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“This work was supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government.”
Dear Colleagues & Friends of the IEEE/IEIE ICCE-Asia 2020 Conference,

On behalf of the IEEE Consumer Technology Society (CTSoc) and the Institute of Electronics and Information Engineers (IEIE), it is my great pleasure and honor to welcome you to the IEEE/IEIE International Conference on Consumer Electronics - Asia (ICCE-Asia) 2020, which is held during November 1st to the 3rd of 2020 at the Paradise Hotel Busan, located in the beautiful Haeundae beach of the Busan Metropolitan City of the Republic of Korea.

Despite the global COVID-19 pandemic, the ICCE-Asia 2020 conference received approximately 250 technical paper submissions and accepted 168 of the best papers. During the conference, the keynote speeches, tutorials, and paper presentations will be conducted both offline and online in order to fully support the safety and convenience of the conference participants. In addition, as the Vice President of Membership of IEEE CTSoc, I am pleased to inform you that the society has officially changed its name from the IEEE “Consumer Electronics Society (CESoc)” to the “Consumer Technology Society (CTSoc),” where the ICCE-Asia 2020 conference demonstrates the full spectrum of the scope of expertise IEEE CTSoc and IEIE.

Due to COVID-19, the conference had to be moved from April to November, and also the location was changed from Seoul to Busan. Even during this very challenging period, I sincerely thank the CTSoc Board of Governors, Keynote and Tutorial speakers, and especially to the ICCE-Asia 2020 Organizing Committee for devoting their time and efforts to make this conference possible. Especially, I thank the General Co-Chairs (CTSoc President) prof. Wahab Almuhtadi and (IEIE President) prof. Hyesook Lim; Organizing Chair prof. Won Woo Ro; Organizing Co-Chairs prof. Stefan G. Mozar, Mr. Raed Abdullah, prof. Supavadee Aramvith, prof. Shingo Yamaguchi, and prof. Yu-Cheng Fan; TPC Chair prof. Sangheon Pack; and the
TPC Vice Co-Chairs, and all CTSoC and IEIE members for their interest and participation.

I sincerely hope that you will enjoy the conference and make many new friends. Thank you very much and I wish you a most healthy and pleasant conference.

General Chair

Jong-Moon Chung
Vice President of Membership, IEEE CTSoC and Associate Dean & Professor, Yonsei University

General Co-Chairs

Hyesook Lim
Ewha Womans University

Wahab Almuhtadi
President, IEEE CTSoC
It is great pleasure to welcome all of you to ICCE-Asia 2020 on behalf of all technical program committee members. First of all, I would like to express my sincere thanks to all program committee members and organizing members who dedicated to the wonderful technical program in ICCE-Asia 2020.

In this year, around 250 papers from 10 countries have been submitted to regular and special sessions. After rigorous review process, 168 regular papers were selected and they are organized into 7 oral presentation sessions, 8 poster presentation sessions, 3 special sessions, and 2 special programs on automotive electronics and women in engineering. The topics of the technical program cover artificial intelligence (AI), machine learning (ML), automotive applications, image/video processing, IoT, and wireless communications.

In ICCE-Asia 2020, we have invited four valuable plenary speakers: Beom Seok Kim (Samsung Electronics), Wen-Chung Kao (National Taiwan Normal University), and SeungJong Choi (LG Electronics), and Stefan Mozar (Fellow of IEEE). In addition, two tutorials were planned to provide both fundamental theories and practical techniques on biomedical electronics and deep learning. All of them contributed to our excellent technical program.

I believe and promise that ICCE-Asia 2020 will be the best opportunity to broaden your perspectives and build real relationships for better collaboration in this field.

Thank you very much.

Technical Program Chair

Sangheon Pack
Korea University, Korea
General Chair
Jong-Moon Chung (VP of IEEE CTSoc, Yonsei University)

General Co-Chairs
Hyesook Lim (President of IEIE, Ewha Womans University)
Wahab Almuhtadi (President, IEEE CTSoc)

Organizing Chair
Won Woo Ro (Yonsei University)

Organizing Co-Chairs
Stephan G. Mozar (IEEE CTSoc)
Raed Abdullah (IEEE CTSoc)
Supavadee Aramvith (IEEE CTSoc)
Shingo Yamaguchi (IEEE CTSoc)
Yu-Cheng Fan (IEEE CTSoc)

TPC Chair
Sangheon Pack (Korea University)

TPC Vice Co-Chairs
Seung-Won Jung (Korea University)
Chul Lee (Dongguk University)
Donghwa Shin (Soongsil University)
Seokhwan Park (Chonbuk National University)
Haneul Ko (Korea University)
Hyung-Min Lee (Korea University)
Soo Jin Kim (Korea University)

Special Session Chair
Sang-Chul Kim (Kookmin University)

Financial Chair
Chan-Byoung Chae (Yonsei University)

Publication Chair
William Song (Yonsei University)
Local Arrangement Chair
Jong-Ok Kim (Korea University)

Local Arrangement Co-Chair
In-Cheon Paik (University of AIZU)

Diversity Chair
SoYoung Kim (Sungkyunkwan University)
Jin Young Hwang (Korea Aerospace University)
JeongYon Shim (Kangnam University)

Society Area Chair
Changick Kim (KAIST)
Joongho Choi (University of Seoul)
Hoon Jin (Baewha University)

International Industry Chair
Raymond C. Garcia (Comcast)

International Industry Co-Chair
Jun Jin Kong (Samsung Electronics)

Publicity Chair
Joongheon Kim (Korea University)

Conference Secretary
Woojoo Lee (Chung-Ang University)

Treasurer
Branislav Djokic (VP of IEEE CTSoc)

Tutorial Chair
Seung Ah Lee (Yonsei University)

WIE (Women in Engineering) Chair
Takako Nonaka (IEEE CTSoc)
Technical Program Committee

Technical Program Committee Chair
Sangheon Pack (Korea University)

