External Awards

LOIS Best Paper Award

Winners: Takeshi Kurashima[*1], Tomoharu Iwata[*2], Go Irie[*1], and Ko Fujimura[*1]

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Organization: IEICE Life Intelligence and Office Information System (LOIS) Technical Group

For "Travel Route Recommendation Using Geotags on Photo Sharing Service".

Published as: T. Kurashima, T. Iwata, G. Irie, and K. Fujimura, "Travel Route Recommendation Using Geotags on Photo Sharing Service," IEICE Tech. Report, Vol. 109, No. 450, pp. 55–60, 2010.

Papers Published in Technical Journals and Conference Proceedings

Single-electron Stochastic Resonance Using Si Nano-wire Transistors

K. Nishiguchi and A. Fujiwara

Proc. of the International Symposium on Nanoscale Transport and Technology (ISNTT2011), p. 133, Atsugi, Kanagawa, Japan.

We demonstrate stochastic resonance (SR) with single electrons (SEs) using nanoscale metal-oxide-semiconductor field-effect transistors (MOSFETs). The input signal applied to a MOSFET modulates SE transport in an average manner based on non-linear characteristics. On the other hand, an individual SE goes through the MOSFET in a completely random manner, which corresponds to shot noise. SEs transferred to a storage node are counted precisely by the other MOSFET and used as an output signal. The correlation between the input and output signals is improved by taking advantage of extrinsic noise as well as the intrinsic shot noise composed of SEs. It is confirmed that the shot-noise-assisted SR allows fast operation with a simple system. Pattern perception utilizing SR is also demonstrated.

A Silicon Nanowire Ion-sensitive Field-effect Transistor with Elementary Charge Sensitivity

N. Clément, K. Nishiguchi, J. F. Dufreche, D. Guerin, A. Fujiwara, and D. Vuillaume

Appl. Phys. Lett., Vol. 98, No. 1, p. 014104, 2011.

We investigate the mechanisms responsible for the low-frequency noise in liquid-gated nanoscale silicon nanowire field-effect transistors (SiNW-FETs) and show that the charge-noise level is lower than the elementary charge. Our measurements also show that the ionic strength of the surrounding electrolyte has a minimal effect on the overall noise. Dielectric polarization noise seems to be at the origin of the 1/*f* noise in our devices. The estimated spectral density of charge noise $Sq = 1.6\times10^{-2}\ e/\mathrm{Hz}^{1/2}$ at 10 Hz opens the door to metrological studies with these SiNW-FETs for the electrical detection of a small number of molecules.

Evaluation of a Gate Capacitance in the Sub-aF Range for a Chemical Field-effect Transistor with a Silicon Nanowire Channel

N. Clément, K. Nishiguchi, A. Fujiwara, and D. Vuillaume

IEEE Trans. Nanotechnology, Vol. PP, No. 99, pp. 1–8, 2011.

An evaluation of the gate capacitance of a field-effect transistor (FET) whose channel length and width are several tens of nanometers is a key point for sensors applications. However, experimental and precise evaluation of capacitance in the attofarad range or less has been extremely difficult. Here, we report an extraction of the capacitance down to 0.55 aF for a silicon FET with a nanoscale wire channel whose width and length are 15 and 50 nm, respectively. The extraction can be achieved by using a combination of four kinds of measurements: current characteristics modulated by double gates, random-telegraph-signal noise induced by the trapping and detrapping of a single electron, dielectric polarization noise, and current characteristics showing Coulomb blockade at low temperature. The extraction of such a small gate-capacitance enables us to evaluate electron mobility in a nanoscale wire using a classical model of the current characteristics of a FET.

A Theater for Viewing and Editing Multi-sensory Content

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

IEEE International Symposium on VR Innovation (ISVRI2011), pp. 239–244, Singapore.

This research has been carried out as part of a multi-sensory theater project that aims at establishing technology to integrate a range of sensations such as visual, audio, force, tactile, vestibular, and odor into passive and interactive media content and communications. This paper describes the approaches that are being examined and the current status of the project. As a platform for the experiments, a prototype version of a multi-sensory theater has been implemented. The theater is equipped with devices that present wind and olfactory sen-

sations. The sensation of wind is generated by both computer-controlled fans and air nozzles connected to a source of compressed air, and the olfactory sensation is presented by emitting odorants into the air. To facilitate the creation of content, a framework for editing multi-sensory information was constructed, in which all of the devices were connected to and controlled by a sequencer based on a MIDI interface.

Standardization Trend of Recent Wireless LANs

Y. Kojima

ARIB Bulletin, the Association of Radio Industries and Businesses (ARIB), No. 73, 2011 (in Japanese).

