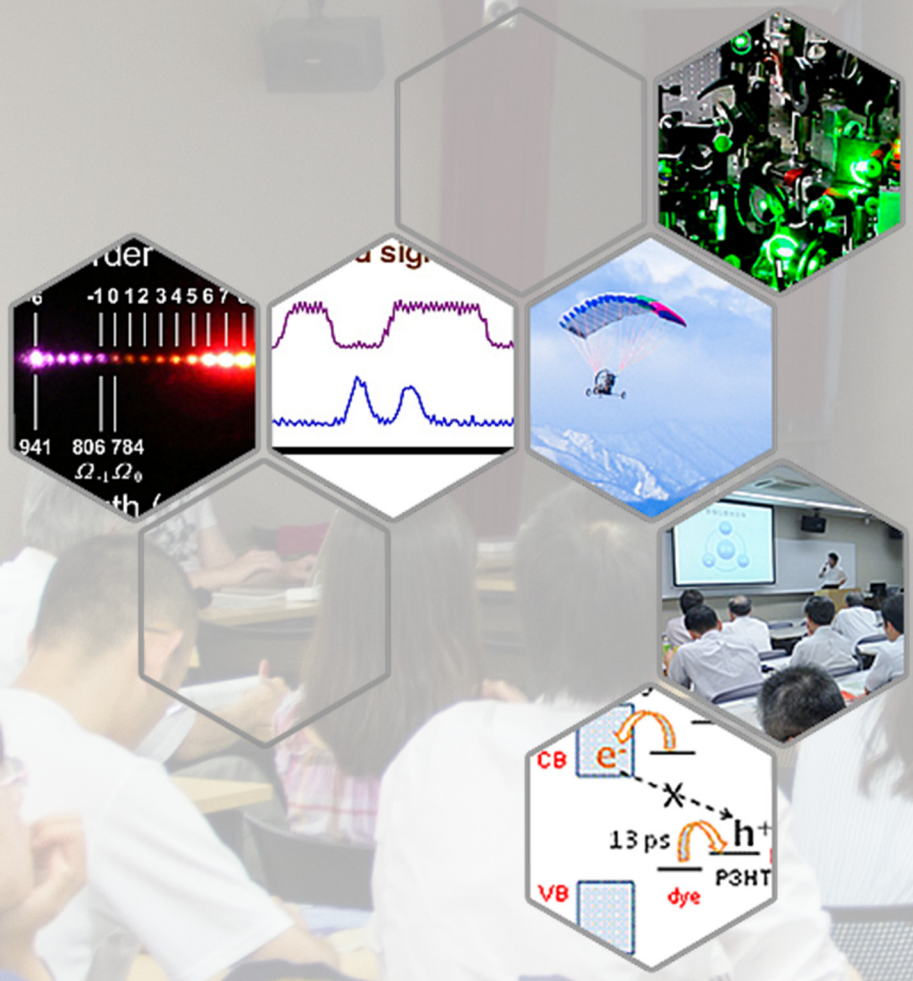
The University of Electro-Communications

UEC e-Bulletin

Updates on research, innovation, and events at UEC:
Unique and Exciting Campus in Tokyo

Vol.2, June 2014



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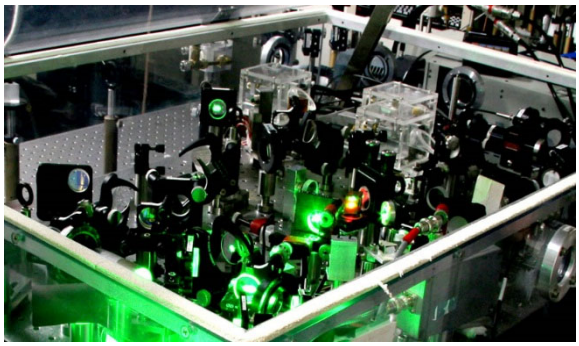
Ultrashort pulses of light produced by Raman scattering from hydrogen for next generation laser optical communications

Professor
Masayuki Katsuragawa

Recent advances in the performance of powerful lasers, optical fibers, and peripheral technology have played a pivotal role in the proliferation of global telecommunications based on the transmission of 10 GHz pulses of light. Notably, the three most important properties of lasers for telecommunications are high power, single frequency, and ultra-short pulse width. But what innovations lie ahead? The answer to this question can be found in the research being conducted by Professor Masayuki Katsuragawa, at the Department of Applied Physics and Chemistry, UEC.