TPC Members
Nippun Kumaar Aa (Amrita Vishwa Vidyapeetham, Amrita School of Engineering)
Jang Woon Baek (ETRI)
Ilija Basicevic (University of Novi Sad)
Milan Bjelica (University of Novi Sad)
Joon-Hyuk Chang (Hanyang University)
Tai-Chen Chen (MAXEDA Technology)
Ji-Woong Choi (DGIST)
Koustabh Dolui (Katholieke Universiteit Leuven)
Tran Trung Duy (Posts and Telecommunications Institute of Technology)
Chih-Peng Fan (National Chung Hsing University)
Huei-Wen Ferng (National Taiwan University of Science and Technology)
Bob Frankston (Frankston)
Thittaporn Ganokratanaa (Chulalongkorn University)
Cheulhee Hahm (Samsung Electronics)
Jong Ki Han (Sejong University)
Junbeom Hur (Korea University)
Sallehuddin Ibrahim (Universiti Teknologi Malaysia)
Byeungwoo Jeon (Sungkyunkwan University)
Moongu Jeon (Gwangju Institute of Science and Technology (GIST))
Seongah Jeong (Kyungpook National University)
Romuald Jolivot (Bangkok University)
Seung-Won Jung (Korea University)
Kyungtae Kang (Hanyang University)
Chang-Su Kim (Korea University)
JongWon Kim (GIST (Gwangju Institute of Science & Technology))
Seon Wook Kim (Korea University)
Soo Jin Kim (Korea University)
Soochan Kim (Hankyong National University)
Sooyoung Kim (Jeonbuk National University)
Sunwoo Kim (Hanyang University)
Wonjong Kim (ETRI)
Haneul Ko (Korea University)
Jun Jin Kong (Samsung Electronics Co., Ltd.)
Goo-Rak Kwon (Chosun University)
Chang-Woo Lee (The Catholic University of Korea)
Chul Lee (Dongguk University)
Hyung-Min Lee (Korea University)
Kyoung-Jae Lee (Hanbat National University)
Yo-Sheng Lin (National Chi Nan University)
Parkash Lohana (Usman Institute of Technology - Hamdard University)
Vivek M (SRM University)
Muhammad Mahmood (Korea University of Technology and Education)
Nashiren Farzilah Mailah (Universiti Putra Malaysia)
Htoo Maung Maung (Department of Research and Innovation)
Stefan Mozar (Dynexsys Pty Ltd, Sydney)
Norwati Mustapha (Universiti Putra Malaysia)
Humaira Nisar (Universiti Tunku Abdul Rahman)
Incheon Paik (The University of Aizu)
Hyunhee Park (Myongji University)
Seok-Hwan Park (Jeonbuk National University)
Young-cheol Park (Yonsei University)
Thinagaran Perumal (University Putra Malaysia)
Ramesh Rayudu (Victoria University of Wellington)
Heejun Roh (Korea University)
Noor Asmawati Samsuri (Universiti Teknologi Malaysia)
Savath Saypadith (Osaka University)
JeongYon Shim (Kangnam University)
Donghwa Shin (Soongsil University)
Punnarai Siricharoen (KMUTT)
Changick Song (Korea National University of Transportation)
Iickho Song (Korea Advanced Institute of Science and Technology)
Hyeon-Jeong Suk (KAIST)
Sudarshan Tsb (PES University, Bangalore, INDIA)
Ei Ei Tun (Chulalongkorn University)
Pakorn Ubolkosold (Bangkok University)
Wei Wei (Xi’an University of Technology)
Chee Sun Won (Dongguk University)
Kuo Guan Wu (National Chung Hsing University)
Jamaiah Yahaya (The National University of Malaysia)
Changwoo Yoon (ETRI)
## Sunday, November 1, 2020

<table>
<thead>
<tr>
<th>Time</th>
<th>Room</th>
<th>Tutorial 1</th>
<th>Room</th>
<th>Tutorial 2</th>
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<tbody>
<tr>
<td>13:30-16:00</td>
<td>Sicily (1F)</td>
<td>Prof. Young-Ro Yoon (Yonsei University)</td>
<td>Atlantis (B1F)</td>
<td>Prof. Shogo Muramatsu (Niigata University)</td>
</tr>
<tr>
<td>14:00-15:30</td>
<td>SS1</td>
<td>AI and Embedded AI SW</td>
<td>SS2</td>
<td>SK Hynix</td>
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<tr>
<td>15:30-16:00</td>
<td>Coffee Break</td>
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<td>16:00-17:30</td>
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## Monday, November 2, 2020

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>08:30-16:00</td>
<td>Registration</td>
<td>OS1: AI and ML, OS2: Automotive Applications</td>
</tr>
<tr>
<td>09:00-10:30</td>
<td>Venice (2F)</td>
<td>OS3: Image and Video Processing</td>
</tr>
<tr>
<td></td>
<td>Miami (2F)</td>
<td>PS1: Automotive Electronics for Future Mobility, Grand Ballroom (2F)</td>
</tr>
<tr>
<td></td>
<td>Sydney (2F)</td>
<td>PS2: Women in Engineering (WIE), PS3: CE Systems</td>
</tr>
<tr>
<td>10:30-10:45</td>
<td></td>
<td>Coffee Break, Lunch (Capri Room 2F)</td>
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<tr>
<td>10:45-12:00</td>
<td></td>
<td>Opening Ceremony (Grand Ballroom 2F), Plenary Sessions 1, 2</td>
</tr>
<tr>
<td>12:00-13:30</td>
<td></td>
<td>OS4: CE Systems, PS5: IoT, PS6: WEIE Workshop</td>
</tr>
<tr>
<td>13:30-15:00</td>
<td></td>
<td>OS6: CE Technologies, PS7: Wireless Communications</td>
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<tr>
<td>15:00-15:30</td>
<td></td>
<td>Coffee Break, Lunch (Capri Room 2F)</td>
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<tr>
<td>15:00-17:00</td>
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<td>PS3 (15:30-16:15), PS4 (16:15-17:00), Plenary Sessions 3, 4</td>
</tr>
<tr>
<td>17:10-18:10</td>
<td></td>
<td>Banquet (Grand Ballroom 2F), Plenary Sessions 3, 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Dr. Stefan Mozar (IEEE Fellow), 4. Dr. Seung-Jong Choi (LG Electronics)</td>
</tr>
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## Tuesday, November 3, 2020

<table>
<thead>
<tr>
<th>Time</th>
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<tr>
<td>08:30-10:30</td>
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<td>OS5: IoT, SS3: WEIE Workshop, PS5 (09:00-09:45)</td>
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<td>09:00-10:30</td>
<td>Venice (2F)</td>
<td>PS6 (09:45-10:30)</td>
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<td>10:45-12:15</td>
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<td>OS6: CE Technologies, PS7: Wireless Communications, PS8 (11:30-12:15)</td>
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## QR Codes for YouTube/Zoom links

