NTU GICE
Newsletter
Graduate Institute of Communication Engineering, National Taiwan University

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GICE Honors

IEEE Fellow, 2025
IEEE, Institute of Electrical and Electronics Engineers

Outstanding Research Award, 2024
National Science and Technology Council, NSTC

Outstanding Electrical Engineering Professor Award, 2024
The Chinese Institute of Electrical Engineering, CIEE

Prof. Hung-Yu Wei

Fellow of the Chinese Institute of Electrical Engineering, 2024
The Chinese Institute of Electrical Engineering, CIEE

Prof. Tzong-Lin Wu

Outstanding Electrical Engineering Professor Award, 2024
The Chinese Institute of Electrical Engineering, CIEE

Prof. Shih-Yuan Chen

Outstanding Young Electrical Engineer Award, 2024
The Chinese Institute of Electrical Engineering, CIEE

Prof. Hao-Chung Cheng

Taiwan Outstanding Women In Science, 2025
Wu Chien-Shiung Education Foundation

Prof. Wanjiun Liao

GICE Outstanding Doctoral Dissertation Award

Doctoral Dissertation *Speech Processing with Higher Efficiency: Self-Supervised Learning for Low-Resource Scenarios*

DS Group | **Student. Andy T. Liu | Advisor Prof. Hung-yi Lee**

Dr. Liu received his Ph.D. in Electrical Engineering & Computer Science (EECS) from the National Taiwan University (NTU) in January 2024, under the supervision of Prof. Hung-yi Lee, as part of the "Speech Processing and Machine Learning" lab.

With over five years of dedicated experience, Dr. Liu specializes in Self-Supervised Learning (SSL), Speech Foundation Models, Automatic Speech Recognition (ASR), Large Language Models (LLM), and Multimodal Models. His research has garnered significant attention, accumulating over 2,200 citations and an h-index of 13 on Google Scholar.

GICE Outstanding Master's Thesis Award

Master's Thesis *Cryogenic Microwave Electronics and Measurement Systems for Quantum Computing Applications*

EM Group | **Student. Shih-Yun Chen | Advisor Prof. Shih-Yuan Chen**

Shih-Yun Chen received his B.S. degree in Electrical Engineering in 2021 and his M.S. degree in Communication Engineering in 2024 from National Taiwan University, Taipei, Taiwan. He is currently a research assistant in Professor Shih-Yuan Chen's lab.

GICE Outstanding Master's Thesis Award

Master's Thesis *Dynamic Thresholds Data Selective Affine Projection Adaptive Algorithm For Acoustic Echo Cancellation*

CSP Group | **Student. Chang-Cyuan Chen | Advisor Prof. Hen-Wai Tsao**

Chang-Cyuan Chen received his master's degree from the Graduate Institute of Communication Engineering, National Taiwan University in 2024. His research interests include adaptive algorithms, data selection, and acoustic echo cancellation.

GICE Outstanding Master's Thesis Award

Master's Thesis *Learning from Demonstration via Density Estimation Using Diffusion Model*

DS Group | **Student. Hsiang-Chun Wang | Advisor Prof. Shao-Hua Sun**

I conducted research on reinforcement learning algorithms during my master's studies, focusing on online and offline imitation learning for my thesis. Currently, I am working as an ML researcher.

Vol.16 No.1 March, 2025

Paving towards 6G through AI-native air interface: view from Laboratory of Intelligent Computation and Communication Interface Design in GICE

