

# UEC **e**-Bulletin

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

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## Research Highlights

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- Aurora-induced atmospheric composition change: Global sodium variation revealed by optical spectroscopic observations from the space
- Developing Robots That Can Learn Like Humans
- Electron transfer and oxidative damage in DNA under biomimetic crowding environment

## Researcher Video Profiles

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- Takuo Tsuda, Assistant Professor, Graduate School of Informatics and Engineering
- Tomoaki Nakamura Assistant Professor, Graduate School of Informatics and Engineering.
- Makiko Tanaka, Assistant Professor, Graduate School of Informatics and Engineering

## News and Events

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- Special lecture to launch the countdown to the 100th anniversary of the establishment of UEC on 8 December 2018

## Aurora-induced atmospheric composition change: Global sodium variation revealed by optical spectroscopic observations from the space

Aurora—northern lights/southern lights—light emission appears at high altitudes in the range 100-300 km the polar atmosphere. Auroras are caused by energetic particles precipitating from space near the Earth. It is thought that such auroral particle precipitation can induce many kinds of effects to the Earth's atmosphere.

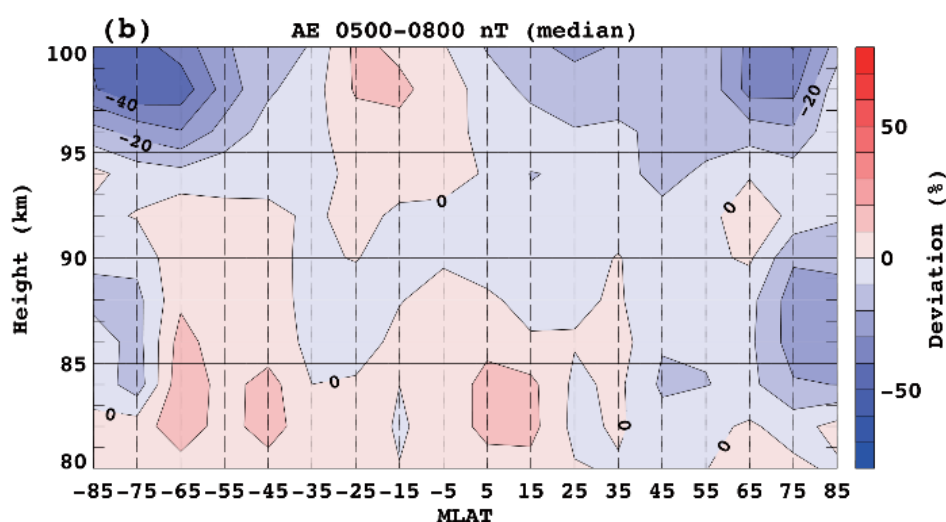
Of interest are variations in the atmospheric composition induced by auroral particles. However, auroral responses of metallic species such as sodium (Na), which is distributed at between 80-110 km, are not well understood, and notably, there is no statistical survey available about this topic because of limited data.

Now, Takuo Tsuda at the University of Electrocommunications, Tokyo (UEC, Tokyo), and colleagues have statistically investigated global Na responses to the auroral activity utilizing six-years of optical spectroscopic observations from the space.

The researchers derived Na density data from the Na D line emission spectra obtained by an Earth-orbiting satellite that provide global data coverage and compared the Na density data with the auroral activity.

Their results showed that Na density can decrease through atmospheric chemical processes during high auroral activity.

The results indicate that the auroral particles can affect metallic species of the atmospheric composition. The findings imply an important link between research on auroras and atmospheric chemistry.



global Na density responses due to the auroral activity.