### YouTube Live Stream

**Monday, November 2, 2020**

<table>
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<tbody>
<tr>
<td>Opening Ceremony</td>
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<tr>
<td>10:45 – 11:00</td>
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<tr>
<td>Plenary 1, 2</td>
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<td><a href="https://youtu.be/DpOSA4q6jM">https://youtu.be/DpOSA4q6jM</a></td>
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</tr>
<tr>
<td>11:00 – 12:00</td>
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<td></td>
<td></td>
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<tr>
<td>SP2: Women in Engineering</td>
<td>Grand Ballroom (2F)</td>
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<tr>
<td>13:30 – 15:00</td>
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<tr>
<td>Plenary 3, 4</td>
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<td><a href="https://youtu.be/DpOSA4q6jM">https://youtu.be/DpOSA4q6jM</a></td>
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<td>17:10 – 18:10</td>
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<tr>
<td>Banquet</td>
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<tr>
<td>18:10 –</td>
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### Zoom

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<th>Link</th>
<th>ID/PW</th>
<th>QR Code</th>
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</thead>
</table>
Main Bldg. B1F

Main Bldg. 1F
Floor Map

Main Bldg. 2F
Author Registration

At least one author of every accepted paper should have a Regular Registration no later than September 29, 2020 to be presented at the conference and included in the proceedings. One regular registration will cover the publication of only one accepted paper. Each additional accepted paper by the same “corresponding” author will follow the policy described below.

<table>
<thead>
<tr>
<th>Accepted Papers (by the Same Author)</th>
<th>First Paper</th>
<th>Second Paper</th>
<th>Third Paper</th>
<th>Rest of the Papers</th>
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</thead>
<tbody>
<tr>
<td>One Paper</td>
<td>Regular registration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Papers</td>
<td>Regular registration</td>
<td>Student Registration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three Papers</td>
<td>Regular registration</td>
<td>Student Registration</td>
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<td>Four Papers or More</td>
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<td>Student Registration</td>
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Pre-Registration Fee

<table>
<thead>
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<th>Category</th>
<th>Pre-registration</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overseas</td>
<td>Domestic</td>
</tr>
<tr>
<td>IEEE/IEIE Member</td>
<td>Non-member of IEEE, IEIE</td>
<td>IEEE CTSoC Member</td>
</tr>
<tr>
<td>Regular</td>
<td>USD 600</td>
<td>USD 750</td>
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<tr>
<td>Student Registration</td>
<td>USD 420</td>
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<table>
<thead>
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<th>Category</th>
<th>Overseas</th>
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<tbody>
<tr>
<td>IEEE/IEIE Member</td>
<td>Non-member of IEEE, IEIE</td>
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<tr>
<td>Regular</td>
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<td>Student Registration</td>
<td>USD 530</td>
<td>USD 660</td>
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</table>

※ Banquet is NOT included in the on-site registration fees.
Registration Fee includes

Regular Registration
Admission to All Sessions, Conference Proceedings, Banquet, Coffee Breaks

Student Registration
Admission to All Sessions, Conference Proceedings, Coffee Breaks
* A banquet ticket is not included.

Payment Method

Credit Card
All transactions by credit card will appear on your statement as payment to Conference by ‘KG Mobilians’

Bank Transfer
- Name of Bank: CITI Bank Korea (Gangnam Business Dep.)
- SWIFT Code: CITIKRSXXX
- Account Number: 186-04460-247-01
- Name of Account Holder: The Institute of Electronics and Information Engineers
* You should transfer registration fee within 7 days from registration.
* You should send a copy of transaction with your name on it to the secretariat by fax (+82 2 552 6093) or e-mail (inter@theieie.org) for confirmation.
* All bank remittance charges are to be paid by the registrants.

Cancellation and Refund Policy

To cancel your registration, please notify the secretariat by an email to inter@theieie.org. Refunds will be made if cancellation occurs before September 29, 2020 with the processing fee of USD 100 (KRW110,000). No refund will be made after September 29, 2020 or for no show. If you have any questions regarding the registration, please contact the secretariat.

All dates and time are indicated in KST (The local time in Korea)
Oral Presentation

Please meet the session chair at your session at least 15 minutes before the session starts. You should identify yourself to the session chair and check in with the AV staff to go over your equipment needs. You need to bring your ppt file on USB memory, and load it on the computer in your session room. You also need to confirm whether it is working properly. This is very important to pay attention to this time frame. The visual equipment provided is a beam projector.

Time assignment including discussion is as follow

Tutorial : 90 minutes
Plenary : 30 minutes
Regular : 15 minutes

Poster Presentation

The size of the poster board is 60cm x 90cm (A1 Size). You need to prepare your poster within this size and attach it on the poster board in your session room at least 10 minutes before the session starts, and then remove your poster immediately after the session finishes.

Lunch

Lunch will be provided to all participants during the conference. Please bring your lunch coupon with your name tag.

<table>
<thead>
<tr>
<th>Location</th>
<th>Capri Room (2F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Time</td>
<td>November 2 (Mon) 12:00-13:30</td>
</tr>
</tbody>
</table>
Social Program

Opening Ceremony
Date : November 2, 2020
Time : 10:45-11:00
Place : Grand Ballroom (2F)
All registered participants are cordially invited to join us and celebrate the official opening.

Plenary Talks 1, 2
Date: Monday, November 2, 2020
Time: 11:00-12:00
Place: Grand Ballroom (2F)

Plenary Talks 3, 4
Date: Monday, November 2, 2020
Time: 17:10-18:10
Place: Grand Ballroom (2F)

Banquet
Date : November 2, 2020
Time : 18:10
Place : Grand Ballroom (2F)

We hope this banquet will offer you a good opportunity to promote friendship with participants. Delicious food and special performance will be offered at the banquet. A banquet ticket is included in the Regular Registration. Student Registration does not include the banquet.
Recent Advances in Electronic Paper Technology

Abstract

The electronic paper made by electrophoretic display has been successfully used in e-books and other consumer products. Although the electronic paper possesses numerous advantages in contrast to other displays, the progress of developing the color electronic paper appears extremely limited. Recently, the next generation of color electrophoretic materials has been proposed. But the drive scheme of the new color electronic paper and the corresponding signal processing engine have not been well studied accordingly. In the talk, Prof. Kao will share the latest developments in this field and propose interesting novel topics for future research.

