

Technology Developed in GICE

Very Closely Located Dual-band Frequency Selective Surfaces

from Electromagnetics Group

INTRODUCTION

Frequency selective surfaces (FSSs) are a periodic assembly comprising identical elements, performing high transmission or high reflection to electromagnetic waves at certain frequencies as spatial filters. FSSs have been widely researched and utilized in applications for decades, such as subreflectors, radomes, absorbers and polarizers [1]. Conventional FSS elements and corresponding performances can be found in [1] as well. In complex military systems (such as aircrafts, missiles, and naval vessels), a multitude of different electromagnetic and optical sensors are used [2]. Furthermore, the rapid development of electronics and wireless communication has led to great demands for mobile devices that can operate using different standards and wireless local-area networks [3]. Multi-band FSSs can be used when channels are closely located in the frequency domain. In these applications, dual-band or

multi-band FSSs is required.

In this letter, a novel very closely located dual-band FSS is proposed and discussed. The ratio of two operating bands can be as low as 1.06, which is barely achieved in other literatures to the best of our knowledge. The performance of the FSSs is examined through full-wave analysis. To validate the simulation results, the prototype of designed FSSs is fabricated and tested.

DESIGNS AND SIMULATION RESULTS

The two bands of the proposed FSSs are attributed to two resonant modes of four identical elements in a unit cell. To improve stability with respect to angle of incidence, asymmetric designs of FSSs are applied. The four identical elements of FSSs are now asymmetric and of comb-like shapes but still with 90° rotation symmetry which $\theta_r = 30^\circ$ case is shown in Fig. 1 as an example, where θ_r is the rotation angle of the FSS elements.

GICE Honors

(Continued on page 2)



Prof. Ping-Cheng Yeh

「Wharton-QS Stars Awards: Reimagine Education. PaGamO-Overall Winner 2014」



Prof. Lin-Shan Lee

「IEEE ComSoc/KICS Exemplary Global Service Award」



Prof. Ju-Hong Lee

「103 Merit MOST Research Fellow Award」

In this issue

GICE Honors 1

Message from the Director 2

Technology Developed in GICE
- Very Closely Located Dual-band Frequency Selective Surfaces 1-3

- Protecting Vertex and Community Identities in Dynamic Social Networks 4-5

Activities
- 2015_01_NTU Delegates Visit France-ENSEEIH and Paris-Sud for Students Recruitment 5-6

- Wireless Power Transfer conference 6-7

- EMC Impact Issues on Wireless Applications from User Scenario Point of View 7-8

Corner of student news 8

Message from the Director



Tzong-Lin Wu

Professor & GICE Director

GICE Newsletter is proud to keep delivering excellent research performances and great news for all GICE supporters.

In this periodical, we publish technology from prof. Yih-Peng Chiou and prof. Ming-Syan Chen. We also have a great honor to announce that prof. ping-cheng Yeh lead his team PaGamO which beat 427 teams from 43 countries and win the award of Reimagine Education-Overall Winner in Wharton-QS Stars Awards.

It is worth mentioning the visit to France ENSEIHT (established a double degree program in October, 2014) for student recruitment is a good success. Students have shown great interest in visiting Taiwan for summer research internship and double degree program.

Please enjoy the latest issue and give us feedback so that we can keep on the improvement.

Technology (Continued from page 1)

Asymmetric designs can improve oblique incidence frequency responses, because the odd resonant mode is less excited. The response is simulated by the full-wave analysis. The corresponding frequency response at normal incidence with $\theta_r = 0^\circ$ of two closely located operating bands has ratio $fr_2 (3.46 \text{ GHz})/fr_1 (3.24 \text{ GHz}) = 1.07$.

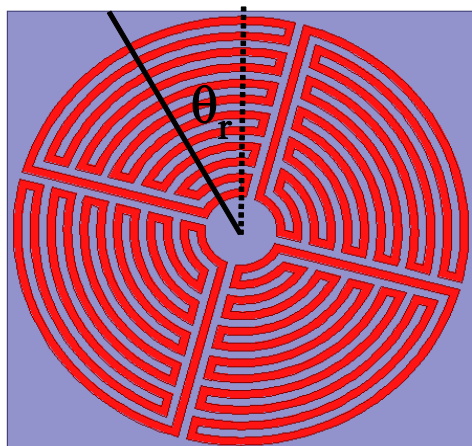


Fig. 1 The designed very closely located dual-band FSS structure with element rotation angle θ_r . It comprises a single layer of metallic elements (red parts) of 0.357 mm linewidth on a 0.2 mm FR4 substrate ($\epsilon_r = 4.4$, loss tangent=0.02) with $\Lambda = 20$ mm.