Dr. Chu-Hsiang Huang

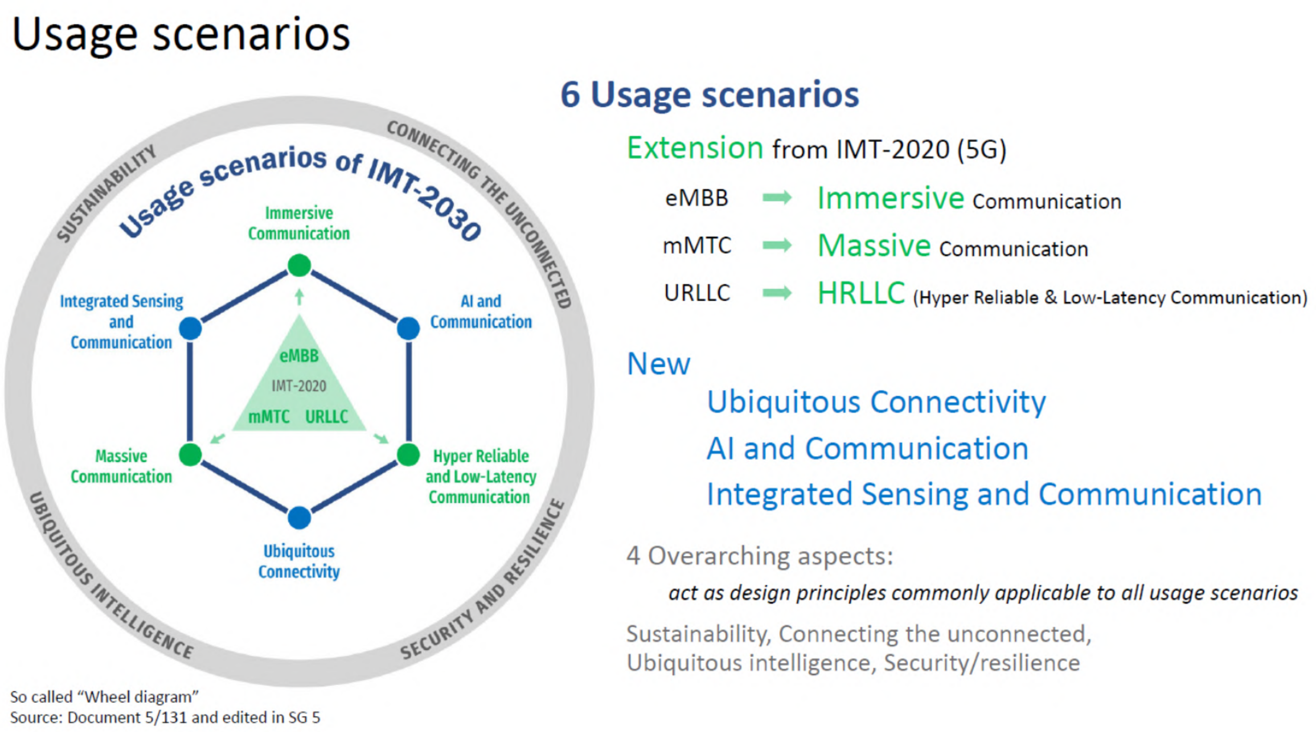
Assistant Professor
Graduate Institute of Communication Engineering
National Taiwan University

While transceiver algorithms in wireless communication systems can keep evolving and incremental changes can be applied to further optimize the performance and energy efficiency, major changes in the air-interface require collaboration across different entities in the eco-system and follow a carefully planned long-term timeline. Therefore, the opportunities to push new features with significant air-interface impact into the wireless communication systems appear only during the generational evolution. Fortunately, we are at the corner of turning into the next generation of cellular communication systems based on 3GPP's planned timeline that targets 2030 commercialization and deployment. Researchers and developers worldwide are excited about such great opportunities and competing fiercely to contribute to the next-generation cellular communication system design.

In fact, there are many challenges and opportunities created by emerging technologies and systems for wireless communication systems design and deployment. Artificial intelligence (AI) and machine learning (ML) technologies enable more and more applications to utilize the data, networking, and computation capabilities on different devices to create novel services and functionalities. In the age of intelligent machines, enabling data and information to flow efficiently through the network of ubiquitously connected devices becomes the key challenge to leverage the great applications and services created by computation and artificial intelligence technologies to build a better and smarter society. This will fuel the growth of the connected intelligent edge, consisting of both distributed processing in the networks and intelligence on devices.

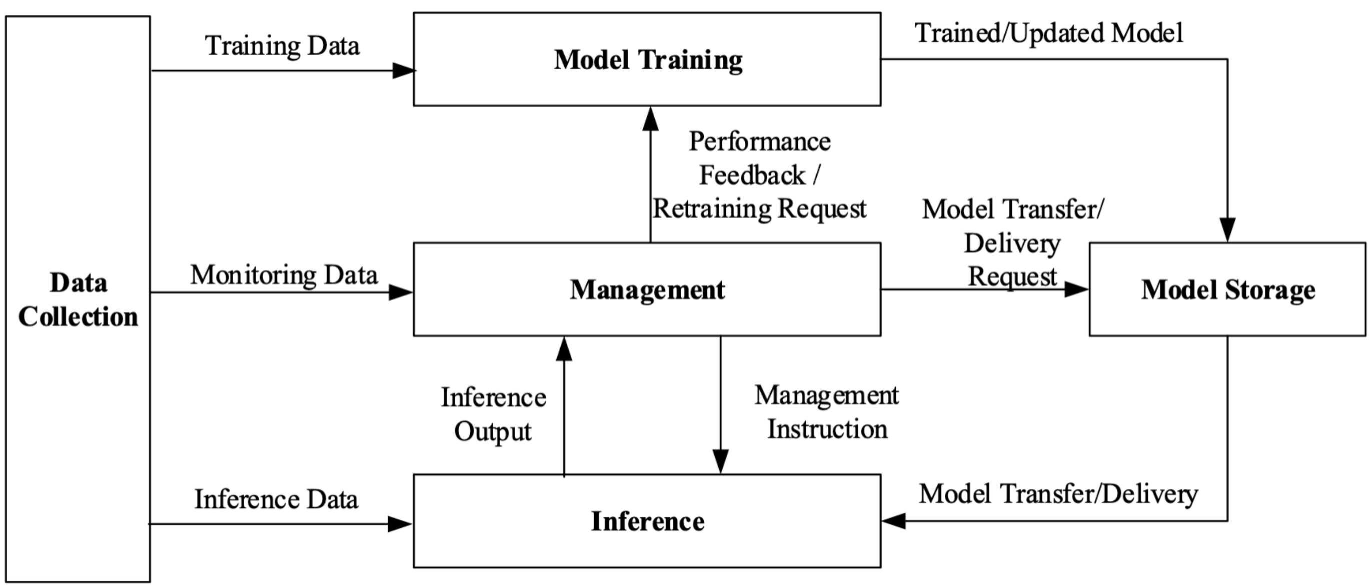
Here is what we have at this transition point: from the application scenario perspective, we have AI-enabled intelligent services and devices flooding data and parameters to the communication networks, and the vision of ubiquitous connectivity becomes much closer due to cheaper satellite launching and cost and energy efficient micro devices; from the communication theory/technology perspective, we emerging techniques such as AI model based transceiver algorithms, semantic communication, satellite communications, integrated sensing and communication, sub-Tera Hz etc. Then the most important question at this point becomes: how do we design the new air-interface to unleash the full potential of these great communication theories and technologies to enable the industry to create great systems for the application scenarios calling for better communication technology?

This is the billion-worth question that many researchers in NTU GICE, including those in our lab, Laboratory of Intelligent Computation and Communication Interface Design, are trying to answer. We focus on the AI-native air-interface design, which aims at creating the air-interface of the intelligent network for carrying and collecting data for AI models and AI-based service, and ubiquitously connects every corner on the planet Earth. In fact, International Telecommunication Union (ITU)' 6G Vision, International Mobile Telecommunications 2030 (IMT-2030), is echoing such vision: the three new directions in IMT-2030, AI and communication, ubiquitous connectivity, integrated sensing and communication, are the three most important pillars to build a network running AI-based services with the capability of ubiquitously connecting and collecting data from all the devices in the world.



Furthermore, such a network requires enabling the computation task/resource distribution of AI model training and inference, enhancing power efficiency to achieve the sustainable development goal set by the UN, and improving the reliability and coverage of the network.

The 3GPP study as a preliminary step from 5G-advance towards 6G provided the following functional framework for AI/ML for NR air interface.



This framework aims at covering a general functional architecture for development, training and life cycle management (LCM) for the AI models in the next generation communication systems. Along with the framework, several general directions, e.g., model identification, model-ID or functionality-based LCM, are discussed in 3GPP standardization procedures. However, a concrete LCM framework guiding the air-interface to support LCM functionalities that leads to system performance guarantee is still missing.

We believe that it's important to develop an analytical framework for theory-based AI-native air-interface design with guaranteed inter-operability and performance monitoring capability to support seamless communication in different environments and application scenarios of AI model and other next-generation services. With the ability to adapt to various environments and connectivity requirements, the AI-native air-interface is expected to be the essential communication technology to build the next generation edge intelligence systems. To be more specific, the AI-native air-interface design has to (1) enable the transceiver algorithm to leverage AI models that can enhance communication performance (2) support life cycle management for the AI models in the transceiver algorithms to ensure reliable connection and data rate performance (3) enable joint design of transceiver algorithms and AI model computations running on network entities and devices (4) support potential environment recognition/sensing to collect data while communicating.

An intelligent network, which ubiquitously connects various types of intelligent devices around the world to collect data, distribute computation resources, and provide AI-powered services, imposes tremendous challenges in wireless communication system design. While LTE and 5G air-interface already provide great broad band services and connect huge number of devices to the internet, re-designing a new AI-native air-interface to address the new communication challenges and opportunities brought up by emerging AI and other novel technologies is the key to the success of 6G evolution.

Dr. Chu-Hsiang Huang

Assistant Professor
Graduate Institute of Communication Engineering
National Taiwan University

Chu-Hsiang Huang received B.S. and M.S. degrees in Electrical Engineering from National Taiwan University in 2007 and 2009, respectively. and his Ph.D. in electrical engineering from UCLA in 2015. He is now with National Taiwan University (NTU) as an assistant professor. Before join NTU, he was working in Qualcomm Technologies, Inc. as a RAN working group delegate for 3GPP Standard Organization. Besides representing Qualcomm in 3GPP standard meetings, he is working on product development projects including multi-user interference mitigation, energy efficient receiver and demodulation algorithm for Qualcomm flagship modems as a senior staff engineer. He was a research assistant for NTU-INTEL research center in Taiwan in 2010. His research interest includes next generation wireless communication system design, communication system standardization, artificial intelligence and machine learning, statistical communication theory .

New-Hire Faculty Prof. Chia-Yi Yeh Refreshes Undergrad Lab Course on Communication Systems

Dr. Chia-Yi Yeh

Assistant Professor
Graduate Institute of Communication Engineering
National Taiwan University

As a new faculty who joined NTU GICE in 2024, I am excited about the opportunity to teach the EE undergrad lab on communication systems as my first course. This communication system's lab is among the ten lab courses for EE undergrads in their junior and senior years after completing the fundamental EE courses. Since wireless communication can be pretty abstract as we cannot "see" or "hear" electromagnetic waves, having the chance to program devices to transmit and receive wireless signals helps the students map what they've learned in textbooks to real-world transmissions and, further, use experiments to show their wildest ideas.

During my PhD and PostDoc, I worked with different versions of software-defined radios for various wireless experiments. This includes a 96-element rectangular array named ArgosV2 built at Rice University, which is among the first to demonstrate massive MIMO systems and later evolved to be the RENEW platform. I also took the lab course offered by key members of the massive MIMO development team at Rice University, Dr. Clayton Shepard and Dr. Rahman Doost-Mohammady, first as a student and later as a teaching assistant, thus having first-hand experience observing how the lab course evolved. During my PostDoc, I further had the chance to use a software-defined radio called "Pi-Radio" which operates at the millimeter wave band with a fully digital array architecture through collaboration with Northeastern University.

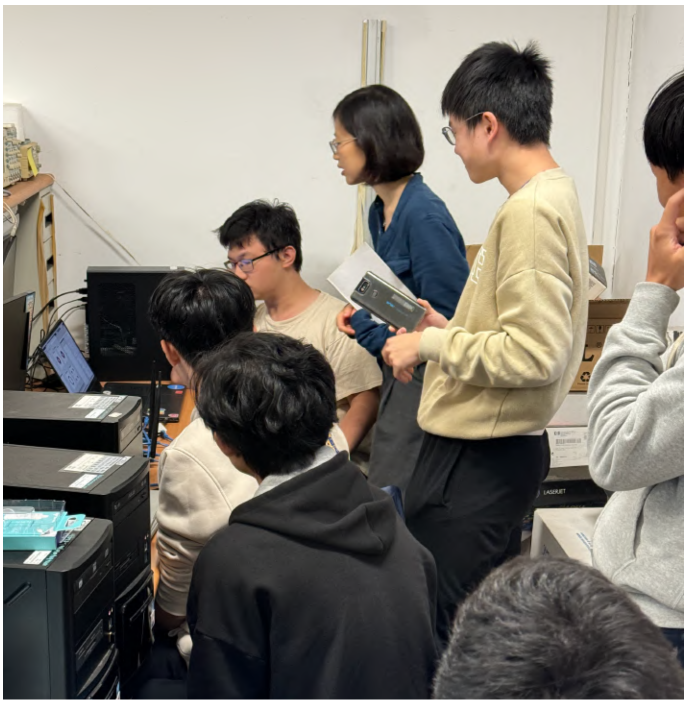
When designing the lab course, I took inspiration from my earlier experience during my PhD and PostDoc. First, for a lab class, I decided the students must conduct over-the-air wireless transmissions using software-defined radios and, through the steps, understand the main components of wireless transmissions deeply and learn issues existing in practical systems. While the labs focus on the fundamentals, I further decided to expose students to the broad applications of wireless systems. From these two central ideas, I started designing the lab course. Above all, I want this class to be fun!

For the over-the-air transmission, I designed five labs, starting from MATLAB simulations, leading to WiFi-like OFDM transmission with software-defined radios. The labs are designed for the students to first learn to write scripts that generate and process the wireless waveforms using MATLAB simulation. Later on, the students learn the control interface with the software-defined radios and program the radios to transmit and receive as scripted in MATLAB. While this sounds not too complicated, there were always uncertainties when getting things to run for the first time, and I sometimes had to change things on the fly. For instance, I originally planned a lab on combining the signals from two receiving antennas but later found that our version of the USRP does not support two receive channels and thus had to cancel that part. Despite a few slip-ups here and there, I am proud that all eight groups in this course successfully demonstrated the targeted WiFi-like transmission using USRPs at the end of the semester.

The defense side and offense side debated the selected paper.

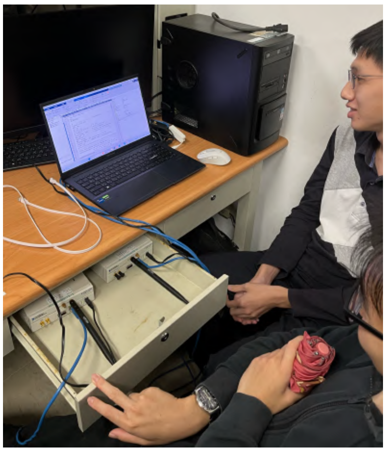
In addition to the labs, I assigned students to read conference papers to broaden their perspectives on the infinite possibilities of wireless systems. I want the students not only to learn about the latest applications but also to think critically about these newly proposed ideas. To this end, I made the students debate the papers. In each paper debate, the defense team summarized and advocated the paper, while the offense team criticized it. The goal is to train the students to think objectively from either perspective. The debate course idea originally came from a class taught by my PhD advisor, Prof. Edward Knightly. It was such a fun experience when I took his course that I decided to create this experience for the undergrads at NTUEE. To adapt the originally graduate-level course for undergrads, I consulted Prof. Knighlty, and based on his suggestion, I added a discussion session for the debate teams before the course debate to resolve questions they might have on the paper and prepare them for their arguments. Despite all the worries, I was amazed by how well the students understood the highly technical papers and brought up arguments from angles that surprised me. The students also strongly agreed that the debate format was not only fun but also helped them think more critically in the end-of-semester survey.

