NTU GICE

Newsletter

Graduate Institute of Communication Engineering, National Taiwan University

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GICE Honors

Prof. Chun-Hsing Li

was awarded a grant in 2023 Exploration Research Award from Pan Wen Yuan Foundation.

Prof. Chun-Hsing Li won 2023 excellent chip design award of the RF/microwave group in the final presentation from Taiwan Semi-conductor Research Institute under the National Applied Research Laboratories.

Prof. Shau-Gang Mao

won 2023 excellent chip design award of the RF/microwave group in the final presentation from Taiwan Semiconductor Research Institute under the National Applied Research Laboratories.

Prof. Hsi-Tseng Chou

Silver medal-National Invention and Creation Award 2022, Taiwan Intellectual Property Office of the Ministry of Economic Affairs.

The goal of this patent is to establish an array antenna far-field calibration procedure under the criteria of high efficiency and accuracy, so that antenna products can be quickly developed when industrialized, and used in industrial production lines and other calibration environments that require high efficiency. Through both simulation and practical verification, this patented technology has shown rich application prospects in the development environment of the fifth generation of mobile communications.

SCMA Codebook Design by Maximizing Minimum Euclidean Distance of Superimposed Codewords

Prof. Borching Su

Associate professor in the Dept. of EE and Graduate Institute of Communication Engineering, National Taiwan University

I. INTRODUCTION

Sparse code multiple access (SCMA), as a codebook-based non-orthogonal multiple access (NOMA) technique, has received research attention in recent years due to its potential advantage in bandwidth efficiency. The codebook design problem for SCMA has also been studied to some extent since codebook choices are highly related to the system's error rate performance. However, although its inception can be traced back to 2014 [1], the search for an optimal codebook design remains an open question today. In this article, an optimization problem to maximize the minimum Euclidean distance (MED) of SCMA superimposed codewords under power constraints is formulated, a new design method is presented, and an upper bound of the problem is derived. Most results presented here have also been reported in [2].

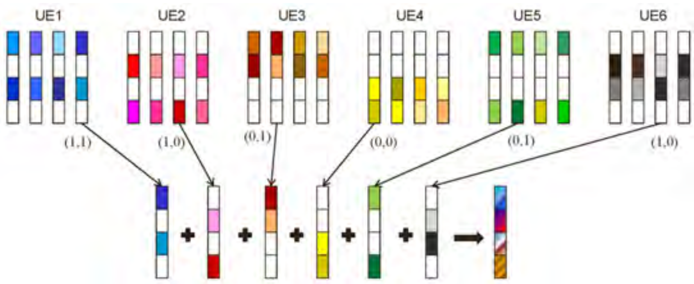

Fig. 1. Illustration of the SCMA encoder that maps data from $J = 6$ users into $K = 4$ resources.

II. SCMA ENCODER

An SCMA encoder takes information from J users and generates an encoded signal that fits into K orthogonal resources with $K < J$. Each user sends an information symbol of $\log_2 M$ bits and occupies only N out of the K resources. Figure 1 illustrates a popular case with $J = 6$ users and $K = 4$ resources, each sending one codeword out of $M = 4$ possibilities, using $N = 2$ resources. Suppose the jth user sends the k_jth codeword with $k_j \in \{1, ..., M\}$. Then the overall superimposed codeword is one of the M^J possibilities:

$$\mathbf{c}(k) = \sum_{j=1}^{J} \mathbf{V}_j \mathbf{C}_j \mathbf{e}_{k_j}^{(M)} \tag{1}$$

where

$$k = 1 + \sum_{j=1}^{J} (k_j - 1) M^{j-1} \in \mathcal{Z}_{M^J}, \tag{2}$$

$\mathbf{C}_j \in \mathbb{C}^{N \times M}$ is the jth user's codebook matrix (to be designed), and $\mathbf{V}_j \in \{0,1\}^{K \times N}$ is the corresponding mapping matrix [2], [3]. For notation simplicity, here we use $\mathcal{Z}_n$ to denote the set $\{1, 2, ..., n\}$ for any positive integer n. There are totally M^J possible combinations of superimposed codewords.

III. MINIMUM EUCLIDEAN DISTANCE

The square of Euclidean distance of the kth and lth superimposed codewords is defined as

$$d_{kl} = \|\mathbf{c}(k) - \mathbf{c}(l)\|^2 = \left\| \sum_{j=1}^{J} \mathbf{V}_j \mathbf{C}_j \left(\mathbf{e}_{k_j}^{(M)} - \mathbf{e}_{l_j}^{(M)} \right) \right\|_2^2 \tag{3}$$

where $k, l \in \mathcal{Z}_{M^J}$ and $k_j, l_j \in \mathcal{Z}_M, \forall j \in \mathcal{Z}_J$ are defined according to the same convention as in (2). There are totally $\binom{M^J}{2}$ possible pairs and the goal is to maximize the minimum Euclidean distance, defined as $d_{\min} = \min_{\substack{k,l \in \mathcal{Z}_{M^J} \\ k \neq l}} \sqrt{d_{kl}}$, subject to a normalized power constraint:

$$\begin{aligned} \underset{\mathbf{C} \in \mathbb{C}^{N \times MJ}, t \in \mathbb{R}}{\text{maximize}} \quad & d_{\min} && \text{(4a)} \\ \text{subject to} \quad & \frac{1}{M} \text{tr}(\mathbf{C}_j^H \mathbf{C}_j) = 1, \forall j \in \mathcal{Z}_J && \text{(4b)} \end{aligned}$$

Let $\mathbf{x} = \text{vec}(\mathbf{C}) \in \mathbb{C}^{NMJ}$, and then Problem (4) can be transformed into an equivalent problem in a QCQP form [3]:

$$\begin{aligned} \underset{\mathbf{x} \in \mathbb{C}^{NMJ}, t \in \mathbb{R}}{\text{maximize}} \quad & t && \text{(5a)} \\ \text{subject to} \quad & \mathbf{x}^H \mathbf{A}_i \mathbf{x} \geq t, \ \forall i \in \mathcal{Z}_{\binom{M^J}{2}} && \text{(5b)} \\ & \mathbf{x}^H \mathbf{B}_j \mathbf{x} = M, \ \forall j \in \mathcal{Z}_J && \text{(5c)} \end{aligned}$$

where $\mathbf{A}_i$ and $\mathbf{B}_j$ are real, symmetric, very sparse matrices defined in [2]. Problem (5) is not convex, so we apply the technique of semidefinite relaxation: let $\mathbf{X} = \mathbf{x}\mathbf{x}^H \in \mathbb{H}_+^{NMJ}$ and reformulate the problem as

$$\begin{aligned}
&\underset{\mathbf{X}\in\mathbb{H}_+^{NMJ}, t\in\mathbb{R}}{\text{maximize}} && t && \text{(6a)}\\
&\text{subject to} && \mathrm{tr}(\mathbf{A}_i\mathbf{X}) \geq t\ ,\ \forall i \in \mathcal{Z}_{\binom{M^J}{2}} && \text{(6b)}\\
& && \mathrm{tr}(\mathbf{B}_j\mathbf{X}) = M,\ \forall j \in \mathcal{Z}_J && \text{(6c)}\\
& && \mathrm{rank}(\mathbf{X}) = 1. && \text{(6d)}
\end{aligned}$$

IV. BICONVEX PROBLEM F ORMULATION WITH EXACT PENALTY APPROACH

To deal with the nonconvex rank constraint (6d), we use the property that [4] for any nonzero matrices $\mathbf{X}_1, \mathbf{X}_2 \in \mathbb{H}_+^{NMJ}$,

$$\mathrm{tr}(\mathbf{X}_1)\mathrm{tr}(\mathbf{X}_2) \geq \mathrm{tr}(\mathbf{X}_1\mathbf{X}_2) \quad (7)$$

with equality holds if and only if $\mathbf{X}_1 = \mathbf{X}_2$ and $\mathrm{rank}(\mathbf{X}_1) = 1$. Then, we reach the following equivalent problem:

$$\begin{aligned}
&\underset{\substack{\mathbf{X}_1,\mathbf{X}_2\in\mathbb{H}_+^{NMJ},\\ t_1,t_2\in\mathbb{R}}}{\text{maximize}} && t_1 + t_2 && \text{(8a)}\\
&\text{subject to} && \mathrm{tr}(\mathbf{A}_i\mathbf{X}_1) \geq t_1,\ \forall i \in \mathcal{Z}_{\binom{M^J}{2}} && \text{(8b)}\\
& && \mathrm{tr}(\mathbf{A}_i\mathbf{X}_2) \geq t_2,\ \forall i \in \mathcal{Z}_{\binom{M^J}{2}} && \text{(8c)}\\
& && \mathrm{tr}(\mathbf{B}_j\mathbf{X}_1) = M,\ \forall j \in \mathcal{Z}_J && \text{(8d)}\\
& && \mathrm{tr}(\mathbf{B}_j\mathbf{X}_2) = M,\ \forall j \in \mathcal{Z}_J && \text{(8e)}\\
& && \mathrm{tr}(\mathbf{X}_1\mathbf{X}_2) = \mathrm{tr}(\mathbf{X}_1)\mathrm{tr}(\mathbf{X}_2). && \text{(8f)}
\end{aligned}$$

This is a bi-convex problem, meaning that it is convex with respect to either one of $\mathbf{X}_1$ and $\mathbf{X}_2$ whenever the other is fixed. An alternating iteration approach can therefore be employed. To deal with constraint (8f), we apply the exact penalty approach and introduce the nonnegative penalty function $\mathrm{tr}(\mathbf{X}_1)\mathrm{tr}(\mathbf{X}_2) - \mathrm{tr}(\mathbf{X}_1\mathbf{X}_2)$ with some positive weight in the objective. With proper choices of initial points and weight, good results can be achieved. More details in this regard are reported in [2].

V. AN UPPER BOUND GIVEN BY THE DUAL PROBLEM

An upper bound of the MED $d_{\min}$ can be found by the derivation of the Lagrange dual problem associated with the primal problem (5).

The Lagrangian of Problem (5) is

$$\begin{aligned}
&\mathcal{L}(\{\lambda_i\},\{\mu_j\},\mathbf{x},t)\\
=\ & t + \sum_{i=1}^{\binom{M^J}{2}} \lambda_i(\mathbf{x}^H\mathbf{A}_i\mathbf{x} - t) + \sum_{j=1}^{J}\mu_j(MP - \mathbf{x}^H\mathbf{B}_j\mathbf{x})\\
=\ & \mathbf{x}^H\left(\sum_{i=1}^{\binom{M^J}{2}}\lambda_i\mathbf{A}_i - \sum_{j=1}^{J}\mu_j\mathbf{B}_j\right)\mathbf{x} + \left(1 - \sum_{i=1}^{\binom{M^J}{2}}\lambda_i\right)t\\
&+\sum_{j=1}^{J}\mu_j MP, \qquad (9)
\end{aligned}$$

where we introduced Lagrange dual variables λ_i and μ_j associated with constraints (5b) and (5c), respectively. The Lagrange dual problem is a convex problem as

$$\begin{aligned}
&\underset{\{\lambda_i\},\{\mu_j\}}{\text{minimize}} && \sum_{j=1}^{J}\mu_j MP && \text{(10a)}\\
&\text{subject to} && \sum_{i=1}^{\binom{M^J}{2}}\lambda_i\mathbf{A}_i \preceq \sum_{j=1}^{J}\mu_j\mathbf{B}_j && \text{(10b)}\\
& && \sum_{i=1}^{\binom{M^J}{2}}\lambda_i = 1 && \text{(10c)}\\
& && \lambda_i \geq 0,\ \forall i \in \mathcal{Z}_{\binom{M^J}{2}}, && \text{(10d)}
\end{aligned}$$

whose optimal value is easy to obtain.

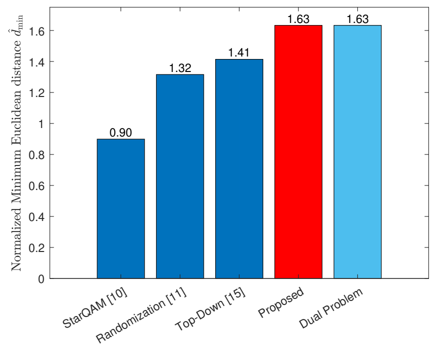

Fig. 2. Minimum Euclidean distance comparison for $J = 3$.

VI. NUMERICAL RESULTS

Figure 2 shows the normalized MED of the codebook designed by the proposed method compared against those of previously reported methods and also against the upper bound predicted by (10). It is observed that the proposed method not only beats all previously reported methods but also yields a codebook with a MED that meets the theoretical upper bound.

Figure 3 shows the more challenging case with $J = 6$, which is also the most desired case. The proposed method once again beats all previously reported methods in terms of a larger MED, and as shown in Figure 4, it also achieves the best SER performance among all codebooks being compared.

However, there is still a noticeable gap from the theoretical upper bound. This means there is still room for improvement: either a codebook with larger MED, or an upper bound tighter than what (10) predicts, can be found.

Due to the length limitation of this letter, for a complete list of references for these previously reported methods as shown in Figures 2 and 3, the readers are referred to [2].

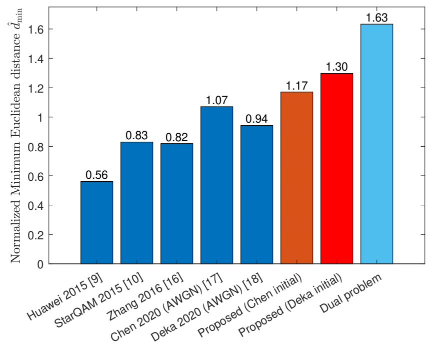

Fig. 3. Minimum Euclidean distance comparison for $J = 6$.

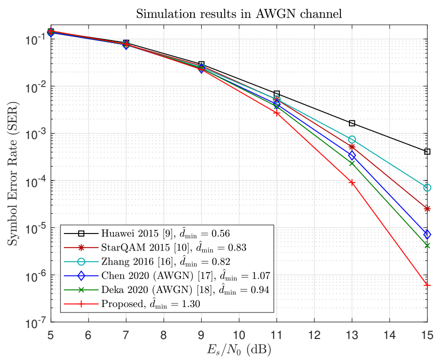

Fig. 4. SER performance comparison for $J = 6$ over AWGN channel.

VII. CONCLUSION

A new algorithm for the MED maximization problem of SCMA codebook designs is introduced which outperforms all existing methods. In addition, an upper bound of MED of any set of codebooks is found by deriving a Lagrange dual problem thereof. Although there is still a nonzero gap between the achieved MED and the derived upper bound, numerical results demonstrate clear advantages in error rate performances of the proposed codebooks over all previously reported codebooks.

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Prof. Borching Su

Borching Su received his Ph.D. degree in EE from the California Institute of Technology in 2008. He joined National Taiwan University in 2009, where he is currently an associate professor in the Dept. of EE and Graduate Institute of Communication Engineering. His research interests include signal processing for wireless communication systems and optimization of transceiver designs.

UWB Ultra-Wideband Positioning Sensor with Application to an Autonomous Ultraviolet-C Disinfection Vehicle

Prof. Shau-Gang Mao

Professor, Dept. Electrical Engineering & Graduate Inst. Communication Engineering, National Taiwan University

I. INTRODUCTION

Due to the COVID-19 virus being highly transmittable, frequently cleaning and disinfecting facilities is common guidance in public places. However, the more often the environment is cleaned, the higher the risk of cleaning staff getting infected. Therefore, strong demand for sanitizing areas in automatic modes is undoubtedly expected. An autonomous disinfection vehicle with an Ultraviolet-C (UVC) lamp is designed and implemented using an ultra-wideband (UWB) positioning sensor. The high-accuracy UWB positioning system, with the time difference of arrival (TDOA) algorithm, is studied for autonomous vehicle navigation in indoor environments. The number of UWB tags that use a synchronization protocol between UWB anchors can be unlimited. Moreover, this proposed Gradient Descent (GD), which uses Taylor method, is a high-efficient algorithm for finding the optimal position for real-time computation due to its low error and short calculating time. The generalized traversal path planning procedure, with the edge searching method, is presented to improve the efficiency of autonomous navigation. Hence, the usefulness of the proposed UWB sensor applied to UVC disinfection vehicles to prevent COVID-19 infection is verified by employing it to sterilize indoor environments without human operation.