## Reference



- Authors: T. T. Tsuda, T. Nakamura, M. K. Ejiri, T. Nishiyama, K. Hosokawa, T. Takahashi, J. Gumbel, and J. Hedin.
- Title of original paper: Statistical investigation of Na layer response to geomagnetic activity using resonance scattering measurements by Odin/OSIRIS.
- Journal, volume, pages and year: *Geophys. Res. Lett.* **44**, 5943-5950 (2017).
- Digital Object Identifier (DOI): 10.1002/2017GL072801
- Affiliations: Department of Computer and Network Engineering, University of Electro-Communications.
- Department website: <http://ttt01.cei.uec.ac.jp/>
- Researcher Video Profiles:  
<http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2018/takuo-tsuda.html>

## Developing Robots That Can Learn Like Humans

Recently, there have been remarkable advances in artificial intelligence (AI). It is said that AI is superior to human intelligence in supervised learning where vast amounts of labeled data is used to perform specific tasks. However, it is considered that it is difficult to realize human-like intelligence using only supervised learning because all supervised labels cannot be obtained for all the sensory information required by robots.

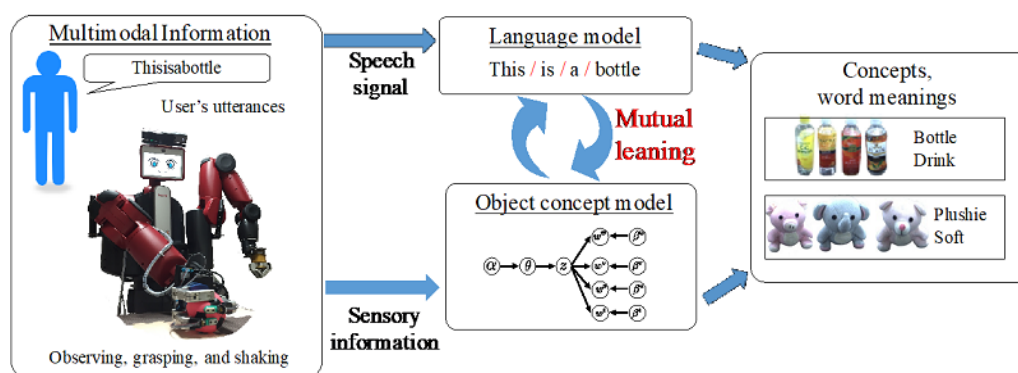
Here, Tomoaki Nakamura of UEC, Tokyo, and colleagues are conducting research on the realization of robots that can acquire knowledge in a manner similar to human beings.

To this end the researcher believes that it is important for robots to understand their environment by structuring their own sensory information in an unsupervised manner.

Recently, Nakamura proposed an algorithm that enables robots to learn concepts and language [1,2]. The robots obtain multimodal information from objects, and linguistic information by communicating with others. Using this information, the algorithm allows robots to form object concepts and learn languages. Moreover, concepts that are learned by robots using this algorithm are compared with the corresponding human concepts and the similarities between them are shown [3].

Nakamura has also proposed a method for robots to learn motions by observing human motion [4]. Additionally, this method also allows robots to learn the rules of interaction by observing human interaction.

"Through this research, I would like to develop robots like humans," says Nakamura. "Additionally, I believe that this research will lead to a better understanding human intelligence."



## Reference



[1] Joe Nishihara, Tomoaki Nakamura, Takayuki Nagai, "Online Algorithm for Robots to Learn Object Concepts and Language Model", IEEE Transactions on Cognitive and Developmental Systems, Vol. 9, No. 3, pp. 255-268, 2017

[2] Tomoaki Nakamura, and Takayuki Nagai, "Ensemble-of-Concept Models for Unsupervised Formation of Multiple Categories", IEEE Transactions on Cognitive and Developmental Systems, DOI:10.1109/TCDS.2017.2745502, 2017

[3] Miyuki Funada, Tomoaki Nakamura, Takayuki Nagai and Masahide Kaneko, "Analysis of the Effect of Infant-Directed Speech on Mutual Learning of Concepts and Language Based on MLDA and Unsupervised Word Segmentation", IROS2017: Workshop on Machine Learning Methods for High-Level Cognitive Capabilities in Robotics, Sep. 2017

[4] Tomoaki Nakamura, Takayuki Nagai, Daichi Mochihashi, Ichiro Kobayashi, Hideki Asoh and Masahide Kaneko, "Segmenting Continuous Motions with Hidden Semi-markov Models and Gaussian Processes", Frontiers in Neurorobotics, DOI:10.3389/fnbot.2017.00067, 2017

Affiliations: Graduate School of Informatics and Engineering, The University of Electro-Communications, Tokyo.