"My research is focused on the manipulation of light-matter interaction for producing ultra-short pulses of laser light," says Katsuragawa. "Our recent experiments on adiabatic stimulated Raman scattering in parahydrogen show potential for the realization of laser light sources producing pulses at terahertz repetition-rate frequencies. These ultra-short pulses offer a new 'axis' in the evolution of laser based optical science."



Here, the new 'axis' refers to ultrahigh-repetition-rate trains of monocycle pulses with precise control of the phase of the laser light pulses. Recently, Katsuragawa and his colleagues have reported on the realization of ultrashort pulse trains of 1.8 femto seconds (fs) in duration and repetition frequency of 125 terahertz (THz) by stimulated Raman scattering (SRSs) produced in parahydrogen. "The critical point in these experiments was driving Raman coherence adiabatically, that is, without dissipation," explains Katsuragawa. "We achieved this by developing an injection-locked laser capable of emitting arbitrary pairs of two friequencies to irradiate the hydrogen gas, in order to control two photon detuning from the Raman resonance."

Recently, the UEC team has produced higher order series of stimulated Raman scattering using two driving lasers by the introduction of a second harmonic in one of the lasers. The resulting emission referred to as a 'Raman comb', covered an octave spectrum range from the infrared to the ultraviolet.

"I am confident that our research has laid the foundations for the development of practical systems for the generation of trains of monocycle pulses with total control of the phase," says Katsuragawa.

Further information
Masayuki Katsuragawa website: http://www.mklab.es.uec.ac.jp/index_e.html

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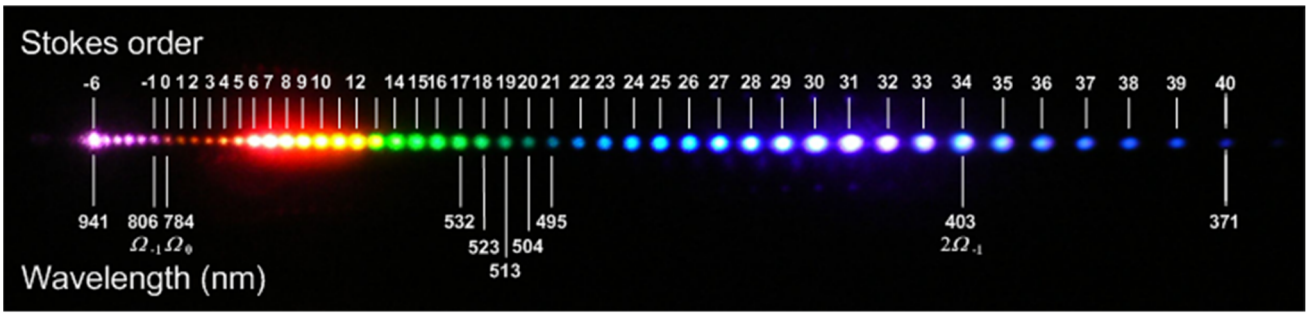

"Raman comb" generated by modulating single-frequency laser radiation with coherent molecular oscillations.

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Tokyo Wireless Technology Summit 2014

Speakers and symposium committee members

The international symposium on fifth generation (5G) cellular communications systems—Tokyo Wireless Technology Summit 2014—was held by the Advanced Wireless Communications Research Center (AWCC) in collaboration with the Global Information and Telecommunications Institute (GITI) of Waseda University, at the Masaru Ibuka Auditorium at Waseda University, Tokyo, on 7 March 2014. Beyond our expectation, more than 200 people from industry and academia participated in the symposium and thoroughly enjoyed the talks by the talented speakers.


Audience enjoyed quite inspiring talks from distinguished professors

The main theme of this symposium was to envision the future of wireless technologies with potential services and markets through inspiring talks and fruitful discussions. The symposium was also intended to reveal technical issues and key enablers of 5G systems.

The six speakers invited to share their perspectives on these issues were: Fumiyuki Adachi (Tohoku University, Japan); Elvino Sousa (University of Toronto, Canada); Rahim Tafazolli(University of Surrey, U.K.); Dipankar Raychaudhuri (Rutgers University, U.S.A); Rudy Lauwereins (IMEC, Belgium); and Zhisheng Niu (Tsinghua University, China).

