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 a general agreement with Indian Institute of Technology, Varanasi.

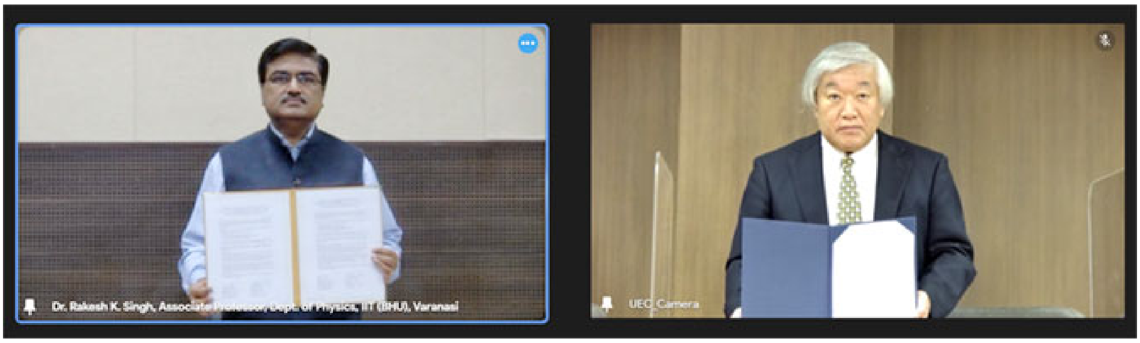
UEC signs a general agreement with Indian Institute of Technology, Varanasi.

On October 4 2022, the University of Electro-Communications（UEC）signed a general agreement with Indian Institute of Technology, Varanasi （IIT-BHU） to promote further international collaboration.

The signing ceremony was held online and attended by UEC President Tano, Director Abe from the Board of Directors, and three other UEC members. The ceremony began with the opening remarks by President Pramod Kumar Jain of IIT-BHU and President Tano.

The signed agreements were presented after the introduction of the two universities.
Following the signing ceremony, the members of IIT-BHU and UEC exchanged ideas for further research and student exchange.

Indian Institute of Technology, Varanasi, is one of India's 23 national universities specializing in engineering, science, and technology. Although the entrance examinations are unified, each school operates with its own autonomous organization. They are research institutions of national importance and are internationally recognized for their high level of research.



President Pramod Kumar Jain（left）and President Tano（right）.

Research Highlights : Innovation

Meteorology **Precipitation on the radar**

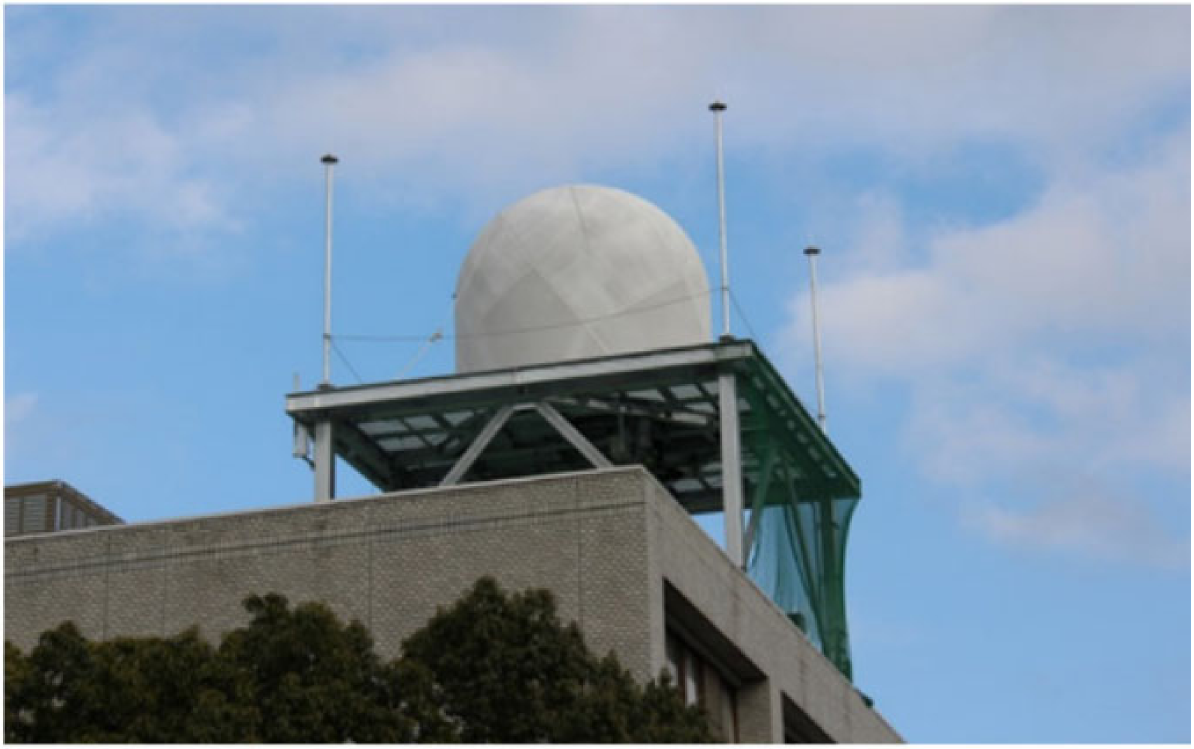
Weather radars are important instruments for measuring precipitation. Traditional radars are based on a parabolic dish antenna. Mechanically rotating and tilting such an antenna takes a relatively long time, and as a result, parabolic-type radars can typically only perform sparse observations. So-called phased array weather radars (PAWRs) can obtain data with better spatial resolution much faster, as they consist of an array of smaller antennas that do not require to be moved. Hiroshi Kikuchi from the University of Electro-Communications, Tokyo, and colleagues have now analysed the performance of a next-generation PAWR based in Japan: the X-Band Dual Polarized PAWR (DP-DAWR), installed in 2017 at Saitama University. Specifically, they assessed the instrument's accuracy of precipitation measurements by comparing with data obtained from a disdrometer (a device used for measuring raindrop sizes and velocities).