Website: <http://www.naka-lab.org/>

Researcher Video Profiles:

<http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2018/tomoaki-nakamura.html>

## Electron transfer and oxidative damage in DNA under biomimetic crowding environment

It is known that an electron-hole injected into DNA moves through double helical DNA and induces oxidative damage at guanine sites. To-date, this process has only been investigated in aqueous dilute solutions.

However, to clarify the unique characteristics of DNA *in vivo*, experiments must be performed under conditions close to biological environments because the intracellular environment is highly crowded with 20-40 wt % various biomolecules.

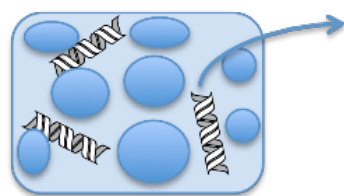
Now, Makiko Tanaka at Department of Engineering Science and colleagues have investigated the effect of the biomimetic medium on DNA damage via photoinduced electron transfer and found that molecular crowding mediums affected the electron transfer and the efficiency of DNA damage.

Upon photoirradiation of pyrene moiety in pyrene-modified DNA, guanine sites in DNA were oxidized via electron transfer and decomposed. The researchers used ethylene glycol, glycerol and poly(ethylene glycol) to produce crowding environments around DNA. The efficiencies of the oxidative damage were analyzed by high-performance liquid chromatography.

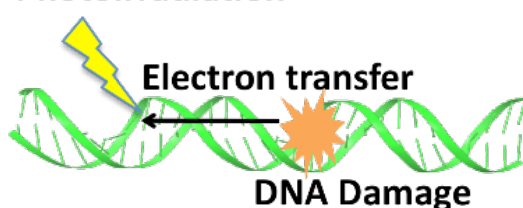
A high viscosity of the crowding environment reduced damage in DNA. When the DNA contained a mismatched base pair, a local structural change of DNA and a low dielectric constant of these crowding mediums promoted DNA damage via through-space electron transfer.

These results suggest that the electron transfer and the oxidative damage in DNA under intracellular environments have wide variety according to the situation.

### Biomimetic crowding environment



### Photoirradiation



DNA damage via photoinduced electron transfer under crowding environment



## Reference



- Authors: Makiko Tanaka, Hiroki Iida and Takayuki Matsumoto.
- Title of original paper: Effects of molecular-crowding on electron transfer and oxidative damage in pyrene-modified oligonucleotides
- Journal, volume, pages and year: *Chemistry Letters* **47**, 62 (2018).
- Digital Object Identifier (DOI): 10.1246/cl.170909
- Affiliations: Department of Engineering Science, Graduate School of Informatics and Engineering, The University of Electro-Communications.
- Department website: <http://www.c3.uec.ac.jp/>
- Researcher Video Profiles:  
<http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2018/makiko-tanaka.html>



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## Takuo Tsuda, Assistant Professor, Graduate School of Informatics and Engineering.

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### Geophysics: Space and upper atmospheric physics

Takuo Tsuda is conducting research on aurora and the Earth's atmosphere. Auroral emission is caused by particles such as electrons and ions entering the Earth's atmosphere from the space. Auroral particles are thought to induce not only emission but also many kinds of other effects in the atmosphere.



Of particular interest is the effect of auroral particles on atmospheric composition, in particular metallic species such as Na and Fe. The metallic species are important for radio propagation for radio communication and broadcast but their effect it is not well known. So, Tsuda and colleagues are analyzing optical spectroscopic data from satellite observations. They found that Na variation can be induced through atmospheric chemical processes triggered by auroral particles. This indicates an important link between the space-related phenomena, that is auroral particles, and atmospheric composition and chemical processes. This research is expected to be important for understanding radio propagation environment.