Biography

Prof. Wen-Chung Kao received the M.S. and Ph.D. degrees in electrical engineering from National Taiwan University, Taiwan, in 1992 and 1996, respectively. From 1996 to 2000, he was a Department Manager at SoC Technology Center, ERSO, ITRI, Taiwan. From 2000 to 2004, he was an Assistant Vice President at NuCam Corporation in Foxlink Group, Taiwan to lead the R/D
Division to develop digital cameras. In 2002, he was invited to form SiPix Technology Inc., Taipei, Taiwan, where he was in charge of setting up the research team of the company and studying flexible electronic paper. Since 2004, he has been with National Taiwan Normal University (NTNU), Taipei, Taiwan, where he is currently a Chair Professor at Department of Electrical Engineering and the Dean of College of Technology and Engineering. His current research interests include system-on-a-chip (SoC) as well as embedded software design, flexible electronic paper, machine vision system, digital camera system, and color imaging science. Currently, he serves as a Senior Editor of IEEE Transactions on Consumer Electronics, VP of International Affairs in IEEE Consumer Electronics Society, and VP of Conferences in IEEE Product Safety Engineering Society. He is a Fellow of IEEE.
Samsung CMOS image sensors have evolved for 20 years based on pixel technologies. We have focused mainly on mobile applications like smart phones. Therefore, most important part was how to shrink pixel pitch maximizing sensitivity and SNR performances such that we could increase resolution at same optical format. Two key points of pixel performance improvement for smaller pixels are sensitivity and crosstalk. Although CMOS image sensors started based on standard CMOS process for lower cost, unique technologies have been developed for best pixel performances. The representative ones are gap-less microlens, light-guide, BSI (back-side illumination), DTI (deep trench isolation, aka ISOCETL\textsuperscript{TM}), and so on. Color filters also had to be improved for better patterning and transmittance spectra. Recently, ISOCCELL Plus technology was developed to enhance sensitivity of pixels less than 0.8\textmu m, where color filters are isolated by low RI materials. We are getting more and more interested in image sensors for invisible region (IR, UV) considering various applications other than mobile camera. The role of cameras equipped with image sensors is increasing, and new technology development is very important.
Biography

Bumsuk Kim was born on November 3, 1971 in Seoul Korea. He received B.S. degree, M.S. degree, and Ph. D degree in physics from SNU (Seoul National University), Seoul, Korea, in 1995, 1997, and 2003, respectively. In 2003, he joined pixel development group in Image development team, System LSI business, Samsung Electronics. Since 2003, he has participated in development of every pixel generation (4.0um to 0.8um) for Samsung CMOS image sensor, including FSI, light-guide, BSI, and ISOCELL pixels. He published 14 technical papers and filed 34 U.S. patents. His specialties are to design optical structure of CMOS image sensor pixels and to develop optical performance.
The Consumer Driven Energy Revolution

Abstract

Consumer energy demands are revolutionizing the way we need to think and consume energy. The technologies created for consumers, is changing the way consumer live and interact with our environment. Our demand for mobile energy is rapidly increasing, and our considerations of the environmental impact are often misleading. Over the whole of life cycle, electric cars are still are not as environmental friendly as assumed or marketed. Converting energy for mobile devices is not efficient. Current technologies, can make a household independent of the energy grid, but many commercial solutions are not as environmental friendly as they could be. This presentation will provide an overview of these issues.

Biography

Dr. Mozar is president of the IEEE Product Safety Engineering Society, and a Past President of the IEEE CT Society. He is the Past Chair of the IEEE Life Science Initiative. He has held many leadership roles in the IEEE, and has significantly contributed towards establishing conferences around the world for the IEEE. He has been a member of several company startups, and is working as an independent consultant and educator. He is an Adjunct Professor at Guangdong University of Technology, China. He currently resides in Sydney, Australia.
AI Chip Solutions and the Product Innovation

Abstract

IT industry has been making great efforts to provide the innovation. Recently, the transition to the era of AI (artificial intelligence) is rapidly going on, and AI technology is being applied to the virtually most of services and products. The big wave behind these activities would be to meet demands for the increasing expectation of user experiences through the customer-tailored evolution.

Global top players such as Google and Amazon provide the speech recognition solutions to maintain and widen their platforms. Even more sophisticated image recognition and context understanding are also emerging to provide more advanced user experiences. On the other hand, AI technology has a great potential to innovate the fundamental performances of products. For example, the picture and sound quality of TV can be revolutionized with AI, and the energy efficiency of home appliance products can be improved with AI.

LG has been successfully launching various market-leading products such as OLED TV, and home appliances. As a system design/manufacturing company, LG has strong advantages for making innovative customer-tailored products with AI utilizing huge amount of accumulated data on products so far. This talk introduces LG AI R&D activities and achievements mainly focusing on the AI chip solution, which plays a crucial role for products to be intelligent.
Biography

Dr. Seung-Jong Choi has been at LG Electronics since 1989, and is presently a Senior Research Fellow. His main research activities has been related with TV system including HDTV, 3DTV, smart TV and UHD TV. He has been leading multiple generation of TV SoC solutions and successfully applied them to the LG TV products contributing LG to be the global top player in TV industry. Currently, he is the task leader to strengthen OLED TV SoC and to exploit the next-generation computing solutions.

Dr. Choi received the B.S. degree from Seoul National University, Seoul, Korea, in 1987, the M.S. degree from Korea Advanced Institute of Science and Technology, Taejon, Korea, in 1989, and Ph.D. degree from Rensselaer Polytechnic Institute, Troy, NY, in 1996, all in electrical engineering. His doctoral research topic was on video compression and video signal processing.
Status and Prospects of Medical Device Industry in South Korea

Abstract

From 1971, the development of the domestic medical device industry had momentary momentum. In 1971, the domestic medical device industry had 91 companies, a total production value of 500 million won, and medical device imports of 11 million dollars. In Korea, introduced the Medical Insurance System in 1977, and then 1,008 domestic medical device companies, total production of 70 It has grown to KRW 37.2 million, with medical device imports of KRW 37.2 million.

