External Awards

Achievement Award

Winner: Yusuke Hiwasaki, Shigeaki Sasaki, and Hitoshi Ohmuro, NTT Cyber Space Laboratories
Date: May 23, 2009
Organization: The Institute of Electronics, Information and Communication Engineers of Japan

For the development of a wideband scalable speech coder and contributions to its standardization in ITU-T.

Advanced Television Technical Award

Winner: Multi-View Hi-Vision System Development Team: Yuichi Iwadate et al.[†1] and Isao Miyagawa[†2]

†1 NHK (Japan Broadcasting Corporation)
†2 NTT Cyber Space Laboratories

Date: May 25, 2009
Organization: The Institute of Image Information and Television Engineers

For contributions to the development of the Multi-View Hi-Vision System.

* This award is given to those who have achieved important results in R&D of hardware, software, and methods related to high-definition television or new high-quality television or to the development/diffusion of content-creation technologies.

Papers Published in Technical Journals and Conferences

Implicit online corrections of reaching movements

H. Gomi

Current Opinion of Neurobiology, Elsevier, Vol. 18, No. 6, pp. 558–564, 2008.

Many neuroscience studies of arm control have attempted to explain how aimed movements are planned, generated, and corrected. The mechanisms of subconscious online reaching correction to a target shift are now being widely examined from computational, physiological, and pathological viewpoints. Recent evidence of a quick manual response to surrounding visual motion suggests an additional online compensatory mechanism in reaching movements for bodily and/or extemal environmental changes, although the computational principle underlying this process remains controversial. Together with preprogrammed voluntary motor command generation, it appears that multiple online visually guided correction mechanisms implicitly govern reaching control to bring the hand to the goal. It is important to reveal unknown mechanisms and underlying neural substrates for generating the response to visual motion, which is additionally modulated by action contexts.

Bear's Beer and Smart Platter —Handheld Interactive Haptic Display—

T. Amemiya, H. Ando, and T. Maeda

SIGGRAPH Asia 2008, ACM, Singapore, Dec. 10–13, 2008.

At SIGGRAPH Asia 2008, a new tray-shaped force feedback display with an interactive robot and a vision-based positioning system debuted. Four slider-crank mechanism pairs were arranged in a cross shape and embedded in a platter, called "smart platter". Each slider-crank mechanism generates a force vector. By using the sum of the generated vectors which are linearly independent, the smart platter can create a force sensation in any arbitrary direction in a two-dimensional plane.

Synthesis of Quantum Circuits for *d*-level Systems by Using Cosine-sine Decomposition

Y. Nakajima, Y. Kawano, H. Sekigawa, M. Nakanishi, S. Yamashita, and Y. Nakashima

Quantum Information and Computation, Rinton Press, Vol. 9, No. 5 & 6, pp. 423–443, 2009.

We are studying the problem of designing minimal quantum circuits for any operations on n d-level quantum systems (qudits) by means of the cosine-sine decomposition. Our method is based on a divide-and-conquer strategy. In that strategy, the size of the produced quantum circuit depends on whether the partitioning is balanced. We provide a new cosine-sine decomposition based on a balanced partitioning for d-level systems. The produced circuit is not asymptotically optimal except when d is a power of two, but, when the number of qudits n is small, our method can produce a smaller quantum circuit than other synthesis methods. For example, when d=3 (three-level systems) and n=2 (two qudits), the number of two-qudit operations called CINC, which is a generalized version of CNOT, is 36 whereas the previous method needs 156 CINC gates. Moreover, we show that our method is useful for designing a polynomial-size quantum circuit for the radix-d quantum Fourier transform.

Multi-Back-Gate Control of Carbon Nanotube Double-Quantum Dot

H. Maki, T. Mizuno, S. Suzuki, T. Sato, and Y. Kobayashi

Jpn. J. Appl. Phys. Vol. 48, No. 4, pp. C201-1–4, 2009.

