The University of Electro-Communications

UEC Research and Innovation

Latest updates on research and innovation at UEC Tokyo.

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News

Researchers unveil avatar “Yui” for teleoperation in real-world environments

Yoshihiro Nakata, Associate Professor, School of Informatics and Engineering, Department of Mechanical and Intelligent Systems Engineering

In a groundbreaking development, researchers unveil an Android Avatar named Yui, designed as a mobile humanoid Cybernetic Avatar (CA). A newly released video showcases the goals of an innovative project on CA and anticipated applications. The project establishes a versatile platform for CAs that can navigate everyday environments via teleoperation, enabling diverse social participation and providing an immersive control interface for operators.

This project is part of the ambitious "The Realization of an Avatar-Symbiotic Society where Everyone can Perform Active Roles without Constraint" initiative, managed by Hiroshi Ishiguro at the Graduate School of Engineering Science at Osaka University. It is part of the Moonshot Research and Development Program's Goal 1; “Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050.”

In this project Yoshihiro Nakata (Group 1/Topic 3) from The University of Electro-Communications Tokyo is developing a mobile humanoid CA that possesses human-like presence and lifelikeness. This cutting-edge research and development project signals a promising step towards a future where android avatars play an integral role in enhancing human capabilities and experiences.

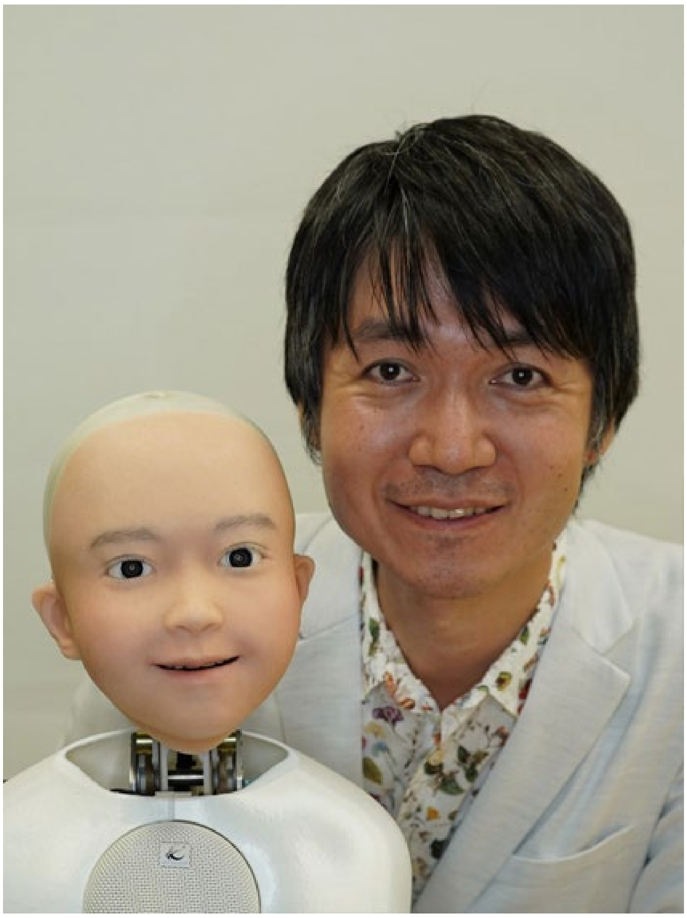
Further information

1. Yoshihiro Nakata, Associate Professor, School of Informatics and Engineering, Department of Mechanical and Intelligent Systems Engineering, UEC Tokyo.
http://www.nakata-lab.mi.uec.ac.jp/home/

2. UEC e-Bulletin Topics, Sept 2021 featuring Yoshihiro Nakata : “Creating robots to coexist in harmony with humans in the real world”
http://www.ru.uec.ac.jp/e-bulletin/topics/202109/a.html

3. Yui: Android Avatar (video)
https://www.youtube.com/watch?v=D0R2R-64RKU

4. Group1 Activities: Development of a CA which has a humanlike presence and a lifelikeness
https://avatar-ss.org/en/activities/group01/index.html



News

10th UEC Seminar in ASEAN 2023: Ushering in a Decade of Interdisciplinary Excellence in ASEAN

In a display of international interdisciplinary collaboration and academic excellence, the 10th UEC Seminar 2023, was held on Saturday 9 September 2023 at Suan Sunandha Rajabhat University, in the vibrant city of Bangkok, Thailand.