In 1985, Medison was established as a representative medical device company, and in 1987, the Ministry of Commerce, which is the predecessor of the Ministry of Trade, Industry and Energy, launched a catch-place “Let's get out of the underdeveloped country in the medical device industry” and prepared comprehensive promotion measures to develop industrial-based technology. In 1995, the Ministry of Health and Welfare developed and fostered the domestic medical device industry through “Health and Medical Technology R&D Project” in which medical engineers, doctors, and companies participated together, and “G7 Project Project” in 1996.
The Ministry of Food and Drug Safety announced on May 20, 2020 that “in 2019, the domestic medical device production performance increased by 11.8% to 7,279.4 billion won, compared to 2016 (6,511.1 billion). The size of the domestic medical device market has been growing at an annual average of 10.3% over the past five years to 7.8 trillion won in 2019.

Through this topic, we will try to predict the future through analysis of the past and present of the Korean medical device industry through the current status and future outlook of the Korean medical device industry.

**Biography**

Professor Young Ro Yoon is currently a professor of dept. Biomedical Engineering, at Yonsei University's School of Health Sciences since February 1994. He served as a visiting professor at University of Florida Gainesville from August 2001 to July 2002, and as a visiting professor at the University of California, San Diego, from February 1, 2010 to January 2011. He received a bachelor's degree in electronic engineering from Yonsei University in 1981 and a master's degree in electrical engineering from California State University in Los Angeles in 1986. He received a Ph.d. in School of electrical engineering from Purdue University in 1991. He has worked as an engineer at Dynatrol National Corp. USA from 1985 to 1986 and as a researcher at the US Naval Research Laboratory in San Diego USA from March 1992 to January 1994. He has been working as a food and drug policy advisor from the Ministry of Food and Drug Safety from April 2017 to the present. He received the Prime Minister's citation on December 5, 2013 and the President's citation on May 29, 2017. Other awards include the Gangwon-do Governor's Citation on November 10, 2017, Wonju Mayor's Citation on October 25, 2007, the Biomedical Engineering Award on November 18, 2018 and December 2, 2005, and the 2018 Korea Medical Device Industry Association Appreciation Plaque. He localized the ear thermometer for the first time in Korea. He has many industrialization results and related patents.
Sparsity-Aware High-Dimensional Data Restoration with Convolutional Dictionary Learning

Abstract

In this tutorial, sparsity-aware restoration process of high-dimensional data is outlined. First, the purpose and application examples of image and volumetric data restoration are introduced. Then, the relationship between simultaneous equations and signal restoration is illustrated. The following topics are also summarized: Inner products and filtering, linear systems and matrices, filter banks and synthesis dictionaries, sparse modeling and MAP estimation, image generation and prior knowledge. Convolutional dictionary learning is also explained in connection with the design of parametric filter banks. Finally, the nonlinear extension of convolution dictionary is discussed and compared with convolutional neural networks (CNNs).

Biography

Shogo Muramatsu received the B.E., M.E. and Ph.D. degrees from Tokyo Metropolitan University, Tokyo, Japan, in 1993, 1995 and 1998, respectively. From 1997 to 1999, he worked at Tokyo Metropolitan University. In 1999, he joined Niigata University, where he is currently a Professor in the Faculty of Engineering. From 2003 to 2004, he was a Visiting Researcher at the University of Florence, Italy. His research interests include multidimensional signal processing, multi-rate systems, image processing, video analysis, and embedded vision systems. Prof. Muramatsu is a Senior
Member of IEEE and IEICE (Institute of Electronics, Information, and Communication Engineers of Japan) and a Member of APSIPA (Asia-Pacific Signal and Information Processing Association) and ITE (Institute of Image Information and Television Engineers of Japan). He is an Associate Editor for the IEEE Transactions on Signal Processing since 2019 and an APSIPA Distinguished Lecturer from 2020 to 2021.
Vehicle Architecture, future development direction of automotive electronics system

Abstract

The automotive industry is facing a paradigm shift from ‘product manufacturers’ to ‘smart mobility solution providers’. The new mobility service will have a big impact on automotive electronics system. The complexity of electrical/electronic systems will be increased significantly due to new features and services. We need a way to effectively manage the complexity of vehicle development while providing the best products and services to our customers.

Innovation in automotive electronic systems requires a change in the way they are developed. First, we are developing a top-down design principle that defines the fundamental structure of the entire electrical system firstly and then develops the appropriate parts and functions. When a vehicle is developed on the basis of architecture, the complexity of the development will be reduced. Second, software will become more important in vehicle development. Software-oriented development will make the vehicle more flexible and agile, making it easier to deliver new features and services, which will improve customer value.

In the smart mobility era where cars are the center of life, please look forward to Hyundai Motor Company’s innovation.
The Direction of Automotive Electronics & Semiconductor for Future Mobility

Abstract

Recently, the automotive industry is moving to the future of smart mobility represented by MECA of Mobility, Electrification, Connectivity and Autonomous driving beyond the electronic-control stage. To lead these technological changes of automotive industry, global OEMs are redefining their own E/E architecture. The change from distributed architecture to domain architecture will increase the functional complexity of S/W, and require the ECU with high-performance H/W to correspond with functional integration and convergence functions. Today, normally a single supplier is developing ECUs including H/W and S/W together, but in the future, H/W and S/W suppliers are expected to be separated to focus on developing the complicated S/W functions. In order to implement S/W with integration and service functions in vehicle level, high-performance APs (Application Processors) are required in vehicles. In applying theses processors, it is important to secure development competitiveness, firstly, in each S/W sector such as BSP, Middleware, and S/W platform. In addition, some OEMs are working to internalize major S/W to implement service functions, which are the core technologies of the future. We can say that it is essential to develop automotive semiconductors, which will be adopted in high-performance ECU, with high reliability such as optimized power consumption and heat dissipation, to ensure H/W performance and reusability/standardization for next-generation architecture.
The Introduction to Automotive Cyber-Security

Abstract

A contemporary automobile is equipped with a great number of electronic control units (ECUs) where these ECUs are connected via different types of wired bus networks such as Controller Area Network (CAN) and Local Interconnect Network (LIN). ECUs in the automobile exchange data for monitoring a status of the automobile or controlling the automobile using in-vehicle network protocols. By the time when these in-vehicle network protocols were designed, the in-vehicle bus networks were considered to be isolated from the external networks. As a consequence, the in-vehicle network protocols do not encrypt data or authenticate messages. Recent automobiles, however, provide many connected wireless services to passengers which includes real-time traffic information, emergency calls in case of an accident, or over-the-air software updates. In order to support these services, many ECUs in a contemporary automobile are connected to external networks such as cellular network, Wi-Fi, and Bluetooth. These ECUs with outward-facing interfaces act as attack surfaces to the in-vehicle networks and other ECUs in the automobile.