This is just the very first semester. I am happy that the lab experiment worked as planned and the students enjoyed the paper debates, yet there is still a long way to the ideal lab course in my head. My vision is to create a lab course that allows the students to experiment on diverse topics in communications. To this end, I plan to add new course modules and acquire additional experimental equipment in the coming semesters. In the meantime, I will continue polishing the course materials to create a more effective learning experience. I'd like to give special thanks to my TAs, Yi-Heng Lin and Harvey Lai, who contributed significantly to the redesign of the lab course. I also thank my students who took the very first version of this course and gave me valuable feedback.



The instructor and TA inspected over-the-air transmission demo of each team.

The audience participated in the paper discussion.



One team hid their devices inside a metal drawer to prevent interference from other groups.

Dr. Chia-Yi Yeh

Assistant Professor
Graduate Institute of Communication Engineering
National Taiwan University

Chia-Yi Yeh is an Assistant Professor at the Graduate Institute of Communication Engineering at National Taiwan University. She received her Ph.D. and M.S. in Electrical and Computer Engineering from Rice University in 2022 and 2018 under the supervision of Prof. Edward W. Knightly, and her B.S. in Electrical Engineering from National Taiwan University in 2014. From 2022 to 2024, Chia-Yi Yeh was a Postdoctoral Associate affiliated jointly with the Department of Electrical Engineering and Computer Science (EECS) at Massachusetts Institute of Technology and the School of Engineering at Brown University under Prof. Muriel Médard and Prof. Daniel M. Mittleman. Her research interests are the design, implementation, and experimental demonstration of next-generation wireless systems for communication, security, and sensing based on theoretical foundations, for systems including massive MIMO, millimeter wave, and terahertz networks.

The 2024 2nd Semi-annual Workshop of Taiwan Electromagnetic Industry-Academia Consortium: Prospective Antenna Applications in Radar Systems and Satellite Communications

The 2024 2nd Semi-annual Workshop of Taiwan Electromagnetic Industry-Academia Consortium was successfully held on October 3rd, 2024. Due to safety concerns regarding Typhoon Krathon, the event was conducted entirely online, with all presentations and discussions taking place virtually.

Despite the change in format, the workshop effectively brought together leading researchers from Taiwan's premier academic institutions to showcase cutting-edge developments in electromagnetic technology. The workshop highlighted significant advances in metasurface technology, terahertz communication, millimeter-wave radar systems, and radar cross-section reduction, demonstrating the dynamic evolution of electromagnetic research and its practical applications.

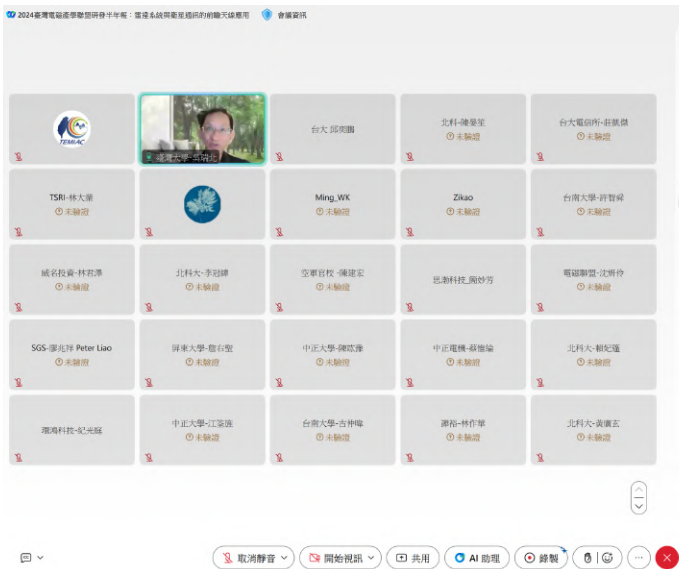


Fig. 1. Professor Ruey-Beei Wu gave a welcome remark.