This article explains the trend of recent wireless LAN standardization for IEEE802.11 and Wi-Fi.

Training Conditional Random Fields Based on Segment-wise Maximum Figure-of-merit Functions

J. Suzuki and H. Isozaki

Journal of IEICE, the Institute of Electronics, Information and Communication Engineers (IEICE), Vol. J94-D, No. 5, pp. 908–918, 2011 (in Japanese).

This paper proposes a framework for training conditional random fields (CRFs) to maximize a figure-of-merit function for task evaluation. Specifically focusing on sequence segmentation tasks such as chunking and named entity recognition tasks in the natural language processing field, this paper introduces an objective function that emulates the segment-wise F-score, which is generally used as an evaluation measure for these tasks. Our experiments show that the segment-wise F-score optimization performs better than standard ML (maximum likelihood) and MAP (maximum a posteriori) training of CRF since it reduces the mismatch between the objective function of CRF training and the task evaluation measure.

Single-electron Counting Statistics of Shot Noise in Nanowire Si Metal-oxide-semiconductor Field-effect transistors

K. Nishiguchi, Y. Ono, and A. Fujiwara

Appl. Phys. Lett., Vol. 98, No. 19, p. 193502, 2011.

Shot noise in the transport of single electrons in a Si metal-oxide-semiconductor field-effect transistor is monitored by real-time measurement with a high-charge-sensitivity electrometer. In the current range between zepto- and attoamperes, the current characteristics are found to be divided into two regimes: a temperature-independent regime in the lower current range and a temperature-dependent one in the higher current range. A time-domain analysis reveals that, for both regimes, the single-electron transport obeys a pure Poisson process with the Fano factor being nearly unity, while the shot noise is suppressed with reduced Fano factors around the boundary.

High Output Power (~400 μW) Oscillators at around 550 GHz Using Resonant Tunneling Diodes with Graded Emitter and Thin Barriers

M. Shiraishi, H. Shibayama, K. Ishigaki, S. Suzuki, M. Asada, H. Sugiyama, and H. Yokoyama.

Appl. Phys. Express, Vol. 4, No. 6, p. 064101, 2011.

We report resonant tunneling diode (RTD) oscillators with a high output power of around 400 μW at frequencies of 530–590 GHz. RTDs with a graded emitter and thin barriers were employed to obtain large negative differential conductance at high frequencies for high output power. An optimized structure of offset slot antennas was also used to maximize the radiation conductance. The highest output power obtained in this study was 420 μW at 548 GHz for an RTD with a peak current density of 24 mA/μm^2; the RTD was placed 58 μm away from the center of a 130-μm-long slot antenna.

Asymptotic Local Hypothesis Testing between a Pure Bipartite State and the Completely Mixed State

M. Owari and M. Hayashi

arXiv, Cornell University Library, Vol. 1105, No. 3789, pp. 1–14, 2011.

In this paper, we treat asymptotic hypothesis testing between an arbitrary known bipartite pure state and the completely mixed state under one-way local quantum operations assisted by classical communication (LOCC), two-way LOCC, and separable positive operator valued measures (POVMs). As a result, we derive analytical formulas for Stein's lemma type of optimal error exponents under all one-way LOCC, two-way LOCC, and separable POVMs; the Chernoff bounds under one-way LOCC POVMs and separable POVMs; and the Hoeffding bounds under one-way LOCC POVMs without any restrictions on a parameter and under separable POVMs in a restricted region of a parameter. We also numerically calculate the Chernoff and Hoeffding bounds for a class of three-step LOCC protocols in low-dimensional systems and show that these bounds not only outperform the bounds for one-way LOCC POVMs, but almost approximate the bounds for separable POVMs in the region of a parameter where the analytical bounds for separable POVMs are derived.

Non-stationary Noise Estimation Method Based on Bias-residual Component Decomposition for Robust Speech Recognition

M. Fujimoto, S. Watanabe, and T. Nakatani

Proc. of the 36th International Conference on Acoustics, Speech and Signal Processing (ICASSP2011), IEEE, pp. 4816–4819, Prague, Czech Republic.

This paper addresses a noise suppression problem, namely the estimation of non-stationary noise sequences. In this problem, we assume that non-stationary noise can be decomposed into stationary and non-stationary components. These components are described respectively as the bias factor and the residual signal between the bias component and noise in each frame. This decomposition clarifies the role of each component, thus enabling us to apply a suitable parameter estimation technique to each component. In this paper, the bias component is estimated by the EM (expectation maximization) algorithm with the entire observed signal sequence. On the other hand, the residual component is sequentially estimated by multiplying the extended Kalman filter with the EM algorithm. In the evaluation results, we confirmed that the proposed method improved speech recognition accuracy compared with noise estimation methods without component decomposition.