External Awards

IEEE Fellow
Winner: Shinji Matsuo, NTT Device Technology Laboratories
Date: January 1, 2016
Organization: The Institute of Electrical and Electronics Engineers (IEEE)

For his contributions to heterogeneous integration of semiconductor lasers.

Best Paper
Winner: Tatsuaki Kimura and Hiroshi Saito, NTT Network Technology Laboratories
Date: November 15, 2016
Organization: The 19th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM '16)

For "Theoretical Interference Analysis of Intervehicular Communication at Intersection with Power Control."
Published as: T. Kimura and H. Saito, "Theoretical Interference Analysis of Intervehicular Communication at Intersection with Power Control," Proc. of MSWiM '16, pp. 3–9, Malta, Nov. 2016.

ITU Kaleidoscope 2016 Best Paper Award
Winner: Kazuhide Nakajima, Takashi Matsui, Kotaro Saito, Taiji Sakamoto, and Noriyuki Araki, NTT Access Network Service Systems Laboratories
Date: November 16, 2016
Organization: International Telecommunication Union (ITU)

For "Space Division Multiplexing Technology: Next Generation Optical Communication Strategy."
Published as: K. Nakajima, T. Matsui, K. Saito, T. Sakamoto, and N. Araki, "Space Division Multiplexing Technology: Next Generation Optical Communication Strategy," ITU Kaleidoscope 2016, Bangkok, Thailand, Nov. 2016.

Electrical Science and Engineering Promotion Award
Winner: Yuichi Higucihi, NTT Device Innovation Center; Masaru Kobayashi and Toru Miura, NTT Advanced Technology Corporation
Date: November 16, 2016
Organization: The Promotion Foundation for Electrical Science and Engineering

For development of a cleaning technique for an optical fiber connector and for diffusion of the optical connector cleaner.

Best Young Presentation Award
Winner: Daisuke Kitayama, NTT Device Technology Laboratories
Date: November 25, 2016
Organization: Symposium on Frontier of Terahertz Science III

For "Metamaterial-based Flat Lens toward Dynamic Control of Transmissive Waves."
Published as: D. Kitayama, "Metamaterial-based Flat Lens toward Dynamic Control of Transmissive Waves," Symposium on Frontier of Terahertz Science III, Fukui, Japan, Nov. 2016.

Papers Published in Technical Journals and Conference Proceedings

Quantum Algorithms for Finding Constant-sized Subhypergraphs
F. L. Gall, H. Nishimura, and S. Tani

Theoretical Computer Science, Vol. 609, No. 3, pp. 569–582, January 2016.

We develop a general framework to construct quantum algorithms that detect if a 3-uniform hypergraph given as input contains a subhypergraph isomorphic to a prespecified constant-sized hypergraph. This framework is based on the concept of nested quantum walks recently proposed by Jeffery, Kothari and Magniez (2013) and extends the methodology designed by Lee, Magniez and Santha (2013) for similar problems over graphs. As applications, we obtain a quantum algorithm for finding a 4-clique in a 3-uniform hypergraph on n vertices with query complexity $O(n^{1.883})$ and a quantum algorithm for determining if a ternary operator over a set of size n is associative with query complexity $O(n^{2.113})$.

Power of Quantum Computation with Few Clean Qubits
K. Fujii, H. Kobayashi, T. Morimae, H. Nishimura, S. Tamate, and S. Tani

Proc. of 43rd International Colloquium on Automata, Languages, and Programming (ICALP 2016), pp. 13:1–13:14, Rome, Italy, July 2016, arXiv:1509.07276 [quant-ph].

This paper investigates the power of polynomial-time quantum

computation in which only a very limited number of qubits are initially clean in the |0> state, and all the remaining qubits are initially in the totally mixed state. No initializations of qubits are allowed during the computation, nor intermediate measurements. The main results of this paper are unexpectedly strong error-reducible properties of such quantum computations. It is proved that any problem solvable by a polynomial-time quantum computation with one-sided bounded error that uses logarithmically many clean qubits can also be solvable with exponentially small one-sided error using just two clean qubits, and with polynomially small one-sided error using just one clean qubit. A similar result is proved in the case of two-sided bounded error.

Optomechanics: Single-photon Frequency Shifting

E. Kuramochi and M. Notomi

Nature Photon, Vol. 10, No. 12, pp. 752–753, December 2016.

A fingertip-sized on-chip optomechanical device offers a controllable way to shift the frequency of single photons in the telecom band while preserving their quantum information.

Quantum Query Complexity of Almost All Functions with Fixed On-set Size

A. Ambainis, K. Iwama, M. Nakanishi, H. Nishimura, R. Raymond, S. Tani, and S. Yamashita

Computational Complexity, Vol. 25, No. 4, pp. 723–735, December 2016.