Metasurface Applications in Satellite Antennas

Assistant Professor Liang-Yu Ou Yang from National Central University presented groundbreaking research on metasurface applications in satellite antenna systems. His work addresses the growing demands of global communication networks, particularly in the context of Low Earth Orbit (LEO) satellites. Metasurfaces, comprised of precisely engineered subwavelength-scale unit cells, enable unprecedented control over electromagnetic wave properties, including amplitude, phase, and polarization. This technological advancement has profound implications for antenna design, allowing for significant size reduction while maintaining optimal performance—a crucial factor in both mobile communication devices and satellite systems.

Professor Ou Yang's research demonstrated that reflective metasurfaces offer remarkable flexibility in beamforming and steering capabilities. Additionally, transmissive arrays have shown promising results in optimizing efficiency for high-frequency communication systems, particularly in emerging 5G and 6G technologies. These innovations lay the groundwork for future developments in Internet of Things (IoT) applications and smart city infrastructure.

Fig. 2. Professor Liang-Yu Ou Yang delivered a talk on Metasurface Applications in Satellite Antennas

300 GHz Antenna Designs and Measurements

The frontier of high-frequency communication was explored in detail by Assistant Professor Yu-Hsiang Cheng from National Taiwan University, who presented innovative work on 300 GHz antenna technology. While atmospheric loss poses significant challenges at these frequencies, Professor Cheng emphasized the technology's particular relevance in space-based applications where atmospheric interference is absent. His team has successfully developed antenna designs that exceed the performance of conventional terahertz configurations in terms of bandwidth, utilizing cost-effective fabrication methods. The presentation also detailed sophisticated measurement techniques, including the implementation of Compact Antenna Test Range (CATR), essential for accurate performance assessment at these extreme frequencies.

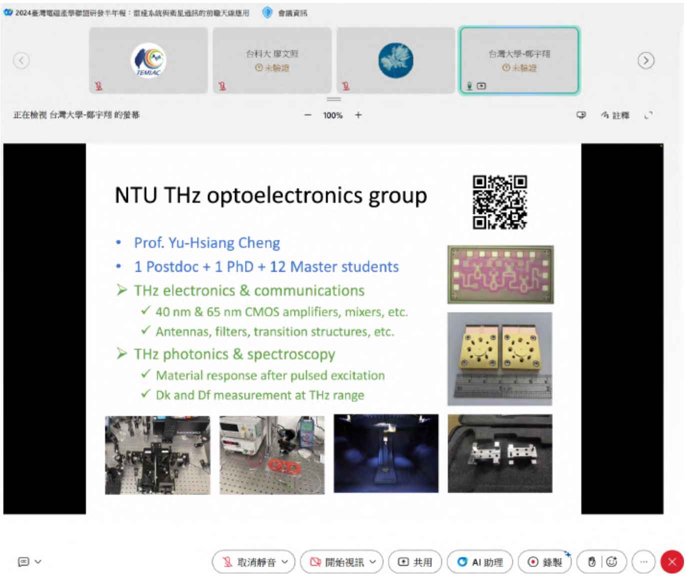


Fig. 3. Professor Yu-Hsiang Cheng delivered a talk on 300 GHz Antenna Designs and Measurements

Millimeter Wave Radars for Micro-motion Detections and Its Applications

Assistant Professor Sung-Nien Hsieh from National Taiwan University of Science and Technology presented compelling applications of millimeter-wave radar technology in both healthcare and industrial settings. His research demonstrates the capability of Frequency-Modulated Continuous Wave (FMCW) radar to detect subtle physiological movements, opening new possibilities in non-invasive health monitoring. The technology's industrial applications are equally promising, offering sophisticated solutions for equipment monitoring and predictive maintenance in smart factory environments. This dual-purpose approach highlights the versatility of millimeter-wave radar systems in enhancing both healthcare delivery and industrial efficiency.