The speakers gave talks from not only theoretical but also practical points of view including a heterogeneous system design with macro- and micro-cells to boost the system capacity; difficulties of microwave circuit design for mm-wave signals; emerging network architecture design to integrate mobile networks with infrastructure. All the speakers pointed out that 5G networks would have to deliver data capacities of 1000 times more than the capabilities of 4G networks, based on the mobile data traffic forecast for 2020. However, they also highlighted that the goal of 5G systems is not only to achieve even higher spectral efficiency, but also to give users the feeling that they have "infinite capacity" by always ensuring each user’s instantaneous data rate for a specific application. Attendees actively asked the speakers many questions and after the session, the participants enjoyed friendly discussions about the talks over coffee.


Attendee actively and friendly discussed 5G systems at coffee break

The symposium succeeded and contributed to the acceleration of research and development in order to realize a networked society with 5G.

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UEC joins forces with universities in Fukushima and Iwate to study disasters

Research Station of Disaster Science on Mega Risk Management (DSMRM) at University of Electro-Communications (UEC); Fukushima Future Center for Regional Revitalization (FURE) at Fukushima University; and Research Center for Regional Disaster Management (RCRDM) at Iwate University.

On 1st August 2013 the UEC established DSMRM as the university's first organization for disaster studies. Later in the year, 18 December, Dr. Takashi Onishi, the chairperson of the Science Council of Japan, gave a lecture entitled, "Disaster studies by the collaboration of scientists in various specialized fields" at the launch of the DSMRM. Approximately 100 scientists and researchers who participated in the meeting exchanged their views about the role of disaster studies at DSMRM.


Academic meeting with members of FURE at Fukushima University

On March 17, 2014, the symposium on "Problems of Reconstruction and Scientists' roles in Fukushima" under the co-sponsorship of DSMRM at the UEC and FURE at Fukushima University was held at the UEC. The symposium included four talks on disaster studies and the roles of scientists in reconstruction support. The lectures underscored the seriousness of secondary damage such as the collapse of community and family, health impairment, and the decline in the price of agricultural products caused by harmful rumors or misinformation. During the general discussion, the approximately 30 participants including scientists, researchers, and general public, recognized the unique aspects of the problems caused by the Fukushima nuclear power plant disaster after the Great East Japan Earthquake in March 2011.


Academic meeting with the members of RCRDM at Iwate University

On June 11, a symposium on "Activities for Recovery and Reconstruction in Iwate" under the co-sponsorship of DSMRM at the UEC and RCRDM at Iwate University was also held at the UEC. Three professors gave lectures on crisis management, disaster reduction, The Iwate Higher Education Consortium, and reconstruction support in damaged areas. The general discussion between the approximately 50 participants highlighted the importance of crisis management and education as measures for disaster prevention and limitation, and the problems of community design for reconstruction in damaged areas.


Symposium under the co-sponsorship with DSMRM and RCRDM at the UEC

Based on the co-sponsorship of the aforementioned symposia, the participants confirmed the resources and current status of each of the participating universities. There are plans to hold further symposia in the future co-sponsorship of DSMRM, FURE, RCRDM and other research organizations, to discuss the possibility of collaborative studies utilizing the strengths of each participating institute.

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Control systems: Fuzzy features

The natural world is not always logical, and precise states such as ‘true’ or ‘false’ are quite rare. The field of fuzzy logic takes account of this fact by creating models in which truth is represented on a continuous scale between 0 and 1. Mathematical control systems based on fuzzy logic have proved useful for real-world situations such as handwriting recognition on pocket computers, auto-focusing on cameras, and earthquake prediction.

One popular fuzzy control methodology is the Takagi-Sugeno (T-S) model, which involves interactions between ‘controllers’ and ‘observers’ represented by matrix polynomials. Now, Kazuo Tanaka and colleagues at the University of Electro-Communications in Tokyo, with co-workers at Kyushu Institute of Technology and Boston University, USA, have used a sum-of-squares approach to design effective observers within three classes of T-S fuzzy systems[1].

