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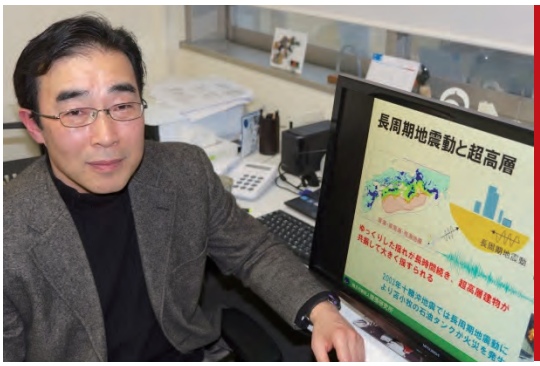
TOYOHASHI UNIVERSITY of TECHNOLOGY
e-Newsletter
News and views from one of Japan's most innovative and dynamic science and technology-based academic institutes

No. 16, September 2014



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Toyohashi Tech Earthquake Disaster Engineering Research: Protecting high-rise buildings from earthquakes

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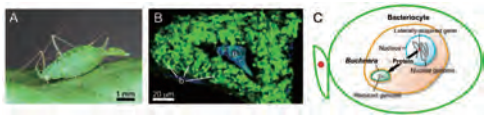
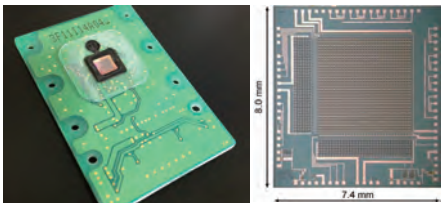
News



Research Highlights



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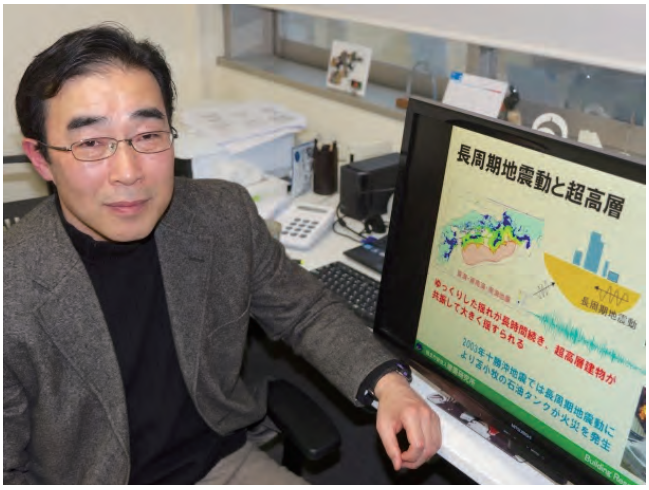
Toyohashi Tech Earthquake Disaster Engineering Research: Protecting high-rise buildings from earthquakes

The huge Tohoku earthquake off the northeast coastline in March 2011 underscores the dangers of earthquakes in Japan. Such devastating earthquakes could occur anywhere in Japan. For example, anywhere along the Nankai Trough off the Pacific coast of central Japan that stretches for hundreds of kilometers to the southwest. Due to the meeting of three tectonic plates in the region, it is an active earthquake zone, and seismologists predict that a major quake will occur along this region by mid-century.

Notably, unlike many previous quakes, such as Kobe in 1995 that destroyed low rise buildings, the Nankai Trough quake is expected to cause great damage to high-rise buildings, oil tanks and suspension bridges in cities including Tokyo, Nagoya, and Osaka.

Most earthquakes last only a few seconds. But even such short shudders lead to the release of enormous energy as shock waves spreading out from the epicenter of the earthquake. When these waves reach the surface of the Earth they cause the ground to shake and set buildings in motion, starting from their foundations and rising up through the structures.