The sensitivity to incident angles of proposed FSSs with $\theta_r = 0^\circ$ has been investigated as well. The frequency responses with respect to incident angle θ for both TE and TM polarizations are examined in Fig. 2. Although there are resonant modes at around 3.6 GHz with TM polarization, these modes are away from the operating bands, and the peak values are below -10 dB even for incident angle greater than 45° . These modes are odd resonant modes that are excited by phase differences of incident waves at oblique incidence. Also, the frequency response with respect to incident angle ϕ is examined. The simulated frequency responses are almost identical, which are not shown here. According to the results, the proposed FSSs show a stable performance with respect to incident angles, which indicates the designed FSSs can be utilized as a good spatial filter.

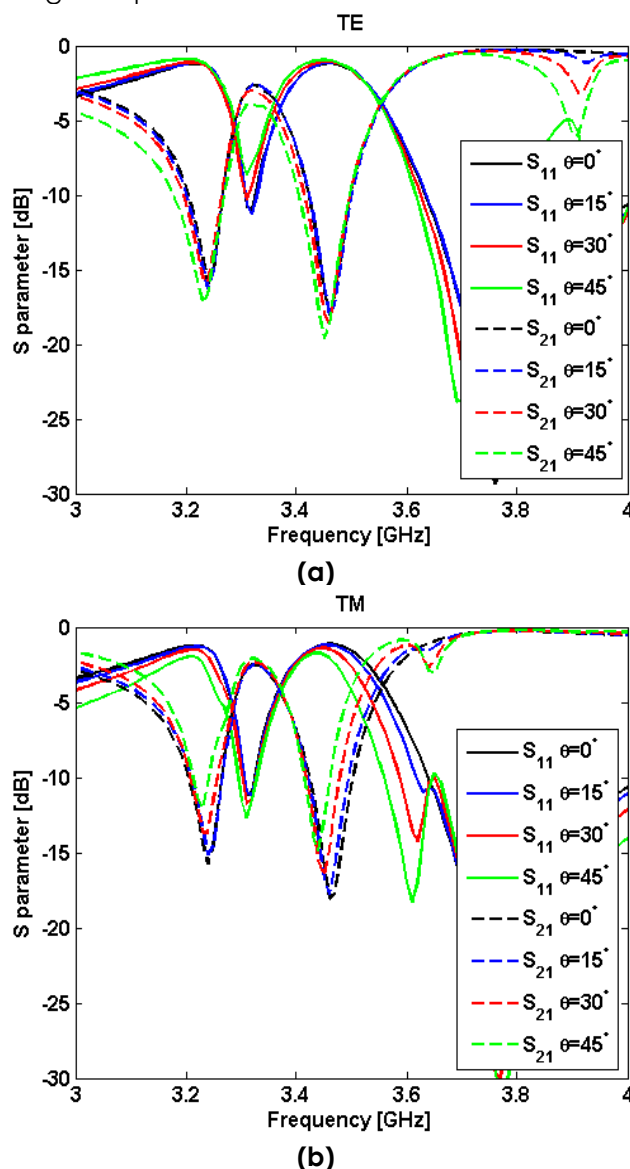


Fig. 2. Frequency responses with respect to incident angle θ when $\phi = 0$ with TE (a) and TM (b) polarization

The frequency responses of the very closely located dual-band FSSs can be controlled by rotating the FSS elements. The corresponding

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Technology *(Continued from page 2)*

frequency responses with respect to θ_r at normal incidence are shown in Fig. 3. Owing to 90° symmetry of the elements of FSSs, the responses to $\theta_r = 0^\circ$ and $\theta_r = 90^\circ$ are identical. By properly choosing θ_r , the fr_2/fr_1 ratio can be tuned from 1.06 ($fr_1 = 3.24$, $fr_2 = 3.43$ at $\theta_r = 15^\circ$) to 1.10 ($fr_1 = 3.27$, $fr_2 = 3.59$ at $\theta_r = 90^\circ$). This provides flexible frequency responses for applications.

