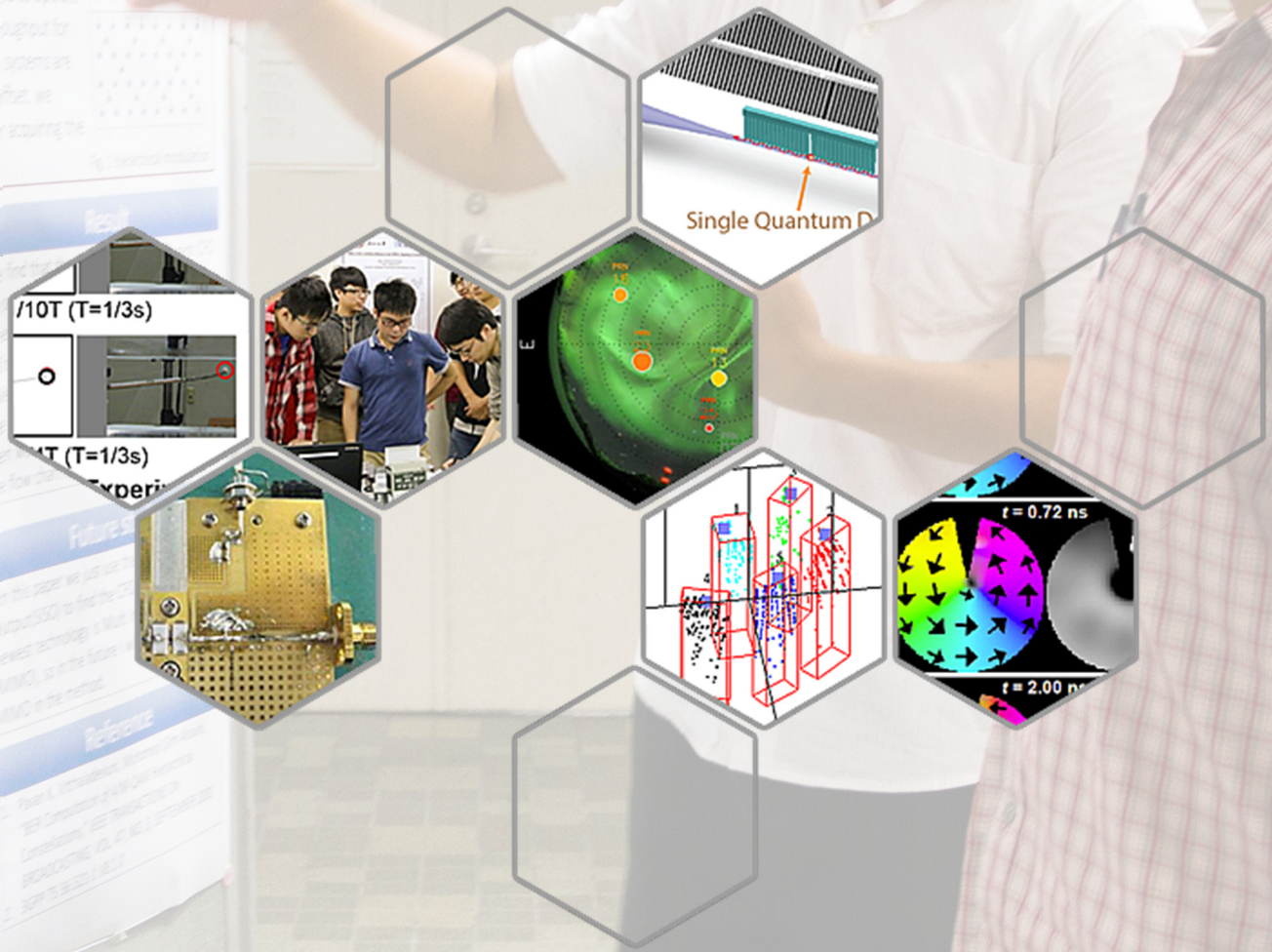
The University of Electro-Communications

UEC e-Bulletin

Updates on research, innovation, and events at UEC:
Unique and Exciting Campus in Tokyo

Vol.4, December 2014



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Feature

News and Events

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Innovative nanophotonics: Integrating quantum light sources with nanofibers for quantum internet applications

Professor Kohzo Hakuta
Director of the Center for Photonic Innovations, University of Electro-Communications (UEC)


Professor Kohzo Hakuta

"I had the idea for 'nanofiber quantum photonics' about 14 years ago," says Kohzo Hakuta, Director of the Center for Photonic Innovations at the University of Electro-Communications (UEC). "I want to integrate quantum light sources e.g. single quantum dot / single atom, into specially designed nanofibers. This 'fiber in-line technology' holds the potential to revolutionize distributed quantum networks for secure, ultra-high speed communication. Namely, the birth of the 'quantum internet. We are supported by Japan Science and Technology Agency through Strategic Innovation Program."

Fiber in-line technology is advantageous for integrating these sources to the conventional fiber-based communication network.


Group photo of the team

Now, Hakuta and his group at the Center for Photonic Innovations are addressing the following issues to develop fiber in-line technology to integrate quantum light sources into optical nanofibers. Fabrication of high efficiency tapered glass nanofibers; development of reproducible methods for integrating single quantum dots with nanofibers; integration of cavity structures with nanofibers; and experimental demonstration of cavity quantum electrodynamics (QED) with nanofibers. The work is carried out by an international group of researchers from countries including India, Vietnam, China and New Zealand.