The most striking feature of the sum-of-squares designs is that, for two of the fuzzy systems tested, the designs realize the ‘separation principle’, meaning that the fuzzy controller and observer can be separately designed without affecting the stability of the overall system. The principle doesn’t hold for the more complicated third system, but Tanaka and co-workers have proposed an algorithm that predicts the best controller and observer designs to maximize stability.

The algorithms developed by Tanaka and co-workers are easily implemented using the SOSTOOLS toolbox within the popular MatLab programming environment. In future, the researchers hope to realize the separation principle for even the third fuzzy system, and will apply their models to improving aerial vehicles control.
On June 11, a symposium on "Activities for Recovery and Reconstruction in Iwate" under the co-sponsorship of DSMRM at the UEC and RCRDM at Iwate University was also held at the UEC. Three professors gave lectures on crisis management, disaster reduction, The Iwate Higher Education Consortium, and reconstruction support in damaged areas.

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Researchers at the University of Electro-Communications in Tokyo have pioneered an approach to applying ‘fuzzy logic’ within mathematical models that could have applications such as improving the control of helicopters. This photograph shows an unmanned aerial vehicle being controlled by Tanaka and colleagues using the ‘fuzzy logic’ described in this paper.

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Optical signal processing: Neater networks

The demand for fast access to data through optical networks requires technology that can handle ever more complex and high-bandwidth signals. However, the signal processing usually requires conversions from optical to electronic and back again, which can be power-hungry and expensive.

To move towards cheaper, more environmentally-friendly photonics, researchers are working on optical signal processing devices that require no signal conversions. A central aim for such devices is 'wavelength division multiplexing' (WDM), whereby one device can operate on many signals at the same time, if each signal has a different wavelength.

Now, Hung Nguyen Tan, Motoharu Matsuura and Naoto Kishi at the University of Electro-Communications in Tokyo have built an optical switching device that not only performs WDM, but also processes signals with different data formats, and convert signals between formats[1].

Their device is based on a conventional photonic design called a Sagnac interferometric switch, and has selectable windows for collecting and processing signals of different wavelengths. It can receive and convert signal formats from so-called non-return-to-zero (NRZ) to return-to-zero (RZ) formats.

Most impressively, the tests performed by Tan, Matsuura and Kishi showed that their device could regenerate signals that have degraded due to dispersion or spontaneous emission in the optic fibres of a network. In a network with mixed NRZ and RZ signals, it demonstrated excellent signal transmission on all wavelengths.

The researchers suggest that their device has potential for other processing tasks, especially for multicasting - the delivery of information such as clock pulses to many computers simultaneously.

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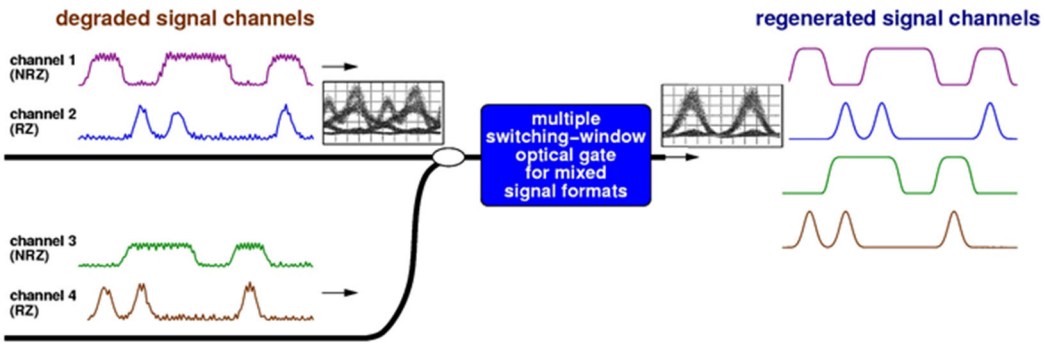

A device developed at the University of Electro-Communications, Tokyo, can process signals of several different wavelengths and data formats at once, and repair degradation caused by defects in optical fiber networks.

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Pharmacophores: The future of drug discovery

Developing new drugs that bind exclusively to target cells in diseases such as cancer is crucial. Masumi Taki and co-workers at the University of Electro-Communications in Tokyo, together with scientists at Kagoshima University, Japan, have expanded on current drug discovery methods to create a hybrid-drug generating system for this purpose.