Recent studies showed that many automobiles are vulnerable to various cyber-attacks that exploit ECUs with the outward-facing interfaces. In 2011, Checkoway et al. discovered that remote exploitation of an automobile is feasible via CD players, Bluetooth, and cellular network, which may lead to vehicle control, location tracking, and theft. Miller and Valasek demonstrated that steering and braking, which is one of the most safety-critical system, of a Jeep Cherokee can be remotely controlled by an adversary.
once the adversary compromises an ECU via Remote Key Entry, FM/AM radio, cellular network, and internet applications in 2015. Although vulnerabilities of ECUs that are connected to the external networks are identified, connected and autonomous automobiles will be equipped with these ECUs to support cutting-edge functionalities.

It is difficult to incorporate message authentication and data encryption to the existing in-vehicle 2 network protocols because of lack of backward compatibility with the legacy systems. Hence, in academia and industry, Intrusion Detection Systems (IDSs) have been developed to detect cyber-attacks on the CAN bus using various physical invariants of ECUs. In addition, a lot of legal legislation organizations establish regulations, security standards, and guidelines that can mitigate or minimize consequences of cyber-attacks. In Europe, UNECE WP29 is now effective. Automobile OEMs have to set up systematic design procedures according to this regulation, and all the cars sold in Europe must be manufactured based on this regulation. In US, NHTSA published a cyber-security guide that specifically indicate functions and data that need to be provided in case of analyzing accidents.

We, as an automobile OEM, recognize current issues and limitations of the connected and autonomous vehicles with respect to security. We also do know that customers would want more connectivity inside a car and higher-level autonomous driving capability. In order to satisfy both our customers and regulations, we are moving fast in the right direction and provide security assurance to future automobiles.
WIE Session 1
‘My Story: Imagine YOUR next’
Moderator: Prof. Jin Young Hwang (Korea Aerospace University, Korea)

13:30-15:00 Monday, November 2, 2020
Room: [Grand Ballroom 2F]

Prof. Hyesook Lim
[Ewha Womans University]

Abstract

As an example of the trajectory of a female engineer’s life, I look back on my own journey. In order for more female engineers to contribute and grow in our society, we will talk about areas that require personal efforts and areas that all members in our society need to work together.

Biography

Hyesook Lim received the B.S. and M.S. degrees at the Department of Control and Instrumentation Engineering in Seoul National University, Seoul, Korea, in 1986 and 1991, respectively. She received the Ph.D. degree at the Electrical and Computer Engineering from the University of Texas at Austin, Texas, in 1996. From 1996-2000, she had been employed as a member of technical staff at Bell Labs in Lucent Technologies, Murray Hill, NJ, USA. From 2000–2002, she had been employed as a hardware engineer for Cisco Systems, San Jose, CA, USA. She is currently a professor in the Department of Electronics and Electrical Engineering, Ewha Womans University, and the president of the Institute of Electronics and Information Engineers, Seoul, Korea. She is also a full member of the National Academy of Engineering of Korea. She is the winner of Women in Science and Engineering Award in 2014 and the President Award commemorating the Science Day in 2020 awarded by Korean Government.
WIE Session 2
(Panel Discussion, Informative Q&A and Networking)
‘Work-life balance : The successful strategy of dual-career couple’

• Facilitator: Prof. SoYoung Kim
  (Sungkyunkwan University, Korea)

• Panelists

Prof. Hyesook Lim
(Ewha Womans University, Korea)

Prof. Jin Young Hwang
(Korea Aerospace University, Korea)

Prof. Seung Ah Lee
(Yonsei University, Korea)

Prof. Sangbeom Jun
(Ewha Womans University, Korea)

Prof. JeongYon Shim
(Kangnam University, Korea)

Abstract

In this panel, both men and women professionals will share tips to plan your career in electrical and computer engineering representing a range of viewpoints, experiences and backgrounds. In the highly competitive IT industry, it is not easy for a dual-career couple who have made a family home to be both happy and highly successful in their careers. We will discuss realistic life strategies that worked and did not work.
01 An Affective Service based on Multi-Modal Emotion Recognition, using EEG enabled Emotion Tracking and Speech Emotion Recognition
Danai Styliani Moschona
(National Taipei University of Technology, Taiwan)

02 Deep Learning Based Detection for Mitigating Sneak Path Interference in Resistive Memory Arrays
Xingwei Zhong, Kui Cai, Guanghui Song, and Nagarajan Raghavan
(Singapore University of Technology and Design (SUTD), Singapore)

03 Neural Network-Based Decoding of Constrained Codes for DNA Data Storage
Panpan Li, Kui Cai, Guanghui Song, Wentu Song, Zhen Mei, and Xingwei Zhong
(Singapore University of Technology and Design (SUTD), Singapore)

04 Caption Attention Map Embedding for Generating Diverse Image Descriptions
Boeun Kim and Hyedong Jung
(KETI, Korea)

05 Deep Learning-Based Deblur Using Gyroscope Data
Jeongmin Lee, Seo-Won Ji, Sung-Jin Cho, Jun-Pyo Hong, and Sung-Jea Ko
(Korea University, Korea)
01 System Data Flow Pipelining for Embedded Heterogenous SoCs using OpenVX
Kedar Chitnis, Jesse Villarreal, Lucas Weaver, Brijesh Jadav, Shyam Jaganathan, Mihir Mody, Taehun Kim, and Sujith Shivalingappa
(Texas Instruments Incorporated (Bangalore, Dallas, Seoul))

02 Lane Level Path Planning for Urban Autonomous Driving using Vector Map
Chanyoung Jung, Deagyu Lee, Boseong Kim, and David Hyunchul Shim
(KAIST, Korea)

03 Time Offsets for Scheduling Tasks in Multicore ECUs
Do Yeon Kim, Jun Young Moon, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

04 Flexible and Efficient sharing of High Performance Hardware Accelerators in a Safe, Secure, Virtualized System
Sriramakrishnan Govindarajan, Kedar Chitnis, Mihir Mody, Greg Shurtz, Sujith Shivalingappa, and Taehun Kim
(Texas Instruments Incorporated (Bangalore, Dallas, Seoul))

01 Design and Implementation of a Hand-held Lensless Light Field Camera
Chun-Hsien Ho¹, Yi-Hsien Lin¹, Jennifer Shueh-Inn Hu², and Yi-Chang Lu¹
(National Taiwan University, Taiwan¹, Ming Chuan University, Taiwan²)