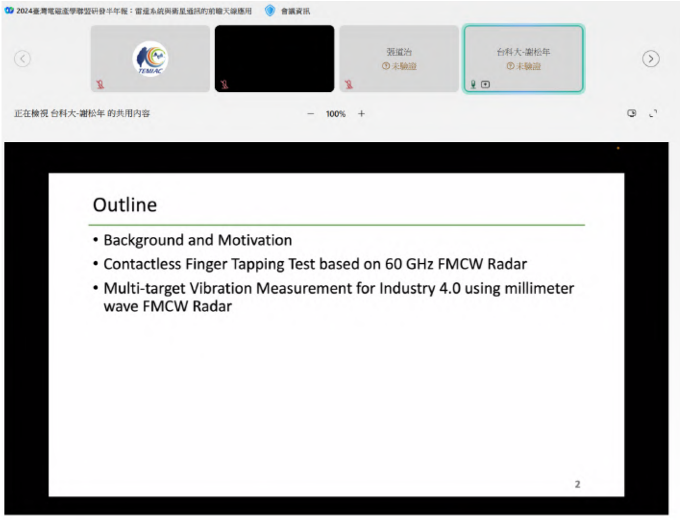


Fig. 4. Professor Sung-Nien Hsieh delivered a talk on Millimeter Wave Radars for Micro-motion Detections and Its Applications

Radar Cross-Section Analysis Method for Stacked Structure

Assistant Professor Yuan-Chang Hou from National Ilan University presented significant advances in radar cross-section (RCS) reduction technology. His team's innovative approach utilizes stacked dielectric plates to achieve superior stealth capabilities, particularly crucial for military applications. The multilayer structures developed by Professor Hou's team effectively achieve phase cancellation of reflected radar waves, resulting in substantial RCS reduction across a wide range of frequencies and angles. While primarily developed for military stealth applications, this technology shows promise for broader applications in civilian communication systems and electromagnetic compatibility design.

The symposium's presentations collectively demonstrated the rapidly evolving landscape of electromagnetic technology and its far-reaching implications. From enhancing global communication networks to advancing healthcare monitoring systems and military capabilities, the research presented reflects the field's dynamic nature and its critical role in technological advancement. These developments not only address current technological challenges but also pave the way for future innovations across multiple sectors.

The convergence of academic research and practical applications showcased at the symposium underscores the vital role of continued collaboration between industry and academia in driving technological progress. As these technologies mature, their integration into various aspects of society promises to bring about significant improvements in communication, healthcare, industrial efficiency, and defense capabilities.

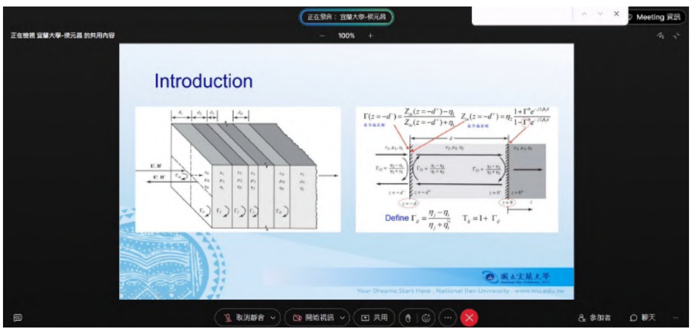


Fig. 5. Professor Yuan-Chang Hou delivered a talk on Radar Cross-Section Analysis Method for Stacked Structure

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