"We have been working with our industrial partner Ishihara Sangyo Inc. to develop equipment for producing tapered nanofibers," explains Hakuta. "The resulting 400 nm diameter tapered fibers have 99% light transmission."

A critical technology is to pick up single quantum dots from colloidal solution and deposit it on the nanofiber. This is accomplished using a computer controlled pico-liter liquid dispenser combined with an inverted microscope and precision translation stages. Photon counting experiments show the realization of single quantum dot deposition with spatial accuracy better than 3μm, and importantly, the maximum photon channelling efficiency is measured to be 22.0% as predicted from the theory.

Furthermore, Hakuta and colleagues have developed a novel method to enhance this photon channelling efficiency by incorporating cavity structures. They are developing two methods. "On one hand, we can produce photonic crystal nanofibers with an array of thousands of highly ordered nano-craters using femto second lasers" explains Hakuta. "We were surprised to find highly periodic craters produced on the shadow sides of the nanofibers. Promptly we understood, it is due to the lensing effect of the nanofiber itself. On the other hand we are developing composite nanofiber cavities with external nano-grating structures". Using these composite nanofiber cavities they have demonstrated cavity QED with single quantum dots.

This research has the potential of being a new paradigm in cavity QED, and forms the basis for quantum internet and other applications. Furthermore, femto-second laser fabricated photonic crystal nanofiber cavities coupled with cold atoms can realize various manipulation methods of single photons which offer the basic tools for the next generation of internet communications.

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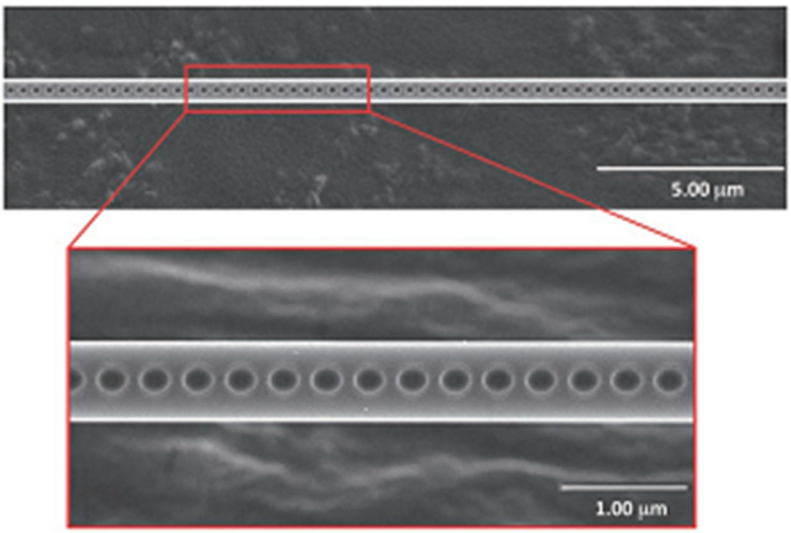
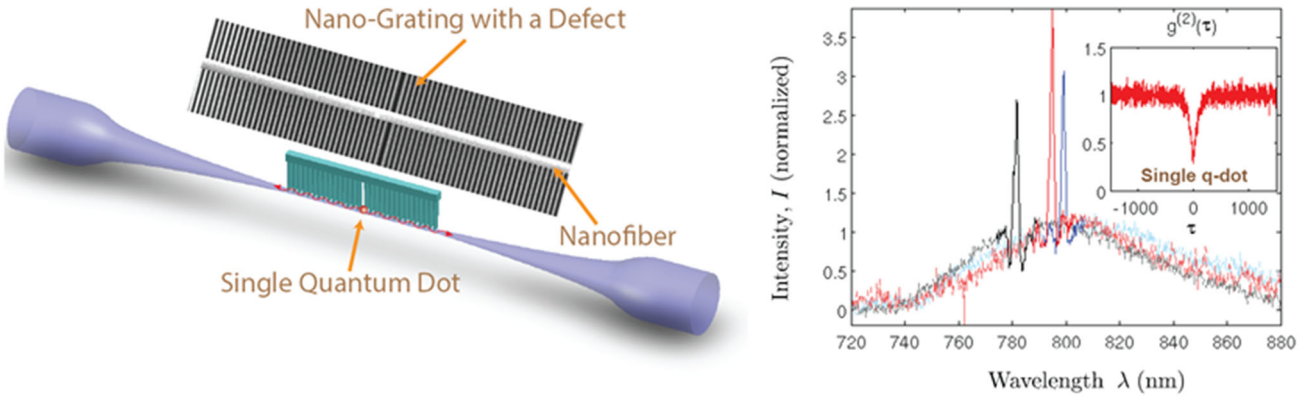
2. K. P. Nayak, P. Zhang, and K. Hakuta, "Optical nanofiber based photonic crystal cavity," Opt. Lett. **39**, 232 (2014).
3. M. Sadgrove, R. R. Yalla, K. P. Nayak, and K. Hakuta. "Photonic crystal nanofiber using an external grating," Opt. Lett. **38**, 2542 (2013).
4. K. P. Nayak and K. Hakuta, "Photonic crystal formation on optical nanofibers using femtosecond laser ablation technique," Opt. Express **21**, 2480 (2013).
5. R. R. Yalla, Fam Le Kien, M. Morinaga, and K. Hakuta, "Efficient channeling of fluorescence photons from single quantum dots into guided modes of optical nanofiber," Phys. Rev. Lett. **109**, 063602 (2012).
6. R. R. Yalla, K. P. Nayak, and K. Hakuta, "Fluorescence photon measurements from single quantum dots on an optical nanofiber," Opt. Express **20**, 2932 (2012).

