The University of Electro-Communications

UEC *e*-Bulletin

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

Vol.23, September 2019

The University of Electro-Communications 1-5-1 Chofugaoka, Chofu, Tokyo 182-8585

The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Research Highlights

Researcher Video Profiles

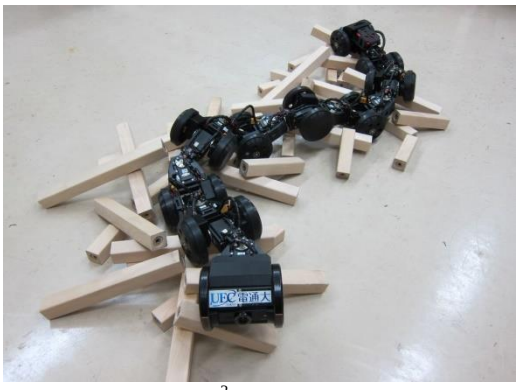
Topics

News and Events

The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Control of snake-like robots for high mobility and dexterity

Snake-like articulated mobile robots can enter narrow spaces and climb obstacles using their long and thin bodies, and are effective for inspection of narrow spaces and search-and-rescue operation on disaster sites. However, it is difficult to control their precise movements because they have so many actuators.


The snake-like robot T^2 Snake-3 [1]

Now, Motoyasu Tanaka and colleagues at the University of Electrocommunications Tokyo, propose methods to control snake-like robots for three-dimensional steering [1], stair climbing [1], and manipulating objects [2], and have developed the snake-like robot T^2 Snake-3 [1,2]. In three-dimensional steering, the robot follows the surrounding terrain by relaxing its joints, and then resumes to move from the robot's posture. The operator can easily control and move the robot on uneven terrain by this method. For climbing stairs, the robot autonomously shifts its motion on stairs from head to tail at the appropriate timing because data of sensors attached to the bottom of the robot are used to trigger the motion. For manipulating an object, the position and orientation of the gripper attached onto the robot's head is controlled by keeping the appropriate posture by autonomously selecting the allocation of the lifted/grounded wheels. Although the robot T^2 Snake-3 has approximately thirty actuators, the operator can easily operate the robot by using these methods and a gamepad.

The robot T^2 Snake-3 entered narrow spaces, climbing a one meter high step, climbing stairs, and rotating valves by using the proposed methods. The snake-like robot was control effectively for inspection equipment and disaster response.

References

[1] M. Tanaka, M. Nakajima, Y. Suzuki, and K. Tanaka: Development and Control of Articulated Mobile Robot for Climbing Steep Stairs, IEEE/ASME Transactions on Mechatronics, vol.23, issue 2, pp.531-541, 2018. DOI: 10.1109/TMECH.2018.2792013

[2] M. Tanaka, K. Tadakuma, M. Nakajima, and M. Fujita: Task-space Control of Articulated Mobile Robots with a Soft Gripper for Operations, IEEE Transactions on Robotics, vol.35, issue 1, pp.135-146, 2019. DOI: 10.1109/TRO.2018.2878361

・Author: Motoyasu Tanaka
・Affiliations: Associate Professor, Department of Mechanical and Intelligent Systems Engineering, The University of Electro-Communications, Tokyo.
・Website: https://sites.google.com/site/motoyasutanakalab
・Researcher Video Profiles: http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2019/motoyasu-tanaka.html

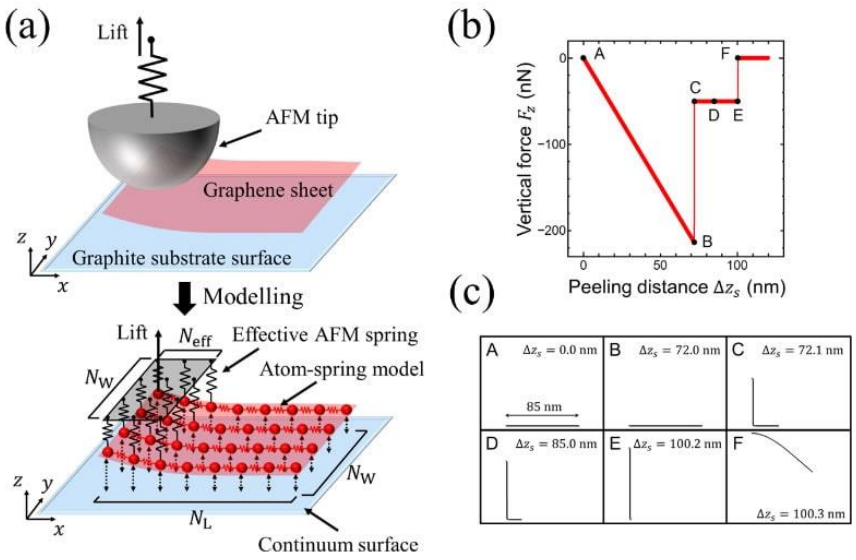
The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Time-saving simulation of peeling graphene sheets

