External Awards

Entropy Best Paper Award 2014, 1st Prize of Review Award
Winner: Katherine L. Brown, School of Physics and Astronomy, University of Leeds; William J. Munro, NTT Basic Research Laboratories; and Vivien M. Kendon, School of Physics and Astronomy, University of Leeds
Date: April 30, 2014
Organization: Multidisciplinary Digital Publishing Institute (MDPI) AG, based in Basel, Switzerland

For "Using Quantum Computers for Quantum Simulation".

In this review we surveyed the theoretical and experimental development of quantum simulation using quantum computers, from the first ideas to the intense research efforts currently underway. This was the first comprehensive review.

Published as: K. L. Brown, W. J. Munro, and V. M. Kendon, "Using Quantum Computers for Quantum Simulation," Entropy 2010, Vol. 12, No. 11, pp. 2268–2307.

Papers Published in Technical Journals and Conference Proceedings

Network Coding and its Application to Content Centric Networking

S. Miyake and H. Asaeda

Proc. of WITMSE (Workshop on Information Theoretic Methods in Science and Engineering) 2013, pp. 55–61, Tokyo, Japan, August 2013.

Content Centric Networking (CCN) is one of the predominant proposals that have been made for the next generation content distribution platform. In CCN each router in a network is equipped with a large sized cache memory and becomes a content router that can be regarded as a temporary content server in the network. This mechanism can reduce the concentration of data traffic going into the original content server.

To enhance the merits of CCN, we propose applying network coding (NWC) to it. Applying NWC in this way makes it possible to implement distributed data storing of content data and to achieve multi-path transmission between content routers and an access router (or an end user). CCN with NWC can provide higher throughput for end users and reduce network load.

In addition to proposing the aforementioned application, in this paper we specify issues needing to be addressed to more successfully combine CCN with NWC.

A Disaster Resilient Image and Video Transmission Scheme Based on Movable and Deployable Resource Units

T. Nakachi, S.Y. Kim, and T. Fujii

Proc. of HTC (Humanitarian Technology Conference) 2013, IEEE Region 10, Sendai, Japan, August 2013.

In this paper, we propose a disaster resilient image and video transmission scheme based on specially designed "Movable and Deployable Resource Units (MDRUs)". The proposed resilient data transmission scheme offers image and video data appropriately to people in disaster areas through MDRUs. The image and video data are transmitted based on the MDRU power supplies and the network bandwidth between the MDRUs and terminal devices in the disaster area. Experimental results and demonstrations show the effectiveness of the proposed disaster resilient image and video transmission scheme.

A Conceptual Foundation of NSCW Transport Design Using an MMT Standard

T. Nakachi, Y. Tonomura, and T. Fujii

Proc. of ICSPCS (International Conference on Signal Processing and Communication Systems) 2013, Gold Coast, Australia, December 2013.

This paper introduces the concept of Network Supported Collaborative Work (NSCW) and its transport design based on the emerging standard of MPEG Media Transport (MMT). Based on extra-high quality 4K video technologies, NSCW is being developed to realize effective remote collaboration for business workspaces. MMT specifies technologies for the delivery of coded media data for multimedia services over the concatenation of heterogeneous packet based network segments including bidirectional IP networks and unidirectional digital broadcasting networks. One of the core technologies for delivery is forward error correction (FEC) codes. Simulation results using our proposed MMT FEC codes show the effectiveness of the proposed method.

An Overlay Network Construction Technique for Minimizing the Impact of Physical Network Disruption in Cloud Storage Systems

K. Suto, H. Nishiyama, N. Kato, T. Nakachi, T. Fujii, and A. Takahara

Proc. of ICNC (International Conference on Computing, Networking and Communications) 2014, pp. 68–72, Honolulu, HI, USA, February 2014.