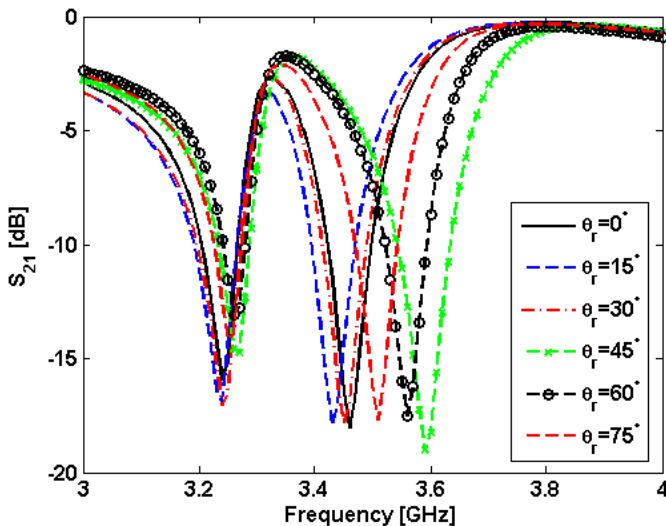


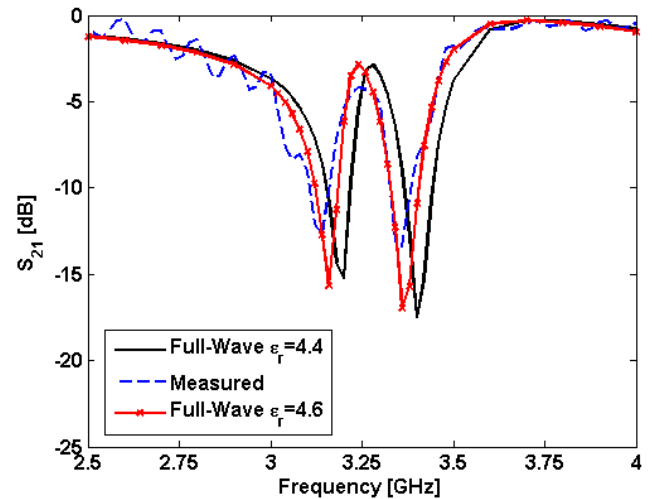
Fig. 3. Frequency responses with respect to the rotation angle θ_r at normal incidence.

EXPERIMENT

The prototype of the proposed FSSs is fabricated and tested to verify simulation results. The FSS prototype is shown in Fig. 4 (a) which is in accordance with the structure as shown in Fig. 1. In measurement, the prototype is placed between two antennas connected to a vector analyzer Agilent 8722ES in an anechoic chamber. The measured S_{21} is shown in Fig. 4 (b) along with full wave results. Although there are slight differences between measured and simulated results, the dips at around 3.14 and 3.36 GHz still verify the FSS designs. The measured ratio of two bands is as small as 1.07. In brief, the measured S_{21} shows satisfactory results.



(a)



(b)

Fig. 4. (a) The prototype of proposed very closely located dual-band FSSs, comprising a single layer metallic elements of 0.357 mm linewidth on a 0.23 mm FR4 substrate ($\epsilon_r = 4.4$, loss tangent=0.02) with $\Lambda = 20$ mm. The size of the prototype is 840 mm \times 580 mm. (b) The measured S_{21} of the prototype along with the full-wave results which FSSs with 0.23 mm FR4 substrate of $\epsilon_r = 4.4$ and $\epsilon_r = 4.6$ (loss tangent=0.02) are simulated, respectively.

CONCLUSION

The very closely located dual-band FSSs have been proposed and investigated. The FSSs are single-layered, providing a low ratio of two operating bands as low as 1.06. Sensitivity with respect to incident angles is examined and shows good performance. Furthermore, through adjusting the rotation angle θ_r , the ratio of operating bands can be tuned from 1.06 to 1.10 with the first operating band almost unchanged. Finally, the prototype of the designed FSS has been fabricated and tested, showing satisfactory agreements with the full-wave results.

