



**No. 11, Jun 2013**

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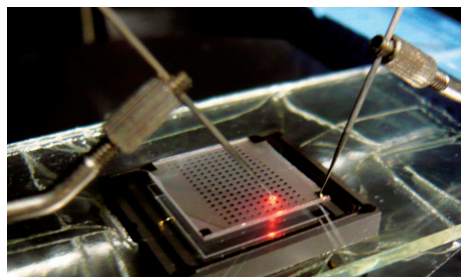
### Growing plants in factories

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## Growing plants in factories

Project Professor Masahiko Saigusa and his team of researchers at Toyohashi Tech's Research Center for Agrotechnology and Biotechnology are investigating ways of growing vegetables more efficiently using intelligent greenhouses and plant factories.

"When you grow vegetables out in a field, you are dependent on the whims of the climate," says Saigusa. "But in an intelligent greenhouse or plant factory, you control the climate by controlling crucial elements such as the quality or amount of light, temperature, humidity and nutritional availability."

Light in these facilities may be a combination of sunlight and artificial light, or completely artificial light; temperature is controlled using air conditioning; while liquid nutritional intake is carefully monitored. "This makes the environment much more stable," explains Saigusa, "and is the reason why we can enjoy fruits and vegetables like tomatoes, strawberries and leafy greens all year round that are free of or low in pesticides"

The Center is also researching how to decrease the phosphate content in soil and nitrate in plants. In field cultiva-



Project Professor Masahiko Saigusa

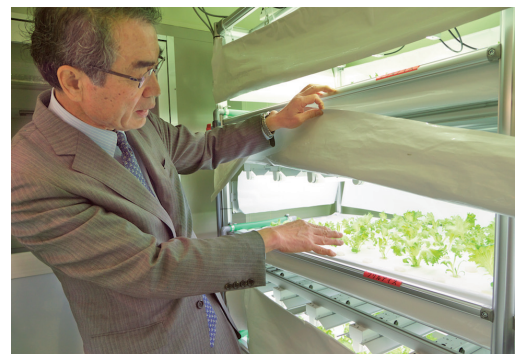
tion, to get several crop yields a year, the soil requires fertilization for each planting. This may lead to an overdose of phosphate, which can deplete the mineral content of plants such as iron and manganese, while nitrate, when over-consumed, is considered a health hazard by some countries, including the European Community. By developing new kinds of iron minerals and analyzing and changing soil content, the Toyohashi Tech researchers have been able to reduce iron deficiencies and have found ways to greatly reduce the amount of nitrate used for fertilization. Another area of research is solution culture and hydroponic farming: growing

plants using water and mineral nutrients but without soil. One Toyohashi Tech intelligent green house contains rows of tomato vines fed with liquid fertilizer and growing from containers of coco peat, the by-product of coconut husks that is used for bedding the vines. "The entire system is remotely controlled and managed by computer and wireless sensors," says Saigusa. "This makes it efficient and cost effective."

In addition to research, the Center has recently begun a program backed by the Japanese government for training plant factory managers. It consists of five months of classroom learning, then 12 months of e-learning and practical training. "Having the students first come together in a classroom helps create friendships and encourages the students to communicate with each other later during the e-learning period," says Saigusa. "Typically, you see around 30 percent of students graduate from this type of program, but by using our approach, we achieved a ratio of 90 percent in the first year."



Vegetables under illumination



Project Professor Masahiko Saigusa opening a light illuminated plant growth bed



## The 26th Prestige Lecture organized by President Yoshiyuki Sakaki was given Nobel Laureate Dr. Toshihide Maskawa, Director General, Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya University

On April 25, Dr. Toshihide Maskawa, the Director General of Nagoya University's Kobayashi-Maskawa Institute for the Origin of Particles and the Universe gave the first lecture for the 2013 academic year as part of the Tailor Made Baton Zone Educational Program's "Development Leader Master's Course" and the 26th lecture of the Prestige Lectures produced by President Yoshiyuki Sakaki.

This lecture on "Intellectual Curiosity as the Source of Creativity" was given to an audience of approximately 640 people, including participants from outside the university, in a dialog format between Dr. Maskawa and president Sakaki. Dr. Maskawa described what inspired him to study particle physics, memories of his graduate school years, the moment he thought of the 6-quark model that became the subject of the Nobel Prize in physics, and other topics. The two talked passionately about



Dr. Maskawa

global research and researchers, and thinking and creativity.

The dialog was fun and passionate and revolved around the following Maskawa philosophy: the fact that one will encounter the real thing for the first time in whatever one decisively jumps into that one admires, finds interesting and fun, and by taking wholehearted action on one's own accord; in regards to work, having general knowledge of its history including matters surrounding it will become an opportunity for good insight; having passionate late night debates with people on about the same level will allow one to grow significantly; that it is

good to undertake research freely without being too concerned about effectiveness because in research, there are those accomplishments that are readily useful, but also those that turn out to be useful at unexpected times and in unexpected places; it is most important to have a sense of play and have broad interest in all sorts of matters and not narrowing objectives too astutely too early.

Further, today, with all the progresses, it is possible to create new academic disciplines in science and engineering; and there is no need to haggle over which area one may be more suited in by thinking about the boundaries of the two. Instead, it is much more meaningful to engage in what one finds interesting. Further, once a scientist thinks, "that is what god decided" he/she loses. "Why does that happen" is something that has to be infinitely questioned, and at the same time, also fun. The fundamental spirit of scientists was discussed as well. With humor at times and Dr. Maskawa's very human way of telling his stories, as well as the coordination of President Sakaki, the lecture was a memorable one for the entire audience.



A large number of audience



Dr. Maskawa responding to questions

## Solving a hard problem (approximately) via nice structures of easier problem

A minimum spanning tree is the cheapest network interconnecting all the existing nodes and various algorithms for computing it can be found in standard algorithm textbooks. In the minimum Steiner tree problem, which first appeared in a letter of mathematician Gauss, the nodes to be interconnected are arbitrarily specified, and the problem becomes hard to compute.

The problem considered here is called minimum tree cover and it lies somewhere in between these two problems although it is as hard as minimum Steiner tree.

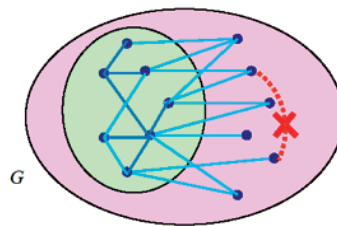
Whereas only inefficient algorithms had been known for minimum tree cover, Toshihiro Fujito at Toyohashi University of Technology came up with a new approach and a fast algorithm for solving it with better accuracy.

One natural approach first finds a set of nodes by solving a hard problem and next interconnect them by a Steiner tree. So it builds a solution by compu-



Toshihiro Fujito

tation of a hard problem on top of the other, and all the previous algorithms followed this approach. The Fujito's algorithm on the other hands does easy computation of a minimum spanning tree and converts it to a better solution



Tree cover is a tree touching every link.

by trimming unnecessary leaves in it.

The algorithm mentioned above also implies a new combinatorial result that a tree cover of good quality can always be found in the vicinity of a minimum spanning tree.

Moreover, success of the algorithm rests on basing it on interlace of two standard techniques, and such an approach should find more applications in designing algorithms for hard problems.

Reference:

Authors: Toshihiro Fujito

Title of original paper: How to trim a MST: A 2-approximation algorithm for minimum cost-tree cover  
Journal, volume, pages and year: *ACM Transactions on Algorithms* 16, No. 2, Article 16 (2012).

Digital Object Identifier (DOI): 10.1145/2151171.2151179

Affiliation(s): Department of Computer Science and Engineering, Toyohashi University of Technology.

## Fabrication of red light-emitting diodes with Eu and Mg codoped GaN active layer

Europium (Eu) doped nitride semiconductors show potential for realization of novel optical devices, such as a low threshold lasers and single photon emitters, due to their sharp line and high efficiency emission.

However, not all the Eu ions in semiconductor are incorporated in optically



Hiroto Sekiguchi

active sites that can be excited through the GaN host. Therefore, it is important to develop methods to selectively incorporate Eu ions in higher-efficiency optical sites.

Here, Hiroto Sekiguchi and colleagues at Toyohashi University of Technology and Hamamatsu Photonics Ltd have im-

proved the emission intensity from Eu ions by Mg co-doping and fabricated red LEDs with Eu and Mg doped active layer grown by ammonia source MBE. The optimal Mg co-doping selectively enhanced a specific emission site and contributed to a photoluminescence (PL) intensity increase of more than one order of magnitude. From the ratio of PL integrated intensity at 25 K to that at 300 K, the PL efficiency was determined to be as high as 77%. On the basis of these results, Eu doped GaN based LEDs were fabricated. Clear rectification characteristics with a turn-on voltage of 3.2 V were observed and a pure red emission was observed by the

naked eye at room temperature. These results suggest that Eu and Mg doped GaN is expected to be utilized for re-

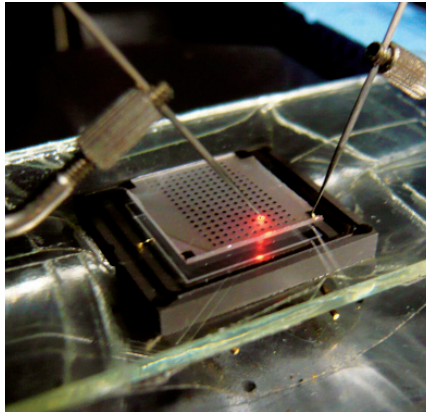


Fig. 1 Typical emission image of Eu doped GaN based LED

alizing new nitride-based light-emitting devices.

Reference:

Author: Hiroto Sekiguchi, Yasufumi Takagi, Tatsuki Otani, Ryota Matsumura, Hiroshi Okada, and Akihiro Wakahara

Title: Red-Light-Emitting Diodes with Site-Selective Eu-Doped GaN Active Layer

Journal: Jpn. J. Appl. Phys. 52 (2013)

DOI: 10.7567/JJAP.52.08JH01

Affiliation(s): Department of Electrical and Electronic Information Engineering, Toyohashi University of Technology.

## Robot Navigation: Fulfilling Tasks for Assisting Human Life

Nowadays robots are widely used to help humans to fulfill their jobs. It is common to order robots to go to a variety of places to finish the jobs while the robot examines its surrounding environment.

However, moving the robot from one place to another in an area with many obstacles and people moving around is not an easy task.

Here, Igi Ardiyanto and Jun Miura have solved these problems by introducing a novel motion planning algorithm for mobile robots called *Heuristic Arrival Time Field-biased (HeAT) Random Tree*.

HeAT Random Tree takes advantage of the high-exploration ability of the randomized tree combined with the arrival time field and heuristics. The arrival time field is used to give a bias and guide the randomized tree expansion in a favorable way. Together with heuristics, the arrival time field effectively ensures the robot to choose the path in



Jun Miura

the tree expansion with a considerable clearance with any obstacle (safety) and has an optimum cost to reach the destination, including the smoothness of the path.

HeAT Random Tree algorithm is tested in both simulations and experiments with the real robot for waypoint following and person tracking problems. The robustness of algorithm is shown by successful runs rate up to 100 % using maximum speed of 600 mm per second, within 0.5 seconds of computational time.

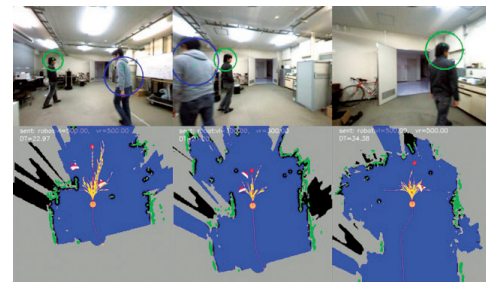
These results imply that HeAT Ran-

dom Tree can act as the robot navigation algorithm in real environments. Furthermore, several possibilities of improvements can be applied for better handling of moving obstacles such as persons, for example, by using a 3D time-space representation.

Reference:

Authors: Igi Ardiyanto and Jun Miura

Title of original paper: Real-Time Navigation using Randomized Kinodynamic Planning with Arrival Time Field.



Experiment of the real robot avoiding moving obstacles (persons): (top) detected persons in the real world, (bottom) planned path in local map scene.



Journal, volume, pages and year: *Robotics and Autonomous Systems*, Vol. 60, No. 12, pp. 1579–1591, 2012.  
 Digital Object Identifier (DOI): 10.1016/j.robot.2012.09.011

Affiliation(s): Active Intelligent Systems Laboratory (AISL), Department of Computer Science and Engineering, Toyohashi University of Technology.  
 Website: <http://www.aisl.cs.tut.ac.jp/>

## A Simple Approach to Chiral Trifluoromethyl Compounds

Organofluorine compounds have attracted significant attention in drug discovery. For instance, introduction of a trifluoromethyl group into biologically active compounds often modifies their physical and/or biological properties such as lipophilicity, metabolic stability, and bioavailability. Although the synthetic method for trifluoromethyl compounds has been progressing steadily, developing an efficient method for the construction of trifluoromethylated stereogenic center remains challenging task.

Diels–Alder reaction using trifluoromethyl olefins as the dienophile is known to be a useful method for the preparation of various trifluoromethyl compounds. However, there is no published report on the enantioselective version of this reaction; despite the fact that the reaction would efficiently provide the chiral cyclohexenes having a trifluoromethylated stereogenic center. Now, Kazutaka Shibatomi and colleagues at Toyohashi University of Technology have succeeded in the enantioselective Diels–Alder reaction of  $\beta$ -trifluoromethylacrylates to give corresponding cyclohexenes having a trifluoromethyl group at the chiral carbon center. The resulting cyclohexenes could be converted into potential synthetic intermediates for new drug candidates.



Kazutaka Shibatomi

The reaction of ethyl 4,4,4-trifluorocrotonate (1 in Fig.1) with cyclopentadiene or furan in the presence of chiral Lewis acid catalyst (2 in Fig.1), which was prepared from an oxazaborolidine and  $\text{SnCl}_4$ , successfully afforded the desired cyclohexenes (3 in Fig. 1) with excellent enantioselectivity (99% ee). A resulting adduct was further converted into ethyl 6-trifluoromethyl-shikimate by a four-step sequence, which could be a key intermediate for anti-influenza agents.

The present method provides a powerful method for the preparation of optically active trifluoromethyl compounds, which will be helpful in new drug design.

### Reference:

Kazutaka Shibatomi, Fumito Kobayashi, Akira Narayama, Ikuhide Fujisawa, and Seiji Iwasa.

A Diels–Alder approach to the enantioselective construction of fluoromethylated stereogenic carbon centers

*Chemical Communications* 48, 413–415 (2012).

DOI: 10.1039/c1cc15889a

Affiliation(s): Department of Environmental and Life Sciences, Toyohashi University of Technology.

Website: <http://www.tutms.tut.ac.jp/STAFF/SHIBATOMI/index.html.en>

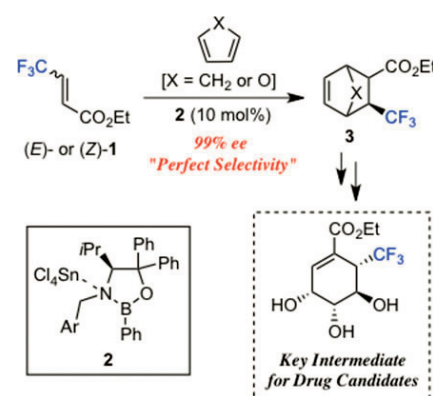


Fig.1 Enantioselective Diels–Alder Reaction of 4,4,4-Trifluorocrotonates.

## Toyohashi Tech Kyudo Club: Fun through serious practice

### Club Activities

Kyudo or 'traditional Japanese archery' is one of the many Japanese martial arts. The Toyohashi Tech Kyudo Club was established 6 years ago. The club members meet three times a week to practice at a dojo located at the Noyori Hachimansha Shrine located about 1.4 km west of the university campus.

The members of the Toyohashi Tech Kyudo Club are a friendly group of young and dynamic students. The practice sessions are fun and enjoyable, even complete beginners can learn to hit the target after a learning the basics of the art.

The Club currently has 50 members, making it the 4th largest club at Toyohashi Tech. Recently, the Club's male and female members were 4th and 1st, respectively, in a local Tokai region competition.

Further information

Website: <http://tutkyudo.web.fc2.com/index.html>

Captain: Tanago Motoaki

Vice captain: Ueno Soutarou

Accounts: Toyoda Masaki

Video production team: Sakuraba Takahiro and Watase Hidetosi



## Cherry Blossom Viewing Party and Pottery

### Excursions

Ohnmar Khaing, second year master's student, Architecture and Civil Engineering

I have been fascinated with Japan since my undergraduate days. I dreamt about going to Japan for a first-hand look at Japanese culture, and its people. Then, I realized my dreams when I was given the opportunity to study at Toyohashi Tech. Since arriving here, I feel that everything looks cute, happy and exciting, especially in the spring, during the cherry blossom (sakura) season.

On Sunday 31st March the Shinshiro Youth Association organized the 'Experience Cherry Blossom Viewing and Pottery' event for international students at Toyohashi Tech at Sakurabuchi Park in Shinshiro City. A total of nine international students participated in this event.

Two members of the Youth Association picked us up at 10:00 in the morning. We thoroughly enjoyed the activities of the days in spite of the chilly and damp weather with gloomy skies on Sunday morning.

Our group arrived at Sakurabuchi Park at 11:15 and I remember seeing the amazing sea of pink and beautiful flowers all around me. I couldn't believe my eyes because it seemed so unreal. I was amazed at beauty of the Sakura flowers. It was the first time I had ever seen so many sakura trees in full bloom. At around 11:30 we started to explore the park. It was raining but the park was full of people enjoying the day. Everybody looked so happy and fresh.

First we went to Japanese Cherry Blossom Festival vendors who were selling many different kinds of food and souvenirs, including regional delicacies. Many stalls and shops were lined up along the main pathways, which were filled with customers. For lunch, I bought fried chicken, stream fish, and local food of Shinshiro. We had a picnic under a sakura tree, which gave a good opportunity to chat about the morning's activities. Also, young members of the Shinshiro groups had brought us special home cooked meals. All the foods were so delicious and the Taranome tempura was my favorite.



Group photograph at the Sakurabuchi park. Ms. Ohnmar Khaing is on the front row, third from the left.

After lunch we visited other areas in park. Crystal clear water flowed in a stream and some people were walking across a beautiful suspension bridge that spanned the stream. Some people were

enjoying riding boats and fishing in the stream. The entire park was covered in pink sakura with a delicate fragrance. The petals were falling on the sidewalks and onto the hair of the Japanese ladies dressed in sakura patterned kimonos who were taking photographs with this dreamy beautiful background. I had never seen scenery like this before and took many beautiful photographs.

Around 14:00 we left Sakurabuchi Park and moved to a workshop for the pottery. After walking for 10 minutes, we found some small, delicate, and beautiful pottery along the bank of the stream. The Japanese pottery master explained and demonstrated in detail how

to make a cup. We created our own clay cups with unique designs and colors to glaze the cups. Now, we all possess our handmade and lovely pottery.

At 16:00 we move back to Toyohashi Tech and I thought to myself how sakura makes people and happy. I do wish to come back here every year during this season. But, I know my wish is impossible for me because I will go back to my country after my graduation. I whispered to myself, "Sayonara Sakura."

I would like to express my gratitude to the organizers, the Shinshiro Youth Association and other participants in this event for giving me the most amazing experience of my life.



Making cups at the pottery experience

## Study Tour in Kyoto

Nihad Karim Chowdhury, first year doctoral student, Computer Science and Engineering

It was March 11th Monday, a sunny bright morning. A two study trip for International Students of Toyohashi Tech to Kyoto was scheduled by the International Affairs Division. The tour was meticulously planned for the 51 participants including Toyohashi Tech staff and students. The International Affairs Division produced a pamphlet with detailed information about the tour.

Some of the students met at 7 AM at the entrance hall of the International House to complete registration for the Kyoto tour before departing for Toyohashi Station, to join another group there. The participants were divided into groups of seven to eight students including a group leader.

I was little bit crazy, and was feeling excited because this would be my first time to ride on the Shinkansen. Really, the train was awesome, as the luxurious Shinkansen accelerated to maximum speed and headed towards Kyoto.

We reached Kyoto station around 10 AM, where two tour buses were waiting for us for sightseeing. From Kyoto station we first went to Nijo Castle. The Castle was originally built in 1603 as the official Kyoto residence of the first Tokugawa Shogun Ieyasu, and it was completed in 1626 by the third shogun Iemitsu, who transferred some of the structures from Fushimi castle. It's inter-



Participants in the front of Nijo Castle



Participants in front of Kinkaku-ji Temple. Mr Nihad Karim Chowdhury is in the back row, fifth from the left.



International students making "Nama-Yatsuhashi"

nal architecture was amazing.

After our delicious lunch, we went to the Kyoto City Disaster Prevention Center. This was also an amazing experience. We frequently hear about earthquakes in Japan, but at this center we experienced an artificial earthquake. In addition to this we enjoyed a short 3D movie and experienced "firefighting training". This program was designed to help us to prepare ourselves to save lives and limit damage during an earthquake.

Next, we went to a place where we experienced "Yuzen-Zome" dyeing. All the international students experienced one type of dyeing: drawing freehand with a brush or "tegaki yuzen". Later we looked around a museum of Japanese arts and crafts, and at about 5 PM, we reached our hotel—the Gion Fukuzumi—where we had a delicious and 'artistic' dinner. The most interesting part in the dinner was meeting with "Maiko San". From this experience, I say that if

you want to comprehend Japanese culture then meet a Maiko san. Her colorful dress and activities were very impressive.

The following day, we went to the outstanding Kinkaku-ji temple. The original purpose of the building was as a residence for the retiring Shogun Ashikaga Yoshimitsu (1358–1409). The temple was rebuilt in 1955 and continues to function as a storehouse of sacred relics. After that, we visited another place to get experience about how to make "Nama-Yatsuhashi", where we got some delicious Kyoto sweets. Finally, we visited Kiyomizu-dera temple, which is one of the most famous temples in Japan. It is made entirely of wood and is situated on a hillside. We enjoyed views of Kyoto city from grounds of the temple.

Then, the tour was over and we reached Toyohashi Station at 7:30 PM. I would like to thank to Toyohashi Tech for arranging this amazing tour.

## 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. 11* that was published on-line in June 2013.

The original *Toyohashi Tech e-Newsletter No. 11*: <http://www.tut.ac.jp/english/newsletter/>

The contents of The *Toyohashi Tech e-Newsletter No.12* include:

### Features

- Investigating mercury pollution in Indonesia

### News

- Toyohashi Tech and Queens College Conclude Exchange Agreement
- Toyohashi Tech Selected for Research University Reinforcement and Promotion Project
- Symposium Commemorating Publication of *Gijutsu Wo Tsukuru—Chi No Honryu No Messe-ji*  
(Creating Technology—Message from the Main Stream of Knowledge)

- First International Exchange Day for the 2013 Academic Year

### Research highlights

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

### Club Activities

- The International Exchange Club “CALLing” the world

### Excursions

- A visit to Toyohashi Gion Festival

### Video Letter

- Toyohashi Tech eNewsletter Video Letter: Through Indonesian Eyes

### Editorial Committee

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