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TOYOHASHI UNIVERSITY of TECHNOLOGY e-Newsletter

News and views from one of Japan's most innovative and dynamic science and technology-based academic institutes

No. 1, Oct 2010

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Founded in 1976, Toyohashi University of Technology (Toyohashi Tech) is a vibrant modern institute with research activities reflecting the modern era of advanced electronics and engineering in which it was established.

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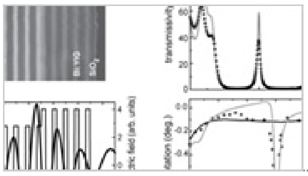

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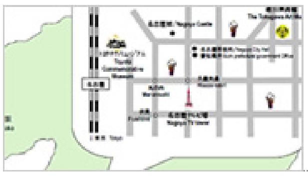

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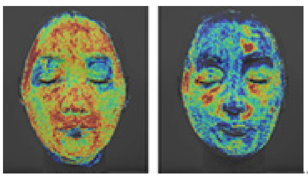

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Features

Innovation and foresight at Toyohashi Tech: President Yoshiyuki Sakaki implements ambitious plans for the future.

President Yoshiyuki Sakaki

Founded in 1976, Toyohashi University of Technology (Toyohashi Tech) is a vibrant modern institute with research activities reflecting the modern era of advanced electronics and engineering in which it was established.

"We are distinct among national engineering universities in a number of ways," says President Yoshiyuki Sakaki. "Not least because some 80 percent of our 2,200 students come from 5-year technical colleges, with the majority continuing on to graduate school."

Toyohashi Tech Toyohashi Tech has devised a spiral-up curriculum to suit the need of its undergraduate and graduate students as they progress in their studies and research. "Certainly basic theory is important, but we also emphasize practical training, an important part of which is a two-month internship we organize with companies both in Japan and overseas" says Sakaki. "Many of our 250 teaching staff are from industry and we encourage them and our students to maintain close relationships with industry."

Approximately 10 percent of Toyohashi Tech students are from abroad, especially Asia. This reflects the success of the university's overseas outreach programs, especially its International Center for Engineering Education Development (ICCEED) program set up in 2001 to promote international student exchange.

"Concerning ICCEED, we're working with the Japanese government in several ways to develop education in Indonesia, Malaysia and Vietnam," says Sakaki. "Some overseas students from this program who graduate from our University go on to work in local manufacturing companies like Toyota, Hitachi and Toshiba, which are well known and representative Japanese companies."

Toyohashi Tech has eight research centers focusing on fields such as intelligent sensing, robotics, agrotechnology and photonic information memory. In October the university completed the construction of the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) that takes a new approach to research.

Fig.2: The new Electronics-Inspired Interdisciplinary Research Institute (EIIRIS)

"The aim of EIIRIS is to produce world-class innovative research," says Sakaki. "To do this we are bringing together ambitious young researchers from diverse fields to collaborate on pioneering new frontiers in science such as brain/neuro-electronics as well as tackling some of the major issues mankind faces today: issues such as environmental changes and aging societies."

As well as literally working alongside each other in the same new dedicated building (Fig.2), these researchers will also collaborate with the well established research institutes at the University and use the facilities at the LSI fabrication facility connected to the new building, forming a huge research complex.

President Sakaki's background is in the field of molecular biology and he was the leader of Japan's International Human Genome Project. He is a native of nearby Nagoya, the center of the country's third largest region after Tokyo and Osaka. Toyohashi itself is a fair-sized city of about 380,000. The Pacific Ocean is only a short bicycle ride away from the Toyohashi Tech campus, and with the spectacular sights of the surrounding mountains, Toyohashi has a mild climate and is within easy reach of Tokyo, Osaka, Kyoto and Kobe by Shinkansen.

EIIRIS spells a unique approach to interdisciplinary research

Plans are well under way to turn Toyohashi University of Technology (Toyohashi Tech) into a world-leading center for innovative interdisciplinary research based on its internationally acknowledged research on electronic devices.

"At the center of this bold initiative is the newly completed Electronics-Inspired Interdisciplinary Research Institute (EIIRIS)," explains Makoto Ishida, Toyohashi Tech's vice president for research affairs and director of EIIRIS (Fig.1).

The new institute houses an international team of ten young researchers with diverse backgrounds including the neuroscience, biotechnology, magnetism, robotics, and nanoelectronics. A key member of EIIRIS is chief scientist Adarsh Sandhu—a bilingual physicist from the U.K. whose research is focused on nano-bio-magnetics, and with 25 years of industrial and academic experience in Japan.

Ishida envisages that the unique environment at EIIRIS will be conducive to producing new innovative concept and technologies ranging from biochips to environmental sensing devices aimed at tackling some of the important challenges facing society and the environment in the 21st Century.

The University already has as strong research base to build on. It was recently selected by the Japanese government to become one of the country's prestigious Global Centers of Excellence (G-COE) and conduct a research program called Frontiers of Intelligence Sensing.

"Being chosen as a G-COE is recognition for eight years of research our team has spent developing advanced intelligent sensor technology," says Ishida, who heads the program. "One outstanding result is the 'Toyohashi Probe', an array of perpendicular nano-wires grown on a silicon chip that can be used as a brain-machine interface (Fig.2). Now our Intelligent Sensing Systems Center will work with members of EIIRIS to design and develop new kinds of sensors."

Two other electronics-based centers, the advanced LSI Research Facilities and the Research Center for Advanced Photonic Information Memories, will also work closely with EIIRIS, as will the centers focused on green technology. In addition, researchers from other Toyohashi Tech centers, including robotics and physical health will also join in the interdisciplinary effort.