II. TDOA Anchor Synchronization

The synchronization of anchors is necessary to implement the UWB positioning system with the TDOA algorithm because the clock frequency ratio (CFR) and transmitting time offset vary in different devices. Fig.1 shows the ranging round in a TDOA network, where the Tag receives all signals from the Center and Anchors. The time difference between two received messages can be transform to the same time scale by comparing the message period of two ranging rounds. Thus, the bias of different CFR is then eliminated, and these synchronized timestamps can be used in TDOA calculation.

III. TDOA Positioning Algorithm

With the synchronized timestamp differences of the Center and Anchors, the differences of the distances can be obtained. However, the hyperbolas generated by the differences of distances may intersect in a region instead of a point. The position of a Tag needs to be estimated by using the TDOA positioning algorithm.

The Taylor method is a recursive method with an initial position. By recursively changing the estimated position of a Tag until the displacement is small enough, the accuracy of the Tag position can be improved. However, at some locations, the estimated position using the Taylor method is far from the real position. The Gradient Descent (GD) method is also a recursive method where the displacement comes from the partial differentials of the TDOA loss function. The GD method gives a better accuracy with the cost of much computing time than Taylor method. Therefore, the GD-Taylor method is proposed by combining the recursive steps in both methods. It possesses the advantages of both the Taylor and GD methods in calculating speed and accuracy.

An experiment is conducted in a meeting room as depicted in Fig.2. The positioning root-mean-square error (RMSE) and the computing time using the least square (LS) method, Chan method, Tayler method, GD method, and the proposed GD-Tayler method are shown in Fig.3 and Fig.4.

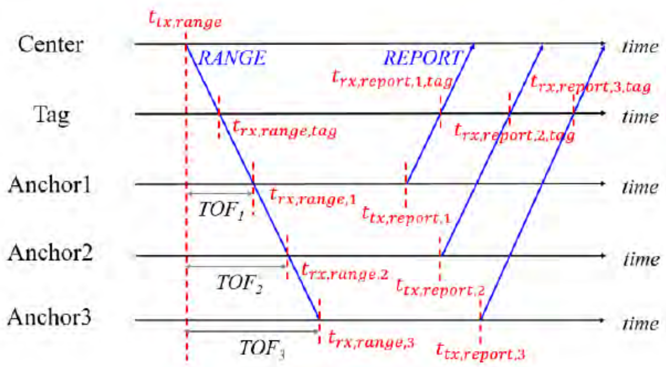


Fig. 1. The ranging round in a TDOA network. The Center device play a role as the controller in this network, where Anchors are the slave devices replying messages in order.

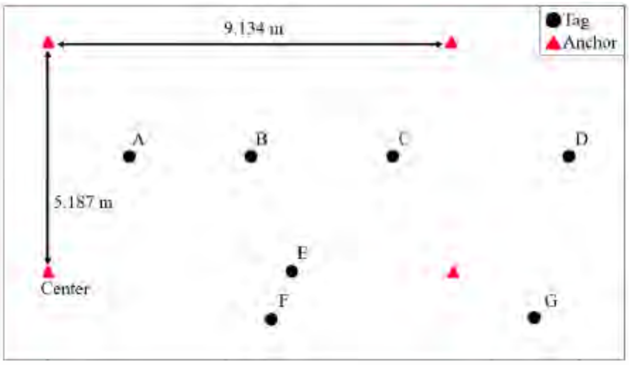


Fig. 2. The deployment in the experiment. The black dots represent the testing points, and the red triangles are the positions of Anchors, including the Center.

Tag	LS	Chan	Taylor	GD	GD-Taylor
A	15.952	8.881	0.183	0.167	0.168
B	2.245	0.701	0.132	0.123	0.124
C	10.648	3.602	6.654E + 07	0.134	0.131
D	15.990	4.036	4.560E + 17	0.483	0.277
E	2.414	0.148	0.168	0.159	0.161
F	133.374	4.844	0.343	0.338	0.339
G	0.805	1.969	0.611	0.594	0.601
Average	25.867	3.454	6.645E + 16	0.279	0.257

Unit: m.

Fig. 3. The RMSEs of Tag positions using different algorithms.

	LS	Chan	Taylor	GD	GD-Taylor
Average Calculating Time	0.0868	0.6141	0.4129	12.4678	3.1685

Unit: ms.

Fig. 4. The average calculation time using different algorithms

III. Generalized Traversal Path Planning

Traversal path planning aims to visit all target nodes in a map with the shortest path. The edge searching method is proposed to optimize the consuming time of path planning. To avoid splitting too many regions in a map, traversing along the edge is considered when using the backtracking method. The way to traverse the whole region in a few decisions is to visit along the corner and edge by selecting the neighbor with the minimal number of available neighbor nodes. The tunnels are found and traversed in the loop, and the dead ends are added after other nodes are visited. The crossing region between two subregions is visitable, but not necessary to be visited. The solution trace connects the subareas through these two regions by the shortest paths. An experiment is carried out using the disinfection vehicle with two UWB tags installed at the front and back area and four UWB anchors, as shown in Fig.4. The planned trace and the real trace of the AGV is illustrated in Fig.5. It shows that the proposed traversal planning algorithm helps find optimal solutions when the map is expressed as target nodes, inaccessible nodes, and accessible nodes.

