrounding the user. Typical Ambisonic systems do not work well if the loudspeakers are not uniformly distributed in space. Our research introduces a new method to reproduce Ambisonics over irregularly distributed loudspeaker arrays.

Layout



Special demonstration of Suzuki Laboratory will take place at Sakura (桜) during the conference.

Members

PM-01 **Challenges to Ultrafast and High-Spectral-Density Optical Communications Systems**
Masataka Nakazawa, Tohoku University, Japan

PM-02 **Hybrid Approach of SPM and Matrix-Inversion to Estimate Current Distribution on EM Sources**
Kunio Sawaya, Tohoku University, Japan

PM-03 **Recent Advances in Gigabit Wireless Technology**
Fumiyuki Adachi, Tohoku University, Japan

PM-04 **A Robust Optimization of Designing P2P Systems with Attack and Fault**
Nei Kato, Tohoku University, Japan

PM-05 **Autonomous Algorithm Selection and Its Applications to Real-World Intelligent Systems**
Michitaka Kameyama, Tohoku University, Japan

PM-06 **Fundamental Technologies of High-Performance VLSI Processor for Multimedia Applications**
Takahiro Hanyu, Tohoku University, Japan

PM-07 **Higher-Order Model Checking and Program Verification**
Naoki Kobayashi, Tohoku University, Japan

PM-08 **Semiconductor Spintronics**
Hideo Ohno, Tohoku University, Japan

PM-09 **Tailor-Made Nano-Structured Material for Highly Qualified Spin Related Devices**
Migaku Takahashi, Tohoku University, Japan

PM-10 **Challenge to Terabit per Square Inch Magnetic Recording**
Hiroaki Muraoka, Tohoku University, Japan

PM-11 **Scanning Nonlinear Dielectric Microscopy**
Yasuo Cho, Tohoku University, Japan

PM-12 **Nanocarbon-Nanoelectronics Oriented Nanoscopic Plasma Control**
Rikizo Hatakeyama, Tohoku University, Japan

PM-13 **Self-ordered Nano-tubular Structures: Formation and Applications**
Micho Niwano, Tohoku University, Japan

PM-14 **Application of the Ultrasonic Microspectroscopy System to Evaluation of GaN and $La_3Ta_{0.5}Ga_{5.3}Al_{0.2}O_{14}$ Single Crystals**
Jun-ichi Kushibiki, Tohoku University, Japan

PM-15 **Multi-photon Quantum Optics and Quantum Information**
Keiichi Edamatsu, Tohoku University, Japan

PM-16 **Atomically Controlled Processing for Future Si-Based Devices**
Junichi Murota, Tohoku University, Japan

Members (Continued)

PM-17 **Toward Realizing High Sense-of-Presence Communications with 3D Spatial Sound Systems**
Yôiti Suzuki, Tohoku University, Japan

PM-18 **Efficient Image Segmentation Algorithms with Flexible Shape Control**
Takeshi Tokuyama, Tohoku University, Japan

PM-19 **Toward Machine Vision Technology Overcoming the Pixel Resolution Limit --- From 3D Vision to Medical Imaging ---**
Takafumi Aoki, Tohoku University, Japan

PM-20 **Development of the Next Generation Highly Functional Display Systems**
Tatsuo Uchida, Tohoku University, Japan

PM-21 **Digital Restoration for Old Film Sequences**
Masayuki Kawamata, Tohoku University, Japan

PM-22 **Probabilistic Graphical Model for Media Understanding**
Kazuyuki Tanaka, Tohoku University, Japan

Research Fellows

PF-01 **Acoustic Privacy Technique Based on Simple Summation by Multichannel Loudspeaker Array**
Takuma Okamoto, Suzuki Laboratory
We propose a new speech privacy technique based on simple summation of numerous N-channel loudspeaker signals. A speech signal is radiated from each loudspeaker with uncorrelated white/pink noise at a relative level that is higher than that of the speech. Radiated speech sounds must have appropriate delay so that they are synchronized at a sweet spot. At the sweet spot, SNR increases proportionally to $N^{1/2}$. The speech signal at and around the sweet spot is enhanced significantly, making it easily recognizable. Results of computer simulations show that SNR and the speech intelligibility index (SII) increase effectively only at and near the sweet spot.