"Every building has its own natural frequency of vibration," says Taiki Saito, a professor in Toyohashi Tech's Department of Architecture and Civil Engineering, who is conducting research into earthquake resistant designs. "If the frequency of an earthquake's shockwaves matches the frequency of a building then resonance takes place and damage results." This, he adds, is what happened in the case of the Kobe earthquake, where the high frequency waves caused small, rigid buildings rather than taller flexible buildings to collapse.



Professor Taiki Saito

"But Tokyo, Nagoya, and Osaka are located near deep layers of sediment," says Saito. "Seismologists now know that such conditions can change the shock waves and create long period ground motions of low frequency even when far from a quake's epicenter." These low frequency waves can travel backwards and forwards through the sediment upon meeting hard obstacles like rock, creating ground movement that resonates with tall structures causing them to sway and topple.

Saito's Earthquake Disaster Engineering Research Lab is investigating quake disaster mitigation for cities and high-rise buildings, including the development of a new type of damper that can be incorporated inside tall structures to absorb vibrations.

He is also deeply interested in promoting international cooperation to prevent damage from earthquakes, and has been working as a teaching expert with the Japan International Cooperation Agency (JICA). "Japan is most advanced in taking countermeasures against earthquakes and tsunami. It's our duty to disseminate this knowledge and technology overseas."

Currently, he is collaborating with Toyohashi Tech's campus in Penang, Malaysia. "We are the only Japanese national university to have a campus abroad. And right now we are helping develop technology that can be applied to buildings in the region to protect them from earthquake damage—which is something else we are proud to be doing."

Toyohashi Tech 2014 World Tea Festival

The Toyohashi Tech 2014 World Tea Festival was held on 13 June 2014. The festival is an annual event for promoting exchange between international students, Japanese students, and staff of the University.

At this year's festival, 17 teams from 16 countries served their local teas and snacks, while several clubs and groups performed music, dance or showed off their club activities on dedicated stages. The festival was attended by about 250 international students and their families, 350 Japanese students, and university staff and their families. This set a new record for participants at the world tea festival.

The participants voted and selected the Malaysian team (who served black tea with milk and sugar with a special pouring technique) for this year's best tea prize. The Bangladeshi and Indonesian teams were second and third, respectively.

International students at the Tea Festival.

Sri Lankan students serving tea.

Tea performance by Malaysian students.

Signing of exchange agreement with Thai-Nichi Institute of Technology (Thailand)

Dr. Krisada Visavateeranon, the President of Thai-Nichi Institute of Technology (Thailand) visited Toyohashi Tech on April 25th to sign an exchange agreement.

The signing is based on Professor Hitoshi Isahara's historical research exchanges with Thai-Nichi Institute of Technology, and during his visit to the Thai-Nichi Institute of Technology he talked about our university's globalization and exchanged opinions with Thai-Nichi Institute of Technology on the possibility of research collaboration and student exchanges. Following that, there was a strong desire on the part of Thai-Nichi Institute of Technology to conclude an exchange agreement, which led to the signing of the agreement.

Thai-Nichi Institute of Technology was established under the parent organization, Technology Promotion of Technology (Thailand-Japan), and nurtures students based on the requirements of Japanese corporations and the idea of Japanese monozukuri (manufacturing). As such, involvement with local corporations is also deep-rooted.

Taking advantage of this agreement, enhancing cooperative relations and advancing exchange projects starting with student exchanges were agreed upon at the signing ceremony. With this recent inter-university exchange agreement, we can greatly anticipate specific project developments.

Dr. Mitsuteru Inoue of Toyohashi Tech and Dr. Krisada Visavateeranon of Thai-Nichi Institute of Technology

Delegates from Tadulako University, Indonesia visit Toyohashi Tech

A group of ten members including Rector, Prof. Muhammad Basir Cyio from Tadulako University, Indonesia, visited Toyohashi University of Technology on 23 June 2014.

Tadulako University is the largest national university in Central Salawesi, Indonesia, and conducts research that is rooted in their community.

Tadulako University and Toyohashi University of Technology signed an Inter-University Exchange Agreement in July, 2011. This visit was requested by Tadulako University, and arranged to discuss exchange students.

