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

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GICE Honors

1st Class Science and Technology Profession Medals

National Science and Technology Council (NSTC)

Prof. Zsehong Tsai

Science and Technology Profession Medals are issued by NSTC in order to reward those who have made special contributions to our country's development of S&T administrative affairs. Prof. Zsehong Tsai, while leading the S&T Policy Advisory Office, has made major contributions through innovation of procedures on S&T program management and provided important policy recommendations.

2023 K. T. Li Women's Outstanding Research Award

Institute of Information & Computing Machinery

Prof. Ai-Chun Pang

In order to encourage domestic female scholars to invest in information technology research, promote domestic information technology, and make outstanding contributions to the field of science and technology, the K. T. Li Women's Outstanding Research Award is specially established.

2023 K. T. Li Young Researcher Award

Institute of Information & Computing Machinery

Prof. Hao-Chung Cheng

The K. T. Li Young Researcher Award is established to inspire young scholars in the country to engage in research work in the field of information technology and to express gratitude for Dr. Kwoh-Ting Li, the Father of Taiwan's Economic Miracle.

The Youth Research Award is awarded once a year, with one to three recipients. Applicants must meet the following basic requirements: Information technology researchers within Taiwan, with most of their research results completed in Taiwan, and with age thirty-six or below (inclusive) (as of June 30 of the current year).

To select the annual winners, the Institute of Information & Computing Machinery will invite scholars and experts to form a review committee. The committee will rigorously select the best candidates from the applicants of the year, with the option of not selecting any if deemed necessary.

NCTS Mathematics Division 2023 Young Theoretical Scientist Award

National Science and Technology Council

The National Center for Theoretical Science (NCTS) Young Theoretical Scientist Award is an annual award and one of its main purposes is to encourage and help young talents in mathematical sciences in Taiwan in their pursue of academic excellence. The applicant has to be less than forty years old and with position of at most Associate professorship. The applicants are evaluated by the NCTS Mathematics Division Committee.

2023 IEEE Taipei Section Master's Thesis Award

Master's Thesis : Broadcast Erasure Channels with Partial Single-User Feedback

Student. Yen-Cheng Chu | Advisor Prof. Shih-Chun Lin

Graduated from NTU GICE in 2023. Currently, I'm a digital signal processing algorithm engineer in TronFuture Technology.

GICE Outstanding Doctoral Dissertation Award

Doctoral Dissertation *Design and Analysis of Power Delivery Network Noise Absorbers for High-Speed Circuits*

EM Group **Student. Li-Ching Huang | Advisor Prof. Tzong-Lin Wu**

Li-Ching Huang received the Ph.D. degree from Graduate Institute of Communication Engineering, National Taiwan University in 2023. She is currently a Senior Engineer with MediaTek, Inc., Hsinchu, Taiwan.

GICE Outstanding Master's Thesis Award

Master's Thesis *Time Switching and Frequency Diversity for 3D & 2D Transmitter Antenna Arrays to Realize Stable Power Reception for Wireless Power Transmission System under Receiver Rotation and Location Variation*

EM Group **Student. Ching-Ya Tseng | Advisor Prof. Hsin-Chia Lu**

Ching-Ya Tseng received the B.S.degree in electrical engineering from National Sun Yat-sen University, Kaohsiung, Taiwan, in 2020, and the M.S. degree from the Graduate Institute of Communication Engineering, National Taiwan University, Taipei, Taiwan, in 2023.She is currently with CHTTL, Taoyuan.

GICE Outstanding Master's Thesis Award

Master's Thesis *Direction-of-Arrival Estimation based on Fourth-Order Difference Co-Arrays: Fundamental Limits and Systematic Array Designs*

CSP Group **Student. Yuan-Pon Chen | Advisor Prof. Chun-Lin Liu**

Yuan-Pon Chen received his master's degree from the Graduate Institute of Communication Engineering, National Taiwan University in 2023. He is pursuing a Ph.D. degree in the Department of Electrical and Computer Engineering at the University of Illinois Urbana-Champaign.

GICE Outstanding Master's Thesis Award

Master's Thesis *Modality-Independent Teachers Meet Weakly-Supervised Audio-Visual Event Parser*

DS Group **Student. Yung-Hsuan Lai | Advisor Prof. Yu-Chiang Frank Wang**

I am Yung-Hsuan Lai, specializing in Audio-Visual Learning. During my master's study, I successfully generated reliable pseudo labels by exploiting modality-independent, large-scale pre-trained models with weak labels to address the audio-visual multi-label classification problem. Since earning my master's degree, I have been working as a research assistant in Professor Yu-Chiang Frank Wang's laboratory.

Antenna measurement systems at 300 GHz

Dr. Yu-Hsiang Cheng

Assistant Professor
Graduate Institute of Communication Engineering
National Taiwan University

Major research areas :
THz electronics and ultrafast spectroscopy

Introduction

Sub-terahertz wireless communcations using carrier frequencies at 140 GHz or 300 GHz have been a hot research topic recently. It is relatively easier to locate a wide absolute bandwidth in those frequency bands so the data rate, proportional to the bandwidth, can be dramatically enhanced. In addition, the atmospheric loss in those two bands is relatively low compared to the nearby frequencies. However, the propagation loss with fixed gain antennas is proportional to the square of the frequency and the energy efficiency to generate power at sub-terahertz bands is much lower than that in the millimeter-wave bands. Thus, it is essential to develop high-gain antennas in sub-terahertz bands to deal with the high loss and low power issues. The measurement of those high-gain and high-frequency antennas can be challenging. Our group develop two antenna measurement systems where one is the direct far field measurement and the other one is the compact test range measurement [1]. With these antenna measurement systems, we can validate our antenna designs up to 330 GHz.

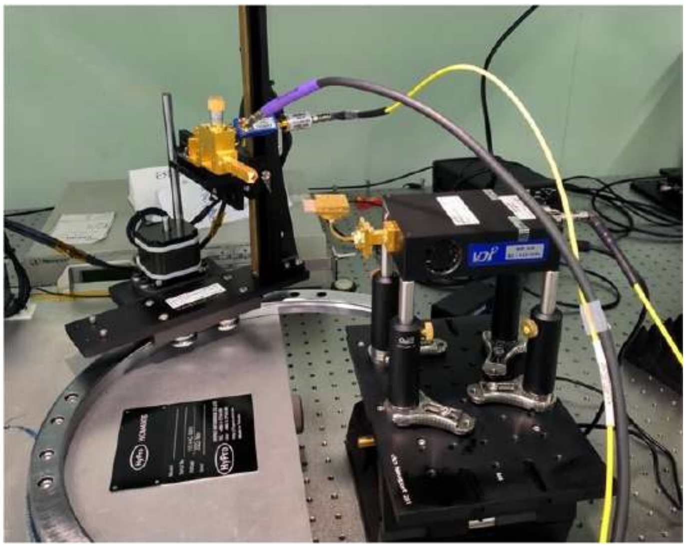


Fig1. Far field antenna measurement

Far field antenna measurement

Figure 1 shows the homebuilt far field antenna measurement system. As an emitter, the antenna under test is connected to a 300 GHz source, which is an 11.11 GHz source multiplied by 9-fold and 3-fold frequency multipliers. For the receiver, a horn antenna of 25 dBi gain is connected to a 20-fold downconverting mixer with a 15 GHz local oscillator. The downconverted signal at 279 MHz is measured in a spectrum analyzer and the dynamic range is greater than 60 dB. The receiver is installed on a curved rail with a software-controlled motor, built by our PhD student Chih-Han Lin, so the radiation pattern of the antenna under test can be measured automatically. Both the source antenna and the receiver antenna can be flipped 90 degrees so total four cuts of the radiation pattern can be measured, including E-plane co-polarization, H-plane co-polarization, E-plane cross-polarization, and H-plane cross-polarization. The measured antenna gain can be calibrated by a standard gain horn.