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Technology (Continued from page 3)

Protecting Vertex and Community Identities in Dynamic Social Networks

from Communication and Signal Processing Group

Introduction

With the scalability and efficiency provided by cloud computing services, mining and analyzing social network data on the cloud platform becomes popular. However, we observed that vertices and communities may still be re-identified by analyzing a sequence of published social network snapshots even if each snapshot is anonymized. Figure 1 is an example of a dynamic social network in a hospital. The disease labels represent the communities that a vertex participates in. Both the social networks at t_1 and t_2 satisfy 2-structural diversity [1], i.e., by considering only t_1 or t_2 , no identity could be uniquely re-identified. However, assume we know that Bob has been to the hospital for the first time. By comparing these two sequential releases, we can conclude that vertex B is Bob and Bob has SARS.

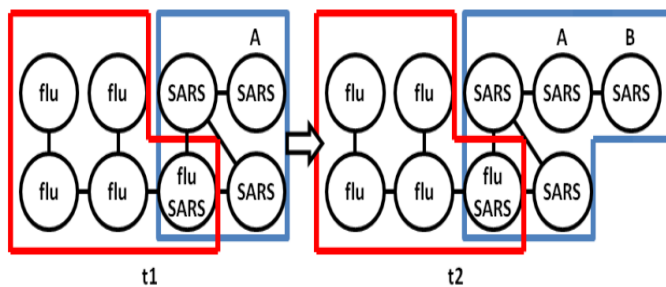


Figure 1. Identity re-identification.

To address the issue of re-identification in dynamic social networks, we propose a novel dynamic k^w -structural diversity anonymity scheme to ensure that the probability of identifying a vertex or community in sequential releases is at most $1/k$.

Problem Formulation and Algorithm Sketch

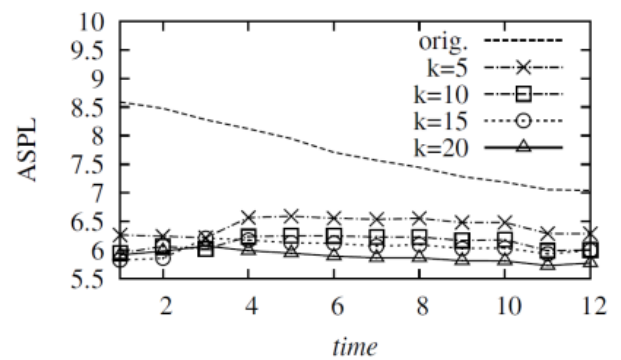
Let $G^t(V^t, E^t, C)$ denote a dynamic social network at time t , where V^t and E^t represent the vertices and edges, respectively. C is the set of communities formed by the vertices. Let w denote a time period. A k -shielding consistent group Θ_{Δ}^w is a set of at least k vertices with the same degree sequence Δ during w , and these vertices are in different communities. Therefore, given a degree sequence, the probability of a vertex or community being identified from Θ_{Δ}^w is limited to $1/k$. The sequential releases of a graph satisfy *dynamic k^w -structural diversity* if for every vertex v , there exists a k -shielding consistent group $\Theta_{\Delta_v}^w$. Given the sequential releases satisfying dynamic k^{w-1} -structural diversity, the problem is to anonymize the incoming snapshot to satisfy k^w -structural diversity subject to the previous releases.

We anonymize the vertices one-by-one according to their degree sequences to satisfy k^w -structural diversity. For a vertex v , we consider two cases. One is

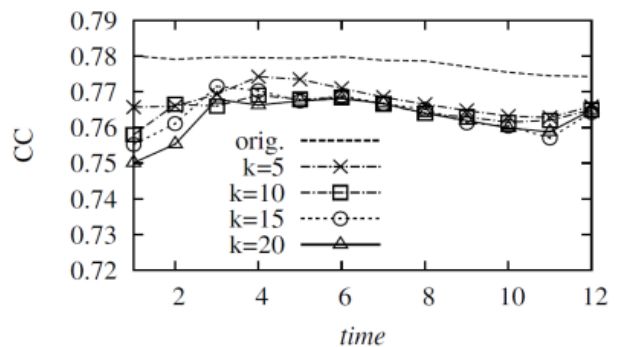
to assign v to the k -shielding consistent group with the most similar degree sequence. The other is to create a new k -shielding consistent group with v and other $k-1$ vertices. Our algorithm efficiently handles both cases with an auxiliary data structure.