Their system uses ‘artificial-molecule evolution’ - taking non-natural core molecules and adapting and optimizing them to make new ‘pharmacophores’. A pharmacophore is a molecular model which can be manipulated to bind molecules for targets such as cancer cells.

Taki’s team designed an artificial core molecule using salicylic acid, a readily available drug-like molecule known never to bind to a target protein on its own. They then used a common technique in drug discovery called ‘phage display’ to manipulate peptides to surround the artificial core molecule. Phage display involves inserting gene fragments into surface protein genes on bacteriophages - naturally-occurring viruses that infect bacteria. A new, non-natural protein or peptide hybrid then appears on the phage surface, and its biological properties can be exploited.

Publication and Affiliation

Yuuki Tokunaga[1], Yuuki Azetsu[1], Keisuke Fukunaga[1], Takaaki Hatanaka[2], Yuji Ito[2] &
Masumi Taki[1*]. Pharmacophore generation from a drug-like core molecule surrounded by a library peptide via the 10BASEd-T on bacteriophage T7. *Molecules* **19** 2481-2496 (2014)

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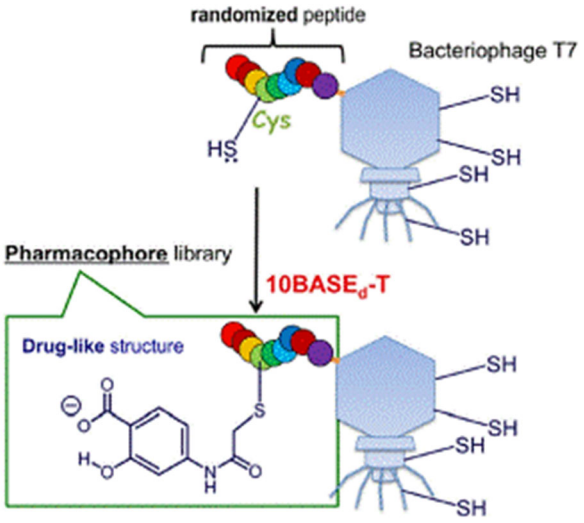

Researchers from the University of Electro-Communications in Tokyo have developed a new method for generating pharmacophores from artificial core molecules linked to T7 phages.

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Hybrid solar cells: The Mechanism of dyeing for greater efficiency

Light-harvesting organic materials have the potential to provide low cost electricity through solar power. However, current designs for organic-inorganic hybrid solar cells (OIHSCs) suffer weaknesses at the interface between organic and inorganic components and this limits efficiency.

Now, Qing Shen at the University of Electro-Communications, Tokyo, and Shuzi Hayase at Kyushu Institute of Technology together with scientists in Hayase JST CREST Research Team across Japan, have succeeded in clarifying the mechanism for improving the performance of an OIHSC by adding a dye sensitizer directly onto the organic-inorganic interface.

When sunlight hits the organic donor material in an OIHSC, excitons are generated (an electrically-neutral state where electron and hole are bound together) and begin to move around. At the interface, the excitons split into electrons in the inorganic acceptor material and holes in the organic donor material. This charge separation allows a current to flow.

Problems with efficiency occur when, instead of remaining separate, the electrons and holes recombine at the interface, slowing down the electricity production.

Shen , Hayase and co-workers in Hayase JST CREST Research Team used an OIHSC made from a film of poly(3-hexylthiophene) (P3HT), a common organic donor material, and an inorganic acceptor made from zinc oxide (ZnO). They studied charge separation and recombination processes at the interfaces using time-resolved laser spectroscopy, namely, transient absorption (TA) technique. They found that when they added dye to the OIHSC interface, the molecules in the dye helped separate the holes in P3HT from the electrons in ZnO. A reduction in ZnO surface states as a result of dye-sensitizing also led to the decrease in electron trapping, helping to minimize the chances of charge recombination.

Overall, the research team found a methodology to design a high-performing OIHSC that provided rapid charge separation, while greatly suppressing charge recombination.