The Saitama University DP-DAWR simultaneously transmits fan-shaped beam pulses of horizontally and vertically polarized radiation at 9.425 GHz, which is in the so-called X-Band (8 – 12 GHz). The dual polarization improves the accuracy of precipitation amount measurements. In research mode, the instrument has a range of 60 km and the shortest temporal resolution is 10 seconds.

Measurements during a rainstorm demonstrated that the DP-DAWR can capture heavy rain at high temporal and spatial resolutions. This is useful in the context of monitoring and anticipating weather disasters in Japan such as flash flood events that are caused by locally generated heavy rain.

To quantify the accuracy of the performance of the radar, Kikuchi and colleagues compared observational data with radar variables derived from disdrometer data. The particle size and velocity (Parsivel) disdrometer used for this purpose is located 32 km away from the DP-DAWR, and provides raindrop size and speed distributions (32 size and 32 speed ranges are distinguished, resulting in 1024 raindrop types). From the disdrometer data, radar variables including the radar reflectivity factor could be calculated and compared to the observations made with the DP-DAWR. The comparison led to values for the mean and standard average of the radar reflectivity factor, a valuable characterization of the instrument's accuracy.

Finally, the researchers studied a thunderstorm event, and could conclude that the DP-PAWR is a convenient tool for observing the rapid growth of local convective thunderstorms, occurring often in Japan. Looking forward, Kikuchi and colleagues point out that in the near future, "quantitative evaluations of the DP-PAWR will be conducted using other precipitation types" and that in addition, "it is necessary to improve the signal processing for the high-reflectivity area near the edges of the different fan beams".



[Fig.1a from the paper]
Photograph of the DP-PAWR.

Hiroshi Kikuchi , Taku Suezawa, Tomoo Ushio, Nobuhiro Takahashi ,Hiroshi Hanado, Katsuhiro Nakagawa, Masahiko Osada, Tsuyoshi Maesaka, Koyuru Iwanami, Kazuhiro Yoshimi, Fumihiko Mizutani, Masakazu Wada and Yasuhide Hobara, Initial Observations for Precipitation Cores With X-Band Dual Polarized Phased Array Weather Radar, IEEE Transactions on Geoscience and Remote Sensing **58**, 3657-3666 (2020).

URL: https://ieeexplore.ieee.org/document/8949744
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Related publications

Hiroshi Kikuchi, Yasuhide Hobara, Tomoo Ushio, Compressive Sensing to Reduce the Number of Elements in a Linear Antenna Array With a Phased Array Weather Radar, IEEE Transactions on Geoscience and Remote Sensing 60, (2022).

DOI: 10.1109/TGRS.2022.3152998

Video Profile：Research

Bioelectromagnetics : interaction between human body and electromagnetic waves

Dairoku Muramatsu
Associate Professor at the Department of Mechanical and Intelligent Systems Engineering

Dairoku Muramatsu's research integrates electronics and bionics in an area known as "bioelectromagnetics". "The human bodies is composed of many biological tissues, such as skin, muscle, fat, bone, and different types of organs," explains Muramatsu. "These tissues and organs are electrically unique materials that interact with electromagnetic waves in a complex manner. The goal of my research is to clarify this complex interaction and utilize it for communication with digital gadgets, medical and healthcare devices, human interfaces, and even for food industry."

In this video, Muramatsu describes two specific applications in the areas of wireless communication and healthcare.

Human body communication is one of the areas of wireless communication technologies. Amazingly, it is possible to use human bodies as signal transmission paths for sending digital data. Once an electrical signal goes inside the body via electrodes, the signal propagates mainly through the human body and the space around the body.

The animation in the video illustrates how the electric field is distributed around the human body when a radio frequency signal is excited at the wrist. Notably, the electric field is distributed only around the body and propagates along the body's surface. This communication principle enables both highly secure and low-power communications.

As an application example of human body communication, Muramatsu implemented an LED color control system where a user selects color information from an app on a smartphone. This information is sent to the transmitter and modulated to a radio frequency signal. The signal is input to the hand through the electrode and subsequently distributed as an electric field around the user's body as described above. The receiver detects the electric field as a radio frequency signal, which is demodulated and used to control the color of the LEDs. "The important point is that the information is transmitted only when the user directly touches the transceiver electrodes," says Muramatsu. "So, human body communication can be used as an intuitive touch interface in e-money transactions, such as a using railway networks.

In the medical healthcare field, Muramatsu is working on non-invasive blood glucose monitoring. The current number of diabetic patients around the world is over 500 million, and that is estimated to 700 million in the next 20 years. Daily monitoring of blood glucose is vital for managing diabetes to prevent serious complications. The current monitoring method requires invasive blood sampling from a patient's fingertip. However, blood sampling with needle puncturing is uncomfortable, vulnerable to infection, and can be high in cost of consumables. To address such drawbacks and to improve patients' quality of life, Muramatsu proposed a non-invasive blood glucose monitoring based on bioelectromagnetics.

"Our method utilizes changes in a patient's bioimpedance as an indicator of blood-glucose concentration," says Muramatsu. "Patients put a wearable device such as a smart watch on the wrist and the device inputs electricity to the patient's body, and detects the bioimpedance from the sensing electrodes on its backside. Then, we estimate the blood glucose level from the patient's bioimpedance. In this way, we can realize non-invasive monitoring without blood samples, infection risk, and any consumables."

These were two examples of bioelectromagnetics. It is a multidisciplinary area of research that uses complex human-electricity interaction to develop practical applications that would not be possible through engineering alone.

"We need the cooperation of researchers in a wide range of expertise," says Muramatsu. "So, we are always open to collaboration and exchange."

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Dairoku Muramatsu website
https://mdairoku.com

Video Profile：Innovation

Soft robotic devices : artificial muscles and soft materials for robotic applications

Jun Shintake, Assistant Professor, Department of Mechanical and Intelligent Systems Engineering

Jun Shintake is developing soft actuators, sensors, and other robotic elements. As a base technology he is using an artificial muscle called dielectric elastomer actuators that consist of a soft membrane with compliant electrodes on both sides. Applying voltages to the electrodes generates an expansion of the membrane as actuation. The principle of this artificial muscle forms the basis for creating robots and other devices.

"We make all the devices by laminating thin film materials which are cut with a laser machine," explains Shintake. "This process allows the realization of various robotics elements such as actuators, sensors, pumps, and wearables."

In addition to the development of soft robotic devices,Shintake is also working on environmentally friendly robots with the vision that in the future many different kinds of robots will blend into human society and the natural environment.

Within this context, if a robot malfunctions or is involved in an accident, then it becomes waste, leading to environmental destruction. This means there is a conflict in the desire to develop soft robots that could cause environmental devastation. With this background, Shintake and his group are developing soft robots using biodegradable materials that return to the soil.

The video includes examples of a biodegradable soft actuator that exhibits bending actuation when air is injected. Gelatin is used as the main material in this device. As illustrated in the video, the actuator gradually degrades and eventually blends into the soil.

However, air-based actuators have limitations including the requirement for external pumps which are often difficult to implement into a robot.

"I have developed biodegradable soft actuators that are electrically driven," says Shintake. "Similar to other examples from our research, we use gelatin together with oil and other biodegradable materials. By using these materials, I have demonstrated that these actuators can generate muscle-like contraction movements."

Shintake add that ultimately plants are promising biodegradable materials for robots. This video includes a concept of a plant robot. Some kinds of plants exhibit physical deformations in response to external stimuli. Shintake is exploiting this behavior for the development of plant-based robots.

“I am also interested in biomimetic robots,” says Shintake. “In this case, I am developing a fish robot that can fly into the air from underwater like a flying fish. My work covers a broad range of areas of expertise involving the development of soft robotic elements, biodegradable devices, and biomimetic robots. Please contact me if you would like to know more about our research and collaborate in the development of these unique robotic elements.”

Further information

Jun Shintake
Assistant Professor, Department of Mechanical and Intelligent Systems Engineering, The University of Electro-Communications, Tokyo.

Website: http://kjk.office.uec.ac.jp/Profiles/74/0007381/prof_e.html
Research Highlight: Soft robotic gripper based on dielectric elastomer actuators