02 Mini-LED displays pixel circuit design
Yi-Cheng Liu, Kuan-Yu Liao, Yen-Ju Li, and Yu-Cheng Fan
(National Taipei University of Technology, Taiwan)
03 **Image Segmentation Algorithm for Semantic Segmentation with Sharp Boundaries using Image Processing and Deep Neural Network**  
Hong-Gu Jeong, Hyeon-Woo Jeong, Byung-Hyun Yoon, and Kang-Sun Choi  
(*KOREATECH, Korea*)

04 **Lensless Imaging with an End-to-End Deep Neural Network**  
Donggeon Bae, Jaewoo Jung, Nakkyu Baek, and Seung Ah Lee*  
(*Yonsei University, Korea*)

05 **Optimization of Vehicle Communication Networking Parameters in eAVB**  
Byoungman An and Youngseop Kim  
(*Dankook University, Korea*)

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**05 CE Systems**

15:30-17:00 Monday, November 2, 2020  
Room: Venice (2F)  
Chair: William Song (Yonsei University)

01 **Indoor Positioning System: Improved deep learning approach based on LSTM and multi-stage activity classification**  
Muhammad Shahid Jabbar, Ghulam Hussain, and Jun-Dong Cho*  
(*Sungkyunkwan University, Korea*)

02 **An EEG device with synchronization of auditory stimuli**  
Tak Chun Kwong¹, Sing Long Wong¹, Man Ho Tsoi¹, Chetwyn C. H. Chan¹, Yat Sze Choy¹, and Steve W. Y. Mung²  
(*The Hong Kong Polytechnic University, Hong Kong, Hong Kong¹, Innovation Technology Company Limited, Hong Kong²*)

03 **High-Speed Lensless Eye Tracker for Microsaccade Measurement**  
Tae Young Kim¹, Kyung Chul Lee¹, Kyungwon Lee¹, Nak Kyu Baek¹, Jaewoo Jung¹, Juhyung Kim², Jinwook Kim², Young-Seok Seo², and Seung Ah Lee¹*  
(*Yonsei University, Korea¹, WONTECH Co, Ltd²*)

04 **Wide-field, High-resolution Computational Microscopy on a Smartphone**  
Kyung Chul Lee, Se Hee Lee, Jaewoo Jung, Kyungwon Lee, and Seung Ah Lee*  
(*Yonsei University, Korea*)
05 Predicting Viewer’s Preference for Music Videos Using EEG Dataset
Shingchern D. You and Yu-Chen Li
(National Taipei University of Technology, Taiwan)

OS5 IoT
09:00-10:30 Tuesday, November 3, 2020
Room: Venice (2F)
Chair: JeongYon Shim (Kangnam University)

01 White-Hat Worm Launcher Based on Deep Learning in Botnet Defense System
Mohd Hafizuddin Bin Kamilin, and Shingo Yamaguchi
(Yamaguchi University, Japan)

02 Smart Safety Hook Monitoring System for Construction Site
Seohyun Jeon\textsuperscript{1}, Sungjun Kim\textsuperscript{2}, Sangseung Kang\textsuperscript{1}, and Kyekyung Kim\textsuperscript{1}
(ETRI, Korea\textsuperscript{1}, HDC Hyundai Development Company, Korea\textsuperscript{2})

03 A System for Monitoring Social Distancing Using Microcomputer Modules on University Campuses
Yutaro Kobayashi, Yoshiaki Taniguchi, Youji Ochi, and Nobukazu Iguchi
(Kindai University, Japan)

04 Reconfigurable frequency switching and synchronization for noise avoidance in power line communication system
Man Ho Tsoi\textsuperscript{1}, Tsz Hong Ng\textsuperscript{2}, Daniel P. K. Lun\textsuperscript{1}, Yat Sze Choy\textsuperscript{1}, and Steve W. Y. Mung\textsuperscript{1}
(Hong Kong Polytechnic University, Hong Kong\textsuperscript{1}, Linked-Technologies Limited, Hong Kong\textsuperscript{2})

OS6 CE Technologies
10:45-12:15 Tuesday, November 3, 2020
Room: Venice (2F)
Chair: Taewon Song (Soon Chun Hyang University)

01 BODCA: Heterogeneous CPU-GPU computing system with Bandwidth-Optimized DRAM cache design
Sungji Choi and Won Woo Ro
(Yonsei University, Korea)
02 Efficiency improvement of power conversion system with multilayer power inductor
Hyun Gyu Jang¹, Dong Yun Jung¹, Doohyung Cho¹, Kun Sik Park¹, Jong-Won Lim¹, and Yong Ha Lee²
(ETRI, Korea¹, Y.TECH., Korea²)

03 Haze Removal of Multispectral Remote Sensing Imagery Using Atmospheric Scattering Model-Based Haze Thickness Map
Hyeongseok Choi, Heunseung Lim, Soohwan Yu, and Joonki Paik
(Chung-Ang University, Korea)

04 Implementation of Compressed YOLOv3-tiny on FPGA-SoC
SeonTaek Oh, Ji-Hwan You, and Young-Keun Kim
(Handong Global University, Korea)

05 Wireless Communications
10:45-12:15 Tuesday, November 3, 2020
Room: Miami (2F)
Chair: Haneul Ko (Korea University)

01 Compact transmission-line circuit for audio and microwave signals
Man Ho Tsoi¹, Ka Ming Wu², Joseph S. M. Yuen², Yat Sze Choy¹, and Steve W. Y. Mung¹,²,*
(Hong Kong Polytechnic University, Hong Kong¹, Innovation Technology Company Limited, Hong Kong²)

02 Wideband Transceiver RF Front-end Design for HDTV/DTV and ISDB-T Applications
Wen-Cheng Lai¹,²
(National Yunlin University of Science and Technology, Taiwan¹ National Taiwan University of Science and Technology, Taiwan²)

03 A Preliminary Study of Machine-Learning-Based Ranging with LTE Channel Impulse Response in Multipath Environment
Halim Lee and Jiwon Seo
(Yonsei University, Korea)

04 High Optical Transparent and Shielding Effectiveness Using Metal Mesh and Saltwater for Transparent EMI Shielding Applications
Duy Tung Phan and Chang Won Jung
(Seoul National University of Science and Technology, Korea)
01 A Lightweight Super-resolution for Compressed Image
Simyung Chang, Jihoon Kim, and Cheul-hee Hahm
(Samsung Electronics, Korea)