Publication and Affiliation

Qing Shen[*ab], Yuhei Ogomi[bc] , Sandeep K. Das[c], Shyam S. Pandey[bc], Kenji Yoshino[bd], Kenji Katayama[e] , Hisayo Momose[f], Taro Toyoda[ab], & Shuzi Hayase[*bc]. Huge suppression of charge recombination in P3HT–ZnO organic–inorganic hybrid solar cells by locating dyes at the ZnO/P3HT interfaces. *PCCP* (2013)

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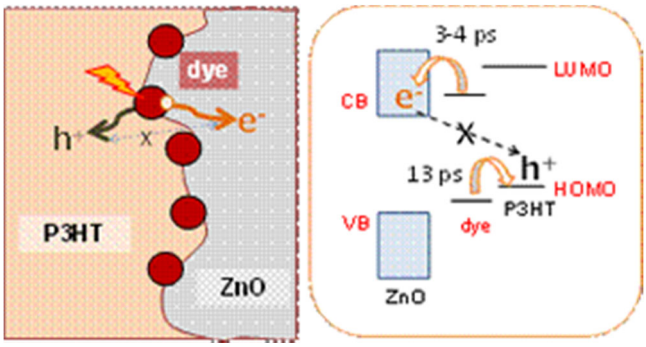

Researchers from the University of Electro-Communications in Tokyo and Kyushu Institute of Technology (Hayase JST CREST Research Term) have succeeded in clarifying the mechanism for improving the performance of organic-inorganic hybrid solar cells by adding a dye sensitizer at interfaces, which may lead to low-cost electricity production.

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Checkmate or should we say 'tsumi': The role of shogi in research on artificial intelligence and cognitive science

UEC researchers shed light on effective methods to 'teach' computers to play board games and conversely, how humans process information when playing these games.

Developing powerful Shogi computer programs


Dr. Kunihito Hoki

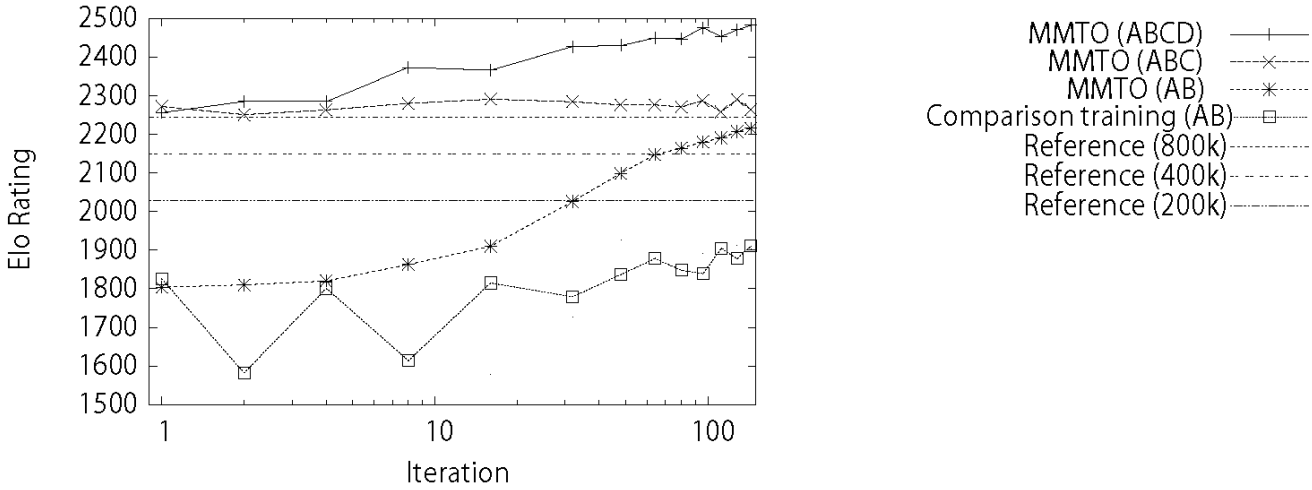
The victory by the computer dubbed 'Deep Blue' over world chess champion Garry Kasparov in 1997 was a turning point for computer scientists in general, and artificial intelligence experts, in particular. Such computer programs for board games rely on powerful heuristic search methods--intelligent guessing based on experience--based on the development of so-called "heuristic evaluation functions".