Evaluations

We present the performance studies conducted on DBLP dataset with 94K vertices and 436K edges representing the co-author relationships. We compare the anonymized graph with the original graph to evaluate the preservation of certain important graph features. Figure 2(a) shows the Average Shortest Path Lengths (ASPL) of the original and anonymized graphs. The curves for different k values have similar trends and the differences are small. Figures 2(b) and 2(c) present Clustering Coefficient (CC) and Degree Centrality (DC) values of the original and anonymized graphs, respectively. For different k , both CC and DC values deviate slightly from the original ones, indicating that the proposed approach preserves the CC and DC values well.



(a)



(b)

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Technology *(Continued from page 4)*

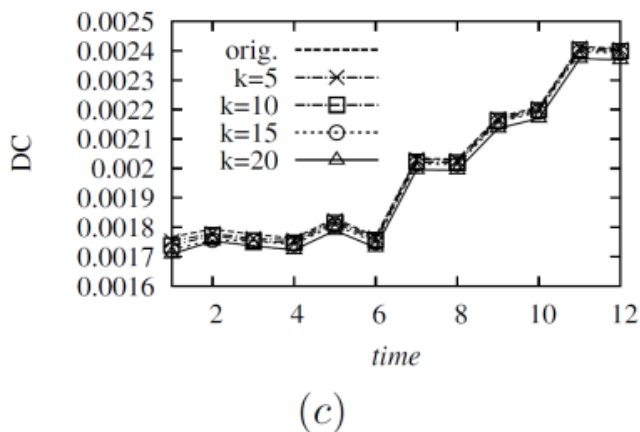


Figure 2. Comparisons of anonymized graphs.

Conclusion

We proposed dynamic k^w -structural diversity for protecting identities in dynamic social networks. The experiments show that the proposed algorithm can

retain much of the characteristics of a dynamic social network while confirming the privacy protection.

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Activities

2015_01_NTU Delegates Visit France-ENSEEIH and Paris-Sud for Students Recruitment

The École nationale supérieure d'électronique, d'électrotechnique, d'informatique, d'hydraulique et des télécommunications (ENSEEIH) is a prestigious French engineering school in Toulouse, and established a double degree program with NTU GICE (Graduate Institute of Communication Engineering) in October, 2014. To further strengthen the international collaboration and recruit double degree students from ENSEEIH, NTU delegates visited ENSEEIH in January 2015. The NTU delegates include Professor Sy-Yen Kuo, Dean of EECS College, Professor Tzong-Lin Wu, Chairman of NTU- GICE, Professor Shih-Yuan Chen, and Professor Hung-Yu Wei.

On January 19th 2015, NTU delegates visited ENSEEIH to meet the professors and students. At the beginning, introductory presentations are given to provide overview of NTU, ENSEEIH, and the double degree program respectively. Then, ENSEEIH professors describe the research in the area of microwave, signal processing, digital communications, telecommunication systems, networking, hyperspectral imaging. Prof. Shih-Yuan Chen introduced the research activities in NTU GICE Electromagnetics Group while Prof. Hung-Yu Wei introduced the research activities in NTU GICE Communication and Signal Processing Group. We also have opportunities to meet with ENSEEIH students. Some of them have shown great interest in visiting Taiwan for summer research internship and also jointing double degree program.



Figure 1: group photo in NTU-ENSEEIH meeting between professors and students

ENSEEIH is part of Institut National Polytechnique de Toulouse (INPT). On January 20th 2015, Professor Michel Doisy, who is the contact window for NTU-ENSEEIH double degree program and our visit, arranged a meeting with the Professor Olivier Simonin, President of INPT, and Professor Herve Remignon, INPT VP for International Affairs. President Simonin has shown strong interest in close international collaboration. Currently, we have collaboration and double degree in the area of communication engineering. It would be great to extend the collaboration into other research areas.