As well as perusing their collaborative research projects, the EIIRIS researchers will also be expected to nurture the research abilities of graduate student assistants assigned to the Institute, explains vice president Yasuyoshi Inagaki, in charge of the Tenure Track Program at the University. "Then later, the researchers will teach Toyohashi Tech students courses based on their own fields of expertise, in preparation for possible tenured positions."

"Our approach to offering tenured positions has been dubbed the Tenure Track," says Inagaki. "Upon completion of five years of research, a screening committee will assess the researchers' work and associated activities, and those achieving particularly excellent results will be appointed tenured faculty."

Toyohashi Tech vice presidents, Makoto Ishida (left) and Yasuyoshi Inagaki.

Fig.1: The new EIIRIS building.

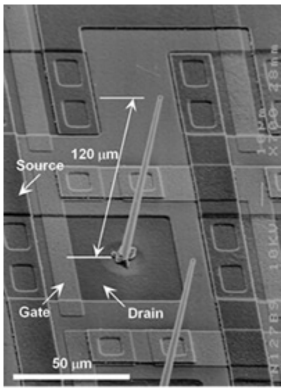

Fig.2: The 'Toyohashi Probe' consisting of an array of nano-wires integrated into an LSI silicon chip, for use as a brain-machine interface.

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News

The birth of EIIRIS: Toyohashi Tech launches the Electronics-Inspired Interdisciplinary Research Institute

Toyohashi Tech is renowned for its innovative approach to research. Examples include the 'Toyohashi Probe' (Fig.1) for capturing electrical signals from living cells and the innovative CCD-based pH sensor for visualizing pH levels in liquids (Fig.2).

Now, building on its tradition of cutting-edge research, and with a view to meeting industrial demands to nurture graduates with more diverse expertise, the University launched the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) on 1st October 2010. (Figs.3–4)

The EIIRIS infrastructure is a unique environment for conducting world-class interdisciplinary research, and houses an international team of young and ambitious researchers from diverse fields including neuroscience, magnetic materials, solid state electron devices, and robotics. Research at EIIRIS will address major issues including the environment and aging societies.

For related information see feature article: *EIIRIS spells an innovative approach to interdisciplinary research*

EIIRIS website: http://www.eiiris.tut.ac.jp/

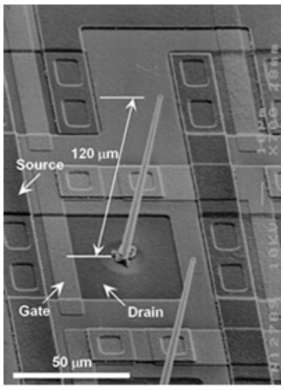

Fig. 1: The Toyohashi Probe developed by Makoto Ishida's team, consisting of an array of perpendicular nano-wires grown on a silicon chip for interfacing with living cells.
http://www.int.ee.tut.ac.jp/icg/

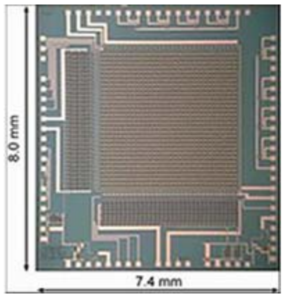

Fig.2: The pH chip developed by Kazuaki Sawada' team enables the visualization of the distribution of pH levels in a test solution.
http://www.int.ee.tut.ac.jp/icg/

Fig. 3: The new dedicated building housing researchers of the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS).

EIIRIS

Fig.4: The new EIIRIS icon and symbol mark

Open Campus 2010: Toyohashi Tech welcomes visitors to the Tempaku Campus

The annual Toyohashi Tech Open Campus day was held on Sunday 29th August 2010. Around 2000 visitors joined the festivities for a first-hand look the education, research, and community activities undertaken by the University.

In his opening speech, President Yoshiyuki Sakaki (Fig.1) welcomed visitors to the Open Campus, and encouraged them to visit the research demonstrations, educational and recreational facilities, and club activities prepared by students and staff for this special day (Fig.2).

The Open Campus day was also an opportunity to learn more about the innovative new curricula and courses offered by Toyohashi Tech directly from members of the academic staff.

Visitors experienced the international tastes, music, and languages in events organized by international students —approximately 10% of the students at Toyohashi Tech are from overseas (Fig.3).

Fig.1: President Yoshiyuki Sakaki welcoming visitors to the Open Campus at Toyohashi Tech.

Fig.2: Students of the Robotics Club discuss their project with visiting high school students.

Fig.3: Members of the Indonesian Student Association

Omotehama Blue Walk: Preserving a precious beach for migrating sea turtles to lay their eggs

The Toyohashi Tech campus is only about four kilometers from the spectacular 50 km long Omotehama beach. A small part of this beautiful beach is a venue for international wind surfing events. But the Omotehama coastline is even more famous as being the natal beach of migrating seas turtles, which lay eggs in the sand.

As part of Toyohashi Tech's efforts to support efforts to preserve the local ecosystem, every year the University joins hands with the local community for the 'Omotehama Blue Walk'—a nine day stroll along the 50 km Omotehama beach to collect discarded litter, and thereby maintain a clean and ecological friendly environment for future generations of sea turtles.

This year's Omotehama Blue Walk started on August 13th, and was organized by students and graduates of Toyohashi Tech in collaboration with members of the local community.

Under blue skies, the intrepid Blue Walkers were given a spirited send-off by Toyohashi Tech vice president Noriyoshi Kakuta. Around 600 people participated in the Blue Walk this year, trekking about 5 km each day, taking a rest and then continuing the following morning on their nine day voyage (See photographs of the walk). The Walk ended at Cape Irago, which is famous for the lighthouse and spectacular views over Mikawa-Bay .