Prof. Hiroyuki Daimon, Director of Center for International Relations (CIR), Prof. Naohiro Hozumi, Director of International Cooperation Center for Engineering Education Development (ICCEED), and Associate Prof. Nobumasa Sekishita joined the preliminary discussions on exchange students with Rector Basir, Prof. Mery Napitupulu, Head of international office.

Also, President Takashi Onishi and Vice President Mitsuteru Inoue and Prof. Takanobu Inoue participated in this meeting and discussed education programs of universities in Indonesia besides exchange student.

In addition, the visitors toured the Center for Human-Robot Symbiosis Research, Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), and Venture Business Laboratory.

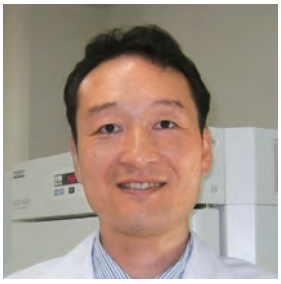
Innovative research with potential for pest control: Evolution of a novel organelle in Animalia

Mitochondria and chloroplasts are descendants of bacteria that were engulfed by ancient unicellular organisms more than a billion years ago. During their evolution, many genes were transferred from ancestral organelles and other bacteria to the host genome. This process required incorporating intact genes into the host genome, acquiring the expression signals that enable their transcription in eukaryotic hosts, and evolving a targeting system to transport and import their protein products into the endosymbiotic organelles.

The advent of this protein-targeting machinery is commonly assumed to be the most crucial step when an endosymbiont becomes an organelle. Although bacterial lineages have repeatedly evolved intimate symbioses with eukaryotic hosts, the establishment of the protein translocation system has been observed only in the cases of bona fide organelles and a symbiosis in an amoeba.

Now, Atsushi Nakabachi at Toyohashi Tech and his colleagues report this type of evolution in Animalia.

Aphids, sap-sucking insects known as agricultural pests, harbor the obligate mutualistic symbiont, Buchnera aphidicola, within specialized cells called bacteriocytes. Buchnera provides nutrients to the host aphids and has been transmitted through host generations for more than 100 million years.



Atsushi Nakabachi

The present immunochemical study revealed that (i) protein is synthesized from an aphid-encoded gene that was horizontally acquired from a bacterium; (ii) the protein is synthesized specifically in the bacteriocyte; and (iii) the synthesized protein is localized in Buchnera, indicating that a translocation system has evolved to target the protein to Buchnera. This is the first report of integration between multicellular eukaryotes and bacteria to the extent of 'organellogenesis'.

These findings are expected to lead to the development of innovative biotechnologies, including the fusion of distantly related organisms, and will enable highly selective pest control.

Reference:

- Authors: Atsushi Nakabachi[1,2], Kinji Ishida[3], Yuichi Hongoh[4], Moriya Ohkuma[2], Shin-ya Miyagishima[5]
- Title of original paper: Aphid gene of bacterial origin encodes a protein transported to an obligate endosymbiont.
- Journal, volume, pages and year: *Current Biology* 24(14), R640–R641 (2014).
- Digital Object Identifier (DOI): 10.1016/j.cub.2014.06.038
- Affiliations: [1]Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), Toyohashi University of Technology, [2]Japan Collection of Microorganisms, RIKEN BioResource Center, [3]The Center for EM & Bio-Imaging Research, Iwate Medical University, [4]Graduate School of Bioscience and Biotechnology, Tokyo Institute of Technology, [5]Center for Frontier Research, National Institute of Genetics
- Department website: http://www.eiiris.tut.ac.jp/