(Continued on page 6)

Activities *(Continued from page 5)*

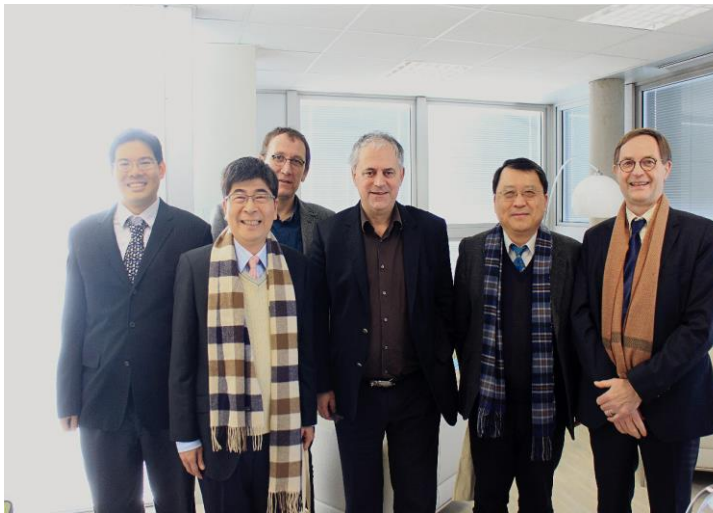


Figure 2: NTU delegates meet Professor Olivier Simonin, President of INPT and Professor Herve Remignon, VP for International Affairs, INPT.

On January 21th 2015, NTU delegates visited University of Paris-Sud. University of Paris-Sud is merged from University of Paris XI and some other premier French engineering schools. In the near future, more prestigious universities and engineering schools will be further merged into a mega school, Universite Paris-Saclay. Prof. Said Zouhdi, Head of International Affairs

Wireless Power Transfer conference

The Wireless Power Transfer conference was held at National Taiwan University in Taipei and National Chung Hsing University in Taichung on 10th and 11st Nov. We invite several specialist of the WPT (Wireless Power Transfer) including Dr. Jenshan Lin from the University of Florida.

Dr. Lin is the Editor-in-Chief of the IEEE Tran. on Microwave Theory and Techniques. In this conference, Dr. Lin talk about the demand in wireless power transfer or wireless charging has been growing rapidly in recent years. Many researchers and engineers that worked on different fields are now focusing on this topic.

In this workshop, several consortiums have been formed to promote the technology and applications in industry and to work on interoperability and standards. In this talk, Dr. Lin presents an overview of wireless power technologies including far-field microwave power transmission, wireless energy harvesting, and near-field magnetic coupling. The advantages and disadvantages of different technologies as well as their applications will be discussed. Dr. Lin gives us perspective on why the near-field wireless power transfer is a better choice for charging consumer electronic devices and where the far-field microwave power transmission will be needed. A few examples demonstrated by Dr. Lin's group, including wirelessly charging a laptop

hosted our visit to University of Paris-Sud. Both sides introduced the universities and research activities. We also looked into the opportunities to establish a double degree program. This visit has been a good start. University of Paris-Sud and NTU both are very interested in establishing closer research collaboration and double degree program.



Figure 3: GICE Chairman Tzong-Lin Wu exchanged gift with Prof. Said Zouhdi, Head of International Affairs in Polytech Paris-Sud.

computer, were described. In addition, Texas Instruments and FuDaTong, demonstrates their wireless power products of which power is from 5W to 100W in exhibition booth.

There are also many manufacturers participate in the conference included: Primax Electronics Technology, Generalplus Technology, GOTREND Technology, Richtek Technology, etc. Several professors gave invited talks. This workshop inspirits the atmosphere of research and development of wireless power transmission in Taiwan, provides opportunities for interdisciplinary exchanges, and strives for the success of 5th IEEE Wireless Power Transfer conference to be held in Taiwan in 2017.



(Continued on page 7)