Further information

- Omotehama Network: http://www.omotehama.net/e_index.html
- Mikawa Bay: http://en.wikipedia.org/wiki/Mikawa_Bay

Time for a memorial photograph of the Omotehama Blue Walk 2010 event.

Spectacular views en-route to Cape Irago.

A long chain of Blue Walkers combing the beach for litter.

The famous lighthouse at Cape Irago, and the end of the 9-day Blue Walk.

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Research highlights

Affective Haptics: Emotional real-time messaging

Affective haptics refers to research on the implementation of devices and systems for enhancing the emotional state of a person via the sense of touch. The research field was created by Dzmitry Tsetserukou and Alena Neviarouskaya.

Here, Dzmitry Tsetserukou of the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) in collaboration with Alena Neviarouskaya at The University of Tokyo, designed iFeel_IM! to intensify the communicators' own feelings or simulate the partner's emotions in order to enhance social interactivity and provide an emotionally immersive experience for real-time messaging. (Fig. 1). The philosophy behind iFeel_IM! is "I feel [therefore] I am!"

Interpersonal relationships and the ability to express empathy are stronger when people become emotionally closer by disclosing thoughts, feelings, and emotions for the sake of understanding. iFeel_IM! tries to influence human emotions not only by the four haptic channels but also by visual feedback.

iFeel_IM! stresses

- automatic sensing of emotions conveyed through text messages, namely artificial intelligence
- visualization of the detected emotions through avatars in a virtual world
- enhancement of the user's affective state
- reproduction of social touch through haptic stimulation in the real world

To support affective communication, iFeel_IM! incorporates three types of haptic devices (Fig. 2):

- HaptiHeart, HaptiButterfly, HaptiTemper, and HaptiShiver implicitly elicit emotion
- HaptiTickler directly evokes emotion
- HaptiHug uses social touch to influence mood and provide a sense of physical co-presence

The researchers have exhibited iFeel_IM! at international conferences such as as Intetain 2009, ACII 2009, Asiagraph 2009, CHI 2010 and more than 400 people have experienced it. Most participants reported that the haptic modalities (the simulated heartbeats, hugging, and tickling) produced highly realistic sensations. The subjects particularly enjoyed wearing HaptiHug—the simultaneous experience of the hugging animation and hugging sensation evoked surprise and joy. The results of user studies revealed that the devices successfully generated the corresponding emotion.
The researchers' iFeel_IM! Demonstrations resulted in keen discussions of possible applications for future research. Examples include

- treating depression and anxiety (problematic emotional states)
- controlling and modulating moods on the basis of physiological signals
- affective and collaborative games
- psychological testing

The iFeel_IM! could greatly enhance communication in online virtual environments that facilitate social contact. It could also greatly enhance social life in terms of both interpersonal relationships and the character of communities.

Reference:

- D. Tsetserukou[1] and A. Neviarouskaya[2]
- iFeel_IM!: augmenting emotions during online communication.
- *IEEE Computer Graphics ad Applications 30*, 72 (2010)
- DOI: 10.1109/MCG.2010.88
- [1]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology;
  [2] University of Tokyo

Further information

- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS):
  http://www.eiiris.tut.ac.jp/
- Video websites:
  http://www.youtube.com/watch?v=Y84XbpDUVxc
  https://sites.google.com/site/dzmitrytsetserukou/media-press/ifeel_im
  http://en.wikipedia.org/wiki/Affective_Haptics
  http://watch.discoverychannel.ca/clip287052#clip287052

Dr . Tsetserukou

Fig.1. A user communicating through iFeel_IM! (Intelligent System for Feeling Enhancement Powered by Affect-Sensitive Instant Messenger). The devices worn on the body reinforce the communicators' own feelings or simulate the partner's emotions.

Enlarge Image
Figure 2. The iFeel_IM! architecture. To communicate through iFeel_IM!, users wear six affective haptic devices: HaptiHeart, HaptiHug, HaptiButterfly, HaptiTickler, HaptiTemper, and HaptiShiver.

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Research highlights

Tamm states: Optical surface states in magnetophotonic crystals

Dr Baryshev

Magnetophotonic crystals are artificial media that provide efficient coupling of light to their magnetic constituents. Light confinement inside magnetophotonic crystals results in a large enhancement of their magneto-optical response, which is a promising property for optical applications such as isolators, circulators and modulators.

Here, using state of the art microfabrication technology to create periodic structures with high accuracy, Alexander Baryshev and colleagues at Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) report the existence of so-called optical surface (Tamm) states at the interfaces of magnetophotonic crystals.

Structures with different designs were fabricated by sputtering where the periodicity of magnetophotonic crystals was terminated by another medium: a material with a negative permittivity or a photonic crystal.

The researchers demonstrated that the tailoring interfaces of magnetophotonic crystals can produce conditions for the existence of Tamm states, where the manifestation of the states was seen as resonant peaks in transmission and Faraday rotation spectra of the crystals (Fig.1).

This novel media shows potential for magnetotunable filters and localizing light within any active material used as the constituent layers of photonic structures.

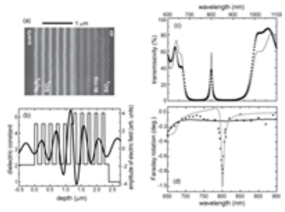

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Fig.1. (a) SEM image of a magnetophotonic crystal, the system of two adjoining multilayers. (b) Sketch of the spatial distribution of dielectric constants and the in-sample distribution of the electric field amplitude for the resonant wavelength. (c), (d) Experimental (circles) and calculated (gray solid line) spectra of the magnetophotonic crystal. Faraday rotation of the garnet/SiO_2 multilayer, the reference sample, is shown by black solid line in plot (d).