Website: http://www.cpi.uec.ac.jp



SEM image of a photonic crystal nanofiber fabricated with femto-second laser. Nanofiber diameter is around 600 nm. Thousands of equidistant nano-craters are fabricated on a nanofiber by irradiating a single femtosecond laser pulse. [Opt. Express **21**, 2480-2490 (2013)]



Composite photonic crystal cavity formed by combining an optical nanofiber and a nanofabricated grating. The PL intensity spectra of single quantum dots show strong enhancement at the cavity resonance demonstrating the cavity QED effect. [Phys. Rev. Lett. **113**, 143601 (2014)]

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Second Moscow Institute of Physics and Technology - University of Electro-Communications (MIPT-UEC) Joint Workshop on Optical Science

The international MIPT--UEC Joint Workshop on Optical Science (Moscow Institute of Physics and Technology, Moscow, Russia and University of Electro-Communications, Tokyo) was held at the University of Electro-Communications from 16th to 21th October, 2013. Since the first MIPT-UEC Joint Workshop was held in Moscow in October 2013, this was the second joint workshop held by the universities. This workshop was organized to promote academic exchange and international cooperation between the universities.


Participants in the workshop

The participants in this workshop included six professors and eight students from MIPT, and more than 40 professors and students from UEC. After the introductions of each universities, there followed 32 oral presentations and active discussion on optical science and related fields.


Snapshot of the workshop

In addition to the oral presentations, poster sessions and laboratory tours were held during the workshop. The MIPT participants visited the education facility of UEC and the laboratories of UEC research groups. The students of MIPT and UEC went on a half-day excursion to the center of Tokyo to promote mutual understanding and cultural exchange between students. The workshop was fruitful for all the participants to promote future international collaboration between the two universities. The next MIPT-UEC joint workshop is scheduled to be held in Moscow in October 2015.


MIPT delegates visiting the undergraduate student laboratory room.

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The 2nd Global Alliance Lab between Tamkang University and University of Electro-Communications

The 2nd Global Alliance Lab (GAL) between Tamkang University (TKU, Taiwn) and University of Electro-Communications (UEC, Tokyo) was set up at both universities on 24th October 2014 with the help of the Office for Advanced IT and Global Creative Engineering Education at UEC. The main scheme of the TKU - UEC GAL includes international collaboration in academic activities such as bi-directional students exchange programs, internships, exchange of special lectures by the faculties as well as international collaboration research.

This special international lab is organized by the steering committee (Fig.2) and a Joint Degree Program will be also be a goal in the future.

Fig.1 Signing ceremony was held at the Intelligent Automation and Robotics Center between TKU and UEC: Prof. Wan-chin Tai (right), TKU Vice President for International Affair, and Prof. Hisayuki Aoyama (left) as a proxy of UEC Vice President, Prof. Kouki Abe.
(*Photo by Intelligent Automation and Robotics Center*)

Fig.2 Steering committee member of "TKU - UEC GAL": Prof. Wan-chin Tai. Vice President for International Affair, Prof. Ho, Chii-Dong, Dean, College of Engineering, Prof. Ching-Chang Wong, Prof. Ching-Tang Hsieh, and Prof. Wei-Tsong Lee, Faculty of Engineering.

One of the unique features of GAL is that both universities can set up one room/lab for themselves on each other's campus for use by faculty, researchers and students to expedite their missions. The TKU - UEC GAL conducts continuous international collaboration activities for each other. Since 2009 students from both universities have collaborated to design, develop, and complete an internet-based cross-over style remote control robot system (Fig.3 and Fig.4) with the financial support of UEC CADET project.

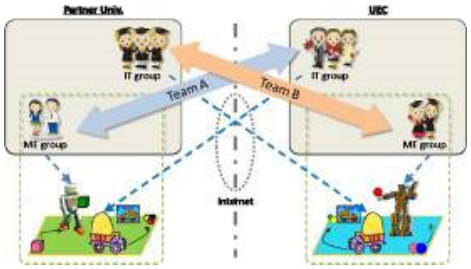

Fig.3 Internet-based cross-over style team work competition for international project training.

Fig.4 Students from both UEC and TKU discussing the development of the internet-based remote control system.
(*Photo by Intelligent Automation and Robotics Center*)

Prof. Ching-Chang Wong, Director of Intelligent Automation and Robotics Center (TKU) is a leader of one of the famous robot teams of the FIRA Robot Soccer Cup Competition. The team has received many awards at robot competitions. There are plans to open other GALs in Thailand, Russia, China, France, and USA.

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Next generation mobile communications: World's first successful use of an electric circuit to compensate for distortions in electric signals due to heat

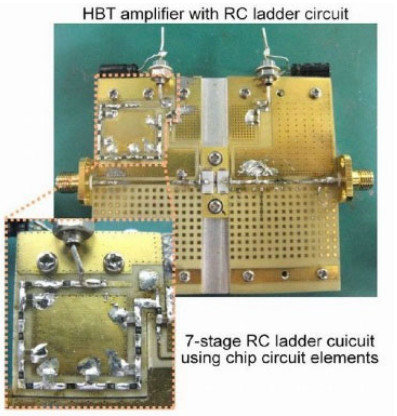
As circuits become smaller and more densely populated with circuit elements, electrical characteristics of the components become more prone to the influence of the heat generated. "The interaction between thermal and electrical phenomena is one of the most troublesome problems in analog and digital integrated circuits," explain Ryo Ishikawa, Junichi Kimura and Kazuhiko Honjo from the University of Electro-communications in Chofu-shi, Japan.