This paper considers the quantum query complexity of almost all functions in the set $F_{N,M}$ of N-variable Boolean functions with on-set size $M(1 \le M \le 2^N/2)$, where the on-set size is the number of inputs on which the function is true. The main result is that, for all functions in $F_{N,M}$ except its polynomially small fraction, the quantum query complexity is $\Theta\left(\frac{log\ M}{c+\log N-\log\log M}+\sqrt{N}\right)$ for a constant $c>0$. This is quite different from the quantum query complexity of the hardest function in $F_{N,M}$: $\Theta\left(\sqrt{N\frac{log\ M}{c+\log N-\log\log M}}+\sqrt{N}\right)$. In contrast, almost all functions in $F_{N,M}$ have the same randomized query complexity $\Theta(N)$ as the hardest one, up to a constant factor.

A Fast Exact Quantum Algorithm for Solitude Verification

S. Tani

arXiv:1612.05317 [quant-ph], December 2016.

Solitude verification is arguably one of the simplest fundamental problems in distributed computing, where the goal is to verify that there is a unique contender in a network. This paper devises a quantum algorithm that exactly solves the problem on an anonymous network, which is known as a network model with minimal assumptions [Angluin, STOC'80]. The algorithm runs in $O(N)$ rounds if every party initially has the common knowledge of an upper bound N on the number of parties. This implies that all solvable problems can be solved in $O(N)$ rounds on average without error (i.e., with zero-sided error) on the network. As a generalization, a quantum algorithm that works in $O(N \log 2\ (\max\{k, 2\}))$ rounds is obtained for the problem of exactly computing any symmetric Boolean function, over n distributed input bits, which is constant over all the n bits whose sum is larger than k for $k \in \{0, 1,\ldots,N-1\}$. All these algorithms work with the bit complexities bounded by a polynomial in N.

Active Manual Movement Improves Directional Perception of Illusory Force

T. Amemiya and H. Gomi

IEEE Transactions on Haptics, Vol. 9, No. 4, pp. 465–473, December 2016.

Active touch sensing is known to facilitate the discrimination or recognition of the spatial properties of an object from the movement of tactile sensors on the skin and by integrating proprioceptive feedback about hand positions or motor commands related to ongoing hand movements. On the other hand, several studies have reported that tactile processing is suppressed by hand movement.

Thus, it is unclear whether or not the active exploration of force direction by using hand or arm movement improves the perception of the force direction. Here, we show that active manual movement in both the rotational and translational directions enhances the precise perception of the force direction. To make it possible to move a hand in space without any physical constraints, we have adopted a method of inducing the sensation of illusory force by asymmetric vibration. We found that the precision of the perceived force direction was significantly better when the shoulder is rotated medially and laterally. We also found that directional errors supplied by the motor response of the perceived force were smaller than those resulting from perceptual judgments between visual and haptic directional stimuli. These results demonstrate that active manual movement boosts the precision of the perceived direction of an illusory force.

Tactile Apparent Motion on the Torso Modulates Perceived Forward Self-motion Velocity

T. Amemiya, K. Hirota, and Y. Ikei

IEEE Transactions on Haptics, Vol. 9, No. 4, pp. 474–482, December 2016.

The present study investigated whether a tactile flow created by a matrix of vibrators in a seat pan simultaneously presented with an optical flow in peripheral vision enhances the perceived forward velocity of self-motion. A brief tactile motion stimulus consisted of four successive rows of vibration, and the interstimulus onset between the tactile rows was varied to change the velocity of the tactile motion. The results show that the forward velocity of self-motion is significantly overestimated for rapid tactile flows and underestimated for slow ones, compared with optical flow alone or non-motion vibrotactile stimulation conditions. In addition, the effect with a temporal tactile rhythm without changing the stimulus location was smaller than that with spatiotemporal tactile motion, with the interstimulus onset interval to elicit a clear sensation of tactile apparent motion. These findings suggest that spatiotemporal tactile motion is effective in inducing a change in the perceived forward velocity of self-motion.

Sanshool on the Fingertip Interferes with Vibration Detection in a Rapidly-adapting (RA) Tactile Channel

S. Kuroki, N. Hagura, S. Nishida, P. Haggard, and J. Watanabe

PLOS ONE, Vol. 11, No. 12, e0165842, December 2016.

