External Awards

Information and Systems Society Excellent Paper Award

Winner: Ryo Masumura, NTT Media Intelligence Laboratories; Taichi Asami, NTT DOCOMO, INC.; Takanobu Oba, NTT Media Intelligence Laboratories; Hirokazu Masataki, NTT TechnoCross Corporation; Sumitaka Sakauchi, NTT Media Intelligence Laboratories (now with NTT EAST); Akinori Ito, Tohoku University; Satoshi Takahashi, NTT TechnoCross Corporation
Date: June 25, 2019
Organization: The Institute of Electronics, Information and Communication Engineers (IEICE)

For their three consecutive papers: "Investigation of Combining Various Major Language Model Technologies including Data Expansion and Adaptation," "N-gram Approximation of Latent Words Language Models for Domain Robust Automatic Speech Recognition," and "Domain Adaptation Based on Mixture of Latent Words Language Models for Automatic Speech Recognition."
Published as: R. Masumura, T. Asami, T. Oba, H. Masataki, S. Sakauchi, and A. Ito, "Investigation of Combining Various Major Language Model Technologies including Data Expansion and Adaptation," IEICE Trans. Inf. & Syst., Vol. E99.D, No. 10, pp. 2452–2461, 2016.
R. Masumura, T. Asami, T. Oba, H. Masataki, S. Sakauchi, and S. Takahashi, "N-gram Approximation of Latent Words Language Models for Domain Robust Automatic Speech Recognition," IEICE Trans. Inf. & Syst., Vol. E99.D, No. 10, pp. 2462–2470, 2016.
R. Masumura, T. Asami, T. Oba, H. Masataki, S. Sakauchi, and A. Ito, "Domain Adaptation Based on Mixture of Latent Words Language Models for Automatic Speech Recognition," IEICE Trans. Inf. & Syst., Vol. E101.D, No. 6, pp. 1581–1590, 2018.

IEVC2019 Best Paper Award

Winner: Kazuhiko Murasaki, NTT Media Intelligence Laboratories; Chihiro Kazato, NTT Access Network Service Systems Laboratories (now with NTT EAST); Shingo Ando, NTT Media Intelligence Laboratories; and Atsushi Sagata, NTT Media Intelligence Laboratories (now with NTT Service Evolution Laboratories)
Date: August 24, 2019
Organization: The Institute of Image Electronics Engineers of Japan (IIEEJ)

For "N-AUC: Maximization of the Narrow Area Under the ROC Curve for Recall-oriented Abnormality Detection."
Published as: K. Murasaki, C. Kazato, S. Ando, and A. Sagata, "N-AUC: Maximization of the Narrow Area Under the ROC Curve for Recall-oriented Abnormality Detection," The 6th IIEEJ International Conference on Image Electronics and Visual Computing (IEVC2019), Kuta Bali, Indonesia, Aug. 2019.

Papers Published in Technical Journals and Conference Proceedings

3-bit Digitized-RoF Retransmission of 12ch 16APSK Broadcast Signals with Improved Nonlinear Compression

R. Shiina, T. Fujiwara, and S. Ikeda

Proc. of the 44th European Conference on Optical Communication (ECOC 2018), pp. 114–116, Rome, Italy, September 2018.

We achieved 3-bit retransmission of 12ch multiplexed 16APSK (amplitude phase shift keying) broadcast satellite signals having extremely wideband, 38.36 MHz/ch, for 4K/8K-UHD (ultrahigh definition) using a DRoF (digitized radio-over-fiber)-based video distribution system with a new compression technique that offers a 40% cut in the transmission rate.

Privacy-preserving Network BMI Decoding of Covert Spatial Attention

T. Nakachi, H. Ishihara, and H. Kiya

Proc. of the 12th International Conference on Signal Processing and Communication Systems (ICSPCS 2018), Cairns, Australia, December 2018.

The brain-machine interface (BMI) has attracted much attention in the fields of biomedical engineering and ICT (information and communication technology) human communications. Of particular interest, neural decoding methods have rapidly developed over the last decade in neuroscience, allowing us to estimate the contents of human perception and subjective mental states by capturing brain activity patterns. However, the development of neural decoding will generate significant concern about privacy violation. In this manuscript, we propose a secure network BMI decoding method based on sparse coding for a covert spatial attention task. It is shown that secure sparse coding enables us to not only protect observed EEG (electroencephalography) signals, but also achieve the same estimation performance as that offered by sparse coding with unprotected observed signals.

Participating-domain Segmentation Based Delay-sensitive Distributed Server Selection Scheme

A. Kawabata, B. C. Chatterjee, and E. Oki

IEEE Access, Vol. 7, pp. 20689–20697, February 2019.

