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**Upcoming Events:**

March 8

**Professor Char-Dir Chung  
Speech**

Professor, GICE, NTU  
Topic: "Spectrally  
Precoded OFDM"

March 15

**Dr. Arun Somani Visit**

Jerry R. Junkins Endowed  
Chair and Anson Marston  
Distinguished Professor  
Chair, Electrical and  
Computer Engineering  
Iowa State University

March 17

**Professor Frank Ellinger Visit**

Head of Chair for Circuit  
Design and Network  
Theory  
Dresden University of  
Technology

March 24

**Professor Joungho Kim Visit**

Director of Convergence  
Device and System Group  
Korea Advanced Institute  
of Science and  
Technology (KAIST)

May 16-19

**2010 IEEE Vehicular  
Technology Conference**

Grand Hotel,  
Taipei, Taiwan

**Foreword****Chun-Hsiung Chen***Emeritus Professor*

Communication engineering has been a primary research area for National Taiwan University since the period nearly half-century ago at the era of Radio Wave Research Laboratory. After fruitful research in microwave and computational electromagnetics, our research

papers on IEEE journals emerged in 1970's and 1980's. Currently in each year, professors and students with Graduate Institute of Communication Engineering (GICE) publish over hundred papers in leading journals over all related areas. We have a good number of faculty serving in leading IEEE/ACM journals and conferences.

My best wish to the very first GICE Newsletter is to successfully allow more people accessing the achievements from GICE research from now on.

**GICE Faculty Honors****Congratulations on GICE's Distinguished Research Chair Professor Winning  
The Nobel Prize in Physics 2009****Dr. Charles K. Kao-  
Father of Fiber Optic Communications**

The Nobel Prize in Physics 2009 winner Dr. Charles K. Kao, discovered how to transmit light signals long distance via optical glass fibers. With a fiber of purest glass, it would be possible to transmit light signals over 100 kilometers. This discovery allows fiber-optic communication networks zip voice, video, and high-speed Internet data in a split-second.

*Distinguished Research  
Chair Professor Dr. Kao  
visited GICE in 2003*

Dr. Charles K. Kao was GICE's Distinguished Research Chair Professor during 2003-2004. His extraordinary achievements have guided us directions for researches in the communication engineering field.

**Congratulations on GICE Professor Elected IEEE MWCL Editor-in-Chief****Professor  
Ching-Kuang C. Tzuang**

IEEE Microwave and Wireless  
Components Letters (MWCL)  
Editor-in-Chief

IEEE MTT-S Administrative Committee held in conjunction with the 39<sup>th</sup> European Microwave Conference 2009 (EuMC) appointed Professor C.-K. Clive Tzuang as Editor-in-Chief of IEEE MWCL (Microwave and Wireless Components Letters) effective January 2010. For the first time in history, IEEE MWCL Editorial Office is moved to Asia since its first publication in 1991.

## Message from the Director



**Kwang-Cheng  
Chen**

*Professor &  
GICE Director*

The graduate Institute of Communication Engineering (GICE) has been Taiwan's top performance graduate school in research, since establishment in 1998. Half the numbers of full professors are IEEE Fellows (14) and two thirds of professors crowned NSC outstanding Research Award. However, it might not be well known for some international colleagues in academia and industry. To allow more understanding about GICE's new achievement and technology development, the very first Newsletter is published 1Q 2010 and is expected

as a quarterly publication in the future. GICE has two major research groups:

- EM: electromagnetic waves, antenna, MMIC, and related issues
- Communications, networks, signal processing, and multimedia technology

In addition to quarterly news, we will have a special section to introduce GICE's technology accomplishments in a more systematic way. Please enjoy the information from the Newsletter.

## GICE Faculty Honors

### Congratulations on GICE's Faculty Members' Major Recognition



**Professor  
Powen Hsu**

2010 IEEE Fellow for leadership in electrical engineering education



**Professor  
Ruey-Beei Wu**

2010 IEEE Fellow for contributions to coplanar waveguide passive components



**Professor  
Wanjiun Liao**

2010 IEEE Fellow for contributions to communication protocols in multimedia networking



**Professor  
Hung-Chun  
Chang**

2010 OSA (Optical Society of America) Fellow for outstanding research achievements in opto-electronics



**Professor  
Ming-Syan  
Chen**

2009 Ministry of Education Academic Award

## GICE Student Honors

### Student Winning 2009 IEEE Radio and Wireless Symposium Student Paper Award

**Shih-Chia Chiu**

*Advisor:* Professor Shih-Yuan Chen & Professor Powen Hsu

*Topic:* Miniaturized Composite Right/Left-Handed Coplanar Waveguide Antenna for Dual-Band Operation