02 A Memory-aware Performance Optimization of Tensor Programs for Embedded Devices
Sunwoong Joo¹, Attila Dusnoki³, Martyn Bliss², Ben Duckworth², Nicolas Scotto Di Perto², Markó Fabó³, Gábor Lóki³, Dániel Vince³, Ákos Kiss³, and Cheul-hee Hahm¹
(Samsung Electronics¹, Samsung Research United Kingdom, United Kingdom², University of Szeged, Hungary³)

03 An Efficient Stack Management by The Selective Revocation of Mapping from Virtual Memory to Physical memory
Jusun Song, Youngho Choi, Seokjae Jeong, and Cheul-hee Hahm
(Samsung Electronics, Korea)

04 LSTM-based Load Curtailment Prediction in Demand Response System
Jimyung Kang¹, Jaemoon Kim², Changun Park¹, and Sungsoo Choi¹
(KERI, Korea¹, Qualcomm Technologies Inc., Korea²)

05 Linear Regression Using Simple Charge and Discharge Circuit
Sung Hwan Paik, Beak Hwan Kim, Sung Jin Kim, and Kang Yoon Lee
(Sungkyunkwan University, Korea)
01 A 128Gbit Cross-point memory for applications of in-memory database and analytics
Taeho Kim, Insoo Lee, Seokjoon Kang, Minchul Shin, Dongkeun Kim, Junghyuk Yoon, Seungmin Baek, Yooncheol Bae, Jonghan Lee, Soohuck Noh, Gapsok Do, Jungwon Seo, Kimyung Kyung, Seoungji Chung, Taekseung Kim, Taehoon Kim, Yongjoo Kim, Junhyun Chun, and Kyowon Jin
(SK Hynix, Korea)

02 A Wafer Fail Bit Map Clustering Method Based On Machine Learning for Enhancing Memory Productivity
Jaewon Jang, Minkyu Kim, Junheon Lee, and Woosik Jeong
(SK Hynix, Korea)

03 Effect of Tungsten Growth by Plasma Surface Treatment on 3D NAND Device Improvement
Youngjin Lee, Sunggon Jin, Seungho Pyi, and Jinkook Kim
(SK Hynix, Korea)

04 Emerging NVM’s Opportunity for AI Edge Device
Sangsu Park, Seho Lee, Ilsup Jin, and Jinkook Kim
(SK Hynix, Korea)

05 Neural Vector Processor (NVP) for Enhanced Flexibility of Deep Learning Accelerator
Yongsang Park¹, Yongjiae Jin¹, Minsoo Lim¹, Euiseok Kim¹, Jeong-Ho Han², Seok Joong Hwang², Myeongjin Cho², Mookyung Chung², Kyung Park¹, and Jaehyeong Lee¹
(SK Hynix, Korea¹, SK Telecom, Korea²)
01 Convolutional Nonlinear Dictionary with Cascaded Structure Filter Banks
Ruiki Kobayashi and Shogo Muramatsu
(Niigata University, Japan)

02 Deep Retinex Decomposition Network for Multi Exposure Image Fusion
Kang-Kyu Lee, Je-Ho Ryu, and Jong-Ok Kim
(Korea University, Korea)

03 Comparison on Word Embeddings for Sentiment Classification with Noisy Twitter Data
Takahiro Yamauchi and Incheon Paik
(The University of Aizu, Japan)

04 Pneumonia: Predicting death rate of patients at the Intensive Care Unit admission
Cherubin Mugisha and Incheon Paik
(The University of Aizu, Japan)

05 What Visual Attributes Make Mascot Characters Memorable? A Case Study on “Yuru-Charas”
Hiroya Ikeda¹, Marie Katsurai¹, Akinori Iwata¹, and Toshihisa Tanaka²
(Doshisha University, Japan¹, Tokyo University of Agriculture and Technology, Japan²)
01 Low-cost Hierarchical Monitoring System for Solar Photovoltaic Systems  
Hyeonkyu Kim¹, Soyeon Choi¹, Yeonshin Joo², Woocheol Shin², and Hoyoung Yoo¹  
(Chungnam National University, Korea¹, Dong Yeok Engineer, Korea²)

02 Real-time Automatic License Plate Recognition System using YOLOv4  
Ju-Yeong Sung, Saet-Byeol Yu, and Se-ho Park  
(KETI, Korea)

03 Comparison of Faster-RCNN, YOLO, and SSD for Real-Time Vehicle Type Recognition  
Jeong-ah Kim, Ju-Yeong Sung, and Se-ho Park  
(KETI, Korea)

04 Movable Dynamic Data Detection and Visualization for Digital Twin City  
Ahyun Lee, Juwan Kim, and Insung Jang  
(ETRI, Korea)

05 Interaction Data Analysis for Personalized Recommendation System  
Seokmin Lee and Won Woo Ro  
(Yonsei University, Korea)

06 BENEFIT: Basic Linear Algebra Subprogram and Neural Network framework for FPGA-based Neural Processing Units  
Dongseok Kang and Won Woo Ro  
(Yonsei University, Korea)

07 OASIS: Overhead Analysis of Systolic Neural Processing Unit on LSTM  
Byunghwy Choi and Won Woo Ro  
(Yonsei University, Korea)

08 Development and Evaluation of High-Density Multi-GPU Sub-System Using PCI Express Expansion Hardware  
Young woo Kim¹, Myung-hoon Oh¹, and Chan-Yeol Park²  
(ETRI, Korea¹, KISTI, Korea²)
09 Online Keyframe Selection Scheme for Semantic Video Segmentation
Mehwish Awan and Jitae Shin
(Sungkyunkwan University, Korea)

10 Self Reorganizing Knowledge Network by Selective Perception
JeongYon Shim
(Kangnam University, Korea)

11 Road Semantic Segmentation Oriented Dataset for Autonomous Driving
Taejin Kim and Hyunchul Shim
(KAIST, Korea)

12 Action Recognition Using Frame Average Feature Map with 2D Convolutional Neural Network for Real-Time Video Analysis
Keonwoo Kang, Hasil Park, Joongchol Shin, Jinsol Ha, and Joonki Paik
(Chung-Ang University, Korea)

13 Emotion Enhancement for Facial Images Using GAN
JