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Upcoming Events:

May 16-19
2010 IEEE Vehicular Technology Conference-Spring
 Grand Hotel,
 Taipei, Taiwan

May 17
Prof. Gerhard Fettweis Visit
 Vodafone Chair Professor
 Dresden Technology of
 University

May 19
2010 IEEE Vehicular Technology Conference
Guests Visit
 GICE, NTU

June 1
Prof. Ji Chen Visit
 ORISE Fellowship
 Department of Electrical and
 Computer Engineering
 University of Houston

June 14
Norway-TW ICT Workshop
 Communication Research
 Center, NTU

Technology Developed in GICE**Millimeter-Wave CMOS MMIC Technology** *from Electromagnetics Group*

There is no doubt that high data rate wireless transmission system is the trend in the next-generation wireless communication. Researches and the industry have shown the interest using unlicensed band around 60GHz. CMOS (complementary metal oxide semiconductor) has become the most widely used integrated circuit design nowadays. GICE Professor Huei Wang and his research team specialize in Monolithic Microwave/Millimeter-Wave Integrated Circuit (MMW MMIC) and Radio Frequency Integrated Circuit (RFIC). They have dedicated their researches especially in 60GHz CMOS RFIC technologies.

Millimeter-wave circuit devices were usually designed by using III-V material systems due to their suitability for high frequencies applications. Since 2004, NTU GICE team has cooperated with TSMC (Taiwan Semiconductor Manufacturing Company Limited)

in research of using SiGe HBT (silicon germanium heterojunction bipolar transistor) and CMOS technology in MMW IC designs. They found that the advanced Si-based devices possesses comparable performance to the III-V-based devices and can be applied to millimeter-wave frequencies. With advanced Si process, the transistors can provide high gain at high frequency and the MMICs can be integrated with other Si components. Not to mention CMOS technology is the major breakthrough in MMW MMICs, the team is one of the world's earliest and leading team in using CMOS technology in MMIC designs.

The World First CMOS 60GHz Transceiver

The unlicensed band around 60GHz provides the possibility of high-data-rate wireless communications while reducing the energy dissipation per bit.

(continued on page 2)

GICE Honors**Congratulations on winning IEEE Transactions on Advanced Packaging-2009 Best Paper Award**

**Professor
Ruey-Beei Wu**



**Professor
Tian-Wei
Huang**



**Student
Wei-Da Guo**



**Student
Jeng-Hau
Lin**

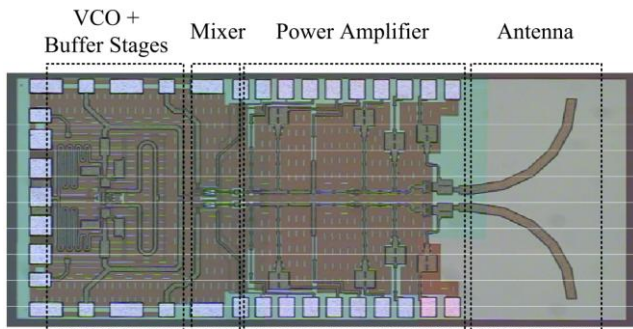
"Fast Methodology for Determining Eye Diagram Characteristics of Lossy Transmission Lines," Vol. 32, No.1, pp.175-183, February 2009.

Technology (continued from page 1)

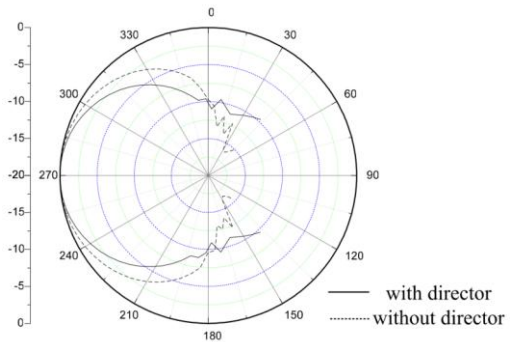
In the past, MMW ICs have mostly been implemented by using GaAs or InP technologies. Recently, MMW ICs using SiGe HBT and CMOS technologies have been demonstrated after the improvement of CMOS processes. Since the silicon-based IC technologies have the major advantage of higher levels of integration, Professor Wang and his team have made attempts on realizing single chip 60 GHz high-data-rate transceivers.