Cloud storage exploiting overlay networks is considered to be a scalable and autonomous architecture. While this technology can ensure the security of storage service, it requires addressing the "server breakdown" problem, which may arise due to malicious attacks on servers and mechanical problems with servers. In existing literature, an overlay network based on bimodal degree distribution was proposed to achieve high connectivity to combat these two types of server breakdown. However, it cannot ensure the high connectivity against physical network disruption that removes numerous nodes from the overlay network. To deal with this issue, in this paper, we propose a physical network aware overlay network, in which the neighboring nodes are connected with one another in the overlay. Moreover, the numerical analysis indicates that the proposed system considerably outperforms the conventional system in terms of service availability.

An Iterative Compensation Approach without Linearization of Projector Responses for Multiple-projector System

I. Miyagawa, Y. Sugaya, H. Arai, and M. Morimoto

IEEE Transactions on Image Processing, Vol. 23, No. 6, pp. 2676–2687, June 2014.

We aim to realize a new and simple compensation method that robustly handles multiple-projector systems without recourse to the linearization of projector response functions. We introduce state equations, which distribute arbitrary brightness among the individual projectors, and control the state equations according to the feedback from a camera. By employing the color-mixing matrix with gradient of projector responses, we compensate the controlled brightness input to each projector. Our method dispenses with cooperation among multiple projectors as well as time-consuming photometric calibration. Compared with existing methods, our method is shown to offer superior compensation performance and a more effective way of compensating multiple-projector systems.

Water Electrolysis and Energy Harvesting with 0D Ion-sensitive Field-effect Transistors

N. Clément, K. Nishiguchi, J. F. Dufrêche, D. Guérin, A. Fujiwara, and D. Vuillaume

Proc. of International Symposium on Energy Challenges & Mechanics, Aberdeen, Scotland, UK, July 2014.

Water electrolysis is one of the most "green" approaches for producing hydrogen (H_2) as a fuel source. As a key issue in the operation of the International Space Station and the mission to Mars, water electrolysis is utilized as a regenerative life support system and is part of the energy conversion system. The behavior of gas bubbles in water electrolysis is a typical interfacial phenomenon. Many experiments including optical, acoustic, and other approaches (e.g., electrical impedance), have been performed to determine the bubble size distribution in samples of water. Here, we show that nanotransistors, which are so small that they can be considered as 0D, can be used to transform energy lost during bubble emission into electrical pulses. This system does not require light, is sensitive to a single bubble, and has no intrinsic limitation in bubble size.

Rapid Switching in High-Q Mechanical Resonators

H. Okamoto, I. Mahboob, K. Onomitsu, and H. Yamaguchi

Applied Physics Letters, Vol. 105, 083114, August 2014.

Sharp resonance spectra of high-Q micromechanical resonators are advantageous in their applications, such as highly precise sensors and narrow band-pass filters. However, the high-Q characteristics hinder quick repetitive operations of mechanical resonators because of their long ring-down time due to their slow energy relaxation. Here, we demonstrate a scheme to solve this trade-off problem in paired GaAs micromechanical resonators by using parametrically induced intermode coupling. The strong intermode coupling induced by the piezoelectric modulation of tension allows on-demand energy transfer between closely spaced mechanical modes of the resonator via coherent control of the coupling. This enables rapid switching of the vibration amplitude within the ring-down time, leading to quick repetitive operations in high-Q mechanical resonators.

On the Computational Power of Constant-depth Exact Quantum Circuits

Y. Takahashi

Proc. of Satellite Workshop of AQUIS (Asian Quantum Information Science Conference) 2014, Tokyo, Japan, August 2014.

We show that there exists a constant-depth polynomial-size quantum circuit for the quantum OR operation. We also show that, under a plausible assumption, there exists a classically hard problem that is solvable by a constant-depth quantum circuit with gates for the quantum Fourier transform.

Hardness of Classically Simulating Quantum Circuits with Unbounded Toffoli and Fan-out Gates

Y. Takahashi, T. Yamazaki, and K. Tanaka

Quantum Information and Computation, Vol. 14, No. 13&14, pp. 1149–1164, October 2014.

We show that there exists a constant-depth quantum circuit with only one unbounded Toffoli gate that is not weakly simulatable, unless BQP $\subseteq$ PostBPP $\cap$ AM. Then, we show that there exists a constant-depth quantum circuit with only two unbounded fan-out gates that is not strongly simulatable, unless P = PP.