### Students Winning 2009 The Chinese Institute of Electrical Engineering Youth Thesis Award

**First Place: Ruei-Bin Lai**

*Advisor:* Huei Wang  
*Topic:* Design of Millimeter-Wave Multiple-Port Switches and Power Amplifier

**Third Place: Chu-Hsiang Hwang**

*Advisor:* Professor Kwang-Cheng Chen  
*Topic:* Information Fusion, Decision and Control of Sensor Network Based Intelligent Systems

### Student Winning 2009 MediaTek Fellowship

**Yi-Hsuan Yang**

*Advisor:* Professor Homer H. Chen

# Technology Developed in GICE

## *Video Technology from Communication and Signal Processing Group*

One of the main goals of GICE's Communication and Signal Processing Group (CSP) is to develop the digital content analysis technology. It allows the users to access, strengthen process, organize, retrieve and browse a variety of digital media effectively in their daily lives. The focus contains text, audio (voice and music), image, video, 3D images, and the combination of a variety of media formats.

The theory and technology GICE have developed have been widely applied in a variety of important applications. In addition, we have developed a considerable number of innovative systems to improve the photo shooting, video viewing, content browsing, video and document analysis as well as the interaction, entertainment, and other important applications of digital media.

In this issue, the theme for Communication and Signal Processing Group is video technology researches which are studied by our faculty – Professor Soo-Chang Pei and Professor Homer H. Chen, who are specialized in image processing, multimedia signal processing, multimedia communications, and other related areas.

This article will be started by introducing image and video optimization, and followed by digital archive, digital video content analysis, image capture device analysis and rate-distortion optimization for video coding.

### **Apply Image and Video Optimization to Daily Lives and Digital Archive**

In 2000, while many display devices still allow a limited number of colors, called color palette, to be displayed simultaneously. Images and videos in the World Wide Web databases are in compressed formats. Professor Pei and his students C. M. Cheng and L. F. Ho, proposed the color-palette design methods for compressed images and videos to retrieve a suitable color palette from compressed domain in order to have fast and faithful color reproduction for these devices. Using extended dependent scalar quantization algorithm of a single image to accomplish the color palette design, the results show the proposed methods of output image quality is acceptable to human eyes.

Color display techniques are also applied to the culture perspectives. Using color contrast enhancement and lacuna texture synthesis, ancient Chinese paintings can be restored. Based on saturation and de-saturation performed in the  $u'v'Y'$  color space, Professor Pei and his students

Y. C. Zeng and C. H. Chang enhanced color contrast to change the saturation value in the chromaticity diagram. They adopted adaptive histogram equalization to adjust the luminance component. In addition, a new texture synthesis algorithm using weighted mask, annular scan, and auxiliary, integrated with synthesis procedure can also restore the various aged damages on paintings. These methods can eliminate undesirable aged painting patterns successfully, such as stains, crevices, and artifacts. It also creates a seamless boundary between original and synthesized textures, and restores fine results simply and efficiently.



(a) Original image of the "Maidservant Holding a Duster"  
(b) Patched image with stains removal and crevice filling

### **Digital Video Content Analysis**

Since the amount of visual information is growing larger and wider, an efficient video browsing and retrieval system is required in order to improve the viewing experience. Professor Pei and his student have come up with a method which uses the macroblock (MB) type of information of MPEG compressed video bitstreams for video analysis. The method using MB type information benefits from easy data extraction from the bitstream, frame-based accuracy and high sensitivity to avoid miss detection.



*Example of gradual scene changes*

*(continued on page 4)*

## Technology *(continued from page 3)*

Since 2004, Professor Pei began many of his research areas toward digital video. With the compressed video files, Pei proposed a novel MPEG codec embedded with scene-effect information detection and insertion to provide more functionality at the decoder end. The proposed method provided a solution toward upgrading the existing MPEG codec with low complexity to accomplish at least two major advantages. Precise and effective video browsing resulting from the scene-effect extraction can significantly reduce the user's time to look up what they are interested in. For video transmission, the bitstreams containing scene-effect information can obtain better error concealment performance when scene changes are involved. For instance, a TV commercial clip would show frequent scene changes and short video clip span and in the basketball sequences, frequent and steady appearance of fast panning effects could be found.

The fundamental element of all the research results mentioned above is the image capture devices --- cameras. GICE's Communication and Signal Processing Group also devoted to the studies in this area.

### Image Capture Devices

The basic structure of a digital still camera (DSC) is letting light path divides into three sub-branches after passing through the camera lens and the optical filter. This structure requires three charged-coupled devices (CCD) to produce a color image. In order to reduce the cost of DSCs, Professor Pei proposed a new color filter array (CFA) interpolation method (or demosaicing) by using a simple image model that correlates the channels that uses a single-CCD structure for a DSC. The proposed method has superior image quality on typical images than conventional methods. It only requires add and shift operations to implement. This research paper titled 'Effective Color Interpolation in CCD Color Filter Arrays Using Signal Correlation' (published on IEEE Transactions on Circuits and Systems for Video Technology, Vol.13, No.6, June 2003) has been highly cited in the engineering, electrical and electronic field.



Detailed image of the interpolation results. The first column is the original image. The second and the third column are the result of the bilinear and edge-sensing methods, respectively. The last column is the result of the proposed method.

### Perceptual Rate-Distortion Optimization for Video Coding

In IEEE Circuits and System Society's 2008 Circuits and Systems for Video Technology Transactions, GICE's Professor Homer H. Chen and his research team were named winners of the Best Paper Award. (Award-winning paper 'Integration of Digital Stabilizer with Video Codec for Digital Video Cameras' was published in IEEE's Transactions on Circuits and Systems for Video Technology, in July 2007.) This was a great honor since this was the first time Taiwanese scholars received this award. The following section introduces the latest research result from Professor Chen and his research team.

There has been constant strive in the video coding community to push higher the envelope of video coding performance. Observing that traditional video quality metrics such as mean square error are poorly correlated with human perception, Professor Homer H. Chen and his graduate students develop a new technology, called perceptual rate-distortion optimization (PRDO), that has driven video coding to an unprecedented quality level. This innovation preserves more structural information and hence reduces the blocky artifact at the highly structured region of an image, as illustrated in Fig. 1. Tables I shows that at the same perceptual quality level, the PRDO achieves an average 15-16% bit-rate reduction over the H.264JM reference algorithm.

The work represents one of the first attempts in the world to incorporate perceptual metrics in the video coding process for quality improvement. The PRDO performs significantly better than the conventional video coding paradigm and holds the promise as a key enabler of the next-generation video coding.



The cropped image of the 41<sup>st</sup> frame of the Bus sequence encoded by (a) the MSE-based RDO and (b) the perceptual-based RDO proposed in this work.

*(continued on page 5)*

(continued from page 4)

TABLE I  
BIT-RATE REDUCTION OF THE PROPOSED FRAMEWORK  
OVER THE JM REFERENCE SOFTWARE

Sequence (CIF)	Bit-rate Reduction (%)	
	Baseline Profile	High Profile
stefan	10.90	11.13
flower	15.01	17.18
akiyo	14.74	12.95
mobile	14.86	14.76
weather	13.21	13.06
bridge-close	19.59	17.99
bus	11.21	12.28
container	29.51	28.62
hall_monitor	21.12	27.69
paris	13.13	12.65
tempete	9.88	11.23
<b>average</b>	<b>15.74</b>	<b>16.32</b>

The efforts that GICE has made on the development of video technology reflect the research ambition and the attitude of devotion that our faculty possessed. We look forward to more international collaborative opportunities.

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## AMiBA (The Array for Microwave Background Anisotropy) LO Modules

from Electromagnetics Group

GICE's Electromagnetics Group begins its researches in earth-ionosphere in the early 1950s. It was observed and studied to support both military and commercial FM-Broadcastings. Nowadays, the researches include Antennas, Transmission Lines, Planar Waveguides, Electronic Packaging and Signal Integrity Designs, Numerical Analyses, Microwave and Millimeter-wave Circuit Designs, Active Device Analysis and Circuit Design, Electromagnetic Compatibility, Optical Fibers, Radar Target Identifications, Inverse Scattering and Medical Applications, Mobile Communication Systems and Applications, Wave Propagations, Wireless Tunnel Propagation Characteristics, Smart Antenna Systems, Smart Transportation Systems, and more.

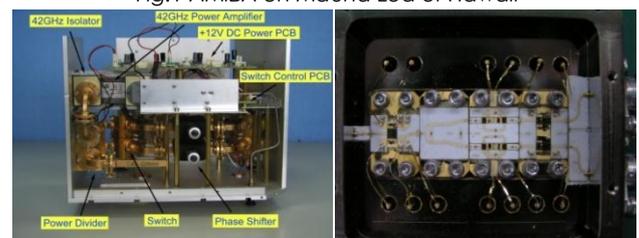
National Taiwan University has recently collaborated with ASIAA (Academia Sinica Institute of Astronomy & Astrophysics) in research and develop the project AMiBA (array for microwave background anisotropy). The development of a full-polarization radio receiver array to detect the cosmic microwave background in the W-band of 85GHz to 105GHz.

AMiBA is currently operating at Mauna Loa of Hawaii, as shown in Fig.1. Being an adjunct research fellow of ASIAA, GICE Professor Tah-Hsiung Chu develops its first two local oscillator (LO) modules with his graduate students L. S. Wang and S. N. Hsieh, and then its miniaturized version with graduate students S. H. Huang and M. H. Chen. The LO module basically consists of a 21GHz dielectric resonant oscillator, a one-to-seven power divider, and seven frequency multipliers to double the frequency of 21GHz to 42GHz with 0°/90° phase

modulation and proper power amplification. The output signals of each LO module then go to two W-band harmonic mixers to down convert the observed radio signals to the intermediate frequency for the followed signal correlation operation. The first two LO modules, as shown in Fig. 2(a), are implemented with the use of waveguide components for the reliability considerations, while the miniaturized version is implemented with MMICs (monolithic microwave integrated circuits), as shown in Fig. 2(b), for the size and power consumption reductions for the future array expansion.



Fig. 1 AMiBA on Mauna Loa of Hawaii



(a)

(b)

Fig. 2 (a) LO module and (b) its miniaturized version

(continued on page 6)

## Technology *(continued from page 5)*

The efforts of graduate students involve the module design, integration and test. Due to the remote observation of the AMiBA operation, the LO modules are designed to have digital and analog interfaces to the personal computer for the status controlling and health monitoring. The drastic environmental temperature variation from daytime to night leads to the issue of thermal consideration. In addition, the issue of maintenance under uncomfortable latitude is considered in the LO module design. This work is now technology transferred to the ASIAA engineers.

AMiBA is the first radio astronomical instrument which is led, designed, and constructed by Taiwan.

It has elevated the level of astronomical research in Taiwan, promoted the cooperation among units in the academic community and in industry, accelerated the training of the next generation, and also established a sound foundation and a plan for the future development of radio astronomy in Taiwan.

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*AMiBA website: <http://amiba.asiaa.sinica.edu.tw/>*

## International Student

**A Dutch Guy in GICE**

*by Joost Kuckartz*

My name is Joost Kuckartz, I'm from The Netherlands and the first Chinese I ever learned was how to write my name: 古卡茲. This strange name is given to me by NTU, because in The Netherlands I never even thought of having a Chinese name.

In the last 2.5 years in the Graduate Institute of Communication Engineering, I've basically spent my life in my lab. Call me a crazy scientist but I wanted to do my outmost best and I really liked all the courses and all the work here, compared to all the required courses full of only theory in my undergraduate. I started with learning the basic image processing capabilities and I got interested in color processing, because color just looks so much better than simple black and white. However, in the image processing lab, there was more signal and Fourier processing in particular than image, and color was special. For the first semester's final project of the image processing course, I decided to look into wavelength and color, linked to color temperature. In the second semester's final project I wanted to make a system which calculates the quality of an image and that introduced me to color appearance models. I learned that correlated color temperature is really old, color appearance models are really new, but they need each other due to the definition of correlated color temperature.

So, that ended up my thesis research, and this is also a brand new research area for my advisor – Professor Soo-Chang Pei. But, as I am graduated now, the professor was really impressed with

my work and immediately asked me to write two conference papers.

After staying here for one year, I started a second master degree in Geography. My initial thought was to combine my work in the Image Processing lab of Professor Pei with the satellite imagery of Geography. It turned out to become two different researches, but nevertheless very interesting.

Learning such different fields also makes me notice how there are even different levels of research within studies in NTU. I personally think Geography is easier, but that could also be because in my undergraduate they taught me 'If you can successfully study Electrical Engineering, you can do anything'. Maybe that's true? It does give me some special insights in parts where others haven't even thought of yet.

I actually like it so much here, not only the study but the Taiwanese people are amazingly friendly and helpful, I don't want to leave. I plan to find some work in Taiwan. Looking back at what I have done already, even outside of my study, it will be something big.



## Communication Research Center

National Taiwan University Communication Research Center (CRC) has drawn international attention to its research contributions accumulated by years. With its excellent performances, CRC gained the opportunities for hosting major international conferences in Taipei and undertaking activities of IEEE Taipei Section from 2007 to 2008. In 2008, Taipei Section was awarded the honor of IEEE MGA Outstanding Large Section Award.

### Upcoming:

#### UK-Taiwan ICT Workshop

March 30 - March 31

*In order to make Taiwan as the first choice of collaborative partners for the United Kingdom and European countries, this year, on 30-31th March, CRC will hold the 2010 UK-Taiwan ICT workshop. By introducing researchers groups and industrial companies in both countries and focusing on the smart grid and green communication themes, we hope that the communication and collaboration between Taiwan and UK in ICT field can be built in the future.*

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### EU-FP ICT National Contact Point

Now, the EU-Framework Project 7 (EU-FP7) Thematic NCP – The Information and Communication Technologies National Contact Point in Taiwan (ICT-NCP) is executed at CRC. Under the efforts of NTU, ICT-Taiwan will play an important role in promoting ICT research.

As a national contact point for ICT research area in Taiwan, we devote our attention to raise international awareness for Taiwan in leading-edge ICT field and to promote advanced ICT developments in Taiwan including Networking, Nano, Photonics, Digital Library & content, Embedded Software, Brain-inspired ICT, Bio-electronic & Healthcare, Multimedia, Wireless Communication and Robot. Besides, we expect that we can reach the goal of stimulating and mating the collaborative researches among ICT area between EU and Taiwan for advanced developments in ICT industry worldwide.



Cello recital  
"The Fantasy of Monkey King and the Moon"

On 11<sup>th</sup> of January 2010, the joint opening ceremony for EU-FP7 thematic NCPs Taiwan was held by National Science Council.

Not only Taiwan's successful research groups but the European important delegates attended this distinguished gathering and showed their great supports to every thematic NCPs of Taiwan to have the opportunities joining EU-FP successfully in the future.



NSC- Minister Lou-Chuang Lee and Mr. Ledoux



CEO of NCPs Taiwan and European scholars and partners

# Activities



**Professor Ezio Biglieri Speech**  
 IEEE Fellow  
 Visiting Fellow, Royal Academy of Engineering of UK  
 University of California at Los Angeles (UCLA)

Topic: Sphere Decoding And The Complexity Problem In



**Professor Tatsuo Itoh Speech**  
 IEEE Fellow  
 Member, National Academy of Engineering  
 University of California at Los Angeles (UCLA)

Topic: Advances of Composite Right/Left Handed Structures for Microwave Applications



**GICE Campus Career Fair**

GICE joint with NTU Communication Research Center to hold the 2009 Campus Career Fair on Nov.21. Exhibitors include Taiwan Semiconductor Manufacturing Company (TSMC), United Microelectronics Corporation (UMC), Pegatron Corporation, Macronix International Co., Ltd (MXIC), Telecommunication Laboratories Chunghwa Telecom Co., Ltd., and more. Over 120 students submitted their resumes, and over 55 students attended the workshop.



IEEE Distinguished Lecturer Series-  
**Prof. Han A. J. Vinck Speech**  
 IEEE Fellow  
 University of Duisburg-Essen  
 Institute for Experimental Mathematics

Topic: Channel Capacity and Coding Problems Motivated by The Powerline Channel Model



**Professor Vijay Bhargava Visit**  
 IEEE Fellow  
 Fellow, Royal Society of Canada  
 The University of British Columbia

Topic: On Publishing in IEEE Journals

**WOCMAT 2009 Workshop on Computer Music and Audio Technology**

GICE Professor Shyh-Kang Jeng and Kainan University to co-host "WOCMAT 2009 Workshop on Computer Music and Audio Technology" on Oct 18 and Oct 19. With five workshops and four paper presentations, it provided a successful academic exchange opportunity between three universities and international scholars.

**NTU Information Security Week**

GICE Professor Tsung-Nan Lin proudly assisted NTU to hold the NTU Information Security Week in Dec. 2009. With a total of 11 workshops, topics including Campus Wireless Network Security, Intellectual Property Rights on Campus, Digital Crime and Justice, Client-side Trojan Horse Virus Attacks, Implementation of Virus Hunting, Web 2.0 and its New Challenges of Information Security.

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