PF-02 **Non-Invasive EMI-Based Fault Injection Analysis against Electrical Devices**
Yu-ichi Hayashi, Sone Laboratory
In this paper, we introduce a new type of intentional electromagnetic interference (IEMI) which causes information leakage in electrical devices without disrupting their operation or damaging their physical structure. Such IEMI could pose a severe threat to a large number of electrical devices with cryptographic modules since it can be used for performing fault injection attacks, which in turn allows for obtaining faulty outputs (i.e., ciphertexts) from cryptographic modules and exploiting them to reveal information about secret keys. We demonstrate fault injection attacks based on the IEMI through experiments using an Advanced Encryption Standard (AES) module implemented on a standard evaluation board (SASEBO). The experimental results indicate that generating effective faults is feasible and, therefore, such IEMI presents a tangible threat to many existing electrical devices and systems that use cryptographic modules for secure communication and transactions.

Research Fellows (Continued)

PF-03 **FPGA Implementation of a Heterogeneous Multicore Processor with SIMD Custom Accelerators**

Hasitha Muthumala Waidyasooriya, Kameyama Laboratory

Heterogeneous multicore processors with CPUs and accelerators attract many attentions since they can achieve power-efficient computing in various areas from low-power embedded processing to high-performance computing. In this paper, we propose a heterogeneous multicore processor with GPU-like SIMD accelerator cores. Although the functions of the accelerator cores are similar to that of GPU, the accelerator architecture is simplified for power-efficient computing. We also exploit the configurability of the FPGA to optimize the architecture for different applications. Experimental results with simple media processing applications show that the proposed platform is 15 times power-efficient compared to the GPU.

PF-04 **Towards Effective Load Distribution in Peer-Assisted Video Streaming**

Mostafa M. Fouda, Kato Laboratory

Digital multimedia distribution technologies are expected to advance with 40G/100G bandwidth, high speed disk drives, and Ultra High Definition Television (UHDTV). Along with these rapid improvements, some of the current protocols need to be reviewed in order to address these new aspects. The Peer-to-Peer (P2P) protocol is one of the most popular techniques to download data, and watch TV-channels online and/or Video-on-Demand (VoD) movies. In this work, we address the challenges involving large volume of video data streaming using P2P, and propose an adequate solution towards effective load distribution in peer-assisted video streaming.

PF-05 **Pure single-Photon Source for Quantum Information Processing**

Ruibo Jin, Edamatsu Laboratory

We report the experiment of heralded pure single photon state generation in the process of spontaneous parametric down-conversion (SPDC) in KDP crystal. This pure single photon state was utilized to interfere with a weak coherent state (local oscillator), without the use of bandpass filters. This nonclassical interference can be applied to construct a polarization entangled state from independent sources. We tested the violation of Bell-CHSH-inequality with such entanglement source. Finally, this pure photon source was employed in homodyne detection of the single photon state.

PF-06 **Compressive Channel Estimation for Sparse Multipath Amplify-and-forward Cooperative Networks**

Guan Gui, Adachi Laboratory

We investigate channel estimation problem in sparse multipath non-orthogonal amplify-and-forward (AF) cooperative networks. Based on the compressive sensing, in this paper, we propose a compressive channel estimation method to exploit sparsity of the cooperative channels. Simulation results confirm the superiority of proposed method than least square based linear estimation method.

17:00--19:00 **Banquet** **Hermitage 3F**

9:00--9:50 **5A-1: Symbolic Interaction in Sound and Music (Keynote)**

Gérard Assayag, IRCAM, CNRS, UPMC, France

The Music Representations team at Ircam has specialized in the symbolic processing of musical structures (Computer assisted music composition and analysis). Other teams at Ircam and elsewhere have investigated issues related to musical digital signal processing or to software architectures for real-time interaction. I call symbolic interaction the convergence between these three paradigms： machine listening through low-level and perceptual signal processing, symbolic computation of formal musical structures, live interaction based on decisions taken on behalf of the resulting model. This idea renews the modality of live interaction between musicians and computers in favor of a more complex setup than mere audio effects or purely reactive actions from the computer. Sophisticated memory structures may emerge in the interaction between the musician and the computer due to structural feed-backs, thus shaping complex temporal architectures.