Reference:

- Taichi Goto[1], Alexander Baryshev[1,2], Mitsuteru Inoue[1], Alexander Dorofeenko[3], Alexander Merzlikin[3], Alexei Vinogradov[3], Alexander Lisyansky[4], Alexander Granovsky[5]
- Tailoring surfaces of one-dimensional magnetophotonic crystals: Optical Tamm state and Faraday rotation
- *Physical Review B 79*, 125103 (2009)
- DOI: 10.1103/PhysRevB.79.125103

[1]Toyohashi University of Technology, Aichi, Japan; [2]Ioffe Physico-Technical Institute, St.Petersburg, Russia; [3]Institute for Theoretical and Applied Electromagnetics, Moscow, Russia; [4]Department of Physics, Queens College of the City University of New York, USA; [5]Moscow State University, Russia

Further information

- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS): http://www.eiiris.tut.ac.jp/
- Inoue Group at Toyohashi University of Technology: http://www.maglab.eee.tut.ac.jp/eng-index.html

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Research highlights

Toyohashi Probe: Silicon whiskers detect neural responses

Dr Kawano

In nanotechnology, the so-called vapor-liquid-solid (VLS) method is widely used for synthesizing a variety of one-dimensional wire-structures including carbon nanotubes, and metallic and semiconducting nanowires for fabricating nanodevices.

Although the VLS method enables batch fabrication of out-of-plane vertically aligned micro and nanowires, a potentially powerful device application for measuring multi-site electrical neural signals has yet to be realized due to: (1) the unavailability of an device process for integrating the three-dimensional wire arrays with active devices; (2) inadequacies in the electrical properties of the tiny wires that are used as probes for recording electrical neural signals; and (3) the lack of an appropriate device packaging process that is compatible with saline.

Here, Takeshi Kawano, Makoto Ishida and colleagues at the Toyohashi University of Technology, Chukyo University, and RIKEN successfully demonstrate the neural recording capability of micrometer sized VLS-silicon wires—'Toyohashi Probe' using the retina of a fish (Fig.1 and Animation).

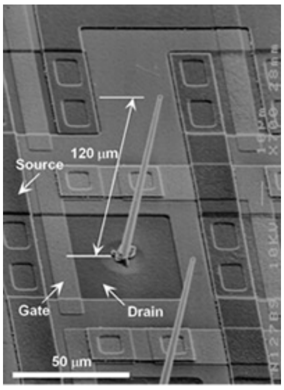
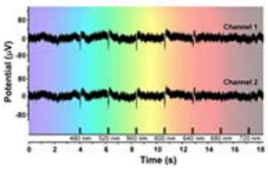


Fig.1: The 'Toyohashi Probe': An integrated VLS-silicon microprobe.

The researchers produced vertically aligned microprobe arrays on a silicon microelectronics substrate by a selective VLS growth of silicon followed by micro-fabrication processing and device packaging. For actual measurements the group placed the retina onto the Toyohashi Probes. These devices successfully detected neural responses representative of local field potentials of the retina (Fig.2).

Toyohashi Probes made by VLS growth show potential as powerful devices for a range of neural recordings because of the advantageous small sizes of the probes and their compatibility LSI electronics.



Enlarge Image

Fig. 2: Light-evoked neural signals of the retina (electro-retinogram (ERG)) measured via two probes.

Reference:

- Takeshi Kawano[a], Tetsuhiro Harimoto[a,c], Akito Ishihara[c], Kuniharu Takei[a], Takahiro Kawashima[b], Shiro Usui[d] and Makoto Ishida[a]
- Electrical Interfacing between Neurons and Electronics via Vertically-integrated Sub-4 Micron-diameter Silicon Probe Arrays Fabricated by Vapor-liquid-solid Growth
- *Biosensors and Bioelectronics 25*, 1809 (2010)
- [a]Department of Electrical and Electronic Engineering, Toyohashi University of Technology, Aichi, Japan
- [b]Department of Production Systems Engineering, Toyohashi University of Technology, Aichi, Japan
- [c]School of Life System Science and Technology, Chukyo University, Aichi, Japan
- [d]Neuroinformatics Lab., RIKEN BSI, Saitama, Japan

Further information

- Takeshi Kawano's website: http://www.int.ee.tut.ac.jp/icg/member/~takekawano
- The Integrated Circuit and Sensor System Group at Toyohashi University of Technology website: http://www.int.ee.tut.ac.jp/icg/

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Research highlights

Neuroscience: Obedient sensory neurons

Dr Koida

In the cerebral cortex of the primate, color information is transmitted from the occipital lobe to the temporal lobe, and ultimately reaches the inferior tempora (IT) cortex.

There are two different functions in visual perception, namely categorization and fine discrimination, both of which are clearly apparent in color vision. Human, and presumably primates, can switch between these two functions depending on task demands. The question arises as to whether task changes affect the response of the IT neurons.

Using monkey electrophysiology, Kowa Koida now at the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) in collaboration with and Hidehiko Komatsu of the National Institute for Physiological Sciences, Okazaki, Japan found that task demand altered the response of the inferior temporal neurons.

In their experiments, researchers recorded the activities of color-selective neurons in the IT cortex, whilst the animal performed two different tasks: A color categorization task, which required the animal to classify sample colors into two color categories —reddish or greenish; and a fine color discrimination task, in which the animal selected one of two choice stimuli that was the same color as the sample stimulus.

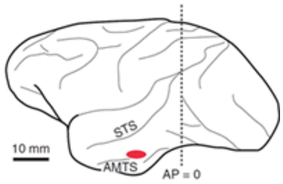

Fig.1: Schematic illustration of the recording site (red) within a lateral view of the monkey cerebral cortex.

The experiments clearly showed the color categorization task to enhance the response, and the fine color-discrimination task to suppress it.

These results suggest that the flow of color information from the IT cortex is strongly controlled by top-down signals representing the ongoing task rule presumably sent from the prefrontal cortex.

References and further information

- K. Koida[1] and H. Komatsu[2]
- Effects of task demands on the responses of color-selective neurons in the inferior temporal cortex
- *Nature Neuroscience 10*, 108 (2007).
- DOI: 10.1038/nn1823
- [1]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS); [2]National Institute for Physiological Sciences, Okazaki, Aichi, Japan.

Further information and related websites:

- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology: http://www.eiiris.tut.ac.jp/
- National Institute for Physiological Sciences: www.nips.ac.jp

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Research highlights

Visual stimuli and cognitive processes: Oddball tasks and blue-colored humans

When humans see objects or hear noise created them, they not only perceive what they are but also implicitly endeavor to estimate their familiarity and naturalness to us. A positive ERP (event-related potential) component occurring 300–500 ms after the onset of a stimulus—known as P3—has been suggested to reflect various cognitive processes.

Here, Tetsuto Minami and colleagues at Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) investigated the P3 component using an oddball paradigm. However, the typical oddball paradigm is inappropriate for examining stimulus familiarity and naturalness, because the difference in task difficulty and frequency between standard and target stimuli contaminates that of the stimulus property itself.

Minami and colleagues focused on the relationship between stimulus pairs and their amplitudes during oddball tasks. The participants in the experiments performed two oddball tasks replacing the target stimulus with the standard stimulus. The researchers used pairs of natural and unnatural visual stimuli: a female face and an inverted face; a human pose and an impossible pose; a natural upright face and a bluish face; a natural orange and a gray orange (Fig. 1).

As a result, the naturalness of the target stimuli differentiated the P3 amplitude: the unnatural target enhanced the P3 amplitude rather than the natural one, and elicited P3 asymmetry (Fig. 2).

The asymmetry of the P3 amplitude during an oddball task might be useful as an evaluation index for stimulus features.

Reference:

- T. Minami[1], K. Goto[2], M. Kitazaki[2] and S. Nakauchi[2]
- Asymmetry of P3 amplitude during oddball tasks reflects the unnaturalness of visual stimuli.
- *Neuroreport 20* 1471
- DOI: 10.1097/WNR.0b013e3283321cfb
- [1]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), University of Technology, Aichi, Japan; [2]Department of Computer Science and Engineering, Toyohashi University of Technology, Aichi, Japan.

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- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology: http://www.eiiris.tut.ac.jp/
- Toyohashi Tech Nakauchi Group: http://www.vpac.cs.tut.ac.jp/jp/index.php

Dr Minami

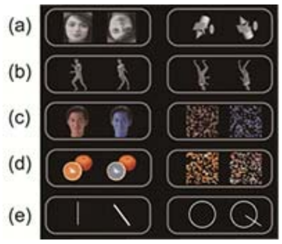

Fig.1: The ten pairs of stimuli used in this study

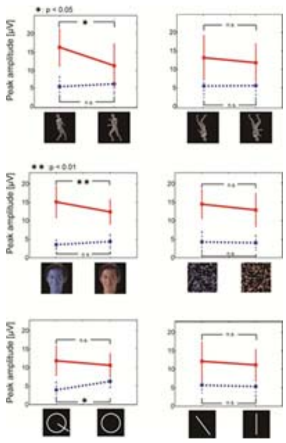

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Figure 2: Peak amplitude at 380–500 ms for target–standard stimulus pairs

No. 1, Oct 2010

Research highlights

Electronic nose: Odorant sensor fabricated from living cells

Dr Misawa

Most chemical sensors are based on inorganic materials such as metal-oxide semiconductors and quartz crystals. However, it has proven difficult to develop chemical sensors equipped with good portability while demonstrating high sensitivity and selectivity.

To overcome this problem, Nobuo Misawa at the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) at Toyohashi Tech and colleagues at The University of Tokyo investigated the possibility of exploiting biological systems, which exhibit unique reactions to a range of chemicals at the molecular level.

Misawa and colleagues focused on a chemical sensor composed of living cells from frog eggs (*Xenopus laevis* oocytes), and compact fluidic devices integrated with glass capillary electrodes (Fig.1). The pairs of glass capillary electrodes were used to detect the oocytes' response to a particular chemical by the two-electrode voltage clamping method. The frog eggs were genetically modified to express specific olfactory receptors.

The chemical sensitivity of the sensor was a few parts per billion in solution and it was possible to simultaneously distinguish different types of chemicals with only slight differences in chemical structure. A semi-automatic method to install cells to the fluidic device was successfully established, enabling stable and reproducible odorant sensing.

Furthermore, the sensor worked for multiple-target chemicals and it was possible to integrate it with a robotic system (Movie 1). The sensor developed by the researchers is compact and easy to replace in the system. These characteristics of the sensor would enable its applicable as part of an active sensing system for environmental monitoring, food administration, and health management.

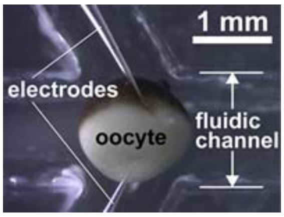

Fig. 1: *Xenopus* oocyte trapped glass capillary electrodes in the fluidic device.

Movie caption: Head-shaking robot can react to the odorant stimulus.