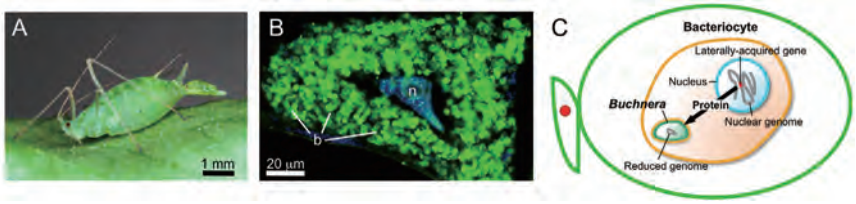


Fig.1: Aphids show integration with bacteria to the extent of 'organellogenesis' (A) Adult aphid giving birth to an offspring. (B) The protein (green signal) is localized in Buchnera within the bacteriocyte. n, nucleus; b, Buchnera. (C) The intimate aphid-Buchnera symbiosis is achieved using a mechanism that is common to the evolution of organelles, mitochondria and chloroplasts.

Biomedical applications of plasma technology

Atmospheric plasma is widely used for medical and biological applications including sterilization, selective killing of tumor cells, gene transfection, and healing wounds.

Acidic and radical species generated by plasma first access a plasma membrane, the outermost layer of a cell. However, it is unclear how these plasma-induced species affect and/or permeate plasma membranes.

Here, Ryugo Tero, Yoshiyuki Suda and colleagues at Toyohashi University of Technology report the effects of atmospheric plasma irradiation on an

artificial plasma membrane system.

A phopholipid bilayer membrane was prepared on a silicon wafer in an aqueous solution, and the atmospheric plasma was irradiated with a home-build dielectric barrier discharge (DBD) instrument.

Observation with a fluorescence microscope and an atomic force microscope revealed that pores on the order of 10 nm to 1 μm in size were formed in the lipid bilayer membrane after the plasma irradiation. Capturing these micropores in a fluid lipid membrane is a significant advantage of the artificial lipid membrane system, and quantitative analysis of the pores was achieved. The results indicate that the micropores act as paths for the non-selective leakage or transportation of solutes into and out of cells during the plasma-induced phenomenon such as sterilization and gene transfection.

The artificial plasma membrane system is valuable for studying the fundamental effects of plasma on biomolecules for establishing medical and biological applications of plasmas.

Ryugo Tero

Reference:

- Authors: Ryugo Tero[1,2], Yoshiyuki Suda[3], Ryo Kato[3], Hideto Tanoue[3] and Hirofumi Takikawa[3]
- Title of original paper: Plasma irradiation of artificial cell membrane system at solid-liquid interface.
- Journal, volume, pages and year: *Applied Physics Express* 7, 077001 (2014) [Open Access].
- Digital Object Identifier (DOI): 10.7567/APEX.7.077001
- Affiliations: [1]Electronics-Inspired Interdisciplinary Research Institute, [2]Department of Environmental and Life Sciences, [3]Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology
- Department website: http://www.eiiris.tut.ac.jp/
- Related topics will be presented at 2014 MRS Fall Meeting (Nov. 30 - Dec. 5, 2014, Boston MA, by Y. Suda: http://www.mrs.org/fall2014/), and the 7th International Symposium on Surface Science (Nov. 2-6, 2014, Matsue, Japan, by R. Tero: http://www.sssj.org/isss7/)

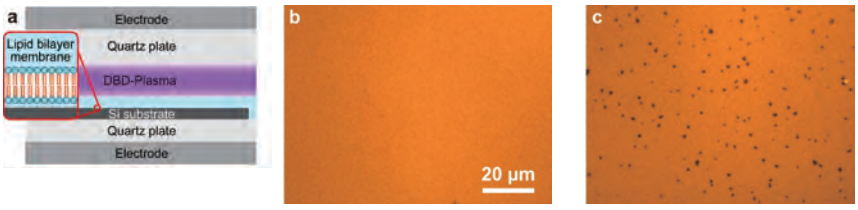


Fig.1: (a) Schematic of the DBD-plasma irradiation of an artificial lipid bilayer membrane. (b, c) Fluorescence images of the lipid bilayer membrane (b) before and (c) after the plasma irradiation.

Experimental study on dynamic behavior of unreinforced masonry walls

The main reason for extensive earthquake damage in developing countries is the collapse of unreinforced masonry houses.