Compact antenna test range

The far field antenna measurement system can only be applied to waveguide-based antennas. We collaborate with BWant Co. to build a compact antenna test range [1] to measure on-chip antennas, as shown in Fig. 2. The transmitter consists of a 15 dBi horn antenna and a frequency extender, which is connected to a vector network analyzer with 5 m cables. The transmitter horn is installed at a focus of a parabolic mirror so plane waves reach the receiving antenna. The transmitter horn and the parabolic mirror are mounted on a software-controlled rotating stage with both phi and theta scanning capabilities in an anechoic chamber. The parabolic mirror is designed by our Master student Zhao-Hong Tu to reduce the edge diffraction effects. The receiving antenna, either waveguide-based or probe-based, is connect to another frequency extender for down-conversion. The on-chip antenna is put on a platform made with a low-dielectric-constant material to reduce its effect on radiation. In addition, an anti-vibration rack and an imaging system is used for probing the on-chip antenna. In this case, both the reflection coefficient and the radiation pattern of the antenna can be measured at the same time.

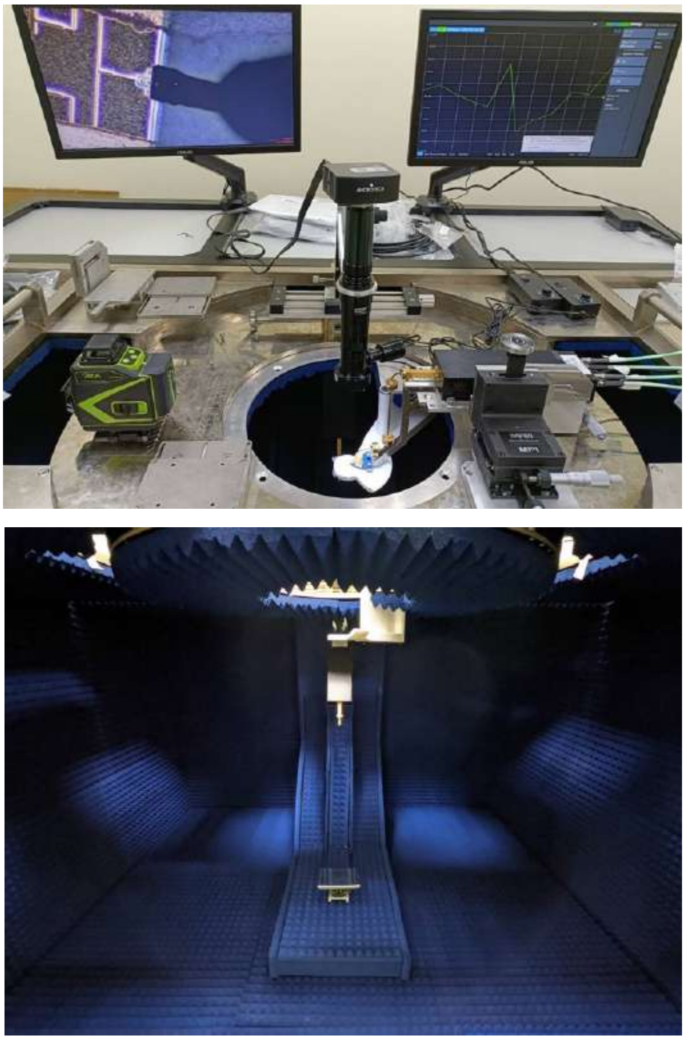


Figure 2. Compact antenna test range

Results

To validate our homebuilt antenna measurement systems, we test two standard gain horns, one of 15 dBi gain and one of 25 dBi gain. The H-plane co-polarization results are shown in Fig. 3. The measured radiation patterns of the 15 dBi horn antenna are consistent in both systems. The measured gain of the 25 dBi horn is 10 dB higher than that of the 15 dBi horn in the compact range system. These antenna systems work as expected at the sub-THz frequency range.

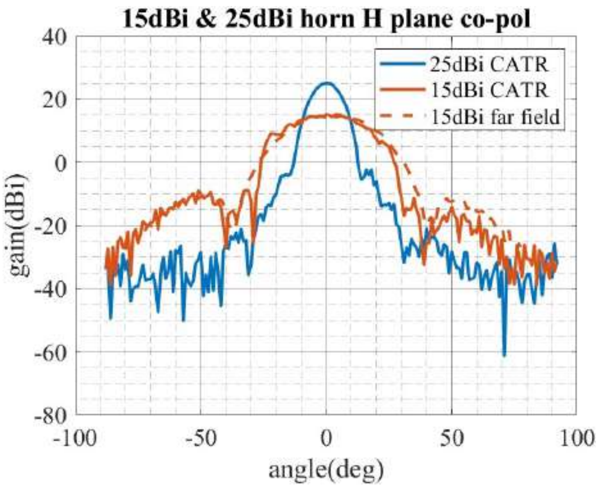
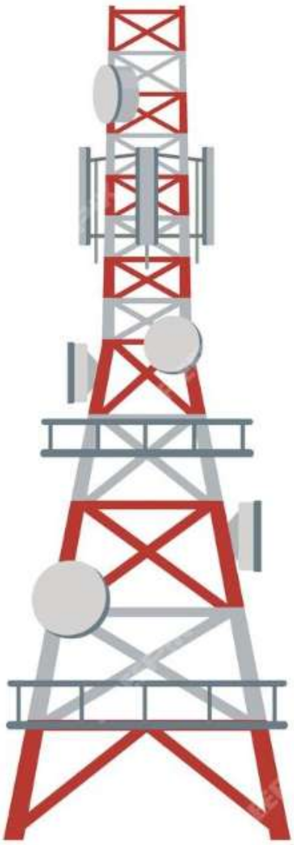


Figure 3. Radiation pattern of horn antennas

References

[1] Zhao-Hong Tu, Pin-Feng Chen, Sung-Lin Ho, Min-Wei Li, Tsung-Wen Chiu, and Yu-Hsiang Cheng, "Probe-Based Antenna Measurements at Sub-THz Frequencies," Asia-Pacific Microwave Conference, Taipei, Taiwan, 2023.



Professor Cheng and lab members visiting a radio station

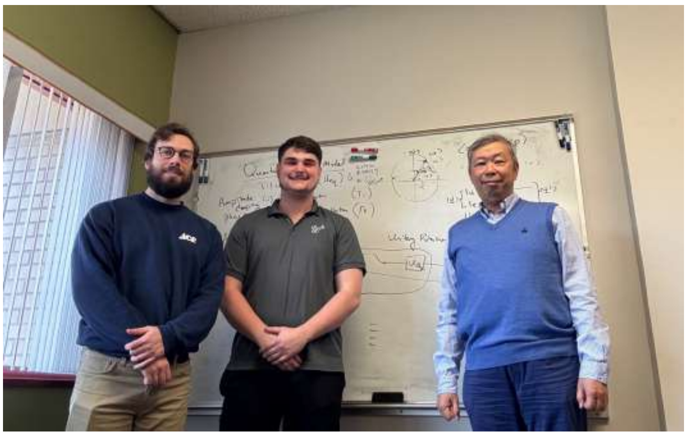
Quantum Communication Engineering Research at USF EE

Dr. Kwang-Cheng Chen

Emeritus Professor and Adjunct Professor
Graduate Institute of Communication Engineering
National Taiwan University
Professor of Electrical Engineering, University of South Florida

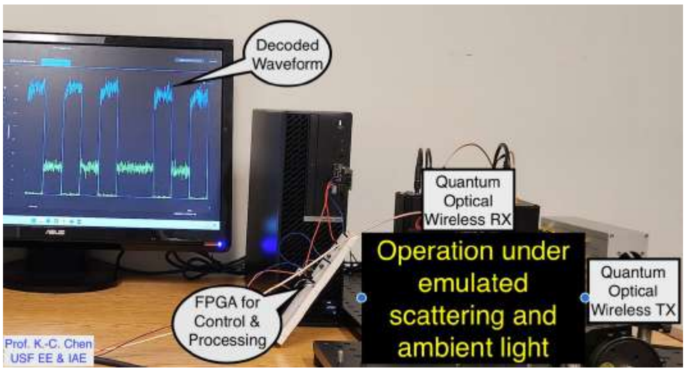
Dr. Kwang-Cheng Chen, Emeritus Professor and Adjunct Professor, Graduate Institute of Communication Engineering, National Taiwan University, and a Professor of Electrical Engineering, University of South Florida, has been active in technological innovations in quantum communications and computing. Dr. Chen is particularly interested in transform quantum information science into quantum information engineering, such that users may enjoy the advantages of quantum mechanics in the broad-range applications.

One of the major quantum engineering research subjects is the quantum optical wireless communication systems. It is well known that quantum wireless channels introduce quantum decoherence to significantly degrade the sensitive quantum states used in transferring information. Dr. Chen and students started from examining the impacts from the imperfect quantum channels and thus developed a new improved quantum key distribution (QKD) mechanism, which was presented and published in the IEEE Military Communications Conference (MILCOM), 2022 [1]. Further communication theoretic investigation on the estimation of an imperfect quantum channel was presented and published in the IEEE Military Communications Conference (MILCOM), 2022 [2], which ignited an initial exploration of quantum channel estimation. This patented technology expects to open the realistic door of quantum communication engineering.



Dr. Chen discussing with PhD students Albert and Barron about quantum channels and quantum computational techniques

In addition to theoretical study, engineering prototyping is always the ultimate goal of Dr. Chen quantum research. Under the DoD research funding support, an initial quantum wireless system has been implemented and working as the following photo showing. Although it is still a low data rate system, to better emulate realistic operating environments, this experimental system operates under the ambient light, which is typically an obstacle in any sensitive optical wireless systems. Furthermore, it does not operate on the optical table nor precise alignment between transmitter and receiver. A mechanism to emulate some disfavored scattering in atmosphere has been introduced, which can significantly reduce the efficiency of optical signal detection.



An experimental quantum optical wireless communication system to transfer classic bits encoded into quantum states over a quantum channel

While Dr. Chen and his students received two paper awards from international conferences, all such research is the first step toward a new technological frontier of quantum information engineering.
Dr. Chen and his students commit excellence to make quantum information engineering (communication and computing) beneficial to future human life. In 2024, Dr. Chen has been selected into US National Committee on Quantum Technologies. He could be reached by kwangcheng@usf.edu and ckc@ntu.edu.tw

Further Reading of Dr. Chen's quantum research:

[1] A. Bristow, K.-C. Chen, "A Robust Self-Synchronized Quantum Key Distribution Protocol", IEEE Military Communications Conference, 2022.

[2] A. Bristow, K.-C. Chen, "Pragmatic Quantum-Classic Phase Estimation of a Quantum Channel", IEEE Military Communications Conference, 2023.

Automatic Full-Song Music Generation

Prof. Yi-Hsuan Yang's group develops machine learning and deep learning models to address research problems related to music, including automatic music analysis (e.g., automatic music transcription, source separation, classification and recommendation), automatic music generation (including the generation of symbolic MIDI as well as music audio), or multimodal models for music (text-to-music or image-to-music). In particular, his group has been focusing on music generation over the recent few years, proposing well-known models such as MidiNet, MuseGAN, and Pop Music Transformer for MIDI generation, the MuseMorphose model for music style transfer, and KaraSinger for singing voice generation.

Self-attention based Transformers have been widely used in building deep generative models for text, for it can learn abstractions of data on its own without much human-imposed domain knowledge or constraints. Transformers can be similarly applied to build generative models for MIDI music, treating a piece of MIDI music as a text sequence. However, Prof. Yang's research shows that Transformers can do even better for generative music modeling, when we improve the way a musical score is converted into the data fed to a Transformer model. For example, in an ACM Multimedia 2020 paper, Prof. Yang proposed to impose a metrical structure in the input data, so that Transformers can be more easily aware of the beat-bar-phrase hierarchical structure in music. The new data representation maintains the flexibility of local tempo changes, and provides hurdles to control the rhythmic and harmonic structure of music. The Pop Music Transformer model built based on this approach can thus compose Pop piano music with better rhythmic structure than previous Transformer models do.

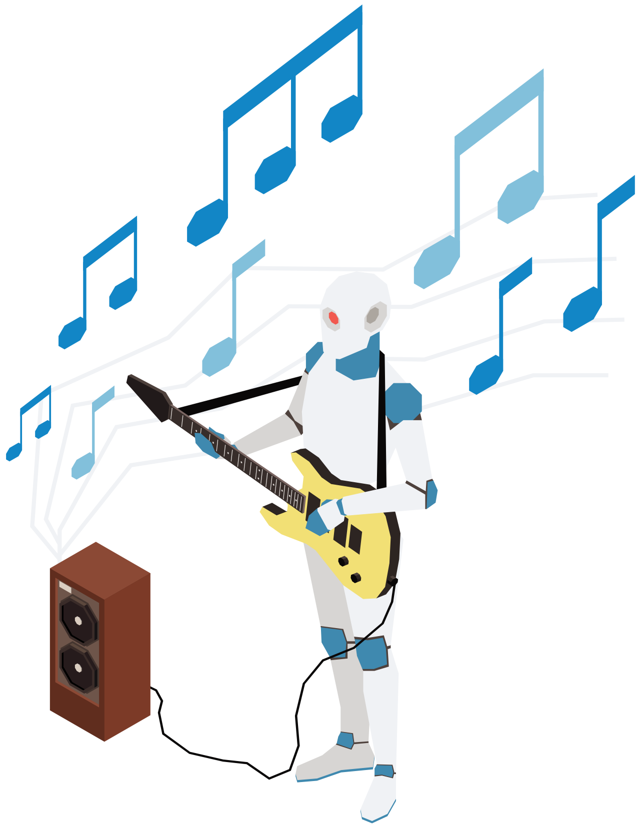
While Transformers are good at modeling long sequences, variational autoencoders (VAEs) hold the promise of allowing users to willingly exert control over different parts (e.g., bars) of the music to be generated. Prof. Yang's group later proposed a new model called MuseMorphose that exhibits the strengths of both Transformers and VAEs in a 2023 IEEE Transactions article. This is done by split the task into two steps. The first step equips Transformer decoders with the ability to accept segment-level, time-varying conditions during sequence generation. Subsequently, the second step combines the developed and tested in-attention decoder with a Transformer encoder, and trains the resulting MuseMorphose model with the VAE objective to achieve style transfer of long music pieces, in which users can specify musical attributes including rhythmic intensity and polyphony (i.e., harmonic fullness) they desire, down to the bar level. Experiments show that MuseMorphose outperforms recurrent neural network (RNN) based baselines on numerous widely-used metrics for style transfer tasks for piano MIDI.

Though these models improved upon their predecessors in creating MIDI music with repetitive structures, it has been repeatedly shown that existing models failed to come up with overarching repetitions and musical development that hold a piece together. On the other hand, a line of research that tackles simpler forms of music, e.g., melodies or lead sheets (melody plus chords) has seen promising results in composing well-structured pieces. A reasonable conjecture then follows: Could it be too demanding for a monolithic model to generate virtuosic performances end-to-end, as it has to process local nuances in texture or emotions, and the high-level musical flow, all at once?

Therefore, a more recent model proposed by Prof. Yang in a 2023 ICASSP paper, named the Compose-and-Embellish model, splits MIDI generation into two stages. Specifically, this model composes a lead sheet first to set the overall structure of a song in the first stage, and then embellishes it with accompaniment and expressive touches through variations in dynamics and timing in the second stage. Such a factorization makes it easier to model the whole-song structure of music in the composition stage, and also enables pretraining on larger amount of lead sheet-only data. Objective and subjective experiments on piano data show that Compose & Embellish composes better-structured and higher-quality piano performances compared to previous end-to-end models. Furthermore, pretraining the first-stage model with extra data contributed to a sizable performance gain. The new model also improves other musical aspects such as richness and coherence as well.

The Theme Transformer model published in another 2023 IEEE Transactions article represents another endeavor of Prof. Yang's group to improve the song-level structure of machine-generated music. The Theme Transformer model incorporates a musicological model that identifies the central musical theme of the piece under consideration. Given knowledge of musical themes within the training set, the Theme Transformer learns to compose music autoregressively, conditioned on both the preceding elements and additionally the musical theme. To balance information from these two memory networks, the model incorporates delicate designs, including a gating mechanism and theme-aware positioning encoding. Additionally, it uses theme-related tokens to mark every occurrence of the theme throughout a music piece. Evaluations show that the Theme Transformer can generate polyphonic pop piano music with repetition and plausible variations of a given thematic condition, improving the overall song-level structure of the generated music.