This paper proposes a participating-domain segmentation based server selection scheme in a delay-sensitive distributed communication approach to reducing the computational time for solving the server selection problem. The proposed scheme divides the users' participation domain into a number of regions. The delay between a region and a server is a function of locations of the region and the server. The length between the region and the server is considered based on conservative approximation. The location of the region is determined regardless of the number of users and their participation location. The proposed scheme includes two phases. The first phase uses the server finding process and determines the number of users that are accommodated from each region by each server, instead of actual server selection, to reduce the computational complexity. The second phase uses the delay improvement process and determines the overall delay and the selected server for each user. We formulate an integer linear programming problem for the server selection in the proposed scheme and evaluate the performance in terms of computation time and delay. The numerical results indicate that the computational time using the proposed scheme is smaller than that of the conventional scheme, and the effectiveness of the proposed scheme improves as the number of users increases.

VLC/RF Channel Switching Process Adapting to User Mobility in Coexistence Architecture

R. Shiina, K. Hara, T. Taniguchi, T. Nakahira, T. Murakami, and S. Ikeda

Proc. of the 24th OptoElectronics and Communications Conference (OECC 2019), WA3-3, Fukuoka, Japan, July 2019.

We propose a seamless channel switching process that considers user mobility in the WiSMA (strategy management architecture for wireless resource optimization)-based VLC/RF (visible light communication/radio frequency) coexistence architecture. Experiments and theoretical evaluations confirm the feasibility of the proposal over an expected range of user velocities.

Observation of Intracellular Protein Localization Area in a Single Neuron Using Gold Nanoparticles with a Scanning Electron Microscope

T. Goto, N. Kasai, R. Filip, K. Sumitomo, and H. Nakashima

Micron, Vol. 126, 102740, August 2019.

The localization areas of intracellular proteins in rat cortical neurons were visualized using a scanning electron microscope (SEM) coupled with a focused ion beam (FIB) system. To obtain a clear contrast in the SEM images, gold nanoparticles (GNPs) were bound to specific intracellular proteins by antigen-antibody reactions. By obtaining a cross section of the desired location of the neurons by FIB milling under the SEM imaging condition, it was possible to observe the proteins inside the cells as clear bright spots. When a neuron was stained with antitau and anti-histone H1 antibodies, the bright spots were localized in the cross section of the axon and the nucleus, respectively. It was confirmed that targeted proteins in a single neuron on a substrate could be successfully identified. The development of FIB/SEM observation with immunological GNP staining will offer important information for the stable growth of neurons on various substrate structures, since the elongation and turning of axons on the substrates are activated by the redistribution of intracellular proteins.

Quantum Key Distribution with Simply Characterized Light Sources

A. Mizutani, T. Sasaki, Y. Takeuchi, K. Tamaki, and M. Koashi

The 9th International Conference on Quantum Cryptography (QCrypt 2019), Montreal, Canada, August 2019.

In general, in order to show that a QKD (quantum key distribution) protocol is secure, some assumptions on light sources and/or measurement apparatuses are necessary. In this work, we have relaxed the assumptions.

Resource-efficient Verification of Quantum Computing Using Serfling's Bound

Y. Takeuchi, A. Mantri, T. Morimae, A. Mizutani, and J. F. Fitzsimons

QCrypt 2019, Montreal, Canada, August 2019.

In order to verify the correctness of measurement-based quantum computation, which is one of the universal quantum computing models, it is important to check whether the target graph state is faithfully prepared. In this work, we have proposed a resource-efficient verification protocol for graph states. Our protocol can be applied to blind quantum computation.

Impossibility of Blind Quantum Sampling for Classical Client

T. Morimae, H. Nishimura, Y. Takeuchi, and S. Tani

Quantum Information and Computation, Vol. 19, No. 9&10, pp. 793–806, August 2019.

Blind quantum computing enables a client, who can only generate or measure single-qubit states, to delegate quantum computing to a remote quantum server in such a way that the input, output, and program are hidden from the server. It is an open problem whether a completely classical client can delegate quantum computing blindly (in the information theoretic sense). In this paper, we show that if a completely classical client can blindly delegate sampling of subuniversal models, such as the DQC1 (deterministic quantum computation with one quantum bit) model and the IQP (instantaneous quantum polynomial time) model, then the polynomial-time hierarchy collapses to the third level. Our delegation protocol is the one where the client first sends a polynomial-length bit string to the server and then the server returns a single bit to the client. Generalizing the no-go result to more general setups is an open problem.

Quantum Computational Universality of Hypergraph States with Pauli-X and Z Basis Measurements

Y. Takeuchi, T. Morimae, and M. Hayashi

Scientific Reports, Vol. 9, 13585, September 2019.