Activities *(Continued from page 6)*

EMC Impact Issues on Wireless Applications from User Scenario Point of View

To enhance the communications and cooperation between industrial and academic sections on Electromagnetic Compatibility issues related to wireless communications performance, Taiwan Electromagnetic Industry-Academia Consortium held 2014 fourth quarterly workshop in Sixth International Conference Hall of Feng Chia University on December 19. The theme of the quarterly workshop is "EMC Impact Issues on Wireless Applications from User Scenario Point of View" to deeply investigate the RFI effect on performance of wireless communication devices, and it was organized by Taiwan Electromagnetic Industry-Academia Consortium and National Taiwan High-Speed RF and Millimeter Wave Technology Center. To wide spread the participating technical communities, the workshop also invited Integrated Circuit EMC Research and Development Center of Feng Chia University, IC-EMC/SI Applied Technology Industry-Academia Alliance, Department of Communications Engineering of Feng Chia University and Advanced Package Technology Academia Alliances of National Kaohsiung University as co-organizers. The workshop attracts more than 110 people to participate the lectures and panel discussion sections. The participators come from various aspects of the industries including TSMC, SPIL, Hon Hai (Foxconn), HiMax, QuieTek, Pegatron, TRC, Alpha, Tenx, R&S, ATL, ANSYS and others. There are also enthusiastic professors and students from several universities including NTUT, YZU, NCUE, NCUT, DYU, FCU and others. The quarterly workshop was a great success with enthusiastic response from all attendance.



The programs are divided into two half-day technical lectures sections and a panel discussion. The workshop began with opening speech from Professor Zonglin Wu, Chairman of Taipei EMC Chapter and

Department of Electrical Engineering of National Taiwan University, and then followed by Professor TC Peng from YZU. The lectures began from mobile device user scenario analysis brought by Mr. Frank Tsai from TRC and followed by continuing lectures with effect investigation from other speakers. The activities of the programs were quite wonderful and attractive, and it also arranged together with the coffee breaks in the middle of the morning and afternoon screening time to provide a joy time for discussion. The workshop also arranged some showcases from ANSYS, Auden and R&S, and also provided recruit booth for Auden.



The lectures and topics of the workshop are as following:

1. Mobile Device User Scenario –
By Frank Tsai, General Manager of Training and Research Co., Ltd.
2. User Scenario Analysis for Platform Noise Impact of Wireless Communications Application –
By Professor Han-Nien Lin, Feng Chia University.
3. SIP Technology in the application and development of wearable devices –
By Jia-Yang Chen, Manager of SPIL Technology.
4. EMC Design Analysis on IC Package Level –
By Professor Song-Mao Wu, National Kaohsiung University.
5. Developments and Trends of IC Test Carrier Industry –
By Jun-Lang Lu, Assistant Director of Keystone Microtech Co., Ltd..

(Continued on page 8)

Activities *(Continued from page 7)*

6. System Level Coupling between Digital Signals and Antenna

- Digital to Antenna
- Antenna to Digital

By Ding-Hao Yeh, Application Engineer of ANSYS, INC., Taiwan Branch.

The workshop ended with a 60-minute panel discussion session, during which many questions and suggestion for further EMC applications development were raised and many issues were thoroughly discussed.

Corner of Student News

by Abdulelah Awad Al-Shehri

Abdulelah Awad Al-Shehri comes from Saudi Arabia and he is studying Master program at NTU GICE.

Seven months yet, I have been living in Taiwan, especially in Taipei city where I am studying communication engineering at NTU GICE National Taiwan University. I start to know a lot about Taiwan.



It is not only the country of the sun as I saw that when I had come here at the end of summer 2014; it is not only the country of typhoons and the cold where the sun and the heat of the day disappear, where people are forced to stay at home; Taiwan has a rich environment. During the orientation visits, I contemplated a lot the mountains with a wonderful vegetal cover in the suburbs of Taipei. Taiwan is also a peaceful country, according to my point of view, where people know how to enjoy their life. The foreigners like me are welcome and offered many entertainments. On the other side, in Taiwan, people are hard-worker and very interested in education. In fact, at NTU for example there is a time to entertain, there is a time to work hard, a time to struggle with the homework's from the morning until late at night. Taiwan is a place that I'll rank in my list of top five most favorite countries. More excitingly, being surrounded by the lush green central and coastal mountain range, only a short distance to the vast Pacific Ocean, and most importantly with full coverage of rustic charm, making my life in National Taiwan University one of the most enjoyable and

memorable moments. I make friends with a bunch of great people right here, who we study and play together. I have seized the golden opportunities offered by Taiwan, and living my life to the fullest every day at here. At the end of the day, I could conclude that exciting activities and challenging opportunities are here in Taiwan, and it's up to you whether to grab it or not.

I love the food in Taiwan I usually go to the night market to enjoy the food there within reasonable price. Taiwanese night markets are mostly about fun snack food, lots of fried stuff and grilled things on sticks. I hope this experience will never end. Taiwan is my second home.

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