TUT Research
e-Newsletter from Toyohashi University of Technology

No.4 Feb. 2016

FEATURE STORY

Twenty Years of Progress with Robot Contests

Toyohashi University of Technology can take pride in its achievement at being six times winners in the NHK Robot Contests for University Students, more than any other single institution. Professor Shinichi Suzuki has been providing advice on the competition to students over a long period of 20 years, as the advisor for the Robot Contest Club.

Research Highlights

Pick Up

Twenty Years of Progress with Robot Contests

Shinichi Suzuki

Toyohashi University of Technology can take pride in its achievement at being six times winners in the NHK Robot Contests for University Students, more than any other single institution. Professor Shinichi Suzuki has been providing advice on the competition to students over a long period of 20 years, as the advisor for the Robot Contest Club. Although they could not progress beyond the best 8 last time around, their almost fully automatic badminton robot drew much attention. Professor Suzuki does not want his students to simply come out victorious in these events but aims to raise their competence level, being mindful about the advancements achieved by robot technologies.

Interview and report by *Madoka Tainaka*

Victories started as soon as he became involved

The NHK Robot Contest began in 1988 for Technical College students, and the contest for university students started in 1992. Toyohashi University of Technology has participated in the contest from the very first event, and Professor Suzuki became involved as the advisor for the Robot Contest Club at Toyohashi University of Technology just two years later, in 1994. The fact that Professor Suzuki's laboratory happened to be located next to the club activity room prompted a student club member to ask him for his participation. Professor Suzuki immediately pulled off the remarkable achievement of guiding the students to win the competition in his first year. Since then he has continued to serve in his post as advisor for over 20 years.

"The year before I joined, our club had the misfortune of having a robot that completely stopped functioning, right in front of the audience. The students were frustrated and really wanted to clinch the victory the following year. So I decided to advise them in a variety of areas, such as the direction of the project, completion of design, and so on," said Professor Suzuki, looking back on those days.

A topic is set for the Robot Contest each year, and it was "Soccer Robot" for 1994. The project involved a one-on-one duel of robots created by two teams, which competed to score goals against each other. The type of robots used at the time still had an operator riding and manipulating them.

"We created a robot that was completely different from the one we had made the previous year, by means such as adopting larger tires to make it more maneuverable. We now have in excess of 40 members in our Robot Contest Club, but back then, there were only a handful of members, and it required absolute commitment from everyone to get things done. We ended up winning the following year in 1995 as well, and that got me hooked on the robot contest." Professor Suzuki laughed a moment, before continuing with a wry smile.
"After being involved for about ten years, I thought perhaps I should resign, but we managed to come in first in 1998, 2002, 2008, and 2009. I guess I got greedy with success and before I realized it, I had been involved with this project for over 20 years."

Is it technology or strategy? The answer is in the technology

The history of the Robot Contest can be traced back to the "King of the Mountain" a contest held at the Massachusetts Institute of Technology in 1988. It was a game that involved robots starting on either side of a mountain, which had been set up indoors. Whoever stacked the biggest load on top of the mountain won. The winner of the game, however, was a robot that only managed to bring one load to the top of the mountain and spent the rest of the time interfering with other robots, by utilizing its speed. Professor Suzuki noted, "This shocking outcome spread the appeal of robot contests both in terms of technology and strategy."

In order to come out victorious in a robot contest, technology alone will not suffice. Creative and strategic thinking are also essential. A review of the participants in a competition for badminton robots in 2015 showcased an array of masterpieces conceived according to the ingenuity of the respective universities. These included one robot that held multiple rackets in its numerous hands and another given intensified agility by enhancing the maneuverability of the controller. The

international version of the competition (ABU Asia-Pacific Robot Contest), which was held in November and pitted the winning teams from various university student robot contests against each other, even featured a robot entered by a Chinese team that recognized human emotions!

Against this backdrop, the badminton robot proposed by Toyohashi University of Technology on that occasion was made with such workmanship that the team considered it their crowning masterpiece. The robot's movements were almost fully automated. The robot captured the image of a shuttle hit by the opponent with two units of high-speed cameras. It predicted and moved to the location of the shuttle drop position by solving equations comprised of Newtonian mechanics and fluid dynamics, then hit the shuttle back. While it was not capable of smashing the shuttle, it certainly had the accuracy to rally against a human opponent, and made for an enjoyably challenging opponent.

"The point in this instance was that the two robots had to operate in harmony, without obstructing the opponent. The movements of our robot were positively evaluated at the award ceremony. The robot was praised for the way it moved, as if it were dancing. I was quite thrilled about that," said Professor Suzuki.

Although the robot did not progress beyond the best eight in the competition, due in part to bugs in the programming, it was nevertheless conferred the Design Award and Special Award. The badminton robot created by Toyohashi University of Technology was selected, together with the robot that won the contest, to be exhibited at the networking event of participants held after the contest. People crowded around our robot to catch a glimpse of it for themselves.

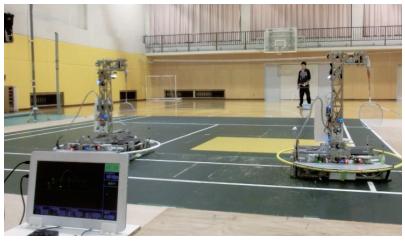
Demonstration at an International Conference

"I was consulted by the students at the very beginning, on whether or not to make the operation of the robot autonomous or manually controlled. I advised them that they should definitely aim for autonomous. The level of competition at these international contests has been increasing in recent years, and I felt that we should not only aim to win but also consider how we should win. I would like to see us competing with fully automatic and autonomous robots in the future. That, I believe, would raise the foundation of robot technology in Japan as a whole, and such is the responsibility vested in us as a prestigious institution that participates in robot contests. Even if we fail to win, the technology will remain with us for the next year. Strategy, on the other hand, is useful only until it is revealed. It is not like that with technology: even when your opponents find out how you did what you have done, it still is not that easy for them to replicate that technology."

It is not only about craftsmanship, as theory is also essential

Professor Suzuki's specialization is fracture mechanics. His work pertains to building theories, particularly regarding high-speed fracture phenomena. Unlike robots, this may appear to be a somewhat humble fundamental study, but it is an extremely important field that is concerned with guaranteeing the security of social infrastructure, such as bridges, tunnels, and huge airplanes.

"I believe it is extremely important to create technologies that are based on science. Students who participate in the robot contests often display an outstanding ability to create by observing and mimicking, and then using their own hands. As a matter of fact, they are often recruited by companies. You see, while many students coming out of universities these days have never done work such as soldering, the students who participate in the robot contests can be hired with peace of mind in this respect. There are, of course, those who find it difficult to back up their efforts with theoretical evidence. It is not possible to hope for any dramatic leaps in technology if one neglects theories. In the end, theory and application, as well as practical implementation, are all very important."



TUT Robot team vs. human

In addition to hardware, the emphasis on development is about to shift to software, as is the case in the industry as a whole. Theory will be essential when this happens. Moreover, the robot context topic for next year is "Clean Energy Recharging the World." It is a difficult topic that has to do with manipulating eco-robots, which are hybrid robots, under very limiting conditions. Professor Suzuki told us of his aspiration to use these robot contests to nurture students in areas that do not merely require them to work with their hands, but equally involve aspects such as academic elements and structural programming of software.

Reporter's Note

Professor Suzuki's original specialization was aerodynamics in the field of aerospace engineering. He witnessed man's first lunar landing by the Apollo Project on television when he was still in high school. This inspired his yearning for flight rockets.

"In order to make an aircraft fly, a number of academic fields other than aerodynamics are in fact required, such as structural theories and flight dynamics. Similarly, robotics can be considered an integrated engineering discipline that consolidates a variety of academic fields, such as mechanical engineering, electrical engineering, computer science, and the like. This may be the reason I was not uncomfortable with the prospect of becoming the advisor, even though the field is outside my specialization," Professor Suzuki told me.

He said that he would like to write articles in the field of robotics, such as on collaborative work performed by robots, at some point in the future. His passion as the advisor for the Robot Contest Club is not declining; rather, Professor Suzuki appears to be heading toward new ground in his pursuit of further robot evolution.

ロボットコンテストと歩んできた20年

豊橋技術科学大学は、NHK大学ロボットコンテストにおいて、過去に全学最多となる6回の優勝を誇る名門である。そのロボコン出場ロボットを制作する部活動「ロボコン同好会」の顧問として、20年の長きにわたり学生に助言してきたのが、鈴木新一教授だ。2015年は惜しくもベスト8にとどまったが、ほぼ全自動のバドミントン・ロボットは大いに注目を集めた。鈴木教授は、ただ勝負に勝つだけでなく、ロボット技術の発展を見据えてさらなる高みを目指している。

就任直後から、優勝に貢献

1988年からスタートしたNHK高専ロボットコンテストに引き続き、大学ロボットコンテストが始まったのは92年のこと。初回から参加していた豊橋技科大のロボコン同好会の顧問として鈴木教授が就任したのは、2年後の94年である。たまたま鈴木教授の研究室が部室のすぐ側にあり、部員の学生に頼まれたのがきっかけだった。するとその年、いきなり優勝の快挙を成し遂げる。以来、20年余りにわたり顧問を続けてきた。

「じつは前年の93年、観客の前でロボットがまったく動かないというアクシデントに見舞われたんですね。学生たちが悔しがって、来年は絶対に優勝したいと。そこで、方向性や最後の仕上げなどで、いろいろとアドバイスをしたのです」と鈴木教授は当時を振り返る。

ロボコンでは毎年、テーマが設定されるが、94年はサッカー・ロボットだった。1対1で相手チームのゴールを狙うというもの。当時はまだ、本体の上に人が乗って操縦するタイプのロボットだった。

「タイヤを大きくして動きやすくするなど、前年とはまったく違うロボットをつくりあげました。現在でこそ、ロボコン同好会は40名を越える大所帯ですが、当時は中心メンバーが数名ほどで、全員必死でした。結局、翌95年も優勝し、私自身もロボコンから足を洗えなくなってしまった（笑）。10年くらい経った頃、そろそろ顧問を辞めようと思ったのですが、その後も98年、2002年、08年、09年と優勝を果たし、欲が出て、気がついたら20年も経っていたという感じです」と鈴木教授は笑う。

技術か戦略か、その答えは技術にあり

ロボコンの歴史は、1988年に開催されたマサチューセッツ工科大学の“King of the Mountain”に遡ると言われる。これは、室内につくられた山の両側から2台のロボットが山頂を目指し、『山頂に多くの荷物を積み上げた方が勝ち』というゲームである。ところが、勝ったのはたった一つの荷物しか山頂に運ばず、後はスピードを生かして、ひたすら相手ロボットの邪魔をするというロボットだった。

「この衝撃の結末は、ロボコンにおける技術と戦略の両面の面白さを知らしめることになりました」と鈴木教授。

確かに、ロボコンに勝つためには、技術力だけでなく、アイディアと戦略が不可欠である。実際に、2015年のバドミントン・ロボットを見てみると、千手観音さながらラケットを何本も携えたロボットや、コントローラーの操作性を高めて動きを俊敏にしたロボットなど、各大学が知恵を絞った作品が並ぶ。大学ロボコンの優勝チームが参加できる11月の世界大会（ABUアジア・太平洋ロボットコンテスト）では、人の感情を認識するロボット（中国チーム）まで登場した。

そうした中、今回の豊橋技科大が提案したロボットは、鈴木教授が最高傑作と自負するほどの出来映えだった。ほぼ全自動で動き、相手が打ったシャトルを2台の高速度カメラで捉え、ロボットはシャトルの落下位置をニュートン力学と流体力学の方程式を解くことで予測し、移動して、打ち返す。スマッシュこそできないが、人を相手にラリーができる精度を誇り、見ていると思わず一緒にプレーしてみたくなる。「さらにポイントは、2台のロボットが、それぞれ相手の邪魔をしないように協調して動くことにあります。授賞式で、その動きがまるでダンスを踊っているようだと評されて、とても嬉しかったですね」

本番ではプログラミングのバグなどが原因でベスト8にとどまったが、デザイン賞と特別賞を受賞。大会終了後、出場者が集う交流会では、優勝ロボットと並んで、豊橋技科大のバドミントン・ロボットが展示作品として選ばれた。しかも、そのロボットを一目見ようと、まわりに人だかりができたという。

「じつは、最初に学生から自動にするか手動にするか、相談を受けたのです。でも、絶対に自動にすべきだと助言しました。近年、国際大会のレベルは非常に高くなってきていますし、ただ勝つだけではなく、勝ち方というのがあるだろうと。今後はやはり全自動の自律ロボットで勝負していきたい。それこそが、日本のロボット技術全体の底上げにもつながるし、ロボコンの名門としての責務だと感じています。そもそも、たとえ勝てなかったとしても技術は翌年に残りますが、戦略は負けてしまえばそれきりです。技術は手のうちがわかったとしても、そうそう真似できませんからね」

モノづくりだけでなく、理論も必要

鈴木教授自身の専門は材料の破壊である。とくに高速な破壊に関する理論構築を手掛ける。ロボットと違って、一見、地味な基礎研究に思えるが、橋やトンネル、ビルといった社会インフラの強度の保証に関わる、非常に重要な分野だ。

「やはりサイエンスをベースにして技術を生み出すことは非常に重要だと感じています。ロボコンの学生は実際に手を動かして、見よう見まねでモノをつくりあげていく能力には長けていますし、実際、企業からの就職の引き合いも多い。最近は、はんだ付けすらしたことがない学生が多い中、ロボコンの学生なら安心して現場に出せるというわけです。一方、理論的な裏付けをするのは苦手な人がいるのも事実。しかし、理論をおざなりにして、技術の飛躍的な発展は望めません。やはり、理論と応用・実践はどちらも大切なんですね」

現在、産業界全体がそうであるように、ハードに加え、ソフト開発に軸足が移りつつある。その際にも、理論は不可欠だろう。ましてや、来年のテーマは「Clean Energy Recharging the World」。限られた条件の中でエコロボットをハイブリッドロボットによって動かすという難解な課題だ。これからは、学問的要素やソフトの構造的なプログラミングなど、単に手を動かすだけはない領域についても、ロボコンを通して養っていきたいと、鈴木教授は抱負を語った。

取材・文＝田井中麻都佳

取材後記

鈴木教授のもともとの専門は、宇宙航空分野の空気力学である。高校生のとき、アポロ計画で人類が初めて月面に着陸したのをテレビで見て、飛行ロケットに憧れた。

「飛行機を飛ばすには、空気力学のほか、構造理論や飛行力学など、いくつもの学問分野が必要です。そういう意味では、ロボットも機械工学、電気工学、コンピュータサイエンスなど、さまざまな学問分野が統合された総合工学と言えます。だから最初、顧問になる際に、専門外でもさほど違和感がなかったのかもしれませんね」と鈴木教授。

いずれは、ロボット同士の協調作業など、ロボット分野の論文も書いてみたいという。ロボコン同好会の顧問としての情熱は衰えるどころか、さらなる進化を目指して、新たな境地へと向かおうとしている。

Researcher Profile

Dr. Shinichi Suzuki studied aerospace engineering until Masters level at Tokai University, and received his PhD. degree in 1980 from the University of Tokyo. He was also a visiting researcher at the Graduate Aeronautical Laboratory at CALTEC supported by MEXT (Ministry of Education, Culture, Sports, Science and Technology) from 1998 to 1999. Currently, Dr. Suzuki is a professor in the Institute of Liberal Arts and Science and the Department of Mechanical Engineering at Toyohashi University of Technology. His research interests are Aeronautics and Astronautics, High-Speed Mechanics and Optical Measurement.

Reporter Profile

Madoka Tainaka is a freelance editor, writer and interpreter. She graduated in Law from Chuo University, Japan. She served as a chief editor of “Nature Interface” magazine, a committee for the promotion of Information and Science Technology at MEXT (Ministry of Education, Culture, Sports, Science and Technology).

Subliminal effect of facial color on fearful faces

Facial color affects N170 stage of subliminal processing of facial expression

By Tetsuto Minami

Tetsuto Minami and his colleagues have found that facial color affects the early stage of subliminal processing of facial expressions using ERPs. This provided the first neurophysiological evidence of the effects of facial color on the perception of emotional expressions. This finding may contribute to promoting emotional interaction using avatars in the world of virtual reality.

Facial color is suggestive of emotional states, as in the phrases: “flushed with anger” and “pale with fear.” Although some behavioral studies have investigated the effects of facial color on expression, there was limited neurophysiological evidence showing the effects of facial color on the perception of emotional expressions.

Now, Tetsuto Minami and his colleagues at TUT’s Electronics-Inspired Interdisciplinary Research Institute (EIIRIS), have demonstrated that facial color affects the early stage of subliminal processing of facial expressions using ERPs, which provided the first neurophysiological evidence of the effects of facial color on the perception of emotional expressions. The researchers measured the brain activity from 15 participants during a facial emotion identification task of (1) neutral expressions of natural facial color, (2) fearful expressions of natural facial color, (3) neutral expressions of bluish facial color, and (4) fearful expressions of bluish facial color both in supraliminal and subliminal conditions.

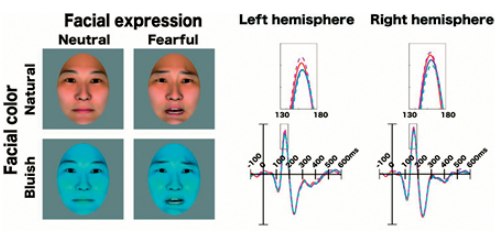
”We have found that the bluish-colored faces increased the N170 latency effect of facial expressions compared to the natural-colored faces, indicating that the bluish color modulated the processing of fearful expressions in the subliminal condition” explains Associate Professor Tetsuto Minami.

The first author Kae Nakajima said “We have been interested in the subliminal effect of facial color since we found the supraliminal effect of facial color using ERPs and fMRI.”

As a result, the study has provided new electrophysiological evidence that facial color affects the subliminal processing of fearful expressions. The results showed that the effect of facial color on expression processing was significant in terms of the latency of the N170 only in the subliminal condition, which suggests that facial color has more of an effect on the early stages of expression processing than on the later processing stages.

This finding may contribute to promoting emotional interaction using avatars in the world of virtual reality. The researchers themselves plan to extend their research by making further studies using the natural change of facial color on the perception of facial expressions.

This study was supported by Grants-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (grant number 22300076), the Global COE Program “Frontiers of Intelligent Sensing” from the Ministry of Education, Culture, Sports, Science, and Technology, and the SCOPE from the Ministry of Internal Affairs and Communications, Japan.



Examples of the target face images and results of the ERPs in the subliminal condition

Reference

Kae Nakajima, Tetsuto Minami, and Shigeki Nakauchi (2015). Effects of facial color on the subliminal processing of fearful faces, Neuroscience. 310, 472-485. 10.1016/j.neuroscience.2015.09.059

Humans can empathize with robots

Neurophysiological evidence for human empathy toward robots in perceived pain

By Michiteru Kitazaki

Michiteru Kitazaki and his colleagues in co-operation with researchers at Kyoto University have presented the first neurophysiological evidence of humans' ability to empathize with a robot in perceived pain. Event-related brain potentials in human observers, reflecting empathy with humanoid robots in perceived pain, were similar to those for other humans in pain, except at the beginning of the top-down process of empathy. This difference may be caused by humans' inability to adopt a robot's perspective.

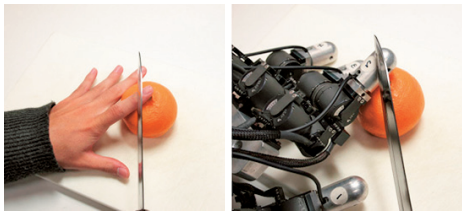
Empathy is a basic human ability. We often feel empathy toward and console others in distress. Is it possible for us to emphasize with humanoid robots? Since robots are becoming increasingly popular and common in our daily lives, it is necessary to understand our interaction with robots in social situations.

However, it is not clear how the human brain responds to robots in empathic situations.

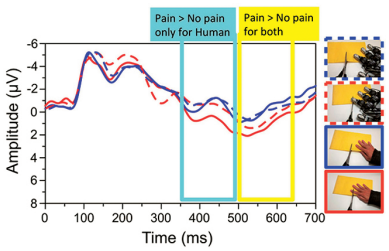
Now, researchers at the Department of Information Science and Engineering, Toyohashi University of Technology, in collaboration with researchers at the Department of Psychology, Kyoto University have found the first neurophysiological evidence of humans' ability to empathize with robots in perceived pain and highlighted the difference in human empathy toward other humans and robots.

They performed electroencephalography (EEG) in 15 healthy adults who were observing pictures of either a human or robotic hand in painful or non-painful situations, such as a finger being cut by a knife. Event-related brain potentials for empathy toward humanoid robots in perceived pain were similar to those for empathy toward humans in pain. However, the beginning of the top-down process of empathy was weaker in empathy toward robots than toward humans.

"The ascending phase of P3 (350–500 ms after the stimulus presentation) showed a positive shift in the observer for a human in pain in comparison with the no-pain condition, but not for a robot in perceived pain. Subsequently, the difference between empathy toward humans and robots disappeared in the descending phase of P3 (500–650 ms)", explains Associate Professor Michiteru Kitazaki, "The positive shift of P3 is considered as reflecting the top-down process of empathy. Its beginning phase seems related to the process of perspective taking, as was shown in a previous study."



Examples of pictures of humans and robots in pain



Averaged ERP at Fz (frontal region) for pain and non-pain stimuli

These results suggest that we empathize with humanoid robots in a similar fashion to the way we do with other humans. However, the beginning of the top-down process of empathy is weaker for empathy toward robots than toward humans. This may be a result of human inability to adopt a robot's perspective.

It is reasonable that we cannot take the perspective of robots because their body and mind (if it exists) are very different from ours. The researchers are experimenting with manipulating humans' adopting of a robot's perspective in a follow up study. This study will contribute to the development of human-friendly robots we can feel sympathy for and be more comfortable with.

This study was supported by a Grant-in-Aid for Scientific Research (A) #25245067, #25240020, and #26240043 by JSPS, MEXT, Japan.

Reference

Yutaka Suzuki, Lisa Galli, Ayaka Ikeda, Shoji Itakura and Michiteru Kitazaki (2015). Measuring empathy for human and robot hand pain using electroencephalography. Scientific Reports, 5:15924; doi: 10.1038/srep15924

Non-destructive sensing of fish freshness

Is there any reliable way to know whether frozen fish is fresh or not?

By Gamal ElMasry

Gamal ElMasry and his colleagues, in cooperation with Tokyo University of Marine Science and Technology and the National Food Research Institute have demonstrated that the autofluorescence spectroscopy associated with statistical multivariate modeling has a high potential in non-invasive sensing of fish freshness in the frozen state. This work is the first in a series of research endeavours to establish an intelligent system for objective estimation of various properties of frozen food.

From left: Gamal ElMasry, Shigeki Nakauchi, and a student

In Japan, freshness is the fundamental and crucial determinant of acceptability and pricing on the market because the valuable and prime fresh fish product is typically suitable to be eaten raw in the form of 'Sashimi' and 'Sushi'. Unfortunately, the critical estimation of the freshness of frozen seafood products is extremely hard to achieve. Thus, determining the initial freshness of fishery products before they are frozen is a big challenge.

The ordinary way to determine fish freshness is by calculating K-values based on chemical assays of nucleotides compounds, however, this method is very time-consuming. Professor Emiko Okazaki stated that "we need couple of hours of intensive works to identify whether a fish sample was fresh before being frozen or not". "It would be of great interest to find an alternative tool to shorten this very prolonged time of analysis.Therefore, the development of a smart, rapid and reliable method is urgently needed in research and industry", she added.

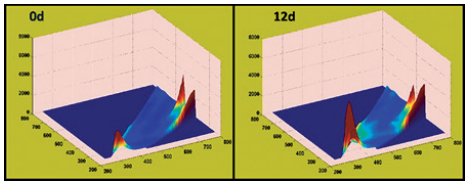


Figure 1. Difference in fluorescence signals with changing freshness conditions of frozen fish

The first author Dr. Gamal ElMasry, a JSPS fellow from Egypt said "As the fluorescence signals from the frozen fish we examined changed dramatically with their initial freshness conditions (Figure 1), autofluorescence spectroscopy as an interesting sensor technology characterized by high sensitivity and accuracy makes this method a substantial and promising tool in the screening of fishery products, even in their frozen state. In other words, changes occurred in the fluorescent-emitting molecules during the degradation of aged fish before the freezing process could be tracked using its fluorescence signals"

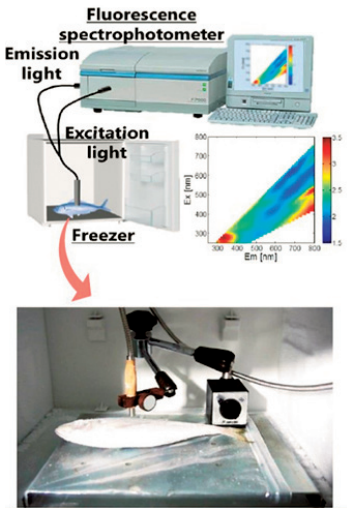


Figure 2. Measurement of excitation-emission matrices (EEMS) of frozen fish

Currently, this research team is working on the first step of developing such a system by analyzing excitation-emission matrices (EEMS) of frozen fish of different freshness conditions and measuring their reference freshness values by high-pressure liquid chromatography (HPLC).

"We have found that there are some specific excitation wavelengths at which the detection of the freshness of frozen fish could be easily recognized. The problem is to identify the most efficient emission wavelengths to move the application forward towards the real-time mode for on-line applications", explains Professor Shigeki Nakauchi.

This study was supported by the Japan Society for the Promotion of Science (JSPS).

References

Gamal ElMasry and Shigeki Nakauchi (2015). Prediction of meat spectral patterns based on optical properties and concentrations of the major constituents, Food Science & Nutrition. doi: 10.1002/fsn3.286

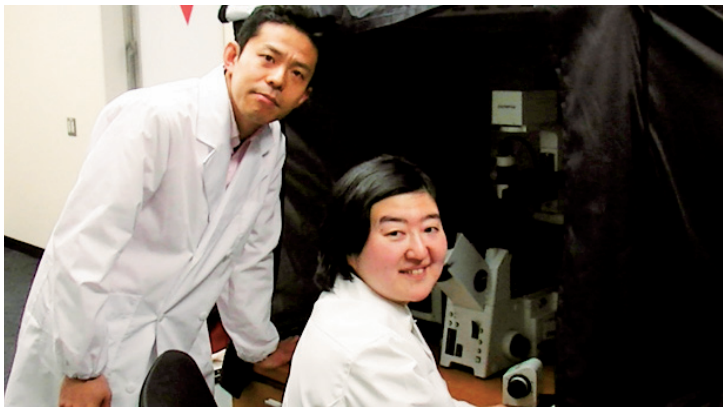
Gamal ElMasry, Hiroto Nagai, Keisuke Moria, Naho Nakazawa, Mizuki Tsuta, Junichi Sugiyama, Emiko Okazaki, and Shigeki Nakauchi (2015). Freshness Estimation of Intact Frozen Fish Using Fluorescence Spectroscopy and Chemometrics of Excitation-Emission Matrix. Talanta 143, 145-156.

Innovative method for delivering genes into cells

Electroporation of cells using electrostatic manipulation in a water-in-oil droplet

By Rika Numano

Rika Numano and her colleagues developed a novel transfection method using water-in-oil droplet electroporation: a liquid droplet with exogenous DNA and cells that is suspended between electrodes in dielectric oil is exposed to a DC electric field. This method enables high-throughput screening and may contribute to the development of cell transfection in regenerative medicine and gene therapy.



From left: Hirofumi Kurita and Rika Numano

Living cells express genes involved in physiological functions like development and metabolism via complex mechanisms. The cell membrane protects the genome from various exogenous molecules. Cell transfection is a fundamental technique that is used to deliver molecules, such as nucleic acids, proteins, and drugs, into living cells. The technique has been implicated in the development of a broad spectrum of life science applications.

Electroporation is a popular technique for the delivery of cell-impermeable molecules into cells through transient pores in the cell membrane, which are formed by exposing cells to electric pulses. However, most commercial electroporation-based transfection methods require the use of specialized pulse generators to produce short electrical pulses at high voltage.

Now, Rika Numano and her colleagues at the Department of Environmental and Life Sciences and the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) of Toyohashi University of Technology, have developed a novel gene-transfection method: water-in-oil (W/O) droplet electroporation with sufficient transfection efficiency and cell viability. In this method, when a liquid droplet suspended between a pair of electrodes in dielectric oil is exposed to a direct current (DC) electric field, the droplet moves between the pair of electrodes periodically and deforms under the intense DC electric field (Figure. 1).

"Water-in-oil droplet electroporation is operated using a DC power supply, which obviates the need for an expensive pulse generator. In addition, the size of the droplet is quite small compared with that in conventional bulk electroporation, resulting in the use of fewer materials in high-throughput analysis", explained Assistant Professor Hirofumi Kurita and Professor Akio Mizuno.

"The water-in-oil droplet electroporation technique has several advantages over conventional transfection techniques: the small cell number required, as low as 1000 cells; the small amount of DNA required, which makes it applicable for various cell types including neural cells; and the changeable genome DNA. There have been improvements in W/O-droplet electroporation electrodes for use in disposable 96-well plates for concurrent performance (Fig. 2). This technique can contribute to further biomedical innovation in high-throughput screening with a large number of samples for applications in regenerative medicine and gene therapy", explains Rika Numano.

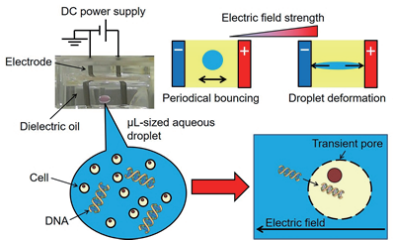


Figure 1. Behavior of a water-in-oil (W/O) droplet in an electrostatic field, and scheme of W/O droplet electroporation

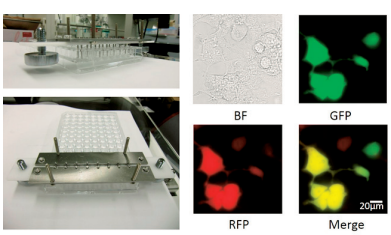


Figure 2. Image of the parallel W/O droplet electroporation electrode for the 8-well string of disposable 96-well plates and cells transfected with fluorescent protein plasmid by W/O droplett

This study was supported by

- MEXT/JSPS KAKENHI Grant Numbers 4590350, 24108005, 24760648, 26390096
- MEXT Supporting Activities for Female Researchers (partnership category)
- TAKEDA Scientific Foundation, TATEMATSU Foundation, Napa Gene Col, Ltd.

Reference

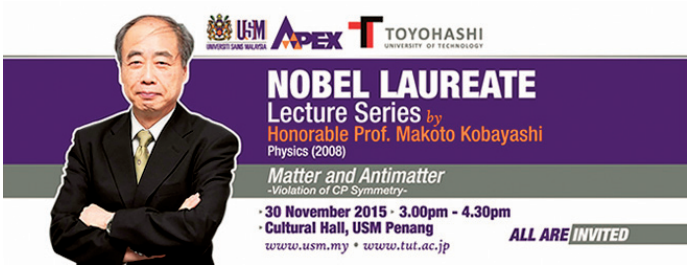
Hirofumi Kurita, Shota Takahashi, Atsushi Asada, Minako Matsuo, Kenta Kishikawa, Akira Mizuno, and Rika Numano (2015). Novel Parallelized Electroporation by Electrostatic Manipulation of a Water-in-oil Droplet as a Microreactor: PLOS ONE: 10.1371/journal.pone.0144254

Pick Up

Invited Nobel Prize winner Prof. Makoto Kobayashi to Penang Malaysia

On 30 November 2015, Toyohashi University of Technology (TUT) and Universiti Sains Malaysia (USM) invited Professor Makoto Kobayashi, the Nobel Prize winner in Physics 2008, to give a special lecture session entitled “Matter and Antimatter - Violation of CP Symmetry” at USM. The audience of around 300 people, including USM students, faculty members and Japanese residents of Penang, were delighted by this opportunity to learn about the extraordinary recent discoveries in the area of particle physics.

The next day, Prof. Kobayashi held a lively interactive session on physics research with USM students as well as visiting the Penang Japanese School for a talk with young Japanese students. He was also invited to MORIS (Magnetics and Optics Research International Symposium) 2015 held at the TUT overseas education base in Penang. The researchers who participated in the conference made the most of the precious opportunity to engage in lively discussions with the Nobel Laureate Professor.



Lecture at USM

Visiting Japanese school

MORIS conference at TUT overseas education base in Penang

Accelerating faculty development for the globalization of higher education

TUT has been promoting the development of faculty resources who can respond to and lead the globalization of higher education. Since 2014, TUT has created and managed a joint Faculty Development (FD) program for TUT, Nagaoka University of Technology (NUT) and the National Institute of Technology (KOSEN). The aim of the program is to develop the teaching in English capability of the faculty members of these institutions. It also provides them with the opportunity to cultivate research and education with a global perspective.

This is a full one-year program and it consists of (1) 3-months pre-study at TUT Toyohashi campus, (2) a 6-month program at Queens College of the City University of New York (QC) and (3) a 3-month post-program at TUT's overseas education base in Penang Malaysia.

The 2015 program dispatched a total of 10 faculty members from KOSEN and TUT, who successfully completed the QC program on December 18th 2015. The program at QC includes intensive English learning, taking regular QC graduate lectures and workshops with QC faculty members to establish potential research collaborations.

The eight KOSEN faculty members from this group have already begun the final stage of the program in Penang, Malaysia.Since early January, the group have been practicing the skills they honed at QC – teaching their specialist area in English - by giving lectures in English at USM, PSP (Seberang Perai Polytechnic) and other institutions.They also presented their research at the IGNITE (International Global Network for Innovative Technology) conference hosted by TUT at Penang in January 2016.

This Global FD program will enter its third year in April 2016, thereby continuing to strengthen the efforts to globalize the educational systems of TUT, NUT and KOSEN.

2015 QC Program graduation ceremony

QC campus

Lecure in a class

After-school study with class mates

Exploring Japanese culture through study trip to Kyoto

A study trip for international students has been held every year since 1995. The purpose of this study trip was to experience Japanese culture by visiting Japanese educational facilities and world cultural heritage sites.

This year, 36 international students attended this trip to Kyoto on 21 - 22 December 2015. They enjoyed visiting Kiyomizu-dera and Kinkaku-ji, and cultural experiences such as making Yatsuhashi and Yuzenzome, as well as learning about Japanese disaster-prevention technology at the Kyoto City Disaster Prevention Center. Kyoto is internationally famous as a Japanese city which still preserves historic landscapes. The international students were deeply impressed by such uniquely Japanese cultural aspects as “Omotenashi” and the traditional dishes served in the Japanese style hotel, or “Ryokan.”

After this trip, one international student summed up their impression as follows: “This trip was a good chance to experience Japanese culture. Thanks to this, I realized that I would like to see more Japanese cities.”

Editorial Committee

The Toyohashi University of Technology (TUT) is one of Japan’s most innovative and dynamic science and technology based academic institutes. TUT Research is published to update readers on research at the university.

Editorial committee
Takaaki Takashima, Chief Editor, International Cooperation Center for Engineering Education Development (ICCEED)
Kunihiko Hara, Research Administration Center (RAC)
Michiteru Kitazaki, Department of Computer Science and Engineering
Eugene Ryan, Center for International Relations (CIR)
Yuko Ito, Research Administration Center (RAC)
Shizuka Fukumura, International Affairs Division
Tomoko Kawai, International Affairs Division

Toyohashi University of Technology

1-1 Hibarigaoka, Tempaku, Toyohashi, Aichi, 441-8580, JAPAN
Inquiries: Committee for Public Relations
E-mail: press@office.tut.ac.jp
Website: http://www.tut.ac.jp/english/

TUT Research

e-Newsletter from Toyohashi University of Technology

http://www.tut.ac.jp/english/newsletter/