An Asian spice, Szechuan pepper (sanshool), is well known for the tingling sensation it induces on the mouth and on the lips. Electrophysiological studies have revealed that its active ingredient can induce firing of mechanoreceptor fibres that typically respond to mechanical vibration. Moreover, a human behavioral study has reported that the perceived frequency of sanshool-induced tingling matches with the preferred frequency range of the tactile rapidly

adapting (RA) channel, suggesting the contribution of sanshool-induced RA channel firing to its unique perceptual experience. However, since the RA channel may not be the only channel activated by sanshool, there could be a possibility that the sanshool tingling percept may be caused in whole or in part by other sensory channels. Here, by using a perceptual interference paradigm, we show that the sanshool-induced RA input indeed contributes to the human tactile processing. The absolute detection thresholds for vibrotactile input were measured with and without sanshool application on the fingertip. Sanshool significantly impaired detection of vibrations at 30 Hz (RA channel dominant frequency), but did not impair detection of higher frequency vibrations at 240 Hz (Pacinian-corpuscle (PC) channel dominant frequency) or lower frequency vibrations at 1 Hz (slowly adapting 1 (SA1) channel dominant frequency). These results show that the sanshool induces a peripheral RA channel activation that is relevant for tactile perception. This anomalous activation of RA channels may contribute to the unique tingling experience of sanshool.

Mobile Silk Fibroin Electrode for Manipulation and Electrical Stimulation of Adherent Cells

T. Teshima, H. Nakashima, N. Kasai, S. Sasaki, A. Tanaka, S. Tsukada, and K. Sumitomo

Advanced Functional Materials, Vol. 26, No. 45, pp. 8185–8193, December 2016.

Microfabricated mobile electrodes, nanopallets, designed to provide adherent cells with electrical stimulation are reported. Nanopallets composed of a cross-linked silk fibroin hydrogel matrix incorporated with poly(3,4-ethylenedioxythiophene):polystyrene sulfonate (PEDOT:PSS) are used. The silk fibroin composite is characterized not only by mechanical and electrical conductive properties, but also by its optical transparency in both the visible and ultraviolet regions, and by its biocompatibility with adherent cells. It is demonstrated that the adherent cells, including normal cell-lined cells and primary neuronal cells, loaded on the nanopallets can be manipulated while faithfully retaining their adhesive properties. By applying voltages via the nanopallets, the voltage-dependent calcium channels expressed in the cells are selectively stimulated, and this is confirmed by using confocal fluorescent microscopy during manipulation and performing multiangle observations. These features are attributed to both the mobile operation of the transparent nanopallets, and the ability to simultaneously measure electrical signals and perform fluorescent observations.

Manipulating and Trapping Light with Photonic Crystals from Fundamental Studies to Applications

E. Kuramochi

Journal of Materials Chemistry C, Vol. 4, No. 47, pp. 11032–11049, December 2016.

Photonic crystal technology, which was initially proposed as a way to realize nanoscale nanocavities and nanowaveguides, is now finding applications as a surface interface layer technology for light-emitting diodes with high brightness and solar cells with high conversion efficiency. On the other hand, nanocavities, which can efficiently confine light in an ultrasmall footprint with significantly enhanced photon lifetime, have greatly contributed to cavity quantum electrodynamics studies. Such nanocavities have also realized prototypes of ultralow-power functional devices and high-density integrated photonic circuits. In this review article, I focus on planar and two-dimensional slab photonic crystal and related structures, which have played major roles in both fundamental studies and device applications.

MSF: Architecture to Leverage Commodity Switches into Carrier-grade Networking

H. Yoshioka

Carrier Network Virtualization 2016, Palo Alto, CA, USA, December 2016.

The vision, development status, and innovation roadmap of NTT's NetroSphere concept and MSF (Multi-Service Fabric) architecture were explained.

Collective First-person Vision for Automatic Gaze Analysis in Multiparty Conversations

S. Kumano, K. Otsuka, R. Ishii, and J. Yamato

IEEE Transactions on Multimedia, Vol. 19, No. 1, pp. 107–122, January 2017.

This paper targets small- to medium-sized-group face-to-face conversations where each person wears a dual-view camera, consisting of inward- and outward-looking cameras, and presents an almost fully automatic but accurate off-line gaze analysis framework that does not require users to perform any calibration steps. Our collective first-person vision framework, where captured audio-visual signals are gathered and processed in a centralized system, jointly undertakes the fundamental functions required for group gaze analysis, including speaker detection, face tracking, and gaze tracking. Of particular note is our self-calibration of gaze trackers by exploiting a general conversation rule, namely that listeners are likely to look at the speaker. From the rough conversational prior knowledge, our system visualizes fine-grained participants' gaze behavior as a gaze-centered heat map. An experiment achieves a mean absolute error of 2.8 degrees in gaze tracking.