Prof. Yang's group has been mostly focusing on the generation of expressive piano performances for the rich musical content and texture piano playing can entail. Having established good results for piano music generation, his group is now working on advanced models for multi-track MIDI generation with more complicated orchestration of instruments, as well as audio-domain text-to-music generation, with special care on again the song-level structure of the generated music.



Dr. Yi-Hsuan Yang

Professor
Graduate Institute of Communication Engineering
National Taiwan University

Dr. Yi-Hsuan Yang received the Ph.D. degree in Communication Engineering from National Taiwan University. Since February 2023, he has been with the College of Electrical Engineering and Computer Science, National Taiwan University, where he is a Full Professor. Prior to that, he was the Chief Music Scientist in an industrial lab called Taiwan AI Labs from 2019 to 2023, and an Associate/Assistant Research Fellow of the Research Center for IT Innovation, Academia Sinica, from 2011 to 2023. His research interests include automatic music generation, music information retrieval, artificial intelligence, and machine learning. His team developed music generation models such as MidiNet, MuseGAN, Pop Music Transformer, and KaraSinger. He was an Associate Editor for the IEEE Transactions on Multimedia and IEEE Transactions on Affective Computing, both from 2016 to 2019. Dr. Yang is a senior member of the IEEE.

Exchange experience at National Taiwan University

Davy Tec-Hinh Lau

Master Program of International Dual Degree Student
Data Science, Mines Saint-Etienne School, France &
Graduate Institute of Communication Engineering
National Taiwan University

In addition to my engineer degree in French school Mines Saint-Etienne, I chose to do a dual degree program with NTU. I had many opportunities to study abroad and I ultimately chose to come to Taiwan due to my prior experience here, I came few years before and I loved the culture, the food and the people. I am very happy and honored to have been accepted to NTU, and to be able to discover again all the good things of Taiwan.

I was surprised to see how big NTU campus is, it is very rare to have such a big campus in France especially in the center of the city. But I love this campus where we can basically find anything we need. The school system is also different in France, so it took me a bit of time to adapt. For example, we do an internship instead of writing a thesis in order to graduate. I'm currently working on it and it's a challenging exercise but I'm sure I will learn a lot from it. Also, during the classes, we have a lot of guests giving us expert talks and sharing their experience about studies, work and life in general, so it's very interesting and we learn a lot from that. I am also meeting a lot of people from diverse background, discussing about our different cultures and its always a pleasure to make new friends from all over the world. Most of them flew back home at the end of the first semester, but we're still keeping contact and I'm very happy about it. One thing that changed the most from my life in France is that I never cook in Taiwan. The food is so cheap and so good that I don't find the need to cook, so I might struggle when I go back to France but I'll have new recipes to try. It's also nice to rediscover Taiwanese street food and its people that are very friendly.

Playing board games with friends

Visiting Taroko gorges

I visited a lot of places in Taiwan, and all of them are very beautiful. It is surprising to see how some places are very developed and right next to it there is a wonderful mountain to go hiking and get a sublime view of Taiwan's landscape. I can still remember the landscape of Taroko Gorge where everywhere I went was breathtaking. Moreover, during winter break I seized the opportunity to travel around Asia. This was a wonderful experience. I got to visit a lot of places that I could only see through videos before, to discover new cultures that I could only hear of. My best experiences in Asia besides Taiwan were Indonesia and Japan. In Indonesia, I visited Java Island which was adventurous but even more rewarding when we finish a hike and get on top of a volcano to admire the view. And as a fan of Japanese culture, it was a pleasure to visit Japan, to have a taste of its culture, food and meet their people. It was such a good time and I plan to continue my trip in Asia after graduation.

I still have a few months here in Taiwan, but so far it is the most rewarding period of my life. It has really opened my mind on many aspects and I am looking forward to what is going to happen in the next few months. I am sure that I will grow a lot as a human being from this experience in Taiwan.

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