Measurement-based quantum computing is one of the most promising quantum computing models. Although various universal resource states have been proposed so far, it was open whether only two Pauli bases are enough for both universal measurement-based quantum computing and its verification. In this paper, we construct a universal hypergraph state that only requires X and Z-basis measurements for universal measurement-based quantum computing. We also show that universal measurement-based quantum computing on our hypergraph state can be verified in polynomial time using only X and Z-basis measurements. Furthermore, in order to demonstrate an advantage of our hypergraph state, we construct a verifiable blind

quantum computing protocol that requires only *X* and *Z*-basis measurements for the client.

Verifying Commuting Quantum Computations via Fidelity Estimation of Weighted Graph States

M. Hayashi and Y. Takeuchi

New Journal of Physics, Vol. 21, No. 9, 093060, September 2019.

The instantaneous quantum polynomial time (IQP) model is a promising model to demonstrate a quantum computational advantage over classical computers. If the IQP model can be efficiently simulated by a classical computer, an unlikely consequence in computer science can be obtained (under some unproven conjectures). In order to experimentally demonstrate the advantage using medium or large-scale IQP circuits, it is inevitable to efficiently verify whether the constructed IQP circuits faithfully work. There exist two types of IQP models, each of which is the sampling on hypergraph states or weighted graph states. For the first-type IQP model, polynomial-time verification protocols have already been proposed. In this paper, we propose verification protocols for the second-type IQP model. To this end, we propose polynomial-time fidelity estimation protocols of weighted graph states for each of the following four situations where a verifier can (i) choose any measurement basis and perform adaptive measurements, (ii) only choose restricted measurement bases and perform adaptive measurements, (iii) choose any measurement basis and only perform non-adaptive measurements, and (iv) only choose restricted measurement bases and only perform non-adaptive measurements. In all of our verification protocols, the verifier's quantum operations are only single-qubit measurements. Since we assume no independent and identically distributed property on quantum states, our protocols work in any situation.

Using Seq2Seq Model to Detect Infection Focusing on Behavioral Features of Processes

S. Tobiyama, Y. Yamaguchi, H. Hasegawa, H. Shimada, M. Akiyama, and T. Yagi

Journal of Information Processing, Vol. 27, pp. 545–554, September 2019.

Sophisticated cyber-attacks intended to earn money or steal confidential information, such as targeted attacks, have become a serious problem. Such attacks often use specially crafted malware, which utilizes the art of hiding such as by process injection. Thus, preventing intrusion using conventional countermeasures is difficult, so a countermeasure needs to be developed that prevents attackers from reaching their ultimate goal. Therefore, we propose a method for estimating process maliciousness by focusing on process behavior. In our proposal, we first use one Seq2Seq model to extract a feature vector sequence from a process behavior log. Then, we use another Seq2Seq model to estimate the process maliciousness score by classifying the obtained feature vectors. By applying Seq2Seq models stepwise, our proposal can compress behavioral logs and extract abstracted behavioral features. We present an experimental evaluation using logs when actual malware is executed. The obtained results show that malicious processes are classified with a highest Areas Under the Curve (AUC) of 0.979 and 80% TPR even when the FPR is 1%. Furthermore, the results of an experiment using the logs when simulated attacks are executed show our proposal can detect unknown malicious processes that do not appear in training data.

Beyond Fourier Analysis: Recipes for Nonlinear Oscillator Expansion

F. Ishiyama

Proc. of the SICE Annual Conference 2019, pp. 1643–1648, Hiroshima, Japan, September 2019.

We are developing a method for time series analysis, which is a superset of Fourier analysis. We piecewisely quantize given time series into five dimensional particles, and we obtain a series expansion with general complex functions. We outline our method and present various recipes to show what we can do with our method. The recipes are less-than-a-cycle analysis, instability detection, trend-mode analysis, nonlinear analysis, and signal-noise separation.

DRoF-based Optical Video Re-transmission of Commercial RF Broadcast Signals

R. Shiina, T. Fujiwara, T. Taniguchi, and S. Ikeda

Journal of Optical Communications and Networking, Vol. 11, No. 11, pp. 559–567, November 2019.

We propose a novel digitized radio-over-fiber (DRoF)-based optical video re-transmission system. This system digitally transmits radio frequency (RF) broadcast signals via the communication network (NW) while maintaining the existing RF interface at both ends of the NW by using DRoF technology. Directly digitizing the RF signal makes the required transmission rate of the optical NW impractically large. In order to resolve this issue, we also propose an improved nonlinear quantization (INL) method that combines amplitude clipping and nonlinear quantization. This paper experimentally evaluates the feasibility of optical re-transmission by using a commercial 9-channel multiplexed digital terrestrial television broadcasting signal. The results of the experiment and our theoretical analysis show that it is necessary to re-transmit with 7-bit quantization at the transmitter in order to achieve the required signal quality. However, we show that re-transmission can be realized while satisfying the required quality with just 5 bits by using our proposed INL method. The resulting 2-bit reduction afforded by the INL proposal reduces the transmission rate by 28.6%.