In 2006, the team reported a 60GHz SiGe HBT transmitter IC with integrated antenna in a standard-bulk 0.18 μ m SiGe BiCMOS technology.

The chip is composed of a VCO, a sub-harmonic (SH) mixer, a PA, and a tapered-slot antenna, all with differential designs. The measured results show 15.8dBm output power and 20.2dB conversion gain at 281mW dc power consumption.



Chip micrograph of the 60GHz SiGe transmitter. (Size 1.3x0.8mm²).



Measured normalized power patterns with and without director under co-polar receiving condition (E-plane).
C.-H. Wang, Y.-H. Cho, C.-S. Lin, H. Wang, C. H. Chen, D.-C. Niu, J. Yeh, C.-Y. Lee, and J. Chern "A 60-GHz transmitter with integrated antenna in 0.18- μ m SiGe BiCMOS technology," 2006 International Solid-State Circuits Conference (ISSCC).

With the recent advances in semiconductor processing technology and the development of reconfigurable devices, the realization of high-bit-rate software-defined transceivers (SDTs) on a single chip has become practical. An SDT can change operating characteristics or parameters such as the operating frequency range, modulation scheme, bandwidth, and network protocols by programming. Therefore, it can be reconfigured to solve interoperability problems between the many different existing communication standards, to implement new standards, and to minimize the amount of necessary hardware in order to perform required communications across these different standards.

(continued on page 3)

GICE Honors

Congratulations on GICE's Faculty Members' Major Recognition



**Professor
Wanjiun Liao**

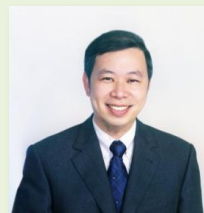
K. T. Li Research Breakthrough Award by Institute of Information & Computing Machinery
Outstanding Engineering Professor Award of Chinese Institute of Engineer
Outstanding Research Award of National Science Council



**Professor
Ming-Syan Chen**

Outstanding Research Award of National Science Council

Message from the Director



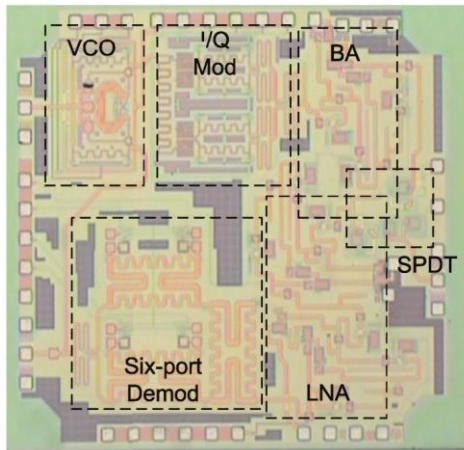
Kwang-Cheng Chen

Professor &
GICE Director

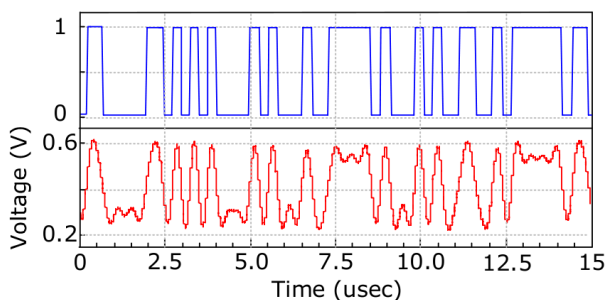
After warming response from the readers, GICE Newsletter is getting into regular quarterly publication. In addition to reports on GICE technology, honors, and activities, we are happy to share GICE team's winning the IEEE Transactions on Advanced Packaging best paper award in 2009, which is the second time for such research recognition from IEEE Transactions, for GICE researchers in 2 years. With 14 IEEE Fellows, GICE again demonstrates outstanding research capability.

Technology (continued from page 2)

In 2007, the team proposed a single-chip six-port transceiver platform for SDT application. It achieves low cost, low complexity, low DC power (only 97.7mW DC power consumption), broad bandwidth, and reconfigurable architecture in a 0.13 μ m bulk CMOS technology. For high-data-rate applications, the transceiver is evaluated using signals of 4Gb/s data rate with BPSK modulation.