Reference:

- N Misawa[1], H. Mitsuno[2], R. Kanzaki[2] and S. Takeuchi[2]
- Highly sensitive and selective odorant sensor using living cells expressing insect olfactory receptors.
- *PNAS 107* 15340
- DOI: 10.1073/pnas.1004334107
- [1]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashu University of Technology, Aichi, Japan; [2]University of Tokyo

Further information

- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology: http://www.eiiris.tut.ac.jp/
- The University of Tokyo: http://www.hybrid.iis.u-tokyo.ac.jp/index-e.php

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No. 1, Oct 2010

Research highlights

Bio-nanomachines: Nano-size biological machinery for manipulating physiological function

Dr Numano

Fig.1:Right :Yin/yang photoswitched channel controls neural activity by UV/VIS irradiation with photoisomers MAG. Center:Yin/yang calligraphy is produced by Adachi-rohshi (Zen priest in Kamakura JAPAN 1932-). Enkaku Jiun (pen name) is signed with seal in left side. This calligraphy work is arranged by permission of Adachi-rohshi.

Rene Descartes proposed that all physiological system could be recognized by mechanistic principles. We recognize intact biostructure ionotropic glutamate receptors (iGluR6) as machinery, which is normally expressed in synaptic neural processes in mammalian brain. To control any neural activity remotely and reversibly, photoswitchable nano-machine—LiGluR & Yin/yang—were developed based on iGluR6 and operated using photoiosomerizable new chemicals, MAG.
Rika Numano at Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi Tech, in collaboration with Ehud Isacoff's group at UC Berkeley have been investigating the dynamics of ion channels and efficiently manipulating them for optical control of neural activity.
Here, Numano and colleagues photo-switched iGluR6 using three kinds of MAG0,1,2, which dangle 2R,4R-allyi glutamate (G) from a linker containing the photoisomerizable azobenzene (A) that is attached to introduced cysteines via maleimide (M). The MAGs were examined at some cysteine mutated positions around the ligand binding domain "clamshell" from geometry.
In neural cells with LigluR (with L439C mutation), action potentials are optimally evoked and extinguished by UV and visible light, respectively. Yin/yang (G486C) optical control makes it possible for a single wavelength of light to elicit action potentials in one set of neurons, while de-exciting a second set of neurons in the same preparation.
The ability to generate opposite responses with short MAG0 and two versions of a target channel, which can be expressed in different cell types, paves the way for engineering opponency in neurons that mediate opposing functions.
The researchers could control notable neural circuit activity to regulate physiology from a mechanistic view.

Reference:

- Rika Numano*, Stephanie Szobota, Albert Y. Lau, Pau Gorostiza, Matthew Volgraf, Benoit Roux, Dirk Trauner and Ehud Y. Isacoff
- *PNAS* **106** 6814 (2009)
- DOI: 10.1073_pnas.0811899106
- *Rika Numano is now at The Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology, Aichi, Japan.

Further information

- The Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology: http://www.eiiris.tut.ac.jp/
- Departments of Molecular and Cell Biology, University of California, Berkeley: Department website: http://mcb.berkeley.edu/

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No. 1, Oct 2010

Research highlights

Biosensing and biomolecular recognition: Self Assembly and chains of rotating magnetic particles

Dr Park

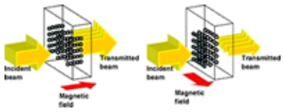

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Fig. 1: Experimental procedure for homogenous biosensing protocol based on chains of self-assembled magnetic particles rotating in solution.

Biosensing based on the detection of magnetic labels offers a rapid, sensitive and inexpensive protocol for point-of-care medical diagnostics, where magnetoresitive sensors are used to detect magnetic beads immobilized onto substrates via biorecognition processes.

However, this approach necessitates multiple steps – immobilization of probe molecules, washing to remove non-specific binding, and so on – constraints which limit the sensitivity, speed and cost, and ultimately the size of the system.

In an alternative approach Sang Yoon Park at the Electronics Inspired Interdisciplinary Research Instiute (EIIRIS), Toyohashi Tech and colleagues at Tokyo Institute of Technology, report on a new biosensing protocol based on monitoring changes in optical transmittance of a solution containing self-assembled chains of functionalized magnetic beads being rotated by an external magnetic field. Importantly, this so-called homogenous method is rapid, highly sensitive over a wide range of concentration and does not require substrates or magnetic sensors.

The lengths of chains of biotinylated magnetic beads rotating in a solution increased with the addition of complementary biomolecules (avidin) to the solution, and importantly, the increase in chain length was directly related to the concentration of avidin added to the solution. This change in the length of the chains was measured with high accuracy by monitoring changes in the optical transmission of the rotating chains in the solution. Notably, optical transmittance through the solution depended on the lengths of the rotating chains, which in turn was related to the concentration of avidin molecules added to the solution.

The experimental set-up consisted of three simple components: a light source of a non-polarized white beam, a cuvette containing a solution of functionalized magnetic beads, and a compact spectrometer. The biotinylated magnetic beads used by the researchers had a diameter of 250 nm, and consisted of superparamagnetic particles embedded into a polymer matrix. The polymer surface was covered with biotin biomolecules and the concentration of avidin added to the solution was measured by applying a rotating magnetic field to the cuvette and monitoring optical transmission of the solution when the target molecule (avidin) was added to the solution.
In 30 seconds, the researchers quantitatively determined the concentration of avidin added to the solution with a sensitivity of 100 pM and a dynamic range of at least four orders of magnitude. This protocol is a rapid, highly sensitive, inexpensive and homogeneous means for quantifying biorecognition processes.