9:50--10:30 **5A-2: High-accuracy Design and Implementation of All Pass-based Hilbert Transformers and Fractional Delay Filters (Invited)**

Georgi Stoyanov, Technical University of Sofia, Bulgaria

Fractional delay (FD) digital filters (fixed and variable) have been recently a subject of an ever growing interest while Hilbert transformers (HT) are investigated since the dawn of the signal processing. The problem with the design and implementation of both is that a high accuracy of realization could be achieved at a price of complicated structures and a very high transfer function order, leading to implementations with many hundreds of multipliers and precluding a real-time tuning. In this work we propose several approaches to increase the accuracy and to extend the frequency range over which the FD filter delay-time and the HT phase difference are near constant. These approaches are based on minimization of the phase sensitivity of the allpass structures used and to realizations of the multiplier coefficients in a way, permitting tuning of the FD-time by changing very few parameters and making it possible to be done in real-time. The complexity of the new structures is tens of times lower than that of many new recently publicized realizations It is shown experimentally that the FD filters and HTs so obtained are outperforming the other known realizations and they are very suitable for different telecommunication applications.

10:30--10:50 **Break**

10:50--11:20

6A-1: Toward Realizing High Sense-of-Presence Communications with 3D Spatial Sound Systems

Yôiti Suzuki, Tohoku University, Japan

In future communications with a high sense-of-presence, the role of sound is extremely important to enhance the quality and versatility of communications because sound itself can provide rich semantic and emotional information. Moreover, sound (auditory information) has good synergy effects with pictures (visual information). In this presentation, we introduce our recent research results to capture and synthesize comprehensive 3D sound space information as well as a high-definition 3D audio--visual display realizing strict audio-visual synchronization. We believe that these systems are useful to advance universal communications, which require particularly high-quality and versatile communications technologies for all.

11:20--11:50

6A-2: Efficient Image Segmentation Algorithms with Flexible Shape Control

Takeshi Tokuyama, Tohoku University, Japan

We propose an efficient polynomial-time algorithm to find an optimal region with geometric shape-constraint in a pixel grid. This is an important function for image segmentation from a digital picture. Compared with known methodology, our method can give constraint about the shapes of segmented objects such that each object is decomposable into parts with simple geometric shapes. In particular, we give an O(n^{1.5}) time algorithm for finding the optimal (maximum weight) region that is decomposable into line-monotone regions with given k guide lines. We show some experimental results to show the feature of our image segmentation function.

11:50--12:20

6A-3: Toward Machine Vision Technology Overcoming the Pixel Resolution Limit --- From 3D Vision to Medical Imaging ---

Takafumi Aoki, Tohoku University, Japan

Recently, image matching/correspondence techniques achieving sub-pixel accuracy and higher robustness against image noise have attracted significant attention in real-world visual computing applications. This presentation provides a brief overview of advanced machine vision technology using Phase-Only Correlation (POC) --- an efficient sub-pixel image matching/correspondence technique using phase components in Discrete Fourier Transforms (DFTs) of given images. Since 1990s, our group has carried out systematic research and development of POC-based machine vision algorithms for various applications, where the term "machine vision" is used in a wider sense. In this presentation, we summarize major research results obtained during our GCOE program.

12:20--12:40 **Break**

Session 6 (B): Friday, February 24th, 10:50--12:20

Display and Signal Processing Technologies

10:50--11:20

6B-1: Development of the Next Generation Highly Functional Display Systems

Tatsuo Uchida, Tohoku University, Japan

High reality and highly functional display technologies have become important for next-generation man-machine interface systems. To achieve this purpose, we have investigated the accurate control method and evaluation method for light and established the polarized light control (PLC) and the diffused light control (DLC) theories. From these results, we devised an incident-angle-independent, quantized-diffusion-angle (QDA) screen and realized a high quality multiple directional viewing projection display system. We also discuss a development of high-resolution 3D projection display with a liquid-crystal shutter dividing an iris-plane for the next generation high quality display systems.

11:20--11:50

6B-2: The Class of Digital Filters with All Second-Order Modes Equal

Masayuki Kawamata, Tohoku University, Japan

This paper reveals the class of digital filters with all second-order modes equal. We first prove that if the second-order modes of a digital filter are all equal, the L2-sensitivity minimization problem of the digital filter can be solved analytically. We derive a general expression of the transfer function of digital filters with all second-order modes equal. Furthermore, we show that the general expression is obtained by a frequency transformation on a first-order prototype FIR digital filter.

11:50--12:20

6B-3: Probabilistic Computational Models for Statistical Inference and Learning Based on Bayesian Analysis and Belief Propagation

Kazuyuki Tanaka, Tohoku University, Japan

In this talk, our recent developments of statistical inference and learning algorithms are reviewed. We show also some new results in statistical performance analysis of our computational models. Our computational models are formulated by means of belief propagation and statistical mathematics as well as some concepts of statistical mechanical informatics. Moreover, we give some quantum-mechanical extensions of our probabilistic computational models.

12:20--12:40 **Break**

12:40--13:20 **7A-1: What Future Robots Will Understand by Analyzing Human Movements and Biological Signals (Invited)**

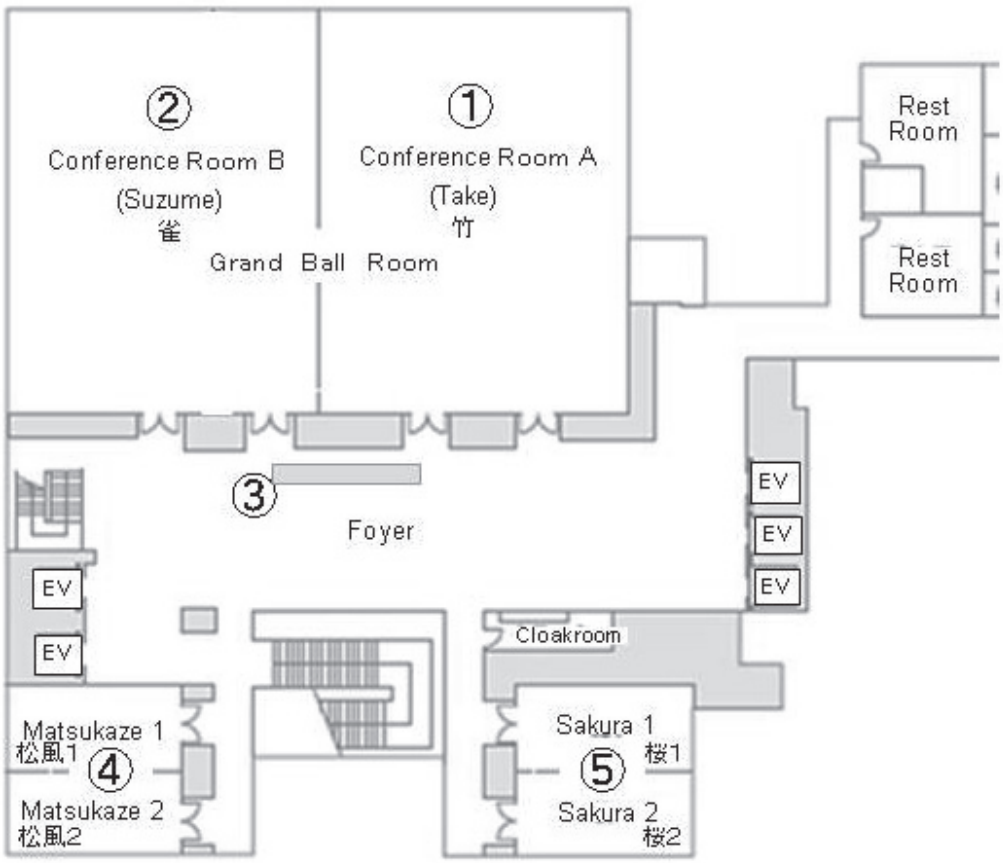
Adrian Stoica, Jet Propulsion Laboratory, USA

Future robots, together with wearable devices and smart buildings will have a fundamental role in increasing people's quality of life, empowering them to exceed current physical and information processing limitations, while also optimizing resources. Core to such advancements will be the ability to correctly interpret human states and commands (sensed by vision or direct measurement of biosignals), predict their consequences, intentions and needs. This talk reviews technologies aimed at answering questions like: Who is the individual? What is he doing? What is his health/emotional condition? What does he request? What does he need? What will he want/do/need in the future?

13:20--13:30 **Closing Remarks**

13:30 **Adjourn**

Conference Space Layout



2nd Floor

① Conference Room A (Take 竹: Half of Grand Ball Room)
② Conference Room B (Suzume 雀: Half of Grand Ball Room)
③ Registration Desk
④ Matsukaze 松風
⑤ Sakura 桜

Note:

- Welcome Reception and Banquet will take place at Hermitage located in 3rd Floor.
- Special demonstration of Suzuki Laboratory will take place at Sakura (桜) during the conference.

Transportation

Sendai Airport

Sendai Airport Access Line (25 minutes)

Narita International Airport

Railway (JR East)
Ltd. Express “Narita Express”
(60 minutes)

Tokyo Station

Railway (JR East)
Tohoku Shinkansen “Hayate/Komachi” or “Yamabiko”
(1.67--2.00 hours)

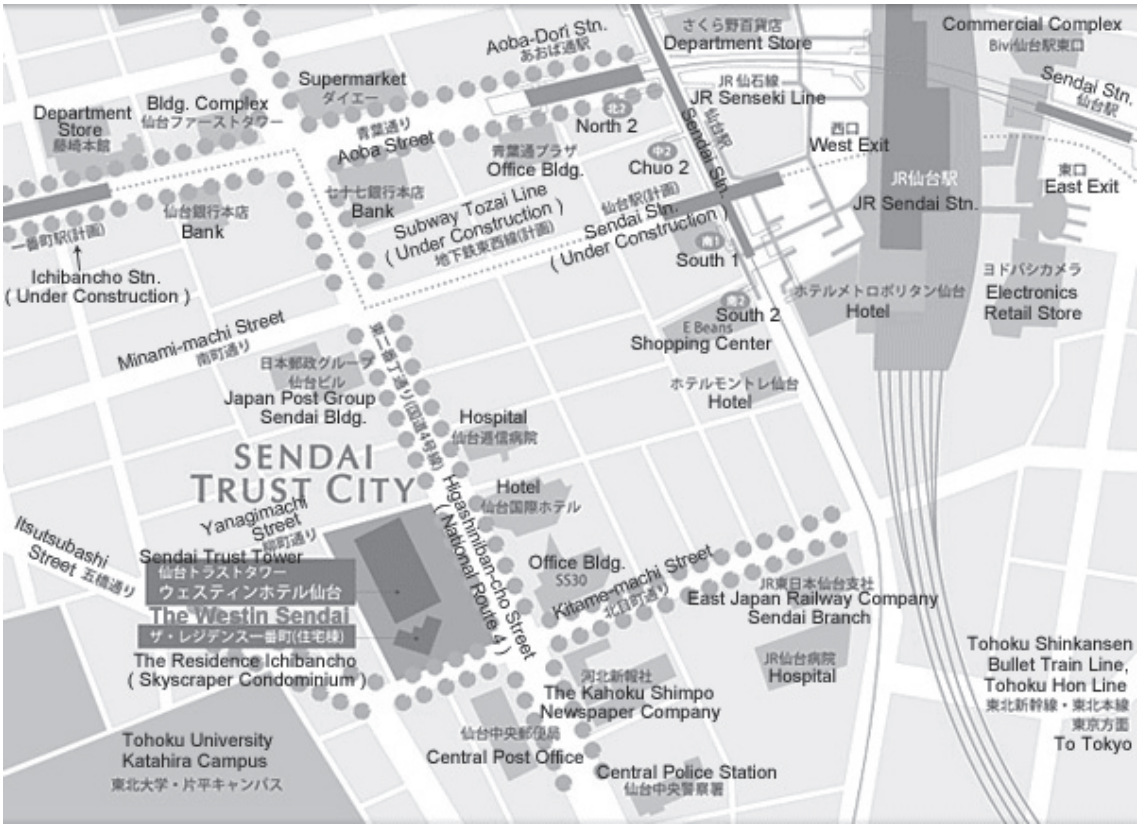
Sendai Station

TAXI: 5 minutes from Sendai Station
40 minutes from Sendai Airport

WALK: 10 minutes from Sendai Station (1 km/0.6 miles)

The Westin Sendai

Address: 1-9-1, Ichibancho, Aoba-ku, Sendai, Miyagi 980-0811
TEL: (81) 22-722-1234, FAX: (81) 22-722-1270



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