Control of atomic-scale friction and adhesion is critical for effective manipulation of the motion of nano- or micro-meter scale objects at interfaces. For example, in nanotechnology controlling adhesion during the peeling process of graphene sheets plays a very important role in manipulation and fabrication. Graphene is a promising material due to its mechanical, electronic, magnetic, spintronic, and optical properties. In previous work, a comparison between simulation and experiment of peeling graphene has revealed its unique frictional and adhesive properties.

However, computation time becomes longer as the size of graphene increases, so a direct comparison of the simulated vertical force curve with experiments is difficult. Furthermore, it is also difficult to separate pure effects related to adhesion from those due to friction during the peeling process.
The robot T^2 Snake-3 entered narrow spaces, climbing a one meter high step, climbing stairs, and rotating valves by using the proposed methods. The snake-like robot was control effectively for inspection equipment and disaster response.

Here, Ryoji Okamoto, Koki Yamasaki, and Naruo Sasaki at The University of Electro-Communications have developed a time-saving potential model to simulate the adhesive characteristics during the peeling process of armchair-type graphene sheets from frictionless graphite substrate surfaces.



(a) Schematic illustration of the peeling experiment (upper) and the peeling simulation by using a time-saving potential model. (b) The vertical force acting on the support position, plotted as a function of the peeling edge during the peeling process. Characteristic step structure appears between B and C, and E and F. (c) Transition of the shape of the armchair graphene sheet (85*196 nm2) during the peeling process from A to F.

Using its structural symmetry, the armchair-type graphene sheet was reduced to the effective spring model [Fig. (a)]. Then the edge of the spring model was lifted along the vertical direction. For each lifting position, the model was structurally optimized using the conjugate gradient method.

The main results were: (1) The computation time by this potential was reduced to 1/6400 compared to our previous model. (2) The transition of the shape of the graphene sheet and the vertical force curve obtained by this model successfully reproduced those obtained by our previous model. (3) This potential model was successfully extended to include the effective stiffness of an atomic force microscopy (AFM), which consists of the stiffness of the cantilever, tip and contact region [Fig. (a)]. The characteristic step structure of the vertical force curve was obtained by the extended model [Figs. (b) and (c)].

Our approach opens new directions for multiscale physics of the peeling process of the elastic sheet from atomic to micrometer-scale, and interpretation of force-spectroscopy observed by AFM.

References

- Authors: Ryoji Okamoto, Koki Yamasaki and Naruo Sasaki.
- Title of original paper: New potential model for atomic-scale peeling of armchair graphene: toward understanding of micrometer-scale peeling.
- Journal, volume, pages and year: *Materials Chemistry Frontiers* 2, 2098-2103 (2018).
- Digital Object Identifier (DOI): 10.1039/c8qm00267c
- Affiliations: Department of Engineering Science, The University of Electro-Communications.
- Sasaki Lab. website: http://nanotribo.g-edu.uec.ac.jp/

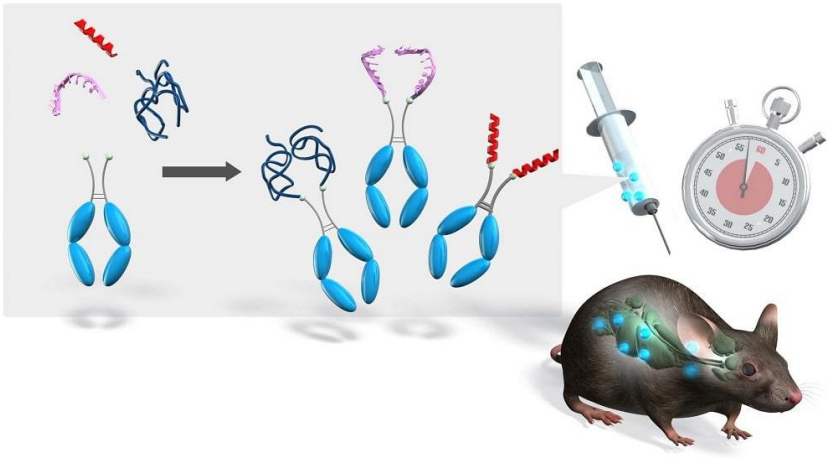
- Author: Naruo Sasaki
- Affiliations: Professor, Department of Engineering Science, The University of Electro-Communications.
- Department Website: http://nanotribo.g-edu.uec.ac.jp/
- Researcher Video Profiles: http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2019/naruo-sasaki.html

The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Convenient synthesis of biopharmaceutic-Fc conjugates: Semi-synthesis and evaluation on the extension of their circulating plasma half-lives

Biopharmaceutics consisting of middle molecules, for example, peptide or nucleic-acid aptamers, have been attracting attention as promising molecular modalities in current drug discovery.

A major problem of such pharmaceutics for therapeutic applications is that the half-lives of their circulating plasma inside the body are too short. Ideally, a precise conjugation of the Fc fragment of human antibodies with pharmaceutics would extend the half-lives. Practically, the conjugation between the complicated molecules is still immature.



Biopharmaceutic-Fc conjugate synthesized by our method possessed a long half-life inside the body.

Now, Masumi Taki and colleagues at the University of Electro-Communications (UEC), and Ajinomoto Co. Inc. have established a facile and efficient semisynthesis method to obtain biopharmaceutics-Fc conjugates.

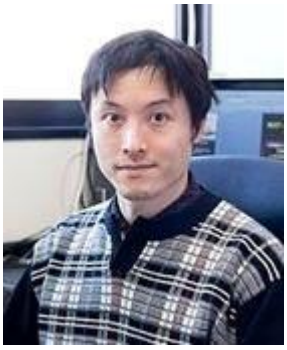
A combination of chemoenzymatic novel reaction (i.e., the NEXT-A reaction) followed by well-known click reaction yielded almost 100% conversion; and the N-terminal specific precise conjugation of the Fc fragment with different kinds of biopharmaceutics was unambiguously identified by several methods including deconvoluted mass spectrometry.

A Fc-conjugated (peptidic) pharmaceutic synthesized by this method led to a long-circulating plasma half-life inside mice while retaining its original biological activity.

The Fc-conjugation platform described can be applied many kinds of biopharmaceutics with different molecular modalities.

References

・Authors: Shigeo Hirasawa, Yoshiro Kitahara,Yoriko Okamatsu,Tomohiro Fujii, Akira Nakayama, Satoko Ueno, Chiori Ijichi, Fumie Futaki, Kunio Nakata, Masumi Taki.
・Title of original paper: Facile and Efficient Chemoenzymatic Semisynthesis of Fc-Fusion Compounds for Half-Life Extension of Pharmaceutical Components.
・Journal, volume, pages and year: *Bioconjugate Chemistry*, *in press* (2019).
・Digital Object Identifier (DOI): 10.1021/acs.bioconjchem.9b00235.
・Affiliations: Department of Engineering Science, Graduate School of Informatics and Engineering, the University of Electro-Communications (UEC).
・Department website: https://www.uec.ac.jp/eng/education/ie_graduate/s/index.html



・Author: Masumi Taki
・Affiliations: Associate Professor, Graduate School of Informatics and Engineering, School of Informatics and Engineering, The University of Electro-Communications, Tokyo.
・Department Website: http://tkl.pc.uec.ac.jp/

The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Motoyasu Tanaka, Associate Professor, Department of Mechanical and Intelligent Systems Engineering

Control and applications of 'snake-like' robots

Motoyasu Tanaka is devising high precision methods to control snake-like robots. "Although actual live snakes do not have legs and hands, they can perform a wide variety of motions," says Tanaka. "In addition, their slender bodies enable them to go into narrow spaces where humans cannot enter."

Robots that imitate snakes are effective for inspection of narrow spaces, and search-and-rescue operations at disaster sites. However, it is difficult to control snake robots because they have so many joints. To solve this problem, Tanaka and his group have developed methods using simple commands to control snake robots for performing a wide range of movements.

Specifically, the team aim to accomplish not only motions similar to snakes but also movements exceeding snakes by deriving mathematical models and designing dedicated control systems.

Any part of the body of a snake robot can touch its surrounding terrain. Sophisticated motions were achieved by appropriately designing the parts of a robot's body that touch its surroundings. Movements include, avoiding falling and obstacles as a smart motion, moving on a step, on stairs, into and onto pipes, and on rubble as motion on complicated terrains.

"As applications, we have developed a massage robot that massages a human by wrapping around a human; cleaning robot that not only cleans the ground but also a step; and a rescue snake robot for equipment inspection and disaster response."

Notably, the rescue snake robot can enter narrow spaces; climb one-meter high steps; semi-autonomously climb stairs; and rotate valves using a gripper attached on its head.

"We will continue to advance our academic research aiming at practical applications to contribute to society through snake robots."

Further information

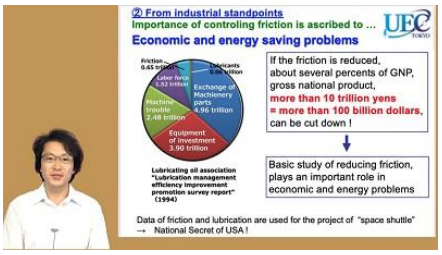
Motoyasu Tanaka
Associate Professor, Department of Mechanical and Intelligent Systems Engineering, The University of Electro-Communications.

Research Highlight:
http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2019/control-of-snake-like-robots-for-high-mobility-and-dexterity.html
Website: https://sites.google.com/site/motoyasutanakalab

The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Naruo Sasaki, Professor, Department of Engineering Science, The University of Electro-Communications

Nanotribology: Controlling friction on the nanometer scale



Naruo Sasaki is developing a system or guiding principle for controlling friction. "Friction is a daily phenomenon that occurs between two sliding surfaces," says Sasaki. "Friction appears at multi-scale from nano to macro, so controlling friction plays a very important role from several standpoints. "

Firstly, the standpoint of economics and energy saving problem. Energy loss of machinery parts due to friction has reached more than about 100 billion dollars or 10 trillion yen per year, so controlling friction is important for industry.

Next, from the perspective of nanotechnology, downsizing objects to nanoscale dramatically increases the effect of friction, which disturbs the smooth motion of objects.

Sasaki and colleagues are devising ways of controlling friction or reducing friction. They have developed a system consisting of fullerene nano-balls sandwiched between graphene nanosheets. In these fullerene bearing systems, frictional forces were successfully reduced to several tens of pico-newtons. So, this system could be applied to super lubricants.

Recently, the team has studied the contact mechanism of silicon and graphite interfaces, which has yielded clues into understanding the formation mechanism of real contact areas.

Furthermore, Sasaki and his colleagues have collaborated with experimentalists to propose new techniques for measuring friction.

"Now, research on controlling friction leads to large scale control of energy dissipation which appears in various research fields from basic science to applied engineering."

The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Further information

Naruo Sasaki
Professor, Graduate School of Informatics and Engineering, The University of Electro-Communications.

Research Highlight:
http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2019/time-saving-simulation-of-peeling-graphene-sheets.html
Website: http://nanotribo.g-edu.uec.ac.jp/english/sasaki.html

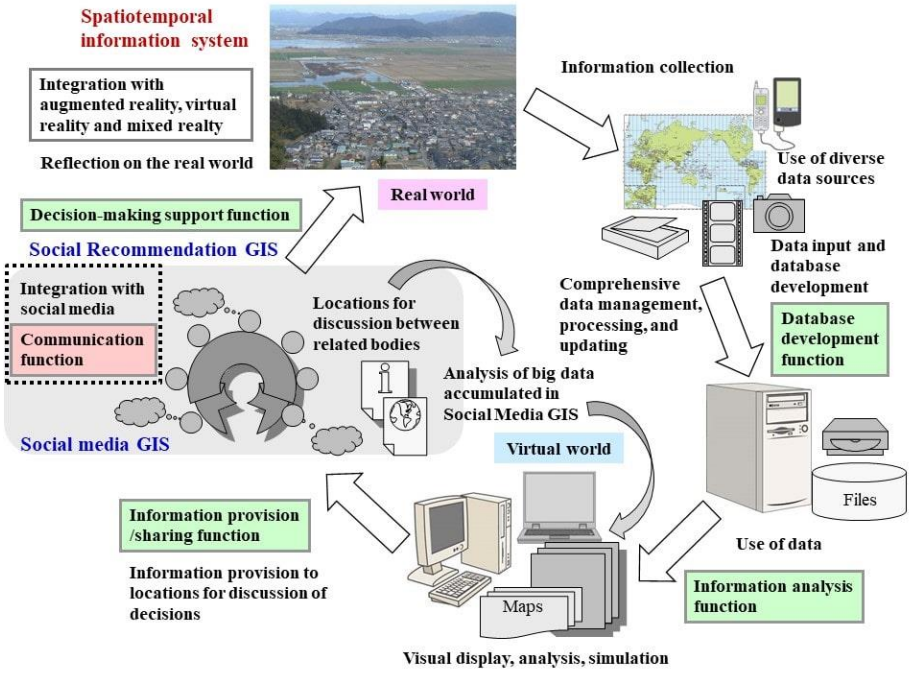
The University of Electro-Communications
UEC e-Bulletin Vol.23, September 2019

Social informatics: Innovative information systems to connect humans and social infrastructure

Kayoko Yamamoto
Professor, Graduate School of Information Systems, The University of Electro-Communications, Tokyo.

"The Great Hanshin Earthquake 1995 that centered on Kobe triggered my interest in using information technology to connect humans with their environment," says Kayoko Yamamoto, a professor at the Graduate School of Information Systems, UEC Tokyo. "After a huge earthquake hits a highly populated city, such as Kobe, it is critical to find safe and open spaces to mitigate danger due to aftershocks. One of my projects is focused on providing such disaster-response information via smart phones where photographs are over laid onto real time maps of the local area. So people can see and recognize their immediate surroundings and follow instructions to move to safe spaces and designated evacuation areas. I refer to this as 'social informatics'."

Geographic Information Systems (GIS) are an example of modern information systems that are widely used by local governments, industries, and citizen's groups. Notably, GIS is multidirectional and interactive, enabling information to be shared based on for example digital maps and photographs for the creation of a better community and local living environment.



Concept of GIS

Specific research projects

Information analysis using GIS

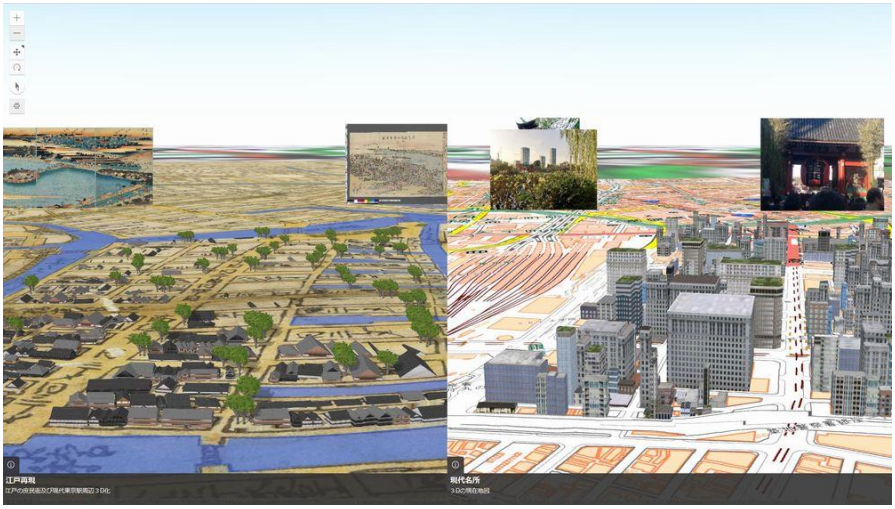
Evaluation of land and space use; environmental disaster prevention; layout of buildings and route search; and geospatial information data as big data.

Integrating GIS and social media

Development of social media and social recommendation GIS; universal design navigation system; spatio-temporal information system using mixed reality (MR); action support system using augmented reality (AR) and virtual reality (VR).

"In one of our projects we are integrating spatiotemporal information with mixed realty for enhancing the experience of sightseeing as well as a means of learning about local areas," says Yamamoto. "Mixed realty means combining virtual reality (VR) and augmented reality (AR). We have developed a dedicated system that includes application software for tablets and smart phones. The system was highly evaluated by 66 users over a period of five weeks. We are confident that our approach will be useful for real-world applications to connect humans with social infrastructure including 'language barrier free interfaces' [1]."

Other projects include providing real-time local weather forecasts based on GIS and data from weather radar systems.