Reference:

- Sang Yoon Park[*], Hiroshi Handa[2,3] and Adarsh Sandhu[1,2,3,4]
- Magneto-Optical Biosensing Platform Based on Light Scattering from Self-Assembled Chains of Functionalized Rotating Magnetic Beads
- [1]Quantum Nanoelectronics Research Center, Tokyo Institute of Technology, Tokyo 152-8552, Japan; [2]Integrated Research Institute, Tokyo Institute of Technology, 2-21-1 Ookayama, Meguro-ku, Tokyo, Japan; [3]Tokyo Tech Global COE Program on Evolving Education and Research Center For Spatiotemporal Biological Network, Tokyo, 152-8552, Japan; [4]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology, Aichi, Japan
[*]S.Y. Park is now at the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology, Aichi, Japan.
- *Nano Letters 10* 446 (2010)
- DOI: 10.1021/nl9030488

Related information

- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS): http://www.eiiris.tut.ac.jp/

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No. 1, Oct 2010

Research highlights

Cell repair mechanisms: Substrate-induced phase separation in ganglioside GM1-containing supported lipid bilayers

Dr Tero

Ganglioside GM1 (GM1), a glycosphingolipid responsible for neuronal plasticity and repair mechanism, works as a seed for the polymerization of amyloid β (Aβ) peptide, which is regarded as one of fundamental processes of Alzheimer's disease.

However, lateral organization of GM1 molecules in cell membranes, such as molecular clustering and domain formation, is still unclear.

Here, Ryugo Tero at the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) in collaboration with Yanli Mao and other colleagues at Institute for Molecular Science found unique phase separation forming triangular domains to occur in a supported lipid bilayer (SLB) consisting of GM1, sphingomyelin (SM) and cholesterol (Chol) at 20:40:40 molar ratio (Fig.1).

The GM1+SM+Chol-SLB was prepared on mica and SiO_2/Si(100) surfaces by vesicle fusion method, where the substrate was immersed at the GM1+SM+Chol-vesicle (=liposome) suspension at 70ºC, and the adsorbed vesicles on the substrate surface spontaneously transformed to SLB. The SLB was again incubated at 37ºC for 24 h and observed by using atomic force microscope (AFM).

Triangular domains appeared only on mica surface, not on SiO2/Si(100), and all triangles were in the same direction, therefore the phase separation was induced by the SLB-mica interaction. Cholera toxin B-subunit (CTXB) assay to GM1 revealed GM1 to localize at the region out of the triangular domains. The researchers also found that the GM1+SM+Chol-SLB on mica was highly active for Aβ-polymerization.

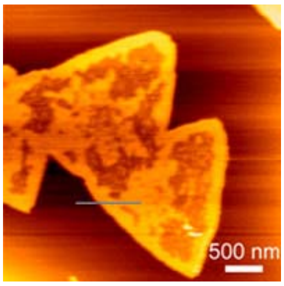

Fig.1: AFM topograph of the triangular domains GM1+SM+Chol-SLB on a mica surface.

These results open the possibility that solid surface functions may be used to control the biological activity of artificial bilayer membranes in vitro as well as their structures.

Reference:

- Yanli Maoa, [b, 1], Zhiguo Shangc,[1] Yosuke Imai[d], Tyuji Hoshino[d], Ryugo Tero[a*, c], Motohiko Tanaka[c, e], Naoki Yamamoto[f, g], Katsuhiko Yanagisawa[g] and Tsuneo Urisu[a, c, h],
- Surface-induced phase separation of a sphingomyelin/cholesterol/ganglioside GM1-planar bilayer on mica surfaces and microdomain molecular conformation that accelerates Aβ oligomerization
- *Biochimica et Biophysica Acta 1798*, 1090 (2010)
- [a]Institute for Molecular Science, Myodaiji, Okazaki 444-8585, Japan; [b]Institute of Optics and Photoelectronic Technology, Henan University, Kaifeng 475001, China; [c]Graduate University for Advanced Studies, Myodaiji, Okazaki 444-8585, Japan; [d]Department of Physical Chemistry, Chiba University, Chiba 263-8522, Japan; [e]National Institute for Fusion Science, Toki 509-5292, Japan; [f]Department of Pharmacy, College of Pharmaceutical Sciences, Ritsumeikan University, Noji, Higashi, Kusatsu, Shiga 525-8577, Japan; [g]Department of Alzheimer's Disease Research, National Institute for Longevity Sciences, National Center for Geriatrics and Gerontology, Obu 474-8522, Japan; [h]JST, CREST, Institute for Molecular Science, Myodaiji, Okazaki 444-8585, Japan
- DOI:10.1016/j.bbamem.2010.03.003
- [*]Ryugo Tero is now at the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology.

Related websites

- Electronics-Inspired Interdisciplinary Research Institute (EIIRIS): http://www.eiiris.tut.ac.jp/

No. 1, Oct 2010

Club Activities

Robotics club: The secret of success

Toyohashi Tech's student Robot-Contest Club is well named. It was established in 1992 expressly to compete in the annual NHK (Japan's national television and radio broadcaster) University Robocon robot contest. Almost from the beginning the Club chalked up a string of championship successes, coming first in 1994, 1995, 1998 and 2000, and again in 2008 and 2009.

"Just being selected to enter the contest is a challenge," says Club leader Takuya Kurebayashi, a fourth-year student in production systems engineering. "Only 20 teams are chosen from around 80 applicants, based on the submission of a project plan and promotional video."

The Club has ten core members who meet once a week for about four hours, plus another 20 members who attend less regularly. "But as the contest draws near, we often meet daily," says Yuta Honda, a fourth-year student in mechanical engineering. Honda says he has been interested in building robots ever since his middle-school days.

This year's contest, which took place in June, tested the ability of the robots to stack Styrofoam boxes into pyramids of different heights; they were judged on the accuracy of placement and speed in stacking. This put a lot of responsibility on Natsumi Isobe, a third-year student in knowledge-based information engineering and will be next year's leader; the first time the Club has had a female leader.

"I became interested in robots in elementary school when I watched the NHK Robocon program on TV," says Isobe. "So I was eager to join the Club."

All three students say they have been well rewarded for their efforts, having gained valuable experience in areas like project management, team building and cooperation, and a testing of their abilities, limits and patience during highly competitive contest conditions. An added bonus is that winners of the NHK contest are chosen to represent Japan in the ABU Asia-Pacific Robot Contest also held annually.

In explaining the Club's success over the years, Shinichi Suzuki, a professor of mechanical engineering and the Robot-Contest Club's advisor, says, "From the beginning dedicated senior members passed on their knowhow and techniques to the next generation of members; this is why we have enjoyed a long history of success."

Fig.1: Core members of the Toyohashi Tech Robotics Club. Takuya Kurebayashi (left), Natsumi Isobe (center) and Yuta Honda

Fig.2 : Robotics Club members with their advisor Professor Shinichi Suzuki.

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No. 1, Oct 2010

Excursions

International students visit some of the famous sites and industries of Aichi prefecture on a trip organized by Toyohashi Tech

Toyohashi Tech is located in eastern Aichi Prefecture (Fig.1). Notably, Aichi is one of the largest industrial regions in Japan, being home to companies such as the Toyota Motor Company. Furthermore, Aichi has played a central role in many events that shaped Japan's history, for example the military conflicts of the 'sengoku period' between the 15th to 17th centuries, which eventually ceased and led to the unification of Japan under the Tokugawa shogunate.

Craftsmanship has also thrived in Aichi. In fact this area of Japan is the location of two of Japan's six ancient ceramic manufacturing centers—Seto and Tokoname.

So, Toyohashi Tech is close to industrial giants, historic sites, and 'onsen' nestled in the scenic mountains that surround the city of Toyohashi.

On September 9–10, a group of international students from Toyohashi Tech went on an excursion around some of the sites of Aichi prefecture (Fig.2). They first went the Asahi Glass Co. Ltd., founded in 1970, this company produces flat glass for automobiles, displays and other products such glass substrates for solar batteries.

The students then visited the INAX Museum, managed by INAX , a company that produces tiles, bathroom furniture in Tokoname.

Aichi is also well known for the production of food stuffs including traditional Japanee vinegar, and the students visited MIZUKAN Museum Su-no-Sato—where the students saw at first hand the tools used in the Edo era (17–19 century) for making vinegar, and the unique 'the fermentation room'.

A trip to Aichi would not be complete without a visit to the Toyota Commemorative Museum of Industry and Technology. The students saw the roots of the Toyota Motor Company in the form of a textile machine, as well as the modern automobile and production technology, for which the company is famous.

The final trip was to the Tokugawa Art Museum with rare exhibits from the Edo period including implements used by the daimyo of the Owari branch of the Tokugawa clan. Interestingly, the famous Tale of Genji scrolls—a national treasure—are on exhibition in the autumn. The Tokugawa park adjacent to the museum is a so-called *chisen-kaiyuu siki* style.
On the evening of the first day, the students spent the night at a hotel with a tradition onsen—Hotel Hana no Maru.
Click video for a direct look at the student's two day trip around Aichi.

Enlarge Image
Fig.1: The location of Aichi prefecture in Japan.

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Fig. 2: The location of Toyohashi Tech in Aichi prefecture and the course taken by the students during this excursion.

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No. 1, Oct 2010

Tech-Overtures

Innovative ideas and inventions from Toyohashi Tech researchers
Quantifying cosmetics: Optical quantification of the spatial distribution of cosmetic facial foundation

Beauty may indeed be in the eye of the beholder, but we could all do with a little help to maintain the 'natural look' just to be on the safe side.

Applying creams and liquids—foundation—to the face and body has a long history, with records showing the ancient Egyptians using 'body paint' to improve their complexion and looks.

Intriguingly, in spite of the countless products offered by the cosmetics industry, the appropriate application of foundation is still more of an art than a science. That is, there is not a scientific way to quantify the spatial distribution of foundation applied to the face.

Now, Shigeki Nakauchi at Toyohashi Tech's Department of Computer Science and Engineering in collaboration with Kanebo Cosmetics Inc., Japan, has developed a technology enabling the quantification and visualization of the 'quality' and finish of foundation applied to the face.

Using this technology, it is possible to produce an optical image of the amount of foundation applied to the face by simply inserting a special filter in front of a camera lens (Fig.1).

For example, this technology enables a direct comparison of the finish of foundation applied by a untrained person (Fig.2 (left) and a professional make-up artist (Fig.2 (right)).

This technology will be used for the development of materials for base make-up, more informed make-up counseling and techniques for beauticians and so on.

Further information

- Shigeki Nakauchi Group : http://www.vpac.cs.tut.ac.jp/en/index.php?FrontPage

Fig.1: The role of the filter used for visualizing the finish of foundation applied to the face. The theoretically derived spectral transmittance was realized experimentally using a multilayer film filter made by vacuum deposition technology.

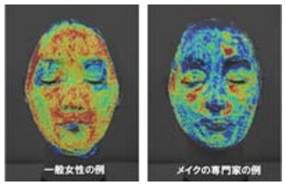

Fig.2: Visualization of the finish of foundation applied by an untrained women (left) and a professional make-up artist (right). The amount of the foundation applied by the professional is much less than an inexperienced woman, which shows that a trained person applies foundation efficiently in order to achieve a 'natural looking' finish to the make-up.