Because of large variations in material properties and construction accuracy, as well as brittle characteristics of brick materials, it is very difficult to treat masonry building in engineering manners. Taiki Saito and colleagues at CISMID – National University of Engineering in Peru and Building Research Institute-conducted shaking table tests to investigate the dynamic behavior of unreinforced masonry walls.

In order to represent typical masonry houses in rural areas in Peru, two specimens were constructed and tested on the shaking table. Both specimens had three walls combined together in the form of a C-shape. One specimen had no floor slab and another one had a wooden floor slab.

From the vibration tests, the generation pattern of cracks and the collapse mechanism were examined. Whereas the first specimen showed the out-of-plane flexural failure mechanism, the other specimen exhibited in-plane shear failure mechanism. This difference is presumed to be due to the restraint effect by the floor diaphragm. Currently, the researchers are developing analytical software that can reproduce the experimental results.

Taiki Saito

Reference:

- Authors: Taiki Saito, Luis Moya, Cesar Fajardo, and Koichi Morita.
- Title of original paper: Experimental study on dynamic behavior of unre-

inforced masonry walls.

- Journal, volume, pages and year: Journal of Disaster Research, Vol.8, No.2, pp. 305-311, 2013
- Digital Object Identifier (DOI): 10.1063/1.3120561
- Affiliations: Department of Architecture and Civil Engineering, Toyohashi University of Technology
- Department website:http://www.ace.tut.ac.jp/

Fig.1: Collapse of the masonry wall specimen with a wooden slab.

Efficiency Angle: Versatile Design Pilotage for Wireless Power Transfer Systems

Wireless power transfer (WPT) is expected to be a huge market for in-motion electric motor car powering as the fourth-generation personal mobility.

However, WPT engineers often lose their way in exploring high-efficiency power transfer structures. This is because there is only one design criterion called k-Q product which was proposed by MIT in 2007, where k and Q stand for coupling coefficient and quality factor, respectively. Although the criterion works well for optimizing the structure of coupled coils to produce strong magnetic resonance, it cannot be used in non-resonant or non-magnetic structures such as power transfer systems exploiting electric displacement current. A more versatile criterion could enable the engineers to find the optimum structure from wider options.

Now, Takashi Ohira at Toyohashi University of Technology has proposed an elegant design criterion called efficiency angle.

A power transfer system can be modelled as a black box consisting of ports #1 and #2, and passive elements inside. Ohira focused on its reciprocal impedance matrix Z = R + jX, and heuristically introduced angular parameter θ that satisfies,

$$\tan 2\theta = \frac{|z_{21}|}{\sqrt{|\mathbf{R}|}}$$

Takashi Ohira

where z21 is a nondiagonal component of matrix Z, and |R| denotes the determinant of matrix R. The double-angle tangent reduces to k-Q product in resonant systems, and even works in general power transfer systems as a lucid pilotage for designers. They no longer need to know resonance or coupling conditions, but just simply to know Z.

The tagent square physically implies the system's maximum available power transfer efficiency,

$$\eta_{\max} = \tan^2 \theta$$

which monotonously increases with θ as well as $\tan 2\theta$. Refer to the chart illustrating how to graphically estimate the maximum efficiency from given Z via angle θ. By employing this chart, Ohira's team successfully developed a via-wheel power transfer system for running vehicles and demonstrated its validity and effectiveness.

Once the WPT engineers master the efficiency angle theory, then they should be able to open up their vista to discover drastically wider ranging ways in research and development of future power transfer systems.

Reference:

- Authors: Takashi Ohira
- Title of original paper: Maximum available efficiency formulation based on a black-box model of linear two-port power transfer systems
- Journal, volume, pages and year: IEICE Electronics Express Vol. 11 (2014) No. 13 pp. 20140448
- Digital Object Identifier (DOI): http://dx.doi.org/10.1587/elex.11.20140448
- Affiliations: Future Vehicle City Research Center, Toyohashi University of Technology
- Department website: http://www.rcfvc.tut.ac.jp

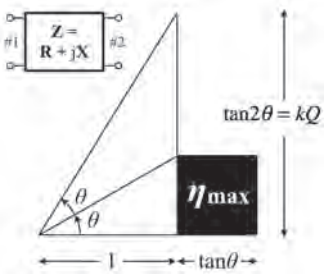


Fig.1: Wireless power transfer system black-box model and k-Q product chart

Innovative semiconductor image sensor for analysis of blood samples for early diagnosis of diabetes and Alzheimer's disease

Kazuaki Sawada

Professor Kazuaki Sawada and Dr. Takigawa of the National Center for Geriatrics and Gerontology and colleagues at Toyohashi University of Technology have established an easy to use, low-cost, rapid, and high sensitivity semiconductor-imaging based medical diagnostic biosensing system for analyzing blood and urine for early diagnosis of ailments including diabetes and Alzheimer's disease.

The new biosensing technology consists of a semiconductor image sensor ('charge coupled device' developed by Toyohashi University of Technology) that is sensitive to extremely small changes in electric potential, and microbeads on which antigen-antibody reactions take place. This technology will enable monitoring and diagnosis of diseases for which specific markers are known using very small volumes of blood or urine. Specifically, this technology has detected amiloid beta-peptide, an agent responsible for Alzheimer's disease.

Contracting a disease leads to expression of proteins specific to the diseases in the blood. This new technology is used for early diagnosis of diseases by using this specific protein as the antigen and a marker that captures the protein as the antibody and checking their antigen-antibody reaction. Conventional protocols used to monitor antibody-antigen reactions employ fluorescent probes and detection of fluorescence with microscopic cameras. This process is time consuming because of the necessity to measure fluorescence from the probes and cannot be used to detect low concentrations of antigens when the fluorescence intensity is too low to detect optically.

With this technology, an antigen-antibody reaction is used as in conventional methods, but fluorescence is not measured. Instead, this method employs a semiconductor image sensor to detect minute changes in electric potential generated during an antigen-antibody reaction.

The semiconductor image sensor [Fig. 1] consists of 128 × 128 pixels that independently sense minute changes in electric potential. The detection sensitivity of antigen-antibody reactions was significantly increased by using microbeads [Fig. 2]. The figures of merit of this technology are given in Table 1. Multiple diseases can also be simultaneously diagnosed by placing different antibodies on different sensing pixels out of a total of 16,384 pixels (128×128).

Implementation of the technology will be tested for daily control of lifestyle diseases such as diabetes and in future the technology will be expanded for the early diagnosis of Alzheimer's and Parkinson' diseases.

Acknowledgement

"Extremely early diagnosis technological development project" of the industrial-academic-government collaboration "Knowledge Hub Aichi" project promoted by Aichi Prefecture

Further information

Akiteru Kono et al, Label free bio image sensor for real time monitoring of potassium ion released from hippocampal slices, Sensors and Actuators B 201, 439–443, (2014)
http://dx.doi.org/10.1016/j.snb.2014.04.019

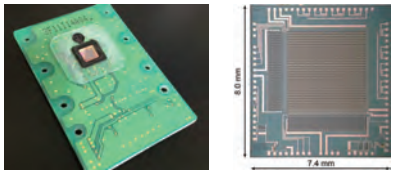


Fig.1 Semiconductor image sensor (128 pixels × 128 pixels)

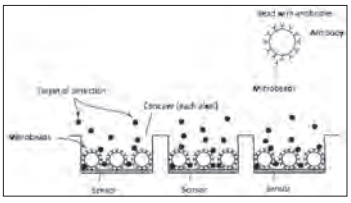


Fig.2 Schematic illustration of microbeads with antibodies on sensors (Patent application filed)

Item	Measuring time	Sensitivity	Cost (per specimen)	Amount of blood
This technology	About 10 min	0.1-10 pM	100 yen or less	1 drop (0.02ml)
Conventional method (ELISA method)	Several hours	1-100 pM	About 1,000 yen	1-5 ml

Table 1 Advantage of this technology over the conventional method

Toyohashi Tech Music Club: Top of the popularity charts

The Toyohashi Tech Pop Music Club has approximately 120 members and is the university's most popular student club. The members of the club form bands from many musical flavors of popular music. Japanese, American, and U.K. rock music is the most popular, with student groups covering bands including the Beatles, Queen, Oasis, Led Zeppelin, and Bump of Chicken.