"The victory of Deep Blue over a grand master was based on hand tuning of parameters in the computer programs," says Kunihito Hoki, an expert in artificial intelligence at UEC. "The goal of my research is to develop fully automated learning of heuristic evaluation functions for artificial intelligence. Recently, in collaboration with Tomoyuki Kaneko of the University of Tokyo, we developed a learning method that is capable of adjusting more than forty million parameters in the evaluation function." The learning method employed a well-modeled objective function and a numerical iterative method to control the heuristic search results by means of a large number of parameters.

In an innovative approach to demonstrate the power of their heuristic search method the researchers decided to implement the new method-- called Minimax Tree Optimization (MMTO)--in a program for playing shogi--a variant of chess also referred to as Japanese chess.

Notably, one of the unique features of shogi is that pieces captured by players can be reused as their own; a rule that makes the game 'divergent' and difficult to predict the outcome. Chess in contrast, 'converges' and the loss of a single piece can quickly lead to an end game. Thus, the quality of the evaluation functions is extremely important for producing powerful computer programs for shogi.

With this background, Hoiki and his colleague implemented their new method for a shogi program known as Bonanza and the power of the program was recognized by its first-place finish in the 2013 World Computer Shogi Championship. "We also have preliminary evidence of broader applications of our method to other two-player games such as chess," says Hoki.



Large-scale optimizations for evaluation functions in Shogi [1]. The left axis shows improvements in strength (Elo rating) achieved by MMTO and comparison training (existing method), and the bottom axis shows the iteration count of numerical optimizations. The evaluation function AB has sixty thousand, ABC has two million, and ABCD has forty million parameters.

Next move experiments: Cognitive science to analyze the human perspective of playing shogi

But what about the other view? How do humans play shogi, and what are the differences in processing powers between champions and amateur players?

Dr. Takeshi Ito

These questions are being addressed by Takeshi Ito, Chairman of the Cognitive Science and Entertainment Research Station at UEC, an experienced amateur player and advisor to the UEC Shogi Club, which is one of the top 8 university clubs in Japan.

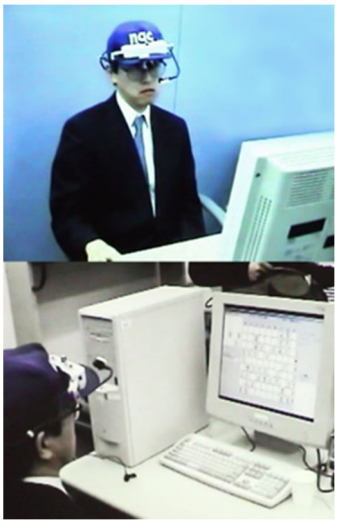
"Shogi is one of the most popular board games in Japan with approximately 12 million playing the game," says Ito. "My experiments on 'next moves' are designed to analyze how players, ranging in ability from beginners to professionals, recognize phases and generate candidate moves."

Ito adds that the 'thought experiments' of shogi players consist of "verbal data from think-aloud protocols and eye-tracking data from an eye camera when solving next move problems".

Results from these experiments show that intermediate players think for longer periods of time (275s) than beginners and advances players (150s). Beginners take a long time (55s) to understand a position and focus on single moves that are possible from the current position. The time to understand a position becomes short with playing strength. Almost all professional players can understand a position within 3 seconds and find a proper candidate move immediately.

Intriguingly, professional players rely on past experience and moves are evaluated as having good or bad prospects without any look-ahead. Also, they recognize a position instantly and based on past experience and knowledge about the position.

"Professionals do not focus on all the piece positions but understand positions based on the flow of the game," says Ito. "My research compliments that of my colleague Kunihito Hoki. We are confident that our findings on shogi will contribute to the wider field of artificial intelligence and cognitive science."



Mr. Yoshiharu Habu, a famous top shogi player who participates in an experiment which investigates the thought process by using eye tracker.

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Letter from Alumni

My academic activities in Thailand

Kosin Chamnongthai, professor of Electronic and Telecommunication Engineering Department, Faculty of Engineering, King Mongkut's University of Tehcnology Thonburi, Bangkok, Thailand

I received my bachelor degree from UEC in 1985, and went back to my home town in Thailand after getting my PhD in 1991. Although I had some choices about my working place, I chose King Mongkut's University of Technology, which is located in the south of Bangkok, because I was born in Bangkok, and at the time I tried to find an appropriate working place in Bangkok where I can attend from home. There was no strong tradition and basis of research in the Electrical Engineering Department where I had worked so that I had to start up a research lab namely "Computer Vision Lab" from nothing in the environment that people concentrated on teaching. The Computer Vision Lab has been started from collecting instruments, students, and documents, gradually grown up, and recently seemed to be well known among graduate students in Thailand in the related fields of IT, Electrical Engineering, Electronics, and Computers. The Computer Vision Lab at KMUTT (visionlab.kmutt.ac.th) has produced more than 100 masters and 8 PhDs, and all of them currently play key role in many important institutes in both government and private sectors of Thailand and neighbouring countries.