Chip micrograph of the 60GHz six-port transceiver (size 1.65x1.5mm²).



Measured 4Gb/s signal waveforms with BPSK modulation of the transceiver with and without the calibration procedure.

Chi-Hsueh Wang, Hong-Yeh Chang, Pei-Si Wu, Kun-You Lin, Tian-Wei Huang, Huei Wang, and Chun Hsiung Chen "A 60GHz low-power six-port transceiver for gigabit software-defined transceiver application," 2007 International Solid-State Circuits Conference (ISSCC), pp. 192-193, USA, Feb. 2007.

MMW Power Amplifier Using CMOS Technology

The major challenge of 60GHz is the interface between the transceiver and antenna. Due to the lossy substrate and low operation voltage of CMOS, it is difficult to reach the high output power, and it limits the RF transceiver output power.

Thus, Professor Wang and his team also presented a series of research of power amplifier (PA) using CMOS technology. Researches include frequency band ranging from 50 to 70 GHz, 68 to 83 GHz, and 90 to 108GHz in 90nm CMOS. These PAs demonstrated the highest gain, PAE, and output power among the reported CMOS PAs around 60GHz. Especially a small signal gain of 17 dB from

90 to 108 GHz and a maximum output power of 12 dBm between 90 and 100 GHz have been achieved. This has been the highest frequency CMOS PA demonstrated to date. These technologies have improved the output power of RF transceivers.

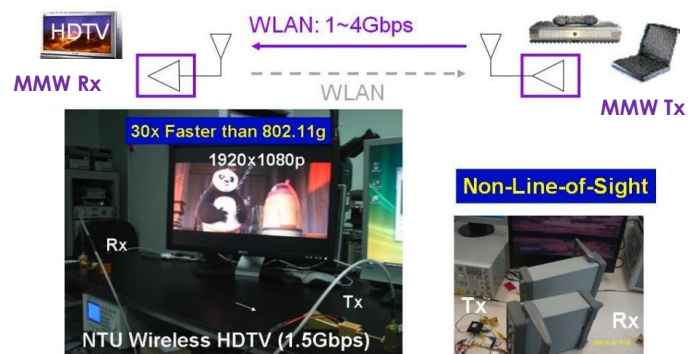
60GHz MMW MMIC Applications

Millimeter-wave MMIC have been applied in many applications, such as seekers and anti-missile systems in military, 94-GHz aircraft landing aid application, astronomy and remote sensing, 77 and 94 GHz automotive radar, and so on and so forth.

Short-distance 60GHz technology can support extremely fast wireless connectivity, such as high-definition video and high-capacity data transmission which all require wide bandwidth. Thus, we can expect to download a movie or transfer gigabytes information between devices in seconds through 60GHz technology.

Trillion Bit Wireless HDTV Video Transmission

The resolution of HDTV reaches 1920 x 1080, and the transmission of uncompressed video imaging of such resolution can be as high as 3.56 Gbps. Owing to its high demand for bandwidth, 60GHz technology will provide an ideal solution in wireless transmission for HDTV. Giving this reason, GICE Electromagnetics Group adopted the existing professional HDTV interface HD-SDI standards to design millimeter-wave circuits, and they have successfully conducted wireless transmission of video images up to 1.5 Gbps bit rate, by directly applying with BPSK modulation. Comparing with the commonly used IEEE 802.11g WLAN system, which has the highest bit rate of only 54 Mbps, GICE's new technology provides 30 times of transmission rate.



Wireless HDTV Demo, presented by NTU team

For more information please contact:
 Professor Huei Wang
 Email: hueiwang@ew.ee.ntu.edu.tw

Technology

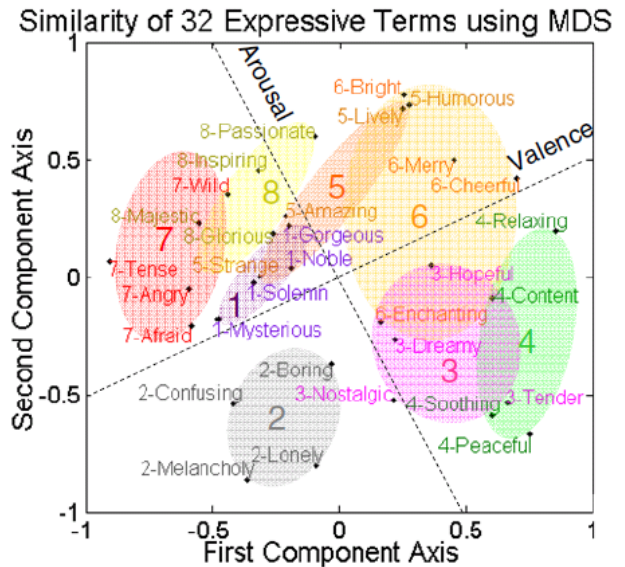
Music Emotion Recognition from Communication and Signal Processing Group

The computer music researches in GICE are aimed at the researches of the perception, performance, retrieval, and personalization of music by computers. Recently, some novel techniques and applications of music emotion recognition have been developed by two teams in GICE Communication and Signal Processing Group (CSP) lead by Professors Homer H. Chen and Shyh-Kang Jeng, respectively. Here we introduce the works mainly accomplished by Jeng's Computer Music Group (JCMG) and the cooperation of JCMG with other groups in College of Electrical Engineering and Computer Science.

Probabilistic Estimation of a Novel Music Emotion Model

To recognize music emotion, a suitable theoretical model for music emotion is very important. An approach has been proposed by Tien-Lin Wu and Shyh-Kang Jeng to estimate the emotional probability distribution of a novel music emotion model based on 32 expressive terms based on the updated Hevner's 8 emotion groups. Possible application includes browsing and mixing music with different emotion distributions. It is based on ground truths collected for 200 30-s clips (subdivided into 1200 segments further) chosen from soundtrack and labeled by 328 subjects online. Averagely, there are 28.2 valid emotional labeling events per clip, and constructing a probability distribution. Next, 88 musical features were extracted by 4 existing programs. The most discriminative 29 features were selected out by the pair-wise F-score comparison.

The resultant 1200 segments were randomly separated into 600 training and 600 testing data, and input to SVM to estimate an 8-class probability distribution. They are finally evaluated by cosine, intersection, and quadratic similarity with the ground truth, where the quadratic metric achieves the best $87.3\% \pm 12.3\%$ similarity.

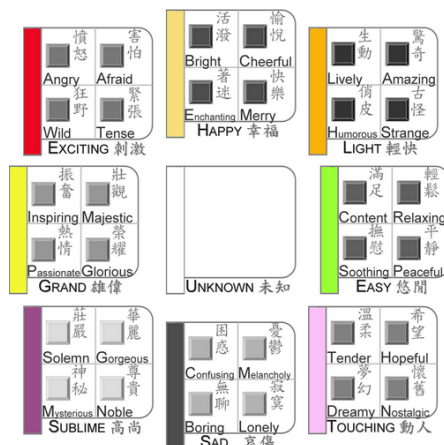


Similarity of 32 expressive terms using MDS by Wu and Jeng

Emotion-Based Music Visualization Using Photos

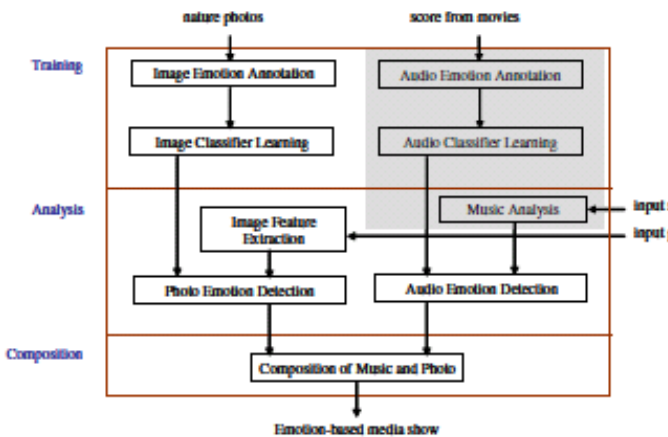
Music players for personal computers are often featured with music visualization by generating animated patterns according to the music's low-level features such as loudness and spectrum. A study by Chin-Han Chen, Ming-Fang Weng (graduate student, Department of Computer Science and Information Engineering), Shyh-Kang Jeng, and Yung-Yu Chung (professor, Department of Computer Science and Information Engineering) proposed an emotion-based music player which synchronizes visualization (photos) with music based on the emotions evoked by auditory stimulus of music and visual content of visualization. For emotion detection from photos, they collected 398 photos with the emotions annotated by 496 users through the web. With these annotations, a Bayesian classification method is proposed for automatic photo emotion detection. For emotion detection from music, Wu and Jeng's method was used. Finally, for composition of music and photos, in addition to matching high-level emotions, Chen, etc., also consider low-level feature harmony and temporal visual coherence. It is formulated as an optimization problem and solved by a greedy algorithm. Subjective evaluation shows emotion-based music visualization enriches users' listening experiences.

(continued on page 5)



8 major and 32 minor music emotion classes proposed by Wu and Jeng

Technology (continued from page 4)



System framework for emotion-based media show



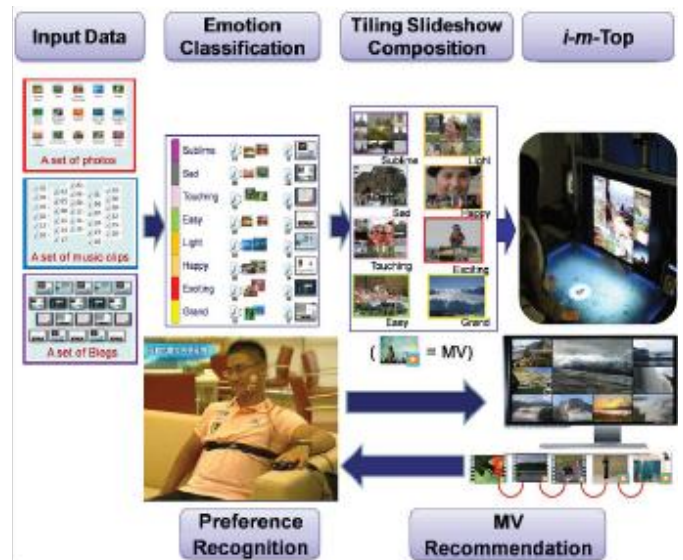
Sample images with different emotion tags

Interactive Content Presentation Based on Expressed Emotion and Physiological Feedback

Tien-Lin Wu and Shyh-Kang Jeng have cooperated with teams lead by Professors Homer H. Chen, Jyh-Horng Chen (Graduate Institute of Biomedical Electronics and Bioinformatics), Yi-Ping Hung (Graduate Institute of Networking and Multimedia), Yung-Yu Chuang (Department of Computer Science and Information Engineering), Hsin-Hsi Chen (Department of Computer Science and Information Engineering) under the Academic Excellence Project supported by National Science Council to develop an interactive content presentation (ICP) system that integrates media-expressed-emotion-based composition, user-perceived preference feedback, and interactive digital art creation. ICP harmonizes the browsing of multimedia contents by presenting them in the form of music videos (photos, blog articles with accompanied music) based on their expressed emotion similarity. ICP facilitates content browsing processing.

Tien-Lin Wu and Shyh-Kang Jeng have cooperated with teams lead by Professors Homer H. Chen, Jyh-Horng Chen (Graduate Institute of Biomedical

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Architecture of the ICP system

For More Information, Please Contact:
 Professor Shyh-Kang Jeng
 Email: skjeng@cc.ee.ntu.edu.tw

Communication Research Center

2010 UK-Taiwan ICT Workshop

Since the world places much importance on Low-Carbon Economy and the related industries in recent years, the Green technology issues became the theme for this first UK-Taiwan ICT Workshop which was held on 30-31 March 2010 at National Taiwan University with the cooperation of Communication Research Center, NTU and British Trade and Cultural Office (BTCO). This Workshop brought together academic and industrial researchers from both Taiwan and UK to discuss the future advanced energy-efficient technologies in technical, application and the current market situation perspectives.

To show the importance to this first UK-Taiwan ICT Workshop from both governments' side, the Director of BTCO, Mr. David Campbell (UK) and the General Director of Department of International Cooperation, National Science Council, Mr. Ching-Ray Chang (Taiwan) were present at the opening. For NTU, the Dean of Research and Development and International Affairs and last but not least the Deputy Dean of Electrical Engineering and Computer Science joined this workshop.

The speakers include four professionals and representatives from UK's top universities and industry and four from Taiwan's part. Also, there are more than 130 participants joined the workshop who are the experts and professionals from academia and industry in Green Communication fields contributing to this successful workshop.



The first UK-Taiwan ICT Workshop focused on the low-carbon and energy-conservation communication issues: Green Communication and Smart Grid Communication. To reduce the global CO₂ emission, Green Communication expects to utilize the advanced wireless communication technology to significantly shrink carbon emissions. For the purpose of saving energy, reducing cost, increasing reliability and transparency, the Smart Grid Communication utilizes intelligent integrated systems for control appliances.

Since the world-class development of Low-Carbon Economy in UK and flourished success of high-tech industries in Taiwan, we believe the technologies cooperation of these two sides will make the best outcomes, not only for the academic research and also for more global business opportunities.

Relying on the fruitful experiences on both Taiwan and UK, we made the great success on the first UK-Taiwan ICT Workshop.



Upcoming:

Norway-Taiwan ICT Workshop

14 June

CRC seeks every opportunity to broaden the road of international cooperation. This time, we have the chance to host Norway-Taiwan ICT Workshop on 14 June which will focus on Robust Wireless Systems, Biomedical technologies and health care applications and ICT-enabled green technologies. Norway delegates will be consisted of the specialists from these fields of academia and industry. With their participating, we believe the share of experiences and the opportunities of future collaboration will be fruitful.

Communication Research Center, National Taiwan University

Tel: +886-2-3366-3075

Fax: +886-2-2368-3824

Email:

cecenter@cc.ee.ntu.edu.tw

EU-FP7 ICT National Contact Point

Email:

ict_taiwan@ee.ntu.edu.tw

Communication Research Center

LTE/LTE-A Broadband Workshop

LTE/LTE-A- the upcoming wireless communication techniques provide at least 10-fold increase on the data rate. It will quickly change the user experience on mobile terminals. On 14th-16th of April 2010, the "Extreme-Speed LTE/LTE-A Broadband Technical Workshop" was jointly held by Communication Center of National Taiwan University (NTU), Nokia Siemens Networks (NSN), Graduate Institute Communication Engineering (GICE) of NTU, Chunghwa Telecom Co., Ltd, and Taiwan Mobile Co., Ltd. In the conference, professors and experts from NTU, NSN, and the two biggest local operators in Taiwan provided talks from various aspects about the upcoming next generation wireless communication. Furthermore, the NSN LTE container (a complete LTE system inside) displayed demos of extraordinary high speed user experience. In the demos, an average data rate of 90Mbps can be achieved. "Extreme-Speed LTE/LTE- A Broadband Technical Conference" delivered a good connection

for the students and participants to the next generation mobile communication technology.



Activities

VTC2010-Spring Preview

The 71st Vehicular Technology Conference: VTC2010- Spring is going to be held on 16-19 May 2010 at Grand Hotel, Taipei, Taiwan. It has been the great pleasure that Taiwan won the chance to host VTC2010-Spring in Taipei with the efforts of IEEE VTS Taipei Chapter. Eight Professors from Graduated Institute of Communication Engineering of NTU serve as the Chairs and Co-Chairs of this VTC2010-Spring team, devoting the time and efforts to make it become one of the best Vehicular Technology Conferences by providing excellent technical and social programs.

IEEE Vehicular Technology Conference (VTC) is the annually symposium of IEEE Vehicular Technology Society (VTS) since 1949. Due to the flourished development of Wireless Communication which is the focusing research area of VTS since 2001, VTC has changed to be held twice a year. The places of the conference are chosen from Europe or Asia countries in turn every year.

With aims of providing a forum for researchers and engineers from industry and academia, to present new ideas and technical papers, and to exchange recent advances related to vehicular technologies, VTC2010-Spring also serves as a great platform for participants to extend their relationships with others working in similar areas. The technical papers of

VTC2010-Spring focus on 11 themes:

- Antennas and Propagation
- Transmission Technologies
- Multi Antenna and Space-time Processing
- Cognitive Radio and Cooperative Communications
- Wireless Access
- Wireless Networks
- Ad-Hoc and Sensor Networks
- Mobile Satellite and Positioning Systems
- Transportation
- Vehicular Electronics and Telematics
- Mobile Applications and Services

VTC/WiVEC Joint Telematics Workshop is one of the series activities of VTC2010-Spring. The main topics of the workshop will include 1)Utilization of wireless communication in Transportation systems, 2) Toward the Realization of A Safe, Efficient, and Environmentally Friendly Transportation System and 3) Advancements in Developments of Cooperative Vehicles and Highways. In this workshop, it will have many professionals and experts in the Vehicular Technology fields from the world, especially the keynote speakers, Randell Iwasaki from California Department of Transportation and K. Venkatesh Prasad from Group and Technical Leader, Ford Motor Company, USA.

Activities

Invited Speeches



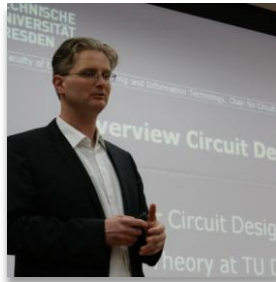
IEEE Distinguished Lecturer Series-

Professor Arun Somani Speech

IEEE Fellow

Iowa State University, USA

Topic: Autonomous Aero-Visual and Sensor Based Inspection Network for Asset Monitoring



IEEE Distinguished Lecturer Series-

Professor Frank Ellinger Speech

Dresden University of Technology,
Germany

Topic: Radio Frequency Integrated Circuits for Adaptive Antenna Beamforming



Dr. Wen-Hsiung Li Speech

Mendel Medal Recipient of the Genetics Society of UK, Academia Sinica Academician, Distinguished Research Fellow & Director of Biodiversity Research Center, Academia Sinica

Topic: My Study and Research Experience

Corner of Student News

by Yangyang Peng

As a visiting student at National Taiwan University (NTU), I am now doing my research under Professor Huei Wang's supervision in Graduate Institute of Communication Engineering.

When I was studying at Zhejiang University in mainland China majored in Microelectronics and Solid Stage Electronics, I read a lot of outstanding papers written by professors and students in Graduate Institute of Communication Engineering of NTU. Also, I have been admiring the excellent research environment of this world-famous university for a long time. In the summer of 2009, sponsored by MediaTek, I had the opportunity to do researches at National Taiwan University as a visiting student for 1 year.

Life in NTU is tight. However, I am very happy with the feeling of progressing every day. The area that I have concentrated on is Monolithic Microwave Integrated Circuit (MMIC) design.

Professor Huei Wang gives me a lot of chances to do interesting research. At the beginning of these assignments, I just felt worried and nervous because I am not sure if I can complete those difficult projects perfectly. But Professor Huei Wang and other students gave me many encouragement and constructive assistance during weekly meetings and discussions. The research facilities are high-standard in Graduate Institute of Communication Engineering, which enable me to realize some new ideas in MMIC design. With the warmly help of people here, five MMICs have been taped out, some of them are ready for measurement. The experiences of doing research in GICE not only made me understand how to deal with projects, but also developed my ability to think critically, to solve problems independently and to cooperate with others efficiently. Working with so many extraordinary and excellent people in GICE is a great enjoyment indeed.

The experience of studying in NTU favors me the chance to work with top professors and students in the field of electronic engineering. I enjoyed working with significant people in GICE and love the school landscape of NTU. It is a pleasure for me to spend my time with these amazing experiences in NTU.



National Taiwan University Graduate Institute of Communication Engineering

No.1, Sec.4, Roosevelt Road,
Taipei 10617, Taiwan

Phone

+886-2-3366-3075

Fax

+886-2-2368-3824

E-mail

gice_newsletter@cc.ee.ntu.edu.tw

Visit us at:

www.comm.ntu.edu.tw

Editors

Hsin-Jung Huang
Ya-Wen Chang