"We meet once a week in the Student's Room to discuss practice sessions and sort out performance schedules," explains club leader Kota Shomura, a third year student studying mechanical engineering. "With about 50 of us attending, we split and form bands to practice at different times throughout the day, each band usually getting about 90 minutes."

With so many members and differing personalities, it's difficult managing them all, Shomura admits. So he has a support team of ten experienced members to help him deal with the schedules.

Shomura plays lead guitar, which he began learning four years ago at his technical high school. "The club has its own set of drums and a keyboard, as well as amps and microphones," he says. "We buy all the other instruments." Prices vary, but can reach as high as 100,000 yen so some members opt to buy used instruments.

The club holds seven or eight live performances a year in the Common Room on campus. Members set up the stage, arrange the lightening and connect the sound and mixing equipment. Members of

the club are joined by other students at the performances. Some bands also play live in a small concert hall in Toyohashi city and in coffee shops in the town. The school festival is another place where they perform live and demonstrate their skills to attract new members and fans.

With so many members enjoying sharing a common interest, the club looks set to stay top of the popularity charts for quite some time.

My experience of visiting Japan and EIIRIS in May-July 2014

This was my third visit to Toyohashi Tech and around the tenth visit to Japan—so Japan has slowly become my home away from home. My most ever lasting impressions of Japan are the work culture and down to earth humility. The fact that every person, irrespective of the type of work they do, all are happy doing their work with the appropriate care and planning for producing the best results.

Being rural and located in an agricultural landscape, Toyohashi University of Technology has helped me to watch and observe the traditional Japanese living in places far away from busy city culture. It is amazing and has been a lesson for me to observe how meticulous each of the farmers are to cultivate the crops from each small or big pieces of land which they own around their houses.

In India, I come from the south Indian state called 'Kerala', which is a small state located just above Sri Lanka. Between Japan and Kerala, I have noticed many similarities. (i) Dance: Japan's 'Kabuki' and Kerala's 'Kathakali'. Both, performed by men only, involve facial coloring, high in facial expressions. (ii) Traditional building and house architecture: Similar roof shapes, tiled roofs etc., probably due to lot of rain throughout the year at both places.

Kabuki & Kathakali stamps by India

Professor Joby Joseph at IIT Delhi.

Coming to my experience and interaction with researchers at the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), the research environment, infrastructure with cutting edge technological equipment, interdisciplinary structure and the work culture have left an everlasting impression on me and surely will help me to continue to carry out collaborative research work between EIIRIS and IIT Delhi.

I am very hopeful that in the future, there will be even more exchange of ideas, students and researchers between Toyohashi Tech and IIT Delhi for the mutual benefit of each institute.

Joby Joseph, Professor of Physics IIT Delhi, New Delhi, India.

Professor Joby Joseph with Professor Adarsh Sandhu and his group, which includes two interns from IIT Delhi.

Welcome to the autumn 2014 Toyohashi Tech e-Newsletter Video Letter.

This video was filmed, edited, and produced by international students and researchers from Vietnam. We hope that you enjoy watching the wide range of student activities featured in the video. Summary of statistics on international students studying at Toyohashi Tech.

1. Toyohashi Tech has 2,188 students of whom 176 (8%) are from overseas.
2. Of the 176 international students, 26 are from Vietnam, 59 from Malaysia, and 31 from Indonesia.

Financial support for international students at Toyohashi Tech comes from a variety of sources including scholarships from MEXT (Japan) and agencies in their own countries.