In addition to my teaching and research duties, around 15 years ago many researchers in electrical and computer engineering fields in Thailand agreed that we should establish an academic association. Hence, the Electronic and Computer Telecommunication and Information (ECTI) association was founded and becomes the first academic association in fields of electrical engineering, electronics, computer, telecommunication, and information technology emerging in Thailand. In the association, I have served as editor of e-magazine, associate editor of international transactions, and main committee for organising many international and national conferences. The ECTI e-magazine is electronically published in every three months, and the No. 1 of Vol. 8 was just published in March 2014 (http://www.ecti-thailand.org/emagazine). For the Transactions, I have been involved as associate editor in both ECTI-EEC Trans (http://www.ecti-thailand.org/paper/journal/ECTI-EEC) and ECTI-CIT Trans (http://www.ecti-thailand.org/paper/journal/ECTI-CIT) since the beginning. For the ECTI-EEC Trans, I have retired two years ago after it was listed in the TCI and Scorpus indices, and I then moved to concentrate on editing ECTI-CIT Trans which will be applied for the indices soon. These transactions become the international stages for researchers, professors, and students from around the world

especially Asian countries to publish their advanced research results, and in some cases publishing in the ECTI transactions can be used as a condition for getting a degree.

In hosting conferences, I started to serve as a local arrangement committee in the organizing team of an international conference called APCAS in 1998 held in Chiangmai, Thailand where I first learned how to distribute the papers to reviewers, how to select the papers, how to set up the parallel sessions, and so on. The first organising of international conference inspired me very much to concentrate on conference activities so that I accordingly organized many conferences with my happiness. I had served as general chair, technical program chair and so on for various well-known conferences both in national and international levels such as EECON, ECTI-CON, ECTI-CARD, IWAIT, NICOGRAPH, ISPACS, ITC-CSCC, SICE, ICESIT, SISA, APSIPA, TENCON, ISCIT, iEECON, ICSEC, JCSSE, KST, JICTEE, and so on. Actually, we expect that the conferences organized in Thailand will benefit participation chances for people in Thailand and the ASEAN region. However, I ultimately recognize what I get is not only know-how of organizing conference but also expansion of my human network in the international level.

Recently, since the population of Japan tends to dramatically decrease, the Japanese universities need to scale down their business, and simultaneously recruit students from oversea for filling in the capacity. UEC which is selected as one of the National Research Universities also has to lead in efficient management and expand its internationalization in its education and research in order to deal with the next generation problem of less population. UEC has accordingly started up the research centre in Bangkok called UARC (UEC ASEAN Research Centre) since Feb 7, 2014. This research centre may feature as the hub for collaborations between university and private sectors in ASEAN region, and contribute in education of students in the region. I as an alumni of UEC currently serve as UARC vice director, and will contribute as coordinator to find collaboration partners in ASEAN, and advertise the UEC reputation in ASEAN.

The University of Electro-Communications (UEC) in Tokyo

is a small, luminous university at the forefront of applied sciences, engineering, and technology research. Its roots go back to the Technical Institute for Wireless Commutations, which was established in 1918 by the Wireless Association to train so-called wireless engineers in maritime communications in response to the Titanic disaster in 1912. In 1949, the UEC was established as a national university by the Japanese Ministry of Education, and moved in 1957 from Meguro to its current Chofu campus Tokyo.

With approximately 4,000 students and 350 faculty, UEC is regarded as a small university, but with particular expertise in wireless communications, laser science, robotics, informatics, and material science, to name just a few areas of research.

The UEC was selected for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities as a result of its strengths in three main areas: optics and photonics research, where we are number one for the number of joint publications with foreign researchers; wireless communications, which reflects our roots; and materials-based research, particularly on fuel cells.

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