We have fabricated a single-walled carbon nanotube (SWNT) quantum dot device with local multi-back gates, in which an SWNT is not surrounded by an insulator or gate electrodes. The charge states of multi-quantum dots, which are separated by an intrinsic defect of an SWNT, can be independently controlled by applying two local back gates. The charge stability diagram changes depending on the gate voltage range, which changes the interdot coupling between two dots. Furthermore, a honeycomb charge stability diagram corresponding to an intermediately coupled double-quantum dot is also observed.

Circuit for Shor's Factoring Algorithm with at Most $2n + 2$ Qubits

Y. Takahashi and N. Kunihiro

Workshop on Theory of Quantum Comp. Comm. Crypto., Institute for Quantum Computing, Univ. of Waterloo, Vol. 1, No. 1, pp. 1–10, Waterloo, Canada, 2009.

On the basis of Zalka's recent idea and our modular subtraction circuit, we describe how to construct a quantum circuit for Shor's factoring algorithm with few qubits. The number of qubits in the circuit depends not only on the length n of the number to be factored but also on the n-bit number N to be factored and a randomly chosen number $a<N$. We show that, for any n, N, and a, it is not more than the best known upper bound $2n + 2$. Moreover, we give an example of n, N, and a for which it is strictly less than that. We also describe how to transform the circuit into one on a linear nearest neighbor architecture.

Quantum Arithmetic Circuits: A Survey

Y. Takahashi

IEICE Transactions on Fundamentals, Vol. E92-A, No. 5, pp. 1276–1283, 2009.

Quantum circuits for elementary arithmetic operations are important not only for implementing Shor's factoring algorithm on a quantum computer but also for understanding the computational power of small quantum circuits, such as linear-size or logarithmic-depth quantum circuits. This paper surveys some recent approaches to constructing efficient quantum circuits for elementary arithmetic operations and their applications to Shor's factoring algorithm. It covers addition, comparison, and the quantum Fourier transform used for addition.

Security Proof of Cryptographic Systems Using Universal Composability Theory

T. Okamoto and Y. Manabe

D-I, IEICE, Vol. J92-D, No. 5, pp. 587–595, 2009.

The security of a cryptographic protocol is usually defined by a game between an attacker and a challenger. Recently, complex cryptographic systems that consist of multiple cryptographic primitives have been designed. The cryptographic protocols might not be secure if they are used with other cryptographic protocols. In order to solve this problem, the theory of universal composability (UC) was proposed. A cryptographic protocol is secure even when it is used with any other protocols if it is proved to be UC secure.

Ultra-thin InAlP/InGaAs Heterojunctions Grown by Metal-organic Vapor-phase Epitaxy

H. Sugiyama, H. Yokoyama, N. Shigekawa, T. Enoki, A. Teranishi, S. Suzuki, and M. Asada

2009 IEEE LEOS IPRM, Vol. 2009, pp. 222–225, Newport Beach, CA, USA.

This paper reports the metal-organic vapor-phase epitaxy (MOVPE) growth of ultra-thin InAlP/InGaAs heterojunctions for use as wet-etching stoppers in InP-based high electron mobility transistors (HEMTs) and as barriers in resonant tunneling diodes (RTDs). InAlP/InGaAs modulation-doped heterojunctions with high electron mobility were successfully grown. Practical wet-etching selectivity in even 2-nm-thick InAlP etch stoppers was demonstrated. High peak current density of 5.4×10^5 A/cm^2 with a peak-to-valley ratio of 1.6 was obtained in RTDs with 1.6-nm-thick $In_{0.75}Al_{0.25}P$ barriers, which reflects the excellent abruptness and flatness of the heterointerfaces.

Computer Simulation of Firing Properties of Auditory Nerves by Using an Auditory Peripheral Model

K. Maki, M. Akagi, and K. Hirota

Acoustical Science and Technology, the Acoustical Society of Japan, Vol. 65, No. 5, pp. 239–250, 2009.

We propose a model of the auditory peripheral system that can faithfully simulate the spike-firing properties of auditory nerve fibers (ANFs). The output stage of this model is a novel ANF model that produces trains of spikes. The model also incorporates a mechanism that makes it possible to control the firing rate and phase-locking level independently. The proposed auditory peripheral model also includes existing models for the stages from the middle ear to the inner hair cells. The output of the peripheral model was compared with existing physiological experimental data. The results demonstrated that the model was able to replicate various firing properties of individual ANFs, which can be characterized in terms of frequency sensitivity, spike-phase and inter-spike-interval distribution, firing, probability, and two tone suppression in rate and synchrony. The proposed auditory peripheral model can provide the primary inputs for a model of the auditory central nervous system.

Odd Sensation Induced by Moving-phantom which Triggers Subconscious Motor Program

T. Fukui, T. Kimura, K. Kadota, S. Shimojo, and H. Gomi

PLoS One, The Public Library of Science, Vol. 4, No. 6, p. e5782, 2009.

Our motor actions are sometimes not properly performed despite our having a complete understanding of the environmental situation with a suitable action intention. In most cases, insufficient skill for motor control can explain the improper performance. A notable exception is the action of stepping onto a stopped escalator, which causes clumsy movements accompanied by an odd sensation. Previous studies have examined short-term sensorimotor adaptations to treadmills and moving sleds, but the relationship between the odd sensation and behavioral properties in a real stopped-escalator situation has never been examined. Understanding this unique action-perception linkage would help us to assess the brain function connecting automatic motor controls and the conscious awareness of action. Here we directly pose a question: Does the odd sensation emerge because of the unfamiliar motor behavior itself toward the irregular step-height of a stopped escalator or as a consequence of an automatic habitual motor program cued by the *escalator itself*. We compared the properties of motor behavior toward a stopped escalator

(SE) with those toward a moving escalator and toward wooden stairs (WS) that mimicked the stopped escalator, and we analyzed the subjective feeling of the odd sensation in the SE and WS conditions. The results show that moving-escalator-specific motor actions emerged after participants had stepped onto the stopped escalator despite their full awarenss that it was stopped, as if the motor behavior was guided by a "phantom" of a moving escalator. Additionally, statistical analysis reveals that postural forward sway that occurred after the stepping action is directly linked with the odd sensation. The results suggest a dissociation between conscious awareness and subconscious motor control: the former makes us perfectly aware of the current environmental situation, but the latter automatically emerges as a result of highly habituated visual input no matter how unsuitable the motor control is. This dissociation appears to yield an attribution conflict, resulting in the odd sensation.

Location-free Haptic Interaction for Large-area Social Applications

T. Amemiya, T. Maeda, and H. Ando

Personal and Ubiquitous Computing, Springer-Verlag, Vol. 13, No. 5, pp. 379–386, 2009.

In this paper, we discuss the potential of force perception technologies for realizing hand-held devices in the field of social systems. We propose and develop an interactive force-sensation-based navigation system for waiters based on a force perception technology that we have proposed. The navigation system consists of our new hand-held haptic interface and a camera-based position and posture identification system. Since the proposed compact haptic interface does not require external grounding, it can be used outside the laboratory and does not interrupt human activity. We verified the feasibility of the system in trials where we collected the responses of system users.

Visualizing Thermal Traces to Reveal Histories of Human-object Interactions

T. Amemiya

HCI International 2009, Human-Object Interaction, Vol. 2, pp. 477–482, San Diego, CA, USA.

Traces of human-object interactions remain on objects in the form of thermal information. This paper describes a human memory aid that exploits such traces to create a thermal 'lifelog' of one's interactions with the environment, without disrupting ongoing activities and without any special apparatus or wires. The goal of the aid is to build a digitized surrogate memory to assist in recalling personal experiences. A system with an infrared camera that records the thermal traces left by human-object interactions was fabricated. Measurements obtained with this system can help us understand the nature of thermal traces and be used to develop thermal models that can describe the heat transfer process on object surfaces after contact.
