

TOYOHASHI UNIVERSITY of TECHNOLOGY

Ursa Minor

e-Newsletter News and views from one of technology-based academic



No. 12, September 2013

Features 2

Professor Takanobu Inoue of Toyohashi Tech's Department of Architecture and Civil Engineering has been conducting field surveys of mercury poisoning in Indonesia for over a decade. His findings have serious implications and the situation is not improving.





News

Toyohashi Tech and Queens College Conclude Exchange Agreement3
Toyohashi Tech Selected for The Program for Promoting the Enhancement of
Research Universities
Symposium Commemorating Publication of Gijutsu Wo Tsukuru—Chi No Honryu No
Messe-ji- (Creating Technology—Message from the Main Stream of Knowledge)3

Research Highlights

Toxin-producing bacteria integrated into a pest insect4
New speech recognition model: Hidden Conditional Neural Fields4
Establishing basic formulas for squeezing wireless energy from radio frequency
systems
Hard materials: Carbon nitride for tribological application6



Club Activities

The International Exchange Club "CALLing" the world7



Excursions
A visit to Toyohashi Gion Festival7



Video Letter

Toyohashi Tech eNewsletter Video Letter: Through Indonesian Eyes7

Investigating mercury pollution in Indonesia

Professor Takanobu Inoue of Toyohashi Tech's Department of Architecture and Civil Engineering has been conducting field surveys of mercury poisoning in Indonesia for over a decade. His findings have serious implications and the situation is not improving.

"The main source of this pollution today is small-scale gold mining," says Inoue, who is an expert on water environmental engineering. "Gold mining is easy to learn and simple to operate, so for people living on the poverty line, it offers hope for the future."

When there is no sophisticated technology available, gold mining involves simply mixing mercury and water with gold ore to form an amalgam. The mixture is then heated to remove the mercury by evaporation—most likely without any filtering— leaving behind the gold, while the water containing mercury residue is usually discarded directly into rivers.

Mercury is a heavy metal that can cause disability and death to miners, and to their families who become exposed to it through contaminated clothing and other items. Chronic poisoning can result in damage to the kidneys and the reproductive system, while the lungs and central nervous system can also be



Professor Takanobu Inoue of Toyohashi Tech's Department of Architecture and Civil Engineering.

severely affected.

"It is necessary to educate the people on the dangers of mercury poisoning," says Inoue. "But there are few environmental researchers in the country, and the equipment they have to test for poisoning is limited, as are funds and government support."

As a result, quantitative information on the extent of mercury pollution each year is scare and often inaccurate. The United Nations Environment Program, for instance, estimated that in 2011 approximately 70 tonnes of mercury was discharged into the environment. "But this UN figure is based on the import of mercury into Indonesia," says Inoue. "It does not take it account illegal imports, so the actual figure is certainly far higher."

Inoue has been sharing his findings with individual professors of several universities in Indonesia. He is encouraging them to join the Indonesia Society of Water and Aquatic Environment, where information can be shared and scientific papers on pollution presented and published at conferences.

To help impress on his Indonesian colleagues the dangers that exist, Inoue describes findings on the Minamata disease that was discovered in Minamata city, Japan, in 1956. It was caused by the release of waste water containing mercury pollutants into Minamata Bay by a local chemical company, where it was ingested by marine animals, which were subsequently consumed by humans.

"We need research institutes to collaborate with each other to facilitate a comprehensive study on mercury pollution in Indonesia," says Inoue. "Such cooperation will enable monitoring of mercury concentrations in gold mining and the impact of this environmental pollutant on local people."



Toyohashi Tech and Queens College Conclude Exchange Agreement

Toyohashi University of Technology (President Yoshiyuki Sakaki) and Queens College, City University of New York City, (President James Leroy Muyskens) concluded an inter-university exchange agreement on 29 July 2013. Since being selected for the Ministry of Education, Culture, Sports, and Science and Technology's National University Reform Enhancement Promotion Project in the 2012 academic year, Toyohashi University of Technology (Toyohashi Tech), Nagaoka University of Technology, and the Institute of National Colleges of Technology, Japan, have worked to develop not only globally-oriented personnel who can play active roles overseas but also innovation-oriented personnel who are internationally competitive and can invigorate local industries. As part of these efforts, there are plans to send teaching staff from Toyohashi Tech to the U.S. for faculty development training at Queens College in order to strengthen their global human resource development

Toyohashi Tech Selected for The Program for Promoting the Enhancement of Research Universities

Toyohashi University of Technology (Toyohashi Tech) was selected as one of twenty-two organizations to receive aid through The Program for Promoting the Enhancement of Research Universities that the Ministry of Education, Culture, Sports, and Science and Technology launched this year.

This project supports efforts by universities and similar organizations to strengthen their research capabilities, including securing research management personnel and implementing intensive reforms to their research environment in order to reinforce universities conducting world-class research and strengthen research capabilities throughout Japan.

Toyohashi Tech is striving to form a hub that promotes interdisciplinary innovation research, which is the evolution of traditional problem-solving-based engineering, the objective of which is to solve problems, to valuecreating engineering, the ideal of which is to create



Queens College President Muyskens concluding the agreement with President Sakaki

skills, which led to this exchange agreement.

Concluding this agreement is extremely significant in that there are hopes that this will lead to additional research and student exchanges with Toyohashi Tech.



new value, by overcoming the barriers of specialization and organization, creating active partnerships with both Japanese and foreign companies and research institutes, and recruiting diverse personnel. This project will create a support system and environment to accelerate these reforms.

Symposium Commemorating Publication of *Gijutsu Wo Tsukuru—Chi No Honryu No Messe-ji-* (Creating Technology—Message from the Main Stream of Knowledge)

The Symposium Commemorating Publication of *Gijutsu Wo Tsukuru—Chi No Honryu No Messe-ji* was held on July 26 at the Fujiwara Hiroshi Hall, Keio University Kyosei-kan, Yokohama, Japan.

When Toyohashi University of Technology (Toyohashi Tech) restructured its undergraduate and graduate programs in the 2010 academic year, the university, in cooperation with industry, launched a new education program whose goal is to train creative engineers and researchers willing to take on the challenges of the next generation. The program includes special lectures by pioneering researchers and visionary managers and entrepreneurs. These special lectures were compiled into a book, which was published under the title *Gijutsu Wo Tsukuru*. This symposium was held to commemorate the publication of the book, and around 300 people, including corporate managers and researchers, and university researchers and students, took part in the symposium.

The symposium consisted of three parts. The first was a conversation between the Broadband Tower Inc. President and CEO Hiroshi Fujiwara, who provided support for the symposium, and Toyohashi University of Technology President Yoshiyuki Sakaki on the topic of "science, technology, and art—the key to creating the future."

In the second part of the

symposium, Makoto Ishida, director of the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) and vice president, discussed the interdisciplinary research being conducted at the institute in a speech covering the latest research highlights titled Toyohashi University of Technology's Challenge, which was followed by four professors discussing their latest research.

The third part of the symposium consisted of a panel discussion by six participants, which was moderated by Toyohashi University of Technology President Yoshiyuki Sakaki. The six participants were Tokyo University of Science President Akira Fujishima, Asahi Kasei Fellow Akira Yoshino, Japan Society for the Promotion of Science President Yuichiro Anzai (former president of Keio University), Meijo University Graduate School



Talk with Broadband Tower Inc. President and CEO Fujiwara and Toyohashi Tech President Sakaki



Commemorative photo of reception participants

Professor Sumio Iijima, Toyota Technological Institute President Hiroyuki Sakaki, and Broadband Tower Inc. President and CEO Hiroshi Fujiwara. During the panel discussion, the participants made comments regarding topics including the form of science and technology– based country that Japan should aim for, and the shift from problem solving to value creation from several perspectives including universities, corporations, and promotion of science and technology policies.

Finally, President Sakaki noted that the symposium embodied the passionate messages from people in various fields and was a good opportunity for participating corporate managers and researchers and university researchers and students to think about the future.

Toxin-producing bacteria integrated into a pest insect

A small cicada-like insect called the Asian citrus psyllid (*Diaphorina citri*) threatens the world's citrus industries, transmitting an incurable and lethal citrus disease. This notorious pest harbors two bacterial species within cells specially prepared for the purpose of symbiosis. Whereas these symbionts are believed to be essential for the host psyllid, their functional roles are not known.

Now, Atsushi Nakabachi at Toyohashi University of Technology and his colleagues have demonstrated that one of the symbionts, named *Candidatus* Profftella armatura, is an unprecedented type of symbiont that is fused into the host animal and plays a protective role to deter host's natural enemies.

The whole genome sequencing of the *D. citri* symbionts revealed that the both genomes are drastically reduced to the level that rivals those of cell organelles such as mitochondria and chloroplasts, indicating their ancient and mutually indispensable association with the host. Such an intimate relationship was



Atsushi Nakabachi

known only for 'nutritional symbionts' that provide the host with essential nutrients. But surprisingly, the genomic structure showed that Profftella is a 'defensive symbiont' that produces a protective toxin. This novel toxin was extracted, structurally and pharmaco-



Adult Asian citrus psyllid. Photographed by Atsushi Nakabachi. logically characterized, and designated diaphorin. Purified diaphorin showed a potent activity to kill cancer cells.

With this cytostatic activity, diaphorin is promising as a keycompound for the development of novel pharmaceuticals including antitumor drugs. The team has started to investigate this possibility, in addition to a project to develop highly selective and safe pest control methods that target this dual symbiotic system.

Reference:

- Authors: Atsushi Nakabachi et al.
- Title of original paper: Defensive bacteriome symbiont with a drastically reduced genome.
- Journal, volume, pages and year: Current Biology 23, 1478-84 (2013).
- Digital Object Identifier (DOI): 10.1016/j.cub.2013.06.027
- Affiliations: Electronics-Inspired Interdisciplinary Research Institute, Toyohashi University of Technology.
- Department website: http://www. eiiris.tut.ac.jp/

New speech recognition model: Hidden Conditional Neural Fields

Toyohashi Tech researchers propose the Hidden Conditional Neural Fields (HCNF) model for continuous speech recognition. The model is a combination of the Hidden Conditional Random Fields (HCRF) and a Multi-Layer Perceptron (MLP), that is, an extension of Hidden Markov Model (HMM).



This new speech recognition model has the discriminative property for sequences from HCRF and the ability to extract non-linear features from an MLP. Furthermore, the HCNF can incorporate many types of features from non-linear features can be extracted, and is trained by sequential criteria.

In this paper, the researchers describe the formulation of HCNF and examine three methods to further improve automatic speech recognition using HCNF, which was an objective function that explicitly considered training errors, provided a hierarchical tandem-style feature, and included a deep non-linear feature extractor for the observation function.

HCRF can use a deep feed forward neural network (DNN) in the observation function, and therefore, a sophisticated pre-training algorithm such as the deep belief network (DBN) can be used to provide a deep observation function. The research shows that HCNF can be

The research shows that HCNF can be trained realistically without any initial model and outperform the HCRF and triphone hidden Markov model trained by the minimum phone error (MPE) manner using experimental results for



Model architectures of HMM, HCFR and HCNF

continuous English phoneme recognition on the TIMIT core test and Japanese phoneme recognition on the IPA 100 test set. Reference:

- Authors: Yasuhisa FUJII, Kazumasa YAMAMOTO, Seiichi NAKAGAWA
- Title of original paper: Hidden Conditional Fields for Continuous Phoneme Speech Recognition
- Journal, volume, pages and year: *IEICE Trans. Inf.&Sys.*, E95-D, 2094-2104 (2012). (2012 IEICE best paper award)
- Digital Object Identifier (DOI): 10.1587/transinf.E95.D.2094
- Affiliations: Department of Computer Science and Engineering, Toyohashi University of Technology
- Website: http://www.slp.cs.tut.ac.jp/ index-e.html

Establishing basic formulas for squeezing wireless energy from radio frequency systems

Radio-frequency (RF) wave rectifier circuits play an invaluable role in extracting the appropriate DC voltage and current in wireless energy applications, such as mobile power supplies and environmental energy harvesting.

To squeeze the maximum power from an RF source, circuit designers have to repeat a process of rectifier topology implementation and element parameter optimization for each system. This approach necessitates extensive numerical simulation and computing resources.

Here, Takashi Ohira at Toyohashi Tech. describes the establishment of a set of mathematical formulas that can characterize RF diode rectifiers [1].

Figure 1 shows a simple example of energy harvesting scheme. Electromagnetic energy arrives at the antenna, is rectified by the diode, smoothed by the capacitor, and output as DC voltage to the load. The designer's primary task is to make the circuit well matched to the load resistance so that the arriving RF



Takashi Ohira

energy is not reflected by the diode but fully converted into DC voltage. This problem is mathematically equivalent to that presented by Takashi Ohira in Fig. 2. Adapting Kirchhoff's laws for the diode's nonlinear switching states, imposing the cyclostationary conditions upon the voltage waveform, and taking the current continuity property into account, Takashi Ohira successfully obtained a type of transcendental equation in terms of the diode's flow angle. By solving this equation, Takashi Ohira finally derived expressions for the DC output voltage and current. The resultant formulas for DC output power show that the source-to-load resistance ratio crucially dominates the circuit behavior. Takashi Ohira consequently derived the optimum source-to-load matching conditions for rectifiers in single-diode half wave, bridged-diode full wave, double-diode double voltage, and double-diode double current operations.



Fig. 1 Wireless energy harvesting scheme, which equivalently comes down to the closed circuit shown in Fig. 2.



The formulas deduced in this work open up a clear vista for circuit designers in RF power electronics. This approach is much more elegant and insightful than exploring the solution by repeating nonlinear time-domain or harmonic-balance simulations. The theory will pave the way to wireless power transfer for running electric vehicles, air-to-air recharging for electric planes, and even underwater feed stations for motor-driven submarine vessels. Reference:

- Author: Takashi Ohira
- Title: Power efficiency and optimum load formulas on RF rectifiers featuring flow-angle equations IEICE Electronics Express, vol. 10, issue 11, pp.1-9, June 2013.
- DOI: 10.1587/elex.10.20130230 http://dx.doi.org/10.1587/elex.10.20130230
- Affiliations : Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology



Simple and basic problem that looks easy but involves the essence of RF-to-DC power conversion.

 Website : http://www.tut.ac.jp/english/ introduction/department02.html

Hard materials: Carbon nitride for tribological application

Carbon nitride is an attractive material for its expected hardness of the hypothetical compound β -C₃N₄. On the other hand, amorphous carbon nitride (CNx) exhibits a low friction coefficient under certain conditions, a property that is promising for tribological application.

However, it is difficult to deposit carbon nitride on steel substrates due to adverse effects associated with carbon/ nitrogen atom diffusion into the steel substrate at elevated temperatures during deposition.

Now, Toshiaki Yasui and colleagues at Toyohashi Tech show that thick layers of CNx can be coated onto steel substrate at elevated temperatures, and describe the mechanical characteristics of coating.

The CNx coatings were deposited on steel substrates by radio frequency plasma assisted pulsed laser deposition with substrate heating. A pulsed Nd:YAG laser (532 nm, 30 mJ) was irradiated onto high purity graphite target. RF power (13.56 MHz, 60 W) was applied to substrate to generate nitrogen plasma around it. Polished



Toshiaki Yasui

steel substrates were heated up to 673 K by a ceramic heater.

The friction coefficient of the CNx coating decreased with RF power and substrate temperature. The minimum friction coefficient of 0.072 was achieved for SUJ2 substrates by high hardness of the CNx coating.

CNx coating could find applications as tribological materials for mechanical instruments.

Reference:

- Authors: Toshiaki Yasui, Shingo Kimura, Ryutaro Nishikawa and Masahiro Fukumoto
- Title of original paper: Carbon nitride deposition onto steel substrate by radio frequency plasma assisted pulsed laser deposition with substrate heating.

- Journal, volume, pages and year: Thin Solid Films, 523, 20-24 (2012).
- Digital Object Identifier (DOI): 10.1016/j.tsf.2012.05.060
- Affiliations: Department of Mechanical Engineering, Toyohashi University of Technology.
- Website: Interface and Surface Fabrication Laboratory

http://isf.me.tut.ac.jp



Fig.1 Plasma assisted pulsed laser deposition with substrate heating.



Fig.2 Friction coefficient of CNx coating.

Club Activities The International Exchange Club "CALLing" the world

The International Exchange Club- CALLis a group of 70 Toyohashi Tech students that supports international students enrolled at the University. Some international students at Toyohashi Tech find it challenging to settling down in Japan because of the cultural differences between Japan and their home countries. CALLs main mission is to help international students overcome these problems by enhancing communication with Japanese students and staff at Toyohashi



Halloween Party at the Toyohashi Tech International House

Tech. So, CALL facilitates opportunities for communication between international and Japanese students as well as cooperating with the university staff to arrange events for international students.

CALL holds a wide range of regular activities, including weekly Japanese conversation classes, as well as monthly CALL parties. In addition to these regular events, the Club also arrange some seasonal events.

The Club's main activity is the CALL Party, where we welcome not only students at Toyohashi Tech but also foreigners living in Toyohashi. Each party has a theme, such as a Yukata Party in July, Halloween in October, and Christmas in December. On average about 30 people participate in such parties, which offer an opportunity to find new friends and help international students to get used to living in Japan.



A visit to Kao Corporation in March 2013

CALL also organizes a visit to a company for international students. Last year the club visited Kao Corporation and Meiji Co., Ltd.. The aim of these visits is to get better understanding about Japanese culture by learning more about company management policies, technology, and work environment at Japanese companies. Some international students want to work in Japan after graduating. CALL promotes its activities and events via Facebook: www.facebook.com/tutcall

A visit to Toyohashi Gion Festival

The centuries old, Gion Festival in Toyohashi is renowned for the hand held fireworks --tezutsu hanabi-produced by igniting a powder contained in large bamboo cylinders.

In fact, Toyohashi is acknowledged as the birth place of tezutsu hanabi, and the Toyohashi Gion Festival is the perfect way to see the special at first hand. The festival is held annually over the third weekend of July during which time a wide range of fireworks, including tezetsu on Friday evening, light up the skies of over the banks of the Toyokawa River that flows through Toyohashi City. Having never seen hand held fireworks we really looked forward to seeing this historical event close up. Our inquisitiveness led us to the festival slightly early, so we visited the remains of Yoshida Castle before walking across to Yoshida Shrine, the venue for the Friday-tezutsu firework display.



Two men holding tezutsu fireworks at the Toyohashi Gion Festival

The initial fireworks display was given by groups who guided bamboo cylinders that were attached onto hand driven carriages. In what seemed to be like a ritual, the flames being emitted from the bamboo cylinders exploded as a climax to the beautiful fireworks. We were particularly amazed to see how only one cylinder could produce so many different

Excursions

kinds of firework

After having some delicious rice cakes we saw the main part of the tezutsu display. We saw how brave men stabilized ignited cylinders vertically by intricate hand movements.

In India, our home country, fireworks are more common and not limited to professionals. However, they are much smaller and none are handheld which clearly explains our excitement at seeing the tezutsu fireworks.

The ambience of the festival was enhanced by the young people dressed in kimono and yukata. Seeing everybody enjoying the evening made this

our first ever Japanese festival, something that we will remember forever.

Vedant Saboo and Jaiyam Sharma Research interns from IIT Delhi, at Electronics Inspired Interdisciplinary Research Institute

Toyohashi Tech e-Newsletter Video Letter: **Through Indonesian Eyes**

This Video Letter was produced by Indonesian Students studying at Toyohashi Tech. There are currently approximately 30 students from Indonesia at Toyohashi Tech. The video shows the wide range of activities of the students including research and education, sports, and culture events. The students describe the facilities and services available for international students including free intensive Japanese course and the Halal menu at the cafeteria. Most of the Indonesian students at Toyohashi Tech are on scholarships from either the Indonesian or Japanese aovernments.

More here .. http://www.tut.ac.jp/english/newsletter/video/ index.html



Video Letter

Introduction to the Toyohashi Tech e-Newsletter

The *Toyohashi Tech e-Newsletter* is a quarterly publication with updates of news, research, and other activities at the Toyohashi University of Technology (Toyohashi Tech). This printed issue is an abridged version of the original *Toyohashi Tech e-Newsletter No. 12* that was published on-line in September 2013.

The original Toyohashi Tech e-Newsletter No. 12: http://www.tut.ac.jp/english/newsletter/

The contents of The Toyohashi Tech e-Newsletter No.13 include:

Features

• Ultrasound microscopy: An aid for surgeons to make the invisible, visible. **News**

- International Student Seminar 2013 with ITB, UTM, and HCMUT
- President Yoshiyuki Sakaki Selected as Person of Cultural Merit
- The Irago Conference 2013

Research highlights

- Nanoscale photonic integrated circuit using surface plasmon polaritons on silicon
- High pressure cold spray technology: Producing thick metallic coatings on polymer substrates
- Hard electronics: Nitride semiconductor Hall effect magnetic field sensors for extreme environments
- Hollow bioprobe: Innovative analytical tool for the life sciences and biotechnology

Club Activities

• Launch of the Toyohashi Tech astronomy club:TT3913-CosmicHunters

Excursions

• Beyond the Overseas Training Program

Video Letter

• Hear from Lao Students about Toyohashi University of Technology

Editorial Committee

Chairman: Adarsh Sandhu,

Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) Kouichi Katsurada, Center for International Relations Hiroshi Okada, Electronics Inspired Interdisciplinary Research Institute (EIIRIS) Takeshi Kawano, Department of Electrical and Electronic Information Engineering Manami Tamura, Center for International Relations Naoki Nakata, International Affairs Division Takao Yogo, International Affairs Division Shizuka Fukumura, International Affairs Division Miki Yanase, International Affairs Division

Toyohashi University of Technology

1-1 Hibarigaoka, Tempaku Toyohashi, Aichi Prefecture, 441-8580, JAPAN Inquiries: International Affairs Division E-mail: ryugaku@office.tut.ac.jp TEL: +81-532-44-6577 or +81-532-44-6546 FAX: +81-532-44-6557 Website: http://www.tut.ac.jp/english/





