The University of Electro-Communications

# UEC Research and Innovation

Latest updates on research and innovation at UEC Tokyo.

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News

# UEC Signs Memorandum of Understanding for Student Exchange with Denmark's Roskilde University

On Thursday, November 21, 2024, UEC and Roskilde University signed a memorandum of understanding (MoU) for student exchange. This milestone builds on the comprehensive agreement signed on January 1, 2023, which has fostered active research collaborations. Notably, Visiting Associate Professor Go Yuasa (Office for International Strategy) has been working with Roskilde University on integrating and visualizing traffic volume and air quality data to advance smart city initiatives.

Through ongoing discussions between Visiting Associate Professor Yuasa and Roskilde University faculty, the concept of student exchange developed naturally, culminating in the signing of this MoU.

Founded in 1972, Roskilde University is one of Denmark's eight national universities and is distinguished by its innovative approach to education. Emphasizing group work and project-based learning over traditional lecture formats, the university encourages active discussion and collaboration. Situated just 30 minutes by train from Copenhagen, Roskilde is one of Denmark's oldest cities, with a population of approximately 53,000 and a welcoming, study-friendly environment.

This new MoU is set to strengthen ties between the two institutions, providing exciting opportunities for UEC students to engage in international exchange and broaden their academic and cultural horizons.

Roskilde University Campus. Photograph from Roskilde University website.

News

# New Zealand Chair of the Japan-New Zealand Business Committee and Aurecon Representatives Visit UEC

On Friday, November 15, 2024, Ian Kennedy, Chair of the New Zealand side of the Japan-New Zealand Business Cooperation Committee, along with Rebecca Mehrtens of Aurecon New Zealand and Kanji Kuwata of Aurecon Australia, visited UEC. They held discussions with UEC President Shunichi Tano and Board of Directors (International and Public Relations Strategy) Kazuaki Oya, responsible for international and public relations strategy.

Following the meeting and a commemorative photograph, the group explored potential collaborations between New Zealand industry and UEC. Representing UEC were Board of Directors Oya, Senior Coordinator Kazuaki Minami (Center for Industrial and Governmental Relations), Chief URA Takanobu Higuchi (Center for industrial and Governmental Relations), and Project Associate Professor Hiroki Furukawa (Internship Promotion Office).

During the discussions, UEC provided an overview of its Center for Industrial and Governmental Relations, UEC Prime, and its internship program, which fosters industry-academia collaboration by providing students with practical experience. Ideas for potential projects and internship opportunities were actively exchanged. Aurecon, a company engaged in energy-related industries, expressed interest in collaborating with UEC's related centers and participating in UEC Prime initiatives.

As part of UEC's efforts to strengthen partnerships in the Oceania region, the University is preparing to host the **3rd UoA/UEC Trans Pacific Symposium on Advanced Science and Engineering** in New Zealand on Tuesday, November 26, 2024, in collaboration with the University of Auckland. President Tano and Board of Directors Oya will also visit other New Zealand universities during their trip to further solidify these valuable relationships.

*(From left: Director Oya, Mr. Kuwata, Ms. Mehrtens, Mr. Kennedy, President Tano, Chief URA Higuchi, Senior Coordinator Minami, and Project Associate Professor Furukawa)*

Research Highlights：Research

Space science

# Gigantic auroras revealed: Unveiling solar dynamics during rare solar wind disappearance

An international research team led by Keisuke Hosokawa and including Takuo Tsuda of the University of Electro-Communications, in collaboration with Kyoto University and the National Institute of Polar Research, has captured a rare and strikingly large aurora spanning the Arctic region. This unprecedented observation occurred during an unusual solar phenomenon where the solar wind, a stream of charged particles that typically interacts with the Earth's magnetosphere to create auroras, almost completely vanished. The study, published in *Science Advances* provides new insights into how auroras can form in the absence of normal solar wind conditions and reveals unexpected complexity in auroral behavior under these rare circumstances.