Hosted by the University of Electro-Communications (UEC), the Seminar included the participation of distinguished researchers, industry leaders, and government officials from across the ASEAN region.

Established in 2015 by the UEC ASEAN Research and Education Center (UAREC), the UEC Seminar in ASEAN has evolved into a prestigious annual gathering. Now, celebrating its 10th year, this year's seminar adopted a hybrid format, enabling participants to engage both in-person and virtually.

The inaugural session featured insightful opening remarks from Vice President Bundit Pungnirund of Suan Sunandha Rajabhat University, President Shunichi Tano of UEC, and Professor Cong-Kha Pham, Director of UAREC. The Embassy of Japan in Vietnam also contributed with valuable perspectives, and partner universities and research institutions from ASEAN delivered highly informative guest speeches.

The seminar provided a platform for UEC to showcase its pioneering research initiatives and international education programs to foster collaborative ties with universities across the ASEAN region. Distinguished organizations such as the Japan Society for the Promotion of Science, Japan International Cooperation Agency, National Institute of Information and Communications Technology, and Tokyo Metropolitan Industrial Technology Research Institute unveiled their activities within the ASEAN sphere.

A special segment shed light on UEC's fruitful collaborations with industries in Thailand, complemented by greetings from the Meguro-kai, the university's alumni association, elaborating on their diverse activities. The seminar was concluded with a speech by Dr. Koji Abe, a member of the UEC Board of Directors in charge of education and international strategy.

The resounding success of the seminar was evident in its participation, drawing approximately 110 attendees representing universities, corporations, and government bodies from ASEAN nations. This symposium marked not only a decade of academic excellence but also a testament to UEC's commitment to fostering cooperation and innovation throughout the ASEAN region.

Further information

Report：The 10th UEC Seminar, 2023

https://www.uec.ac.jp/eng/news/announcement/2023/20230914_5629.html

Group photograph of the participants in the 10th UEC Seminar held at Suan Sunandha Rajabhat University, Bangkok, Thailand.

Research Highlights：Research

Turing patterns go nano

The formation of certain patterns in nature, such as particular animal skin stripes or spots, can be explained by means of reaction–diffusion theory. This formalism, developed by Alan Turing, is based on the presence of two components (called ‘activator’ and ‘inhibitor’) with different diffusion rates. These two-component situations can give rise to what is collectively known as Turing patterns, such as the stripes seen on the skin of tropical fish or emerging order in chemical systems. Typical length scales of biological Turing patterns range from millimetres to centimetres. For purely chemical systems, the characteristic lengths are usually sub-millimetre. Although reaction–diffusion theory does not pose limits on intrinsic length scales, Turing patterns on the nanometre scale are rare. Recently, however, Yuki Fuseya from the University of Electro-Communications, Tokyo, and colleagues have identified a new type of nanoscale Turing patterns in a monolayer of bismuth atoms on a substrate.

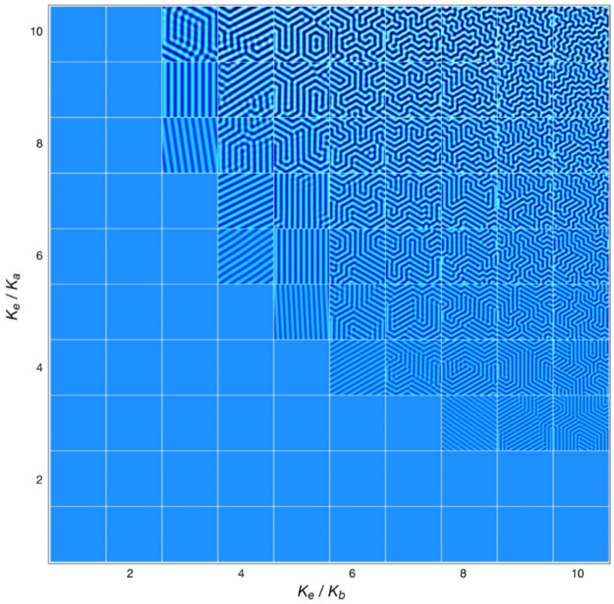
The patterns had been observed earlier, when scientists tried growing atomic monolayers of bismuth (Bi) on niobium diselenide ($NbSe_2$); such materials are investigated for their promising electronic properties. Fuseya and colleagues were intrigued by the mysterious patterns seen in these Bi/$NbSe_2$ systems, in the form of ripples, as they resembled the Y-shaped arrangement of stripes on angelfish. What is remarkable is that the monolayer stripe patterns are more than a million times smaller than the fish patterns.

Fuseya and colleagues built a model describing how Bi atoms arrange themselves on a $NbSe_2$ substrate. The height of a Bi atom is the variable determining the ripple pattern, consisting of ‘peaks and ‘valleys’. The researchers found that it is not enough to include elastic interactions between Bi atoms and adsorption interactions between Bi atoms and the $NbSe_2$ substrate in the model: orientational effects in the Bi–Bi interactions have to be taken into account as well— specifically, the angles between Bi–Bi bonds.

The dynamics of the set of Bi atoms could then be described by an equation of motion for the displacements of the atoms. Numerical evaluations of the equation led to various types of ripple patterns, including the Y-shaped arrangements seen in the earlier experiments, with an intrinsic length (between peaks or valleys) of five times the interatomic Bi distance. The scientists then checked whether their model could be interpreted as a reaction–diffusion situation. They were indeed able to rewrite the system’s equation of motion as a reaction–diffusion equation, with a Bi atom’s vertical displacement (perpendicular to the $NbSe_2$ substrate) as the activator, and the horizontal displacement (parallel to the substrate) as the inhibitor.

The researchers then tested what happened when a pattern was perturbed. They observed self-restoration of the original pattern, thus recovering the ‘wound healing’ property of reaction–diffusion systems. Finally, they studied the effect of applying strain to the system, and showed that doing so can change the Bi atom patterns in a controlled way.

The findings of Fuseya and colleagues are of particular importance as they demonstrate the existence of Turing patterns in ‘hard condensed matter’, which are moreover expected to have practical relevance. Quoting the researchers, “[the] obtained patterns can prove to be building blocks for new devices or new physics that have been unexplored”.



Caption: Various nanoscale Turing patterns of bismuth atoms on a substrate.

Reference

Yuki Fuseya, Hiroyasu Katsuno, Kamran Behnia and Aharon Kapitulnik, Nanoscale Turing patterns in a bismuth monolayer, Nature Physics 17, 1031–1036 (2021).

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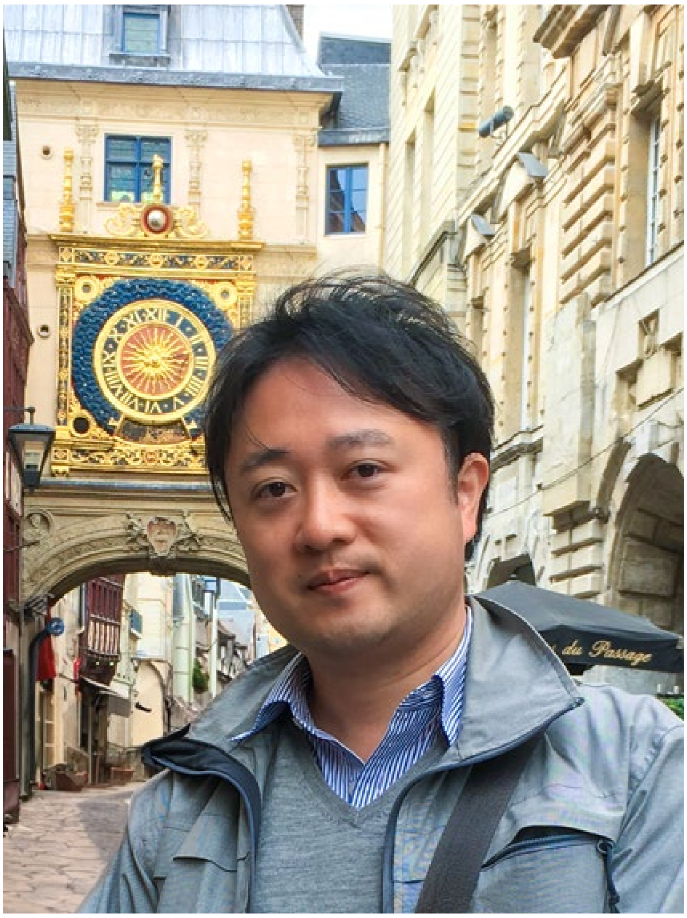

Yuki Fuseya, Professor, Department of Engineering Science

Research Highlights : Research

Impact of the largest Gamma-Ray Burst on the Earth's ionosphere

Satellites detect gamma-ray bursts most days but rarely do these events affect the ionosphere. However, when they do, they have a measurable impact on the propagation of Low Frequency (LF) and Very Low Frequency (VLF) radio waves there. Now researchers led by Yasuhide Hobara at the University of Electro-Communications have examined the impact of the Gamma-Ray Burst GRB221009A, which took place on 9th October 2022 and is the largest detected gamma-ray burst ever recorded on Earth. They reported their results in the journal Atmosphere on 20th January 2023.

The ionosphere is the upper part of the atmosphere from around 48 km to 965 km above sea level, and it is characterized by extensive ionization of its atoms and molecules due to solar UV and X-ray radiation. At lower heights, the density of air increases so that the resulting electrons and ions soon recombine into neutral particles. However, in the ionosphere, where a high level of ionization persists, the air behaves like a conductor so that the space between the ionosphere and the Earth's surface acts as a waveguide for the propagation of VLF and LF radio waves.

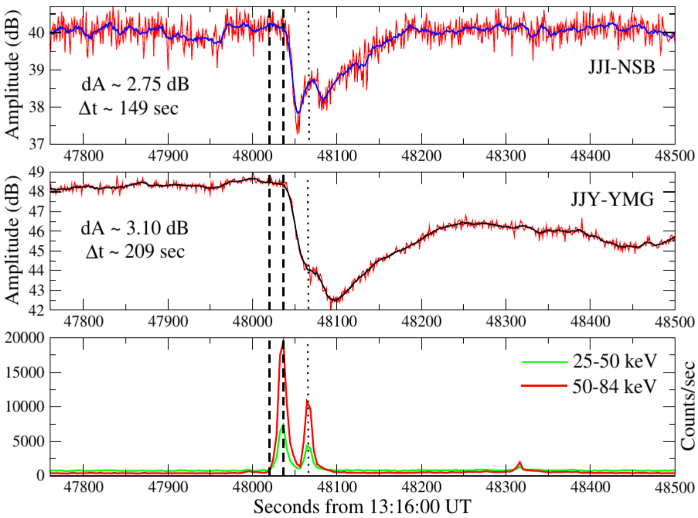

Fig. 1: Nighttime perturbations of VLF/LF signals transmitted from Japanese transmitters JJI and JJY due to the GRB220910A observed in Nakashibetsu (NSB) and Yamaguchi (YMG) stations (in Japan). The third panel shows the light curve of the GRB in two energy bands 25–50 keV (green) and 50–84 keV (red). The two vertical dashed lines indicate the event trigger and peak flux times. The third dotted line indicates the peak flux time of the subsequent trigger. © 2023 Pal, et al., Atmosphere (Pal, S.; Hobara, Y.; Shvets, A.; Schnoor, P. W.; Hayakawa, M.; and Koloskov, O. First Detction of Global Ionospheric Disturbances Associated with the Most Powerful Gamma Ray Burst GRB221009A. Atmosphere 2023, 14, 217. https:// doi.org/10.3390/atmos14020217)

All sorts of space weather events can affect the ionosphere and its ionization levels, including soft X-rays from solar flares, energetic particle precipitation from geomagnetic storms, and even the daily fluctuation in solar flux between day and night. All these effects on ionization levels lead to measurable perturbations in LF and VLF radio signals. The researchers recorded the impact of GRB221009A on the nighttime ionosphere using a UEC-operated network of VLF/LF receivers in Japan. An example of radio signal perturbations observed in two Japanese stations Nakashibetsu (NSB) and Yamaguchi (YMG) due to the GRB is shown in Fig.1. The radio signals were transmitted from two Japanese transmitters JJI (22.1 kHz) and JJY (40 kHz). Two consecutive bursts of gamma-ray photons are seen in the light curve of the GRB as observed by satellite and displayed in the third panel in two separate energy bands. They also took data from the Kiel long-wave monitor (KLM) in Germany, Supersid network in Germany and Poland, and a Ukrainian network, which were in daylight during the gamma-ray burst. Depending on the distance travelled and the frequency of the transmissions, it took anywhere from two minutes to around an hour to recover the radio signals from the perturbation. In general, LF signals took a longer time to recover, likely because they propagate at a height where N2, O2 and O are less dense resulting in slower recombination. Recovery times were also greater for regions exposed during the day than those where it was nighttime, suggesting greater disturbance.

Previous gamma-ray bursts have been observed as perturbations in VLF signals with amplitudes ranging from 0.3 to 26 dB, sometimes taking as long as an hour before the ionized particles recombine and the signal settles to within 25% of its pre-event amplitude. However, the researchers point out in their report that the Gamma-Ray Burst GRB221009A was the “record-breaking event detected so far by any space satellites”. Satellite measurements recorded two peaks in energetic photons, with the most energetic photons at 99 GeV measured 240 seconds after the first trigger “making it a once-in-a-century event”. Measurements of VLF/LF signals also confirmed the two peaks in the gamma-ray burst. Astronomers attribute this event to a supernova explosion from a massive star 2.4 billion light years away from the Earth. They describe it as the “birth cry of a black hole”.

The authors conclude with the prospect of further details of the chemical reactions that lead to the longer recovery times based on theoretical simulations.

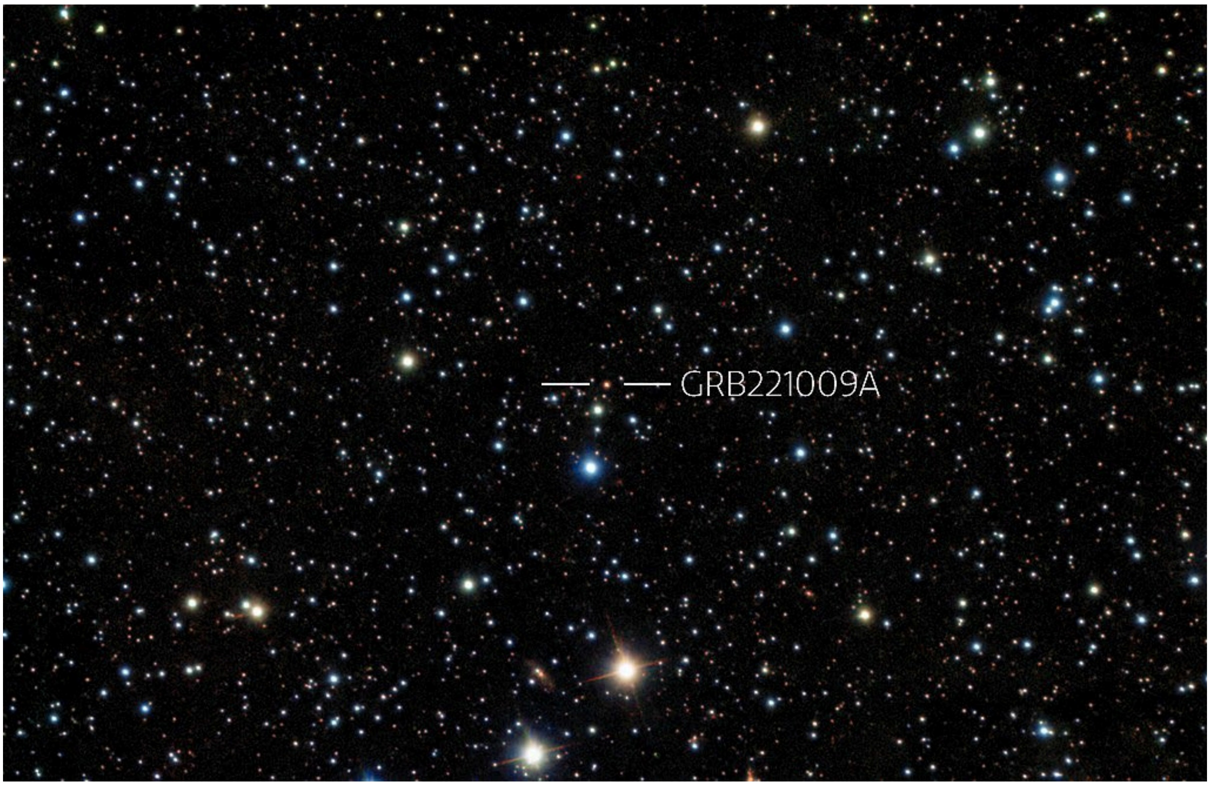

Fig. 2: Record-breaking gamma ray burst caught with Gemini: Scientists report the disturbance to the ionosphere by GRB221009A, the largest gamma ray burst on record. Credit: International Gemini Observatory/NOIRLab/NSF/AURA/B. O'Connor (UMD/GWU) & J. Rastinejad & W Fong (Northwestern Univ)Image processing: T.A. Rector (University of Alaska Anchorage/NSF's NOIRLab), J. Miller, M. Zamani & D. de Martin (NSF's NOIRLab)

Sujay Pal, Yasuhide Hobara, Alexander Shvets, Peter Wilhelm Schnoor, Masashi Hayakawa and Oleksandr Koloskov First Detection of Global Ionospheric Disturbances Associated with the Most Powerful Gamma Ray Burst GRB221009A Atmosphere 14, 217 (2023)
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DOI: 10.3390/atmos14020217

Yasuhide Hobara, Professor, Department of Computer and Network Engineering

Video Profile：Research

Artificial intelligence for energy, materials science, and quantum computing

Tomah Sogabe
Associate Professor, Faculty of Informatics and Engineering,

Tomah Sogabe’s research focuses on integrating cutting-edge AI techniques into three key research areas: energy optimization, device design, and quantum computing. The primary objective is to create automatic control systems and design schemes that tackle tasks too complex for human knowledge alone.

In AI-based smart grid optimization, Sogabe's research group has successfully developed an ensemble deep reinforcement learning algorithm. This algorithm trained multiple learning agents to handle a wide range of weather scenarios, simulated through a global weather forecasting package. The trained agents not only learned optimal policies but also provided risk evaluations for decision-making processes.

In device design, Sogabe’s group has excelled in optimizing transparent solar cells to maximize efficiency, transmittance, and device lifespan. Traditionally, device optimization relies on trial and error, but the design complexity is beyond human capabilities, with over 30 parameters requiring optimization. The AI-based approach explored and optimized molecular structures with specific absorption profiles, ensuring maximum light absorption and visible light transmittance. This was accomplished using time-dependent DFT atomic simulation and reinforcement learning to predict and optimize molecular structures, resulting in optical absorption profiles closely resembling the target profile.

Finally, Sogabe and colleagues have demonstrated the applicability of AI technology in quantum circuit design, considered one of the most challenging aspects of advanced quantum computing. Quantum circuits exhibit intricate features such as high dimensionality and non-linearity, aligning well with AI's strengths. The integration of AI and quantum computing proved highly synergistic, facilitating the generation of target quantum states and the creation of robust and reliable ansatz states with minimal molecular energy.

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Website
https://cluster-iperc.matrix.jp/

Video Profile：Innovation

Acoustic electronics

Hideyuki Nomura
Professor, Graduate School of Informatics and Engineering

Hideyuki Nomura specializes in acoustic electronics. While traditional acoustics research focuses on applications such as speech recognition and media processing for listening purposes, Nomura's group explores acoustic technology development without the goal of listening. They work across a wide frequency range, from audible to ultrasonic frequencies, to improve our lives.

Recent research highlights

Acoustic Imaging: Sound waves are used for visualization, particularly vibro-acoustography, which captures the mechanical characteristics of objects by inducing transient response vibrations.

Medical Applications: Acoustic imaging finds applications in medical fields, including ultrasound diagnostics and therapeutic treatments. They aim to assess the safety and distribution of acoustic energy within the body.

Directional Audio: Nomura's group is working on directional audio systems, such as parametric speakers, which can transmit sound in specific directions. They have developed a technology to maintain directionality while stopping sound propagation, which can prevent reverberation in confined spaces.

Overall, their research combines acoustic phenomena and electronics to enhance our quality of life. They plan to incorporate artificial intelligence and other technologies for the development of next-generation acoustic systems in the future.

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