Spatiotemporal Information System

Related educational programs

Joint Doctoral Program for Sustainability Research
http://www.tufs-tuat-uec.jp/page/gakubu.html

This program is a collaboration between UEC Tokyo, Tokyo University of Agriculture and Technology (TUAT), and Tokyo University of Foreign Studies (TUFS)--three academic institutes that are located within

close proximity enabling easy interaction between staff and students affiliated with them. "This is an interdisciplinary program designed to nurture students who will be able to contribute to the resolution of global issues," says Yamamoto. "The students are able to learn from experts reflecting the different strengths of the three universities: languages, liberal arts, and regional studies at TUFS; food, energy, and life sciences at TUAT); and big data, ICT, artificial intelligence, and optoelectronics at UEC Tokyo. It's a challenging and comprehensive program."

References

1. Book, "Computational Urban Planning and Management for Smart Cities", Editors: S Geertman, Q. Zhan, A. Allan, C. Pettit, (Eds.) 2019, Springer.
   R. Makino and K. Yamamoto, "Spatiotemporal Information System Using Mixed Reality for Area-Based Learning and Sightseeing", Chapter 6, pages 283-302, 2019.
   ISBN 978-3-030-19424-6
2. Shinya Abe, Nagi Yoshitsugu, Daisuke Miki, and Kayoko Yamamoto, "An Information Retrieval System with Language-Barrier-Free Interfaces", JISSJ Vol. 14, No. 2, 57-64, 2018.

To resolve this issue Hiroshi Kikuchi, Tomoo Ushio and colleagues at The University of Electro-Communications and Tokyo Metropolitan University show that network observations with two phased array weather radars improves the accuracy of estimating the rain rate within the networked area.

Further information

・Kayoko Yamamoto, Professor, Graduate School of Information Systems, The University of Electro-Communications, Tokyo..
・Website: http://www.si.is.uec.ac.jp/yamamotohp/?page_id=565

The University of Electro-Communications
UEC e-Bulletin
Vol.23, September 2019

Irago Conference 2019

UEC will host the Irago Conference 2019 at the Chofu campus.

Main theme: Insights into the Sustainable Development Goals:
What About The Earth Resources?
Date: 29 October 2019
Place: Auditorium, UEC Tokyo, Chofu

Further information

http://iragoconference.jp/

The University of Electro-Communications
UEC e-Bulletin
Vol.23, September 2019

Delegation of TKU visits UEC

On July 4, 2019, President Keh and six other delegates from Tamkang University (TKU) , in Taipei, visited the University of Electro-Communications. President Fukuda and four executive board members and professors of UEC welcomed the delegation, and they had active discussion to enhance collaboration between the two universities. After the meeting the delegates had a lively meeting with UEC's international students from TKU.

Delegates from Tamkang University (TKU) meet UEC

TKU was established in 1950, and has three campuses and a Cyber Campus. TKU and UEC signed cooperation agreement in 1998 and have been cultivating mutual collaboration through research and students exchange. In 2014 the two universities set up laboratories in each other's universities that can be jointly used by faculty and students of both universities. Furthermore, in addition to the half year to one year student exchange program, TKU and UEC are jointly running a student exchange program for graduate students under which the exchange students take jointly offered intensive courses and give research presentations at the Host institution.

The University of Electro-Communications
UEC e-Bulletin
Vol.23, September 2019

Delegation from WUST visits UEC

On June 12, 2019, a delegation of five members led by Professor SHENG Jianlong, the vice president of Wuhan University of Science and Technology （WUST） visited the University of Electro-Communications. President Fukuda and five executive members and professors of UEC welcomed the delegation and exchanged information and ideas for further collaboration between the two universities. The delegation was given a tour of the UEC University library after the meeting.


Group photograph of the meeting.

Established in 1898, WUST is a university of science and engineering with great quality and tradition, located in Wuhan City, which is one of the leading industrial city in China. WUST and UEC signed a cooperation agreement in 2005 and have been cultivating mutual collaboration through research and student exchange.

The University of Electro-Communications (UEC) in Tokyo

is a small, luminous university at the forefront of pure and 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.

International Public Relations
The University of Electro-Communications
1-5-1 Chofugaoka, Chofu, Tokyo 182-8585
E-mail : kokusai-k@office.uec.ac.jp
Website : http://www.uec.ac.jp/eng/