IV. Conclusion

In this study, an autonomous disinfection vehicle with a UVC lamp is designed and implemented by using a UWB TDOA positioning network. A wireless anchor synchronization method is introduced, and the GD-Taylor method for the TDOA algorithm is proposed. The simulated and measured results show that the GD-Taylor method possesses high accuracy and short computing time. A traversal route in the shortest path is established using the generalized traversal path planning procedure with the edge searching method. Experimental results validate the effectiveness of the proposed algorithm and the performance of the autonomous disinfection vehicle. Thus, the UVC disinfection vehicle demonstrates the effectiveness of autonomous vehicles and is suitable for sterilization without human assistance in indoor environments.

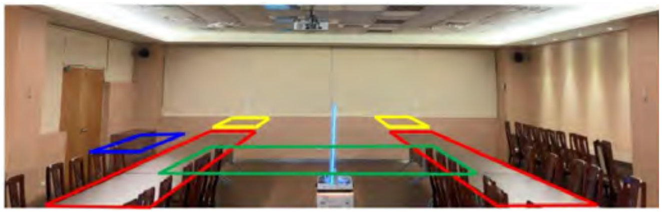


Fig. 4. The disinfection vehicle and the environment of the experiment. The blue and the yellow squares are the slow-down regions that the AGV would move slowly inside. The red squares are the obstacles, and the green square is the crossing region.

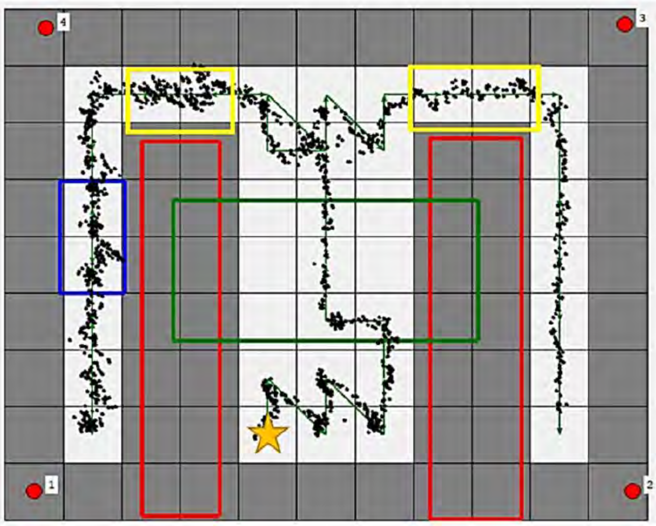


Fig. 5. The planned path and positioning results in the experiment. The green arrows represent the path and its direction. The path started from the yellow star and ended at the bottom-right node.

Prof. Shau-Gang Mao

Shau-Gang Mao received the Ph.D. degree in electrical engineering in 1998 from the National Taiwan University, Taipei, Taiwan, R.O.C. From 1998 to 2000, he fulfilled military service with the Coast Guard Administration, where he conducted projects on coastal surveillance and communication systems. From 2000 to 2002, he was with Da-Yeh University. He has been a professor at National Taipei University of Technology from 2002 to 2012. Since August 2012, he is a professor with the Department of Electrical Engineering and Graduate Institute of Communication Engineering, National Taiwan University, Taiwan. His research interests are in the areas of metamaterial, antenna, and active and passive circuits in RF front-end system.

What is it like to do research in Japan?

Wei-Shun Liao

B.S., M.S., and Ph.D. degrees in electrical engineering and Graduate Institute of Communication Engineering, National Taiwan University in 2000, 2002, and 2014

People in Taiwan feel quite familiar with and close to Japan. According to statistics, the pre-pandemic level of Taiwanese tourists to Japan was 5 million visits per year, and that of Japanese tourists to Taiwan was 2 million visits per year. Interactions were frequent and connections were strong. However, Japan remains to be an unexplored territory for Taiwan's researchers, probably due to linguistic and cultural barriers. When students or researchers in Taiwan think about going abroad for academic pursuits, English-speaking regions with similar research cultures like Europe and the US are usually one of the first places that come to their mind, not the research institutes in Japan. The author has been a researcher at the National Institute of Information and Communications Technology (NICT), an affiliation of the Ministry of Internal Affairs and Communications (MIC), since 2016. In the following paragraphs, the author will share what he learned from the past seven years about NICT-related research areas and work culture. As the author also graduated from the Graduate Institute of Communication Engineering (GICE), NTU, he hopes that the information and reflections can help students have a better understanding of what it is like to do research in Japan.

Figure 1. The JST calculated by NICT's atomic clock, demonstrated on the roof of the NICT headquarters in Koganei City, Tokyo. Image source: extracted from the NICT introduction video in the NICT Channel, URL: https://www.youtube.com/watch?v=huX7X20FL9E

NICT runs under the purview of MIC, the largest and most important government agency in the country. The role of MIC in Japan is like the Ministry of the Interior (MOI) in Taiwan. MIC's responsibilities cover a wide range of areas, including information and communications technology (ICT) development. As an MIC research institute, NICT's main tasks also include helping facilitate ICT development in Japan. The research areas include technologies of wireless communication, aerospace communication, cybersecurity, artificial intelligence, speech translation, information and neural network, and other fields. Next, the author will elaborate on the projects that he is more familiar with or interested in among the said areas.

Figure 2. NICT's Wireless Networks Research Center (WNRC), located in Yokosuka City, Kanagawa Prefecture. Image source: photographed by the author.

The research laboratory where the author works is the Wireless Networks Research Center (WNRC) of NICT, which lies in Yokosuka City, Kanagawa Prefecture (see Figure 2). The WNRC's job mainly involves the research and development of various wireless communication systems, including 5G/B5G wireless communication, Low-Power Wide-Area (LPWA) communication, and unmanned aerial vehicle (UAV) communication. Unlike those in other countries, the research institutions in Japan, particularly the national ones like the NICT, are entirely funded by taxes. Therefore, it has been particularly emphasized that the research results must have feedback to society as a whole. Instead of ending the research projects with paper publications, the researchers are required to have further cooperation with the industry, put the research results into practice, and eventually achieve potential application within society. In other words, exchanges and collaboration are commonly seen between industry and research institutions in Japan. Moreover, the research topics tend to be more localized, compared to those in other countries, for example laying special emphasis on the application to critical issues in Japan, such as aging society and disaster prevention.

Figure 3. The application of the energy-saving Wi-SUN device, developed by the NICT, in agriculture and fishery. Image source: NICT SEED, URL: https://www2.nict.go.jp/oihq/seeds/detail/0011.html

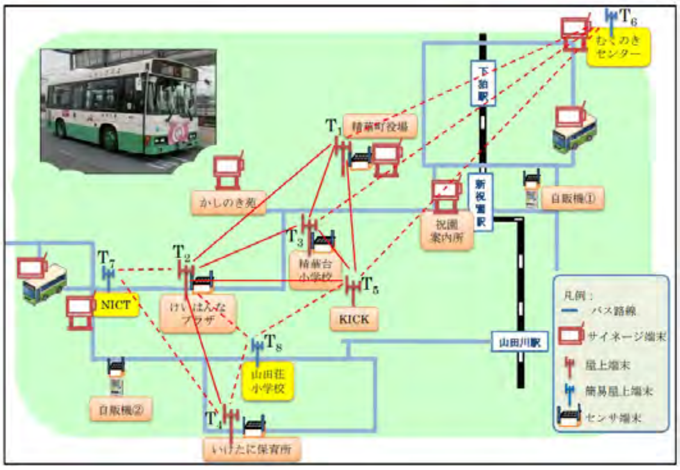


Figure 4. A local information sharing system that utilizes the bus system and the IoT technology, developed by the NICT and Seika Cho, Kyoto Prefecture. Image source: NICT Report, URL: https://www.nict.go.jp/publication/shuppan/kihou-journal/houkoku-vol63-2/K2017W-02-07.pdf

Taking WNRC's past research results as an example. In terms of the LPWA application, the author participated in a joint research project between the NICT and agricultural research institutes of the Ministry of Agriculture, Forestry, and Fisheries. Adopting an energy-saving Wi-SUN device developed by the NICT, the researchers could provide farmers and fishermen with real-time information about farmland and sea state, so as to reduce workload (see Figure 3). Besides, in collaboration with Seika Cho, Kyoto Prefecture, the researchers applied the Internet of Things (IoT) technology to the development of a wireless network system, in which the local bus system was used as a carrier, to share local information among households within a community. People who live in the community, the elderly in particular, could have easy access to local information once they log in to the network system, effectively replacing the traditional "kailanban", or a notice distributed to households within a neighborhood (see Figure 4). Furthermore, the development of the UAV-carried wireless access point has been set out shortly after the Great East Japan Earthquake. Such a technique may make possible the online connection with the disaster region once a natural disaster such as an earthquake or flood happens (see Figure 5).

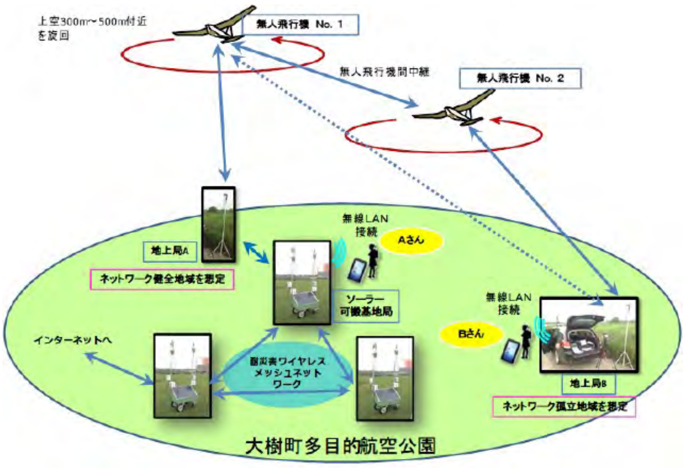
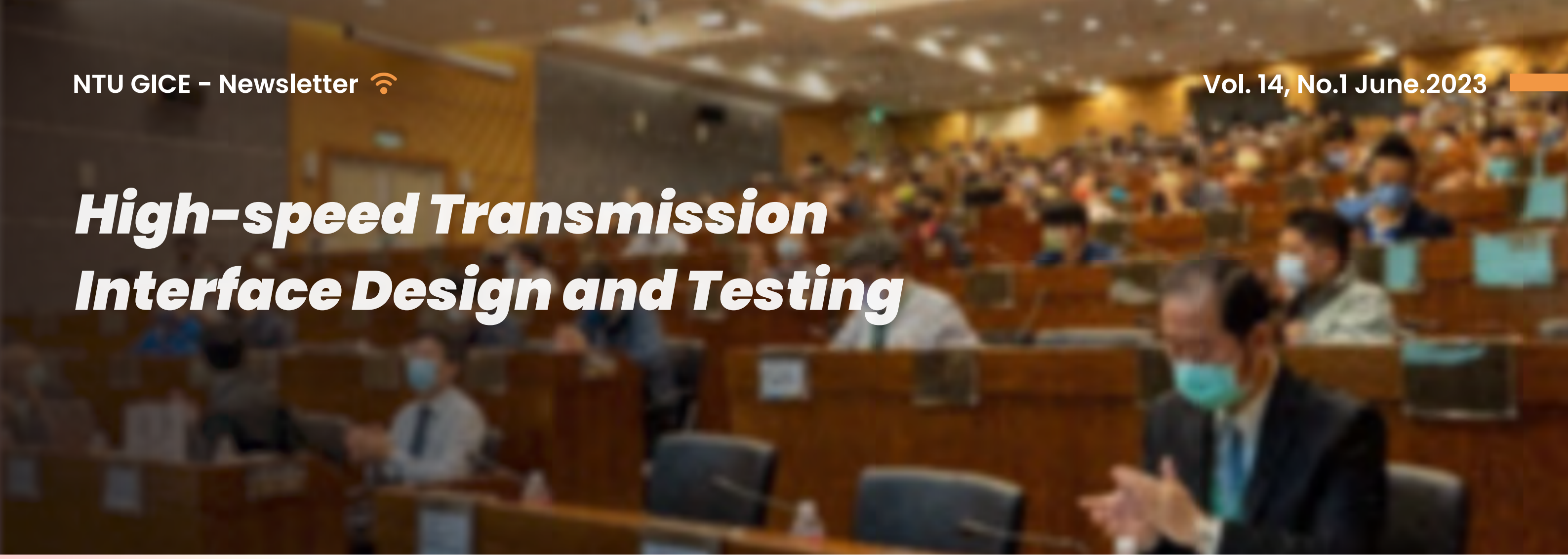


Figure 5. The UAV-utilized technology to relay wireless signals for online connection with the disaster-stricken area. Image source: NICT News, URL: https://www.nict.go.jp/press/2013/07/17-1.html

In summary, this article delivers a brief introduction to the research conducted by the NICT and hopes to help the GICE students have an initial understanding of what it is like to be a researcher in Japan. Finally, what the author intends to share is as follows. GICE provides you everyone with wonderful teachers and brilliant peers, both of whom are second to none around the globe. Enjoy yourself when studying and doing research in the GICE. Make every endeavor to hone your own skills and become well-prepared to explore and challenge different possibilities in the future.

Wei-Shun Liao

Wei-Shun Liao (Member, IEEE) received the B.S., M.S., and Ph.D. degrees in electrical engineering and Graduate Institute of Communication Engineering from National Taiwan University (NTU), Taipei, Taiwan, in 2000, 2002, and 2014, respectively. From 2002 to 2007, he was with BenQ Corporation, to develop the technologies about eNB, cellular phones, multimedia transmission, and digital home. From 2014 to 2015, he was a Postdoctoral Researcher with the Graduate Institute of Communication Engineering (GICE), NTU. Since 2016, he has been with the National Institute of Information and Communications Technology (NICT), Yokosuka, Kanagawa, Japan, where he is currently a Researcher with the Wireless System Laboratory (WSL), Wireless Networks Research Center. His research interests include wireless communications, cross-layer algorithm design, wireless signal processing, and homogeneous networks.



High-speed Transmission Interface Design and Testing

On November 25, 2022, a full-day workshop on "High-speed Transmission Interface Design and Testing" was held at Lunghwa University of Science and Technology, Taoyuan City, Taiwan. The Coordinator of the Taiwan Electromagnetic Industry-Academia Consortium (TEMIAC), Professor Ruey-Beei Wu, Department of Electrical Engineering, National Taiwan University, Professor Ding-Bing Lin, head of the 5G Antenna and RF Technology Alliance of the Ministry of Education, National Taiwan University of Science and Technology, and other important academic members of the electromagnetic field of universities and colleges, and industry practitioners discussed the topic to share and exchange opinions, obtain the latest high-speed transmission interface application information, and hope to jointly promote technological development and innovation, so as to attract more outstanding talents and enhance Taiwan's international competitiveness. In addition, this semi-annual report has received sponsorship and support from Atenlab, C.C.P. Contact Probes, Unimicron Technology, Cybernet Systems Taiwan, TMY Technology, Auden Techno, Honestco Electric, and other manufacturers, exhibiting R&D projects and related application features or setting up booths to recruit talents, providing students with industry-university links and employment opportunities.

Fig.1 Taiwan Electromagnetic Industry-Academia Consortium (TEMIAC) held a high-speed transmission interface design and testing seminar at Lunghwa University of Science and Technology to promote research and innovation.

The opening was held by Dr. Ru-Jen Lin, the executive Vice President of Lunghwa University of Science and Technology, on behalf of the President Tzu-Hsiang Ko, she welcomed distinguished guests from the industry and academia to the school and delivered a speech saying, from wireless transceiver chips, mobile phone antennas, RFID for the Internet of Things, and even advanced semiconductor 3D IC connections, it can be said that electromagnetic waves are ubiquitous in the Information and Communication Technology (ICT) industry. The more advanced and cutting-edge technology is, the more critical the role electromagnetic waves will play. As 5G becomes a new generation of a communication standard, in response to the demand for high-speed transmission and processing of huge data volumes in 5G, coupled with the fact that remote communication has become the new normal in the workplace, students study and life, it must rely on the performance of high-speed transmission chips. Various types of transmission interface technologies are also evolving towards higher performance specifications, and there is a strong demand for industry-related technical talents. Then, Professor Ruey-Beei Wu and Professor Ding-Bing Lin were invited to give speeches to get the show started in the semi-annual report, also wish the conference a complete success and all the guests who attended the conference will return home with a rewarding experience.

In this event, Dr. Yih-Chien Chen, the academic Vice President of Lunghwa University of Science and Technology, first shared the development status of the school in electronic structure, he also shared that the school will complete the construction of the "High-Speed Transmission Interface Electronic Structure Design and Test Talent and Technology Training Center" with a subsidy of 100 million yuan from the Ministry of Education next year. It deepens the results of industry-university research and development and makes more contributions to the country's high-tech development.

Next, the main event of this semi-annual report is thematic speeches, a total of 7 industry representative speakers are invited to share, and each special speech is hosted by a representative of the academic field. The speeches are divided into morning and afternoon sessions. In the first half, representatives of equipment manufacturers are planned, and the afternoon session will be representatives of related industries in the field of high-speed transmission. The topics are arranged in order as follows:

Morning Session

1. Topic : 5G High-Speed Transmission System Analysis with Simulation Solution
   Speaker : Cybernet Systems Taiwan Co., Ltd. / Chief Product Engineer Min-Qi Zhang
   Host : Department of Electrical Engineering, National Taiwan University / Professor Ruey-Beei Wu

2. Topic : How to Test USB type-C Cable More Efficiently
   Speaker : Keysight Technologies Taiwan Ltd. / Senior Project Manager Kang-You Liao
   Host : Department of Electrical Engineering, National Taiwan University of Science and Technology / Professor Chang-Fa Yang

3. Topic : Analysis and Fast Verification of High-speed Signal Products
   Speaker : Simutech Solution Corporation / Engineer Xuan-Qi Wu
   Host : Graduate Institute of Communication Engineering, National Taiwan University / Professor Hsi-Tseng Chou

Afternoon Session

4. Topic : Millimeter-Wave Phased Array Antennas Design and Challenges
   Speaker : TMY Technology, Inc. / Founder and Chairman Su-Wei Chang
   Host : Department of Communications Engineering and Research Center, National Chung Cheng University / Professor Sheng-Fuh Chang

5. Topic : Study of High Speed Transmission by Thin Film RDL Technology Applied for Co-Packaged Optics
   Speaker : Unimicron Technology Corp. / Vice Minister Pu-Ru Lin
   Host : Department of Electrical Engineering, National Taiwan University / Professor Tzong-Lin Wu

6. Topic : Why the Differential Characteristic Impedance is Defined 85 Ohms Instead of 100 Ohms in Type C High-Speed Cables and Connectors?
   Speaker : Atenlab Corporation / Professor Dau-Chyrh Chang
   Host : Department of Electronics, National Taiwan University of Science and Technology / Professor Ding-Bing Lin

7. Topic : Systematic High-Speed Cable in the Cloud Field
   Speaker : Atenlab Corporation / Manager Zheng-Ting Liu
   Host : Department of Electronics, National Taiwan University of Science and Technology / Professor Ding-Bing Lin

Fig.2 Guests from all walks of life in the industry, academia, and research institutes listened to the speeches.

Fig.3 Professor Ruey-Beei Wu, Coordinator of TEMIAC, gave a welcome speech to the attendees.

In addition to arranging 7 special speeches for this semi-annual report, at the venue of the event, a total of alliance member manufacturers and sponsors were arranged to conduct booth activities, displaying the introduction of each company's R&D projects and related application features, such as Atenlab, Unimicron Technology, Cybernet Systems Taiwan, TMY Technology, Auden Techno, Honestco Electric, and a talent recruitment briefing was held during lunchtime: Auden Techno fully communicated with the participants about the company's direction, development technology, required talents, and salary overview, hoping to recruit excellent new talents for the company. In order to attract more students and related industry manufacturers to sign up for this semi-annual report activity, this event plans a lottery for booth collection, as long as you collect 4 booth badges, you will have a chance to win a prize. The rich prizes attracted many participants to collect stamps at the manufacturer's booth and save them until the end of the event. At the same time, it drove the popularity of the booth and actively interacted and communicated. At the end of this research and development semi-annual report, representatives of 6 sponsoring manufacturers, Vice President Yih-Chien Chen, President Tzu-Hsiang Ko, and Professor Ding-Bing Lin were invited to draw a total of 28 awards. The biggest prize is the iPad Air 5. In this pleasant atmosphere, the research and development semi-annual report activity was successfully concluded.

A total of 265 participants attended the workshop, including students, engineers, and researchers from industry and academia. The participants reported that they were satisfied with the agenda, lecturers, booths, meals, and venue of this seminar. It provides suggestions such as the hope that it can be handled continuously every year; themes can include automotive electronic structure, Terahertz-related applications, and industrial development in the future.

Fig.5 Professor Hsi-Tseng Chou, Director of Graduate Institute of Communication Engineering, NTU

Fig.4 Professor Ruey-Beei Wu, Coordinator of TEMIAC, gave a welcome speech to the attendees.

Fig.6 Professor Tzong-Lin Wu, Associate Dean of College of Electrical Engineering and Computer Science, NTU

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