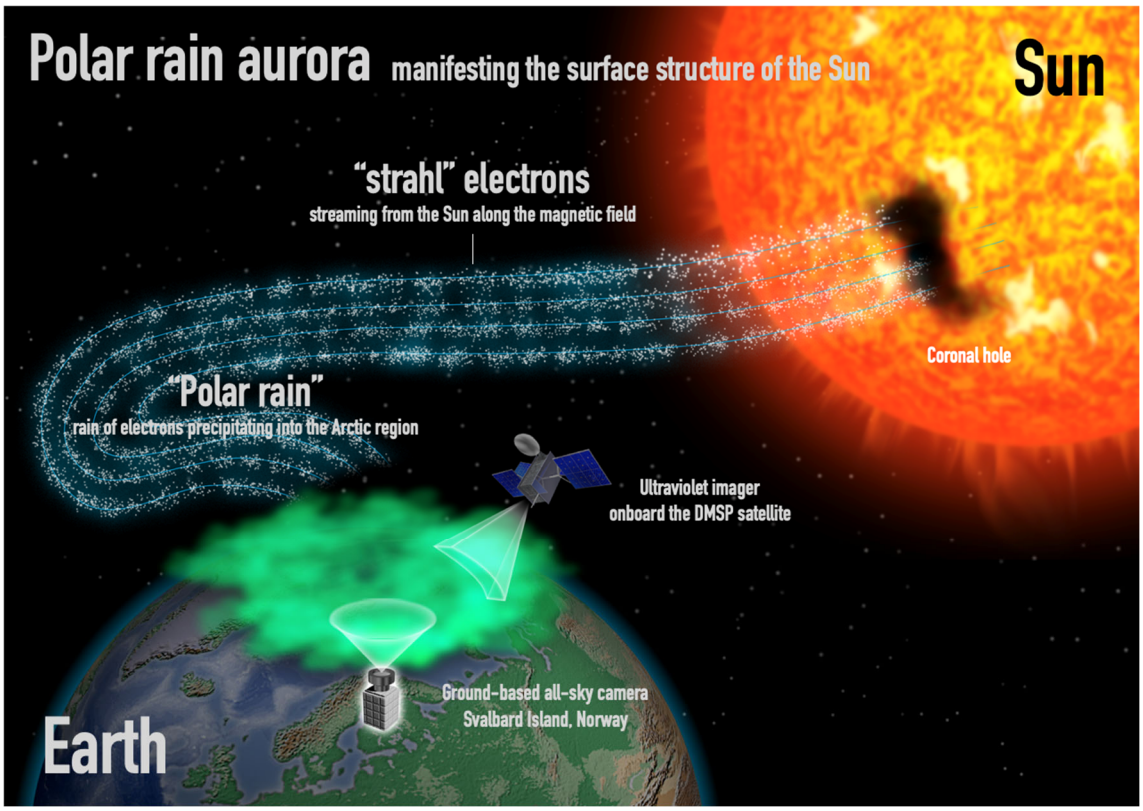
The aurora, observed on December 25, 2022, coincided with a day-long disappearance of solar wind—a phenomenon so rare that it has been recorded only a few times in recent history. This event provided a unique opportunity to study aurora formation under unusual space weather conditions. Using a combination of ground-based all-sky aurora cameras located in Svalbard, Norway, and ultraviolet imaging instruments aboard the DMSP satellite, the research team was able to observe and analyze the aurora simultaneously from both space and Earth. The aurora covered the entire Arctic region, producing an extraordinarily bright display visible even to the naked eye from the ground.

The formation of this aurora was found to be caused by a process known as "polar rain", in which electrons from the Sun are funneled directly along magnetic field lines to Earth’s polar regions. Unlike typical auroras, which are driven by interactions between the solar wind and Earth’s magnetosphere, this polar rain aurora occurred when the solar wind had nearly disappeared. This finding reveals a different mechanism for aurora formation, one that involves direct streams of electrons from the sun’s surface, rather than the more commonly observed solar wind interactions.

The research also uncovered intricate patterns within the aurora that had not been previously documented in such detail. High-resolution ground-based imaging revealed wave-like structures and mushroom-shaped formations that moved dynamically across the sky at speeds of around 400 meters per second. These complex patterns are thought to reflect the structure of the Sun’s surface, essentially projecting the solar surface onto the Earth’s polar atmosphere. This discovery suggests that auroras, particularly those created by polar rain, could potentially be used as a new method to study the magnetic and plasma structures on the Sun’s surface remotely from Earth.

The simultaneous observation of this polar rain aurora from both space and the ground marks a first in the field of auroral studies and provides valuable data on how such auroras can form under

unique space weather conditions. This research not only expands our understanding of auroral dynamics but also opens up new avenues for studying solar activity and its direct impacts on Earth. The authors say: “The implications of this work are far-reaching, suggesting that future auroral observations could help map solar surface structures and improve our understanding of the sun-Earth connection, particularly during periods of reduced solar wind activity.”

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Research Highlights：Innovation

Face recognition **Voice coming into the picture**

During the COVID-19 pandemic, requiring people to wear facemasks in public places and shops was an important measure taken by governments all over the world. The requirement is no longer in place, but in Japan and elsewhere, many people still choose to wear a facemask as a precaution, and it is expected that facemasks will remain commonplace. This poses a problem to security and identification systems, as it is difficult to correctly automatically identify a person whose half face is covered by a mask. To address this situation, computational methods capable of 'inpainting' masked face images have been developed, with some degree of success. Now, Yuichi Sei and colleagues from The University of Electro-Communications, Tokyo, have created a method that not only uses visual information, but also audio — the person's voice — to reconstruct a masked face. The approach enables face shape restoration with improved quality.

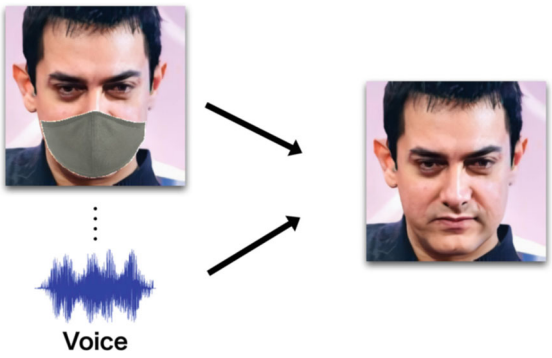
The researchers were led by the notion that a relationship exists between a person's face shape and the person's voice. Indeed, facial muscles and the shape of the nasal cavity, for example, contribute to how a voice sounds. In addition, a person's age, gender and ethnicity have an impact on intonation. Importantly, relevant scenarios for which both visual and audio information are available are conceivable, for example audiovisual recordings of a crime scene in which the criminal wears a mask.

Partly based on an earlier, machine-learning method for face completion, the approach of Sei and colleagues required a data set for training and testing the method. To this end, the researchers used a database with face (pictures) and voice (audio recordings) information of 1,225 people. It is worth noting that much more than one picture and one audio recording were available per person (in total, almost 300,000 picture and voice files were used). Masked face images were created from unmasked images by erasing out the areas that would be covered by a randomly chosen mask type.

Comparisons between the unmasked images and the inpainted images confirmed the high quality of the achieved face shape restoration. Situations in which the reconstruction worked particularly well were faces with sharp contours, and faces with high nasal heads.

It should be noted that the data used as input was in fact a combination of two different datasets: one for the faces, and one for the voices. This means that a face image did not necessarily correspond to the actual face during the utterance of the voice. Moreover, there may have been discrepancies due to a person's face shape and voice quality changing with time. Nevertheless, the quality of the results obtained with the approach of Sei and colleagues was better than that for earlier methods. Quoting the scientists: "[Our] experimental results show that the proposed method improves the quality both qualitatively and quantitatively compared to the method without

voice."




[Fig. 1 from the paper]
A person's masked face is reconstructed by including audio of the person's voice.

Tetsumaru Akatsuka , Ryohei Orihara , Yuichi Sei ,Yasuyuki Tahara , and Akihiko Ohsuga, Estimation of Unmasked Face Images Based on Voice and 3DMM, In: Liu, T., Webb, G., Yue, L., Wang, D. (eds) AI 2023: *Advances in Artificial Intelligence*. AI 2023. Lecture Notes in Computer Science (LNCS), volume 14471. Springer, Singapore.

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Sei Lab Home Page
http://www.sei.lab.uec.ac.jp/~sei/en/

Yuichi Sei

Video Profile：Innovation

# Applied mathematics for optimization of society

Satoshi Takahashi
Associate Professor Department of Computer and Network Engineering.


Satoshi Takahashi is using his expertise in mathematical optimization and game theory to address practical social issues including optimizing transportation timetables, factory work schedules, economic problems like price determination, and stock trading.

His group is creating mathematical models to determine optimal solutions for minimizing or maximizing specific goals, such as finding the most efficient traffic routes or maximizing factory production plans. His research is based on using fundamental mathematics including linear algebra, statistics, and probability.

Game theory, particularly mechanism design, is another key tool in his research. This involves creating rules to achieve economically desirable outcomes in resource allocation and decision-making. For instance, the Vickrey-Clarke-Groves mechanism is applied in auction designs to meet these criteria.

One of Takahashi's recent notable projects, "Beat the Traffic Jams," addresses congestion issues in urban Japan, including car traffic, human traffic on railways, and airport runway congestion. Takahashi and his group are developing and scheduling transportation networks and designing effective traffic rules using mathematical optimization and game theory. Importantly, despite efforts, congestion persists due to selfish behavior, necessitating models that predict congestion levels under such conditions.

To tackle this aspect of traffic jams, the team uses selfish routing games to find equilibrium states of congestion, employing evolutionary computation techniques like replicator dynamics, which they have significantly accelerated. This equilibrium helps quantitatively evaluate network congestion and traffic regulations.

The goal of this research is to develop systems that evaluate and optimize traffic control during events and disasters, facilitating better planning and regulation. Their broader goal is societal optimization, and Takahashi welcomes suggestions for real-world problems to resolve through his expertise. As Takahashi puts it, "Optimization of society is our slogan."

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