In this paper, the researchers report on the world's first method to compensate the disturbed electrical characteristics by using an electric circuit that cancels signal distortion caused by thermal behaviour of a heterojunction bipolar transistor. This research should help design devices that are better equipped to handle heat effects.

A modulated high-frequency signal is distorted by the thermal behaviour through complex intermodulation phenomena, although the temperature response of the circuit is slow. The researchers modelled the thermal effects of a heterojunction bipolar transistor in an integrated circuit using thermal resistors and thermal capacitors. The circuit elements were arranged in a 'ladder circuit' comprising repeating units of thermal resistors and thermal capacitors. To compensate the signal distortion on the integrated circuit, an electric 'ladder circuit' was connected.

Although the validity of the electric ladder circuit to compensate the signal distortion has already been confirmed by experiments and simulations, a theoretical derivation for the behaviour has so far been lacking. Honjo and his team derived nonlinear expressions describing the circuit parameters, and solved the expressions using series expansions. The model compared well with experiments and simulations.

Experiments for an InGaP/GaAs heterojunction bipolar transistor power amplifier operating at 1.95GHz provide compelling validation for their analytical design, emphasising its potential for designing circuits that cope better with heat effects.



A fabricated InGaP/GaAs heterojunction bipolar transistor amplifier at 1.95 GHz including a thermal memory effect compensation circuit.

1. Ishikawa R, Kimura J and Honjo K Analytical design method for a low-distortion microwave InGaP/GaAs HBT amplifies based on transient thermal behaviour in a GaAs substrate IEEE Transactions on components, packaging and Manufacturing Technology 3, 1705-1712 (2013) doi: 10.1109/TCPMT.2013.2262504

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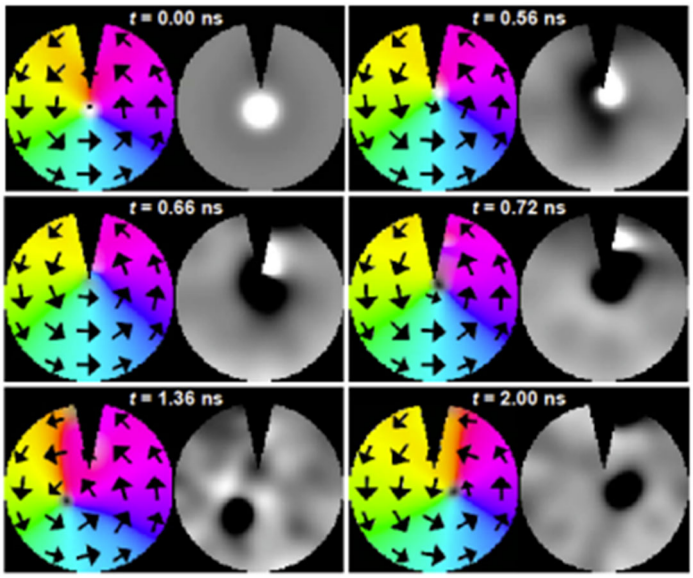
Magnetic vortices: Controlling core switching in Pac-man disks

Magnetic vortices in thin films can encode information in the perpendicular magnetization pointing up or down relative to the vortex core. These binary states could be useful for non-volatile data storage devices such as RAM memories, but the switching between them must be fast and energy-efficient. However, despite many efforts switching is still slow and requires very large currents. Pac-man disks, whose shape resembles the retro arcade game, seem to be a promising approach and Yoshinobu Nakatani and co-workers from the University of Electro-Communications now show a more efficient way of controlling switching in these devices.

To better understand the mechanisms and the best switching conditions in the Pac-man disks, Nakatani's team used micro-magnetic simulations to investigate vortex core switching driven by an in-plane nanosecond current pulse. The simulations uncovered several interesting features. They found that the notch - Pac-man's mouth - plays the double role of annihilating and nucleating the vortex core. The kinetic field induced by the core motion gives the direction of nucleation.

These results suggest that "by utilizing both the core switching at the notch edge and the direction of the core motion, the core polarity can be uniquely controlled by adjusting the direction of the current pulse". In this way the current density could be reduced by 75% compared with that of a circular disk of the same diameter and thickness. The insights provided by Nakatani's team could lead to an improved design of vortex core memory cells.

Sato, T., Yamada, K., and Nakatani, Y. Control of magnetic vortex core switching in a Pac-man disk using a single current pulse. Applied Physics Express 7, 073003 (2014) doi: 10.7567/APEX.7.073003



Prof. Nakatani team performed micro-magnetic simulations and took snapshots of the Pac-man disk (diameter = 200 nm, thickness = 40 nm) at different times (t = 0 ~ 2.0 ns) .The rainbow images indicating the direction of the in-plane magnetization component, whereas the grayscale images show the out-of-plane magnetization (white,up; black,down). The vortex core switches from upward to downward.