### Further information

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Takuo Tsuda laboratory:

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Research Highlight:

<http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2018/aurora-induced-atmospheric-composition-change-global-sodium-variation-revealed-by-optical-spectroscopy.html>

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## Tomoaki Nakamura Assistant Professor, Graduate School of Informatics and Engineering.

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### Developing robots that are as smart as humans

The goal of Tomoaki Nakamura's research is the realization of robots that are able to learn and become smart like humans. Recently advances in artificial intelligence has enabled the realization of many types of abilities by learning from the huge amount of labeled data. However, humans do not learn from such huge amounts of labeled data.



Humans learn by structuring information obtained from their ambient environment through their own sensors. Nakamura aims to realize robots with such abilities.

In one of his projects, Nakamura is studying how robots can acquire concepts and languages by linking information obtained from their sensors and information on languages obtained by communication with others. Other research includes how robots learn by observing from the behavior and activities of people, and autonomously learn rules that exist in the interaction of many people.

"Through this research I want to realize smart intelligence like human beings," says Nakamura.

### Further information

Tomoaki Nakamura Assistant Professor, Department of Mechanical and Intelligent Systems Engineering Graduate School of Informatics and Engineering, The University of Electro-Communications, Tokyo.

Website:

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Research Highlight:

<http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2018/developing-robots-that-can-learn-like-humans.htm>

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## Makiko Tanaka, Assistant Professor, Graduate School of Informatics and Engineering.

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### Charge transfer and damage in DNA by oxidizing DNA with light

It is known that the DNA in our body carries genetic information and when it is oxidized, charge is generated, and this charge moves through DNA and causes damage. To-date, this process has been examined mainly in ordinary aqueous solutions. However, the inside of cells where DNA exists is a highly dense congested state due to many kinds of molecules, and in order to examine the actual characteristics of DNA, it is necessary to study under conditions closer to a living environment.



Therefore, Makiko Tanaka studying charge transfer and damage in DNA using a method where DNA is oxidized with light, in an intracellular model environment mixed with high concentrations of artificial molecules. Experimental results show that decreasing the dielectric constant and increasing the viscosity of the surrounding environment greatly affect the path and efficiency of damage caused by charge transfer.

This research is expected to uncover unknown characteristics of DNA in an in-vivo environment to advance knowledge in medicine.

### Further information

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Research Highlight:

<http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2018/electron-transfer-and-oxidative-damage-in-dna-under-biomimetic-crowding-environment.html>

## Special lecture to launch the countdown to the 100th anniversary of the establishment of UEC on 8 December 2018

On 10 February 2018, the University of Electro-Communications, Tokyo (UEC, Tokyo) held the first of many lectures and events planned for 2018 to commemorate the university's centennial anniversary—UEC Tokyo was established on 8th December 1918.

After an opening address by UEC President Takashi Fukuda, the audience of more than 460 people saw the unveiling of a bulletin board displaying the number of days until the 8<sup>th</sup> December. Then alumni Ken Kutaragi, the President of Cyber AI Entertainment Inc., who is the creator of 'PlayStation' and Ms. Masako Wakamiya, a descendant of the first director of the Technical Institute for Wireless-Communications, the predecessor of UEC, Tokyo, gave special lectures.

The participants also enjoyed a special program on 'performances by historical acoustic equipment' that included listening to sounds produced Edison's wax gramophone, which is exhibited in the UEC Communications Museum.

Dr. Kutaragi said that he enrolled at UEC, Tokyo, to fulfill his dream of becoming an engineer and that he developed household game machines at SONY after graduation. He also described his experiences as an engineer and views on topics such as artificial intelligence.

Ms. Wakamiya said that she bought a personal computer after retirement and became addicted to create art work using excel. She eventually developed a smart phone application known as 'hinadan' for senior citizens, which led her to meeting Apple's CEO and making a keynote speech at the United Nations.



President Fukuda unveiling the bulletin board.



Ms. Masako Wakamiya



Dr. Ken Kutaragi



Listening to Edison's gramophone.



## **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 Communications, 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

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