External Awards

Achievement Award

Winner: Tadao Nagatsuma[†1], Akihiko Hirata[†2], and Toshihiko Kosugi[†3]

†1 NTT Microsystem Integration (Research Professor)
†2 NTT Microsystem Integration Laboratories
†3 NTT Photonics Laboratories

Date: May 25, 2007

Organization: The Institute of Electronics, Information and Communication Engineers

For pioneering research about the development of unused radio wave bands by photonics technologies and application to wireless communications.

We have succeeded in the generation and detection of radio wave signals at the frequency of from 100 GHz to 1 THz precisely by using photonics technologies. We have realized 10-Gbit/s data transmission by applying these photonics technologies to the wireless communications.

References: "10-Gbit/s Wireless Link Technology Using the 120-GHz Band," NTT Technical Review, Vol. 2, No. 11, pp. 58–62.

"Multiplexed Transmission of Uncompressed HDTV Signals Using 120-GHz-band Millimeter-wave Wireless Communications System," NTT Technical Review, Vol. 4, No. 3, pp. 64–70.

The Best Paper Award

Winner: Satoshi Shigematsu[†1], Koji Fujii[†1], Hiroki Morimura[†1], Takahiro Hatano[†1], Mamoru Nakanishi[†1], Namiko Ikeda[†1], Toshishige Shimamura[†1], Katsuyuki Machida[†2], Yukio Okazaki[†3], and Hakaru Kyuragi[†1]

†1 NTT Microsystem Integration Laboratories.
†2 NTT Advance Technology
†3 NTT

Date: May 25, 2007

Organization: The Institute of Electronics, Information and Communication Engineers

For "Fingerprint Image Enhancement and Rotation Schemes for a Single-chip Fingerprint Sensor and Identifier."

This paper presents fingerprint image enhancement and rotation schemes that improve the identification accuracy with the pixel-parallel processing of pixels. In the schemes, the range of the fingerprint sensor is adjusted to the finger state, the captured image is retouched to obtain the suitable image for identification, and the image is rotated to the correct angle on the pixel array. Sensor and pixel circuits that provide these operations were devised and a test chip was fabricated using 0.25-μm CMOS and the sensor process. It was confirmed in 150,000 identification tests that the schemes reduce the false rejection rate to 6.17% from 30.59%, when the false acceptance rate is 0.1%.

Papers Published in Technical Journals and Conferences

Fabrication of an Electrochemical Sensor Array for 2D H_2O_2 Imaging

N. Kasai, A. Shimada, N. Tobias, and K. Torimitsu
Electrochemistry, Vol. 74, No. 8, pp. 628–631, Aug. 2006.

To achieve accurate real-time 2D H_2O_2 distribution imaging, we fabricated an H_2O_2 sensor array by dispensing small quantities of enzyme solution very accurately onto electrodes in an electrode array. We confirmed the accuracy of the dispensing technique. We then investigated the responses of each sensor to H_2O_2 injection using a 64-channel multipotentiostat and found they varied by 20%. Real-time 2D H_2O_2 imaging was therefore successfully realized by using our flow cell system. This sensor array will be useful for the non-invasive, real-time monitoring of the H_2O_2 distribution in biological samples.

Gate Capacitance-voltage Characteristics of Submicron-long-gate Diamond field-effect Transistors with Hydrogen Surface Termination

M. Kasu, K. Ueda, Y. Yamauchi, and T. Makimoto
Appl. Phys. Lett. Vol. 90, No. 3, pp. 043509–043509, Jan. 2007.

The radio-frequency characteristics of p-type diamond field-effect transistors with hydrogen surface termination were numerically analyzed using an equivalent-circuit model. From the gate-source capacitance (C_{GS})-voltage (V_{GS}) results extracted from measured s parameters, the authors found a plateau in C_{GS} within a certain V_{GS} range. This means that a two-dimensional hole gas channel forms parallel to the surface and that the channel is separated by a thin energy-barrier layer with an infinite height from the gate metal. At a high negative V_{GS}, as negative V_{GS} is increased, C_{GS} increases steeply. This results from holes penetrating the energy barrier.

Open-air Type Ultrasonic Earphone System Combined with Audible-band Bone-conduction Vibration

M. Okamoto, M. Miyoshi, A. Kataoka, and S. Iwamiya
IEICE, Vol. J90-A, No. 2, pp. 73–82, Feb. 2007.

We describe an open-air type earphone system with flat frequency characteristics and little sound leakage. This earphone is a hybrid ultrasonic earphone system combined with an audible-band bone-conduction earphone. The ultrasonic earphone system vibrates a listener' s tragus by ultrasound amplitude modulated by audible

sound, and since it is not close to the listener's ear canal, sound leakage is small. However, it is hard to reproduce low-frequency-band sound. Sound leakage of the audible-band bone-conduction earphone is small in the low frequency band. In an experimental earphone system, we set the cross-over frequency to 1.6 kHz. We obtained nearly flat frequency characteristics of 88±6 dB (SPL) in the range from 200 Hz to 10 kHz and sound leakage of less than 50 dB(C). In particular, the sound leakage above 2 kHz was less than the background noise (33 dB(C)).

AIN p-n Junction UV-LEDs

Y. Taniyasu, M. Kasu, and T. Makimoto

The 3rd Asia-Pacific Workshop on Widegap Semiconductor, Jeonju, Korea, pp. 57–61, Mar. 2007.

We report AIN p-n junction light-emitting diodes (LEDs) with an emission wavelength of 210 nm, the shortest wavelength ever observed among semiconductors. N-type AIN was obtained by Si doping. By reducing dislocation density in n-type Si-doped AIN, we achieved a room-temperature electron mobility of 426 cm^2 V^{-1} s^{-1}, the highest value ever reported for n-type AIN. The temperature dependence of the electron mobility agreed well with calculated one considering specific scattering mechanisms. P-type AIN was obtained by Mg doping and the acceptor ionization energy was estimated to be 630 meV. From the characteristics of the AIN LEDs, we discuss the conduction and emission mechanisms.

Development of TO-BOSA for FTTH Using New Optical Path Alignment Technique

A.Ohki, S. Fukushima, M. Sugo, K. Kato, and Y. Akatsu

IEE Electron. Lett., Vol. 43, No. 6, pp. 358–359, Mar. 2007.

Proposed is a new assembly technique that provides a cost-effective way to integrate Tx and Rx in one TO-package. The TO-BOSA developed using this technique performed sufficiently well for FTTH service applications.

Highly Reliable 1.5-μm DFB Laser with High-Mesa SIBH Structure

T. Takeshita, T. Tadokoro, R. Iga, Y. Tohmori, M. Yamamoto, and M. Sugo

IEEE Transaction on Electron Devices, Vol. 54, No. 3, pp. 456–461, Mar. 2007.

The degradation behavior of 1.5-μm uncooled distributed feedback (DFB) lasers with a semiinsulating buried heterostructure during constant-power aging is investigated. Long-term stability is achieved by suppressing the $t^{0.5}$ deterioration in the current increase rate (second-stage degradation). The improvement in reliability is attributed to the fact that some defects on the grating interface are simultaneously suppressed by the mutual diffusion that occurs when growing the SI-InP layer. We realized a DFB laser with high reliability (< 1000 failure digits) at 95°C that is capable of error-free 2.5-Gb/s 80-km transmission at -20°C to 100°C.

Dense WDM Transmission through Multiple OADMs Using Optical RZ-DQPSK Modulation

A. Sano, Y. Miyamoto, and S. Norimatsu

IEICE, Vol. J90-B, No. 4, pp. 321–330, Apr. 2007.

This paper analyzes the transmission characteristics of 43-Gbit/s/ch, 50-GHz spaced WDM signals using optical DQPSK format through multiple OADM nodes. In linear transmission through narrowband optical filters, the NRZ-DQPSK format is shown to have good performance compared to the RZ-DQPSK format. The use of partial RZ format effectively improves the transmission characteristics in the multiple OADM networks. Next, in numerical simulations taking account of the nonlinear effect in the transmission fibers, it is shown that the decrease in the degree of RZ modulation induces the power penalties caused by XPM and FWM, and the optimum degree of RZ modulation exists.

Dispersion Matching of Sample and Reference Arms in Optical Frequency Domain Reflectometry-optical Coherence Tomography Using a Dispersion-shifted Fiber

K. Asaka and K. Ohbayashi

OSA, Opt. Express, Vol. 15, No. 8, pp. 5030–5042, Apr. 2007.

We demonstrate dispersion matching of sample and reference arms in an optical frequency domain reflectometry-optical coherence tomography (OFDR-OCT) system with a discretely swept light source centered at 1550 nm, using a dispersion-shifted fiber (DSF) in the reference arm. By adjusting the optical length of the DSF so that it is equal to that of the free space in the sample arm, we achieve a high resolution of 27.2 μm (in air), which is very close to the theoretically expected value of 26.8 μm when we measure the reflective mirror. This improves the degraded resolution (36.1 μm) in a system using a conventional single-mode fiber when the free-space length in the sample arm was 909 mm. We also demonstrate a clear interface between air and the enamel layer of an extracted human tooth with the discretely swept (DS) OFDR-OCT imaging due to the improved resolution provided by this technique. In addition, we confirmed the enhanced sharpness of the cellular structure in a dispersion matched OCT image of an onion sample. These results show the potential of our DS-OFDR-OCT system for a compact low-cost apparatus with a high axial resolution.

Three-dimensional Obstacle Avoidance of Blimp-type Unmanned Aerial Vehicle Flying in Unknown and Non-uniform Wind Disturbance

H. Kawano

JSME, International Journal of Robotics and Mechatronics, Vol. 19, No. 2, pp. 166–173, Apr. 2007.

A blimp-type unmanned aerial vehicle (BUAV) maintains its longitudinal motion using buoyancy provided by the air around it. This means the density of a BUAV equals that of the surrounding air. Because of this, the motion of a BUAV is seriously affected by flow disturbances, whose distribution is usually non-uniform and unknown. In addition, the inertia in the heading motion is very large. There is also a strict limitation on the weight of equipment in a BUAV, so most BUAVs are so-called under-actuated robots. From this situation, it can be said that the motion planning of the BUAV considering the stochastic property of the disturbance is needed for obstacle avoidance. In this paper, we propose an approach to the motion planning of a BUAV via the application of Markov decision process (MDP). The proposed approach consists of a method to prepare a discrete MDP model of the BUAV motion and a method to maintain the effect of the unknown wind on the BUAV's motion. A dynamical simulation of a BUAV in an environment with wind disturbance shows high performance of the proposed method.

Feature-based Processing of Audio-visual Synchrony Perception Revealed by Random Pulse Trains

W. Fujisaki, S. Nishida

Computationally, audio-visual temporal synchrony detection is analogous to visual motion detection in the sense that both solve the correspondence problem. We examined whether audio-visual synchrony detection is mediated by a mechanism similar to low-level motion sensors, by one similar to a higher-level feature matching process, or by both types of mechanisms as in the case of visual motion detection. We found that audio-visual synchrony-asynchrony-discrimination for temporally dense random pulse trains was difficult, whereas motion detection is known to be easy for spatially dense random dot patterns (random dot kinematograms) due to the operation of low-level motion sensors. Subsequent experiments further indicated that the temporal limiting factor of audio-visual synchrony discrimination is the temporal density of salient features not the temporal frequency of the stimulus, nor the physical density of the stimulus. These results suggest that audio-visual synchrony perception is based solely on a salient feature matching mechanism similar to that proposed for high-level visual motion detection.

Amplified Gigabit PON Systems

K. Suzuki, Y. Fukada, D. Nesset, and R. Davey

We describe how a passive optical network (PON) extender box can be implemented at standard PON wavelengths (1310 and 1490 nm) using either optical fiber amplifiers (praseodymium and thulium) or semiconductor optical amplifiers to further increase the physical reach and split of a current standardized PON system such as a G-PON or GE-PON. The transparency to PON protocol of this approach means no changes to the existing standards are required. This is attractive as operators and vendors are keen to fully exploit the investment made in current PON standard.