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Underwater robotics: Analyzing the propulsion of a soft robotic fish

In the world of underwater robotics, fish-like structures are able to accelerate and maneuver better than most other artificial underwater vehicles. For these reasons, fish-like robots are well suited for submarine exploration tasks. However, a complete understanding of mechanisms governing the swimming movements of fish-like robots remains elusive, limiting the performance of such underwater robot.

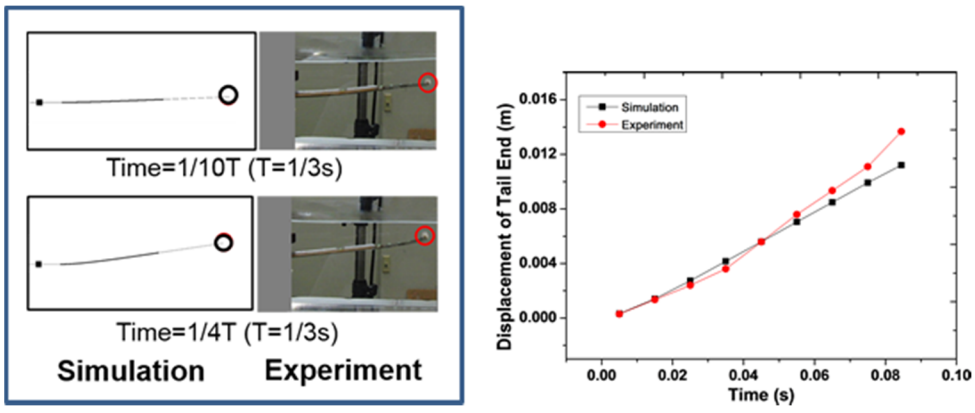
Notably, propulsion by undulation entails complicated interplay between body deformation and fluid motion. Developing high performance robots by utilizing such complex dynamics is the main goal of the research on robotic fish led by Aiguo Ming and colleagues at the University of Electro-Communications, Tokyo.

Recently, Ming and his colleagues including Wenjing Zhao demonstrated how fluid-structure interaction analysis can be applied to capture the propulsion of a soft robotic fish. The coupled equations describing the interaction between the fluid pressure on the robot and the load generated by the fish motion were solved numerically through a mesh method followed by a algorithm. The simulated dynamics was compared to the experimentally measured behavior of a robotic fish propelled by a piezoelectric fiber composite.

In the oscillation motion of the robotic fish, an increase in oscillation frequency led to a decrease in the displacement of tail fin, and the propulsive force has no direct proportional relationship with the robot oscillation frequency. Trends in the variation of the displacement and propulsive force of the robotic fish at different frequencies were determined by fluid-structure interaction analysis and confirmed experimentally using an actual prototype robot. The effectiveness of the fluid-structure interaction analysis was verified and was useful for evaluating the robotic fish's propulsion characteristics for improving robot design and control.

The successful analysis paves the way for future applications of fluid-structure interaction analysis to improve the performance of underwater robots.

Zhao, W., Ming, A., Shimojo, M., Inoue, Y. & Maekawa, H. Fluid-structure interaction analysis of a soft robotic fish using piezoelectric fiber composite. Journal of Robotics and Mechatronics 26(5), 638-648 (2014)



Comparison between simulated and experimental displacement of the fin of a robotic fish. A successful simulation of the dynamical interaction between a soft robotic fish and its surroundings was demonstrated by researchers of the University of Electro-Communications, Tokyo. A better understanding of fish propulsion could improve the performances of fishlike robots, useful for underwater tasks.

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Artificial intelligence: Brain-training for baseball robot

The human brain continually monitors and influences all bodily movements, helping the body adapt to different circumstances in order to maintain fine motor control. The part of the brain responsible for fine motor control, including precision co-ordination and accurate timing, is called the cerebellum. In the field of robotics, developing an artificial cerebellum capable of 'teaching' a robot to move with accurate timing is a key goal.

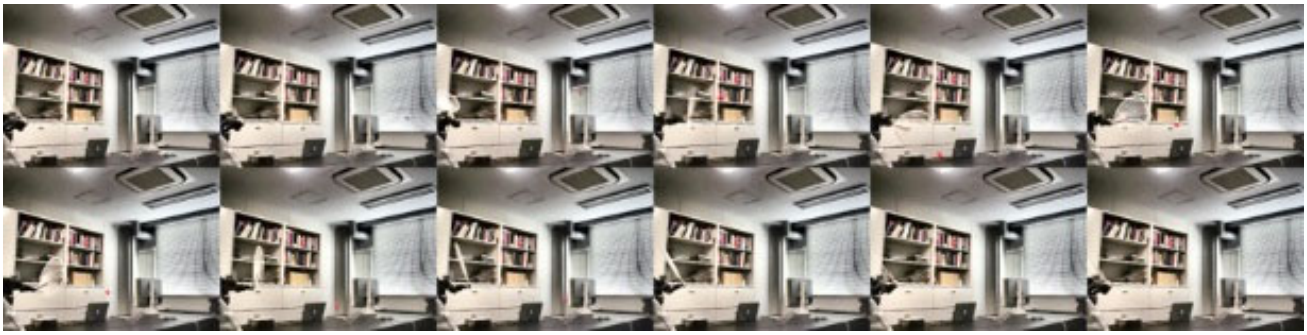
Now, Tadashi Yamazaki at the University of Electro-Communications in Tokyo with Jun Igarashi at Okinawa Institute of Science and Technology have created a model of the cerebellum comprising over 100,000 'neurons'--which was implemented on dedicated hardware for parallel computing known as a graphics processing unit (GPU)--is able to train a robot to accurately hit a ball bowled in real-time.

The 'real-time cerebellum' built by the team is a large-scale version of a so-called 'spiking network model' - a mathematical description of neurons which can learn accurate timing through practice, just as the human cerebellum can. By connecting the cerebellum implemented on a GPU with a small humanoid robot, the team were able to test whether or not their cerebellum could help the robot learn accurate timing.

The researchers' aim was to train the robot to hit a ball bowled in real-time by a bowling machine. They found that, over time, the robot learnt through repeated practice when to raise the bat in order to hit the flying ball accurately. The real-time cerebellum could provide a powerful learning and training tool for robots in various applications in future.

Reference

1. Yamazaki, T. & Igarashi, J. Realtime cerebellum: A large-scale spiking network model of the cerebellum that runs in realtime using a graphics processing unit. Neural Networks 47 (2013)



Yamazaki, T. & Igarashi, J. Realtime cerebellum: A large-scale spiking network model of the cerebellum that runs in realtime using a graphics processing unit. Neural Networks 47 (2013)

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Eyes on the sky: Monitoring effects of solar activity on aurora and global positioning systems

Assistant Professor,
Department of Communication Engineering and Informatics, University of Electro-Communications, Tokyo, and Center for Space Science and Radio Engineering, University of Electro-Communications, Tokyo.

Keisuke Hosokawa

Keisuke Hosokawa is a geophysicist conducting research on the dynamics of the ionosphere. "I am interested in a wide range of topics in space physics," explains Hosokawa. "Recently, I have been monitoring the effects of fluctuations in the ionosphere on global positioning systems (GPS). Solar winds affect GPS systems, and could potentially cause chaos with aviation navigation systems. So it's an important area of research in space physics."

Hosakawa has developed 2D imaging methodology--using all sky CCD cameras (ASC) to map fluctuations of the ionosphere. "This approach yields much more information than traditional single-point radar observation methods," emphasizes Hosokawa. The core of the ASC system are CCD cameras that are cooled to approximately minus 70 degrees Celsius to reduce thermal noise. A filter between the fish eye lens and CCD chip is used to capture red light only--approximately 630 nanometeres due to ionized oxygen in the ionosphere.

Recent highlights include simultaneous observations of ionospheric scintillation during an auroral substorm on the night of 19 November 2009 in Tromsø, Norway. The substorm led to "a transient enhancement of the phase scintillation at the time of the onset of the substorm expansion phase". Also, experiment on 12 November 2013 using cameras located in Longyearbyen, Norway and Resolute Bay, Canada showed "regions of increased 630.0 nm airglow emissions.....which indicates that these are optical manifestations of polar cap patches propagating across the polar cap".

Experiments in the future include increasing the area covered by the sky cameras by using a larger number of less expensive CCD cameras.

Publications

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doi:10.1186/2197-4284-1-16
2. K. Hosokawa, K et al., Global imaging of polar cap patches with dual airglow imagers, Geophysics Research Letters, 41, 1-6, (2014).
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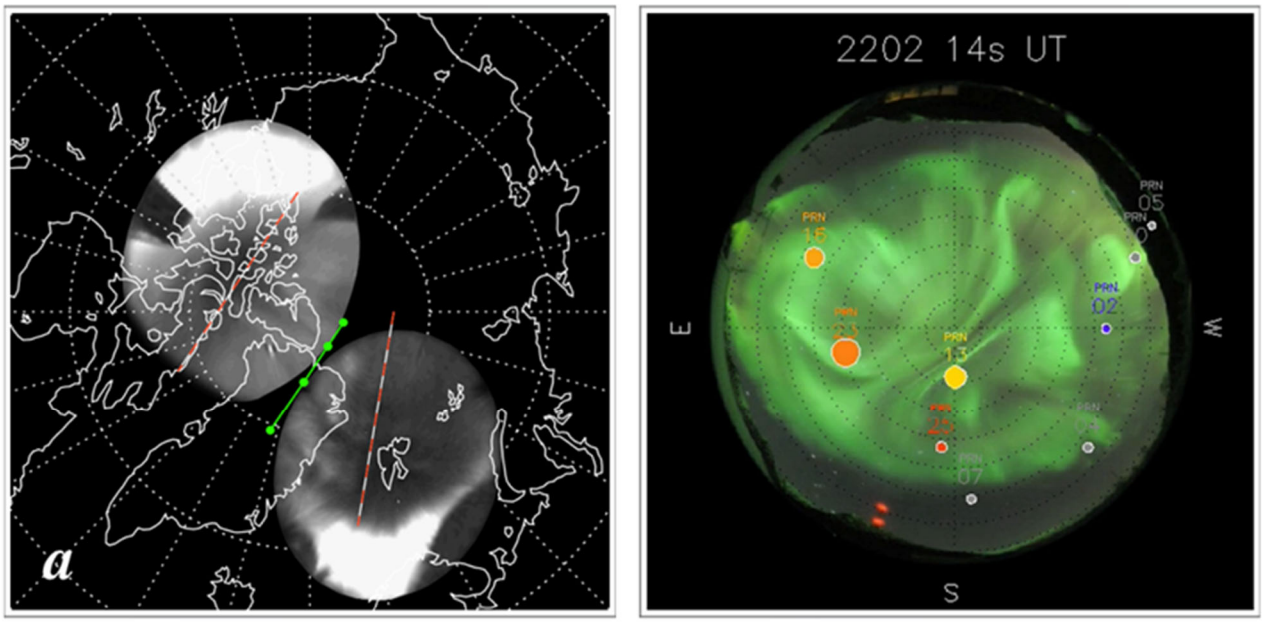
Further information

Website: http://gwave.ice.uec.ac.jp/~hosokawa



(Left) A snapshot of 630.0 nm airglow obtained by two all-sky airglow imagers in the northern polar region. The optical data have been mapped onto the geographic coordinate system as viewed from northern space. A stream of high-density ionized atmosphere at 300 km altitude is visualized.
(Right) An all-sky auroral image taken at Tromsø, Norway, during an auroral substorm. Superimposed circles indicate the geometries of the GPS satellite, their size representing the level of fluctuations in the phase of the GPS signal received on the ground.

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The FoodCam: Smart phone application for real time food recognition for personalized healthcare

Keiji Yanai, Associate Professor, Graduate School of Information Engineering, University of Electro-Communications, Tokyo.


Keiji Yanai

The ubiquitous smart phone is becoming more than just a device for communicating and internet browsing. Increasingly, innovators are developing 'apps' for health and medical care such as monitoring blood pressure.

Here, in a significant extension of the applications of smart phones for health care, Keiji Yanai, an associate professor at the Graduate School of Information Engineering of the University of Electro-Communications, Tokyo, has developed the "FoodCam"--a real time, a unique mobile food recognition system.

"By taking a smart phone photograph of food such as a bowl of noodles, the FoodCam enables the user to estimate the number of calories and nutritional value of 256 different types of food," says Yanai. "An internet connection is not necessary. The computation to recognize and analyze the food is carried out by the mobile device itself."

Recognition accuracy is important as stated in a recent publication by Yanai: "Experiments show a 79.2 % classification rate for food from the top 5 category candidates for a 100-category food dataset with the ground-truth bounding boxes when we used HOG and color patches with the Fisher Vector coding as image features".


A screen-shot of the 'FoodCam' and smartphone.

Plans for future studies include automatic recognition to initiate detection procedures without any user operation, measuring the volume of food, use of 'deep learning' to minimize the memory usage of smart phones, and improvement of the accuracy by using more than a single image.

Publication

1. Yoshiyuki Kawano and Keiji Yanai, Multimedia Tools and Applications, April 2014
DOI 10.1007/s11042-014-2000-8

Further information

1. Yanai Lab. website: http://mm.cs.uec.ac.jp/e/
2. FoodCam project page: An Android application of the mobile food recognition system and 100/256-class food dataset "UEC-FOOD100/256" can be downloaded from http://foodcam.mobi/

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Intelligent robotics: The ultimate automatic door system

Assistant Professor, Department of Human Media Systems at Graduate School of Information Systems, University of Electro-Communications, Tokyo.


Tetsuo Tomizawa

Tetsuo Tomizawa is an assistant professor at the Department of Human Media Systems at Graduate School of Information Systems, University of Electro-Communications (UEC). "I spent my graduate school days developing 'town-robotic systems' that fit seamlessly into the real word to support humans in their daily lives," says Tomizawa. "Examples include a remote book browsing system to enable people to control a robot in a library to select a book and then transmit images of the contents via a camera. The robot turns the pages as instructed. A virtual version of a genuine library in the comfort of your own home."

Recently, Tomizawa has directed his attention to the development of intelligent automatic door systems. "I am reapplying laser scanning technology from my research on town robots," says Tomizawa. The major goals are to develop automatic doors that open only for people who intend to use them and adjust the precise timing of the doors to open to match the speed of people moving towards the doors. Rather like the rapid and precise movement of sliding doors in the Star Trek movies.

The automatic door system consists of an innovative three-dimensional laser range sensor that makes Lissajous figure scans in real time near the doors (measurement range at a height of 3.5 m is 5.0 m by 3.0 m; observation of 5440 points/frame at frame rate of 10 Hz) and algorithms to control the opening times of the doors. Examples of the 'intelligence' of the system include robustness to changes in the sunlight and rain, and visual recognition of people who are just passing by with no intension of using the doors.

Another innovation is using the 3D laser scanner to count people using the automatic doors. "The challenge in people counting is to identify individuals who are walking in close proximity to each other," says Tomizawa. Notably, the UEC automatic door system has achieved 99% accuracy in counting 500 people over a period of 90 minutes. "We are working with industrial partners to commercialise these ideas," says Tomizawa. "We envisage many other applications of our Star Trek door system."

Publications

1. Daiki Nishida et al, Development of Intelligent Automatic Door System, *2014 IEEE International Conference on Robotics & Automation (ICRA 2014)*, pp 6368-6374, May 31 - June 7, 2014. Hong Kong.

Further information

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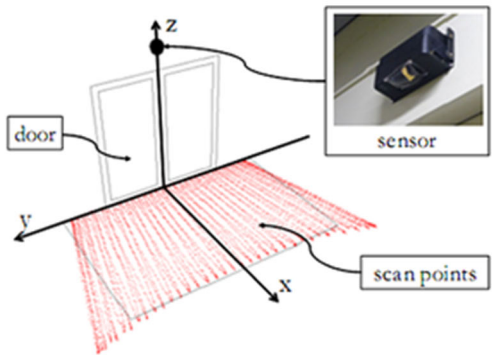
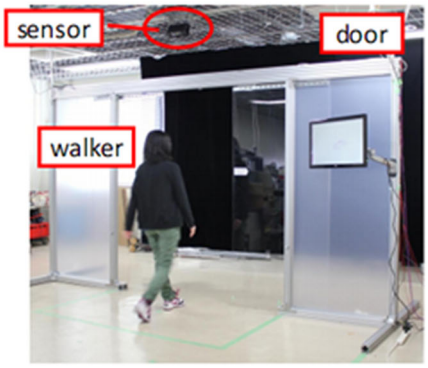
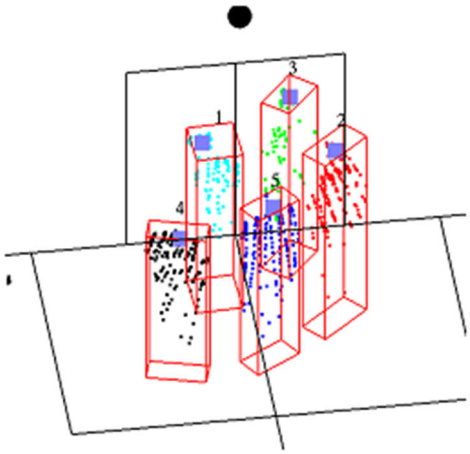


Automatic door system concept and 3D sensor



Intelligent automatic door



Counting people

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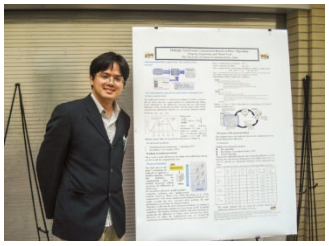
Letter From Alumni

Alumni in Thailand

Pokpong Songmuang Lecturer at Department of Computer Science, Faculty of Science and Technology, Thammasat University (TU), Pathumthani, Thailand



At Carnegie-Mellon University, USA, when I attended AAAI EDM 2010.

I studied for my doctorate at the Graduate School of Information Systems under the supervision of Professor Maomi Ueno and received the degree in 2010. My research at UEC was supported by a Japanese government scholarship.

I studied information systems and the design and development of e-Testing systems. I designed and developed several systems for supporting automated test construction, collaborative test construction, response data analysis, and so on in order to improve the quality of large-scale high stake tests. I proposed system generating test form that consist of different item sets but have equivalent quality (average score, standard error, test information and so on). Two papers from this research were accepted by the leading journal, IEEE Transactions on Learning Technology, Computer Science Society and another two papers were accepted by IEICE Transaction on Information Systems.

I also presented the results of my research at many conferences in Japan and abroad such as the highly acclaimed conferences AAAI, EDM 2010, USA (photograph). Since I came from a small country and had no experience of travelling abroad, I learnt a lot from attending conferences to present my research and made many new friends. All of my travels to present my research were supported by UEC and my supervisor's research grants. I really appreciate all the support and I hope that all students at UEC will have similar opportunities. At that time, several organizations were interested in the e-Testing systems including the Information-technology Promotion Agency (IPA at Ministry of economy, trade, and industry in Japan) and they planed to transfer tests from paper-based to computer-based formats. Therefore, when I was a third year student in the doctoral course, the Ueno laboratory was asked by IPA to develop a prototype of the e-Testing system. I had a hard time with this project while continuing my dissertation but it was a valuable experience for me. In the following year, IPA opened a large test center and the e-Testing system of IPA (Jouhoushori gijyutsusha shiken in Japanese) was established based on our prototype system. This made me proud of my research since my supervisor and UEC not only taught me to do research but also to contribute to the betterment of society. Moreover, this project opened me up to a new world to work in Japan as a researcher.

After I graduated, I worked at a research institute for educational measurement for one year. I had a good time at the institute and learned a lot about Japanese industry and business culture. Before I went back to my home country, I had an opportunity to work at Waseda University as an assistant professor for several years. All the wonderful opportunities of my working life are a result of my research at UEC and excellent advice from my

supervisor. I really appreciate my supervisor's support and UEC's efforts in providing a wonderful environment for a foreign student like me.

Recently, I became a lecture at Thammasat University (TU) and want to form a closer relationship between TU and UEC by visiting UEC every year with my colleagues and continuing the process of proposing a Memorandum of Understanding (MOU) between TU and UEC. I hope in near the future, UEC and TU will conduct collaborative activities such as workshop, exchange student program, research, and so on.

The University of Electro-Communications (UEC) in Tokyo

is a small, luminous university at the forefront of applied sciences, engineering, and technology research. Its roots go back to the Technical Institute for Wireless Commutations, which was established in 1918 by the Wireless Association to train so-called wireless engineers in maritime communications in response to the Titanic disaster in 1912. In 1949, the UEC was established as a national university by the Japanese Ministry of Education, and moved in 1957 from Meguro to its current Chofu campus Tokyo.

With approximately 4,000 students and 350 faculty, UEC is regarded as a small university, but with particular expertise in wireless communications, laser science, robotics, informatics, and material science, to name just a few areas of research.

The UEC was selected for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities as a result of its strengths in three main areas: optics and photonics research, where we are number one for the number of joint publications with foreign researchers; wireless communications, which reflects our roots; and materials-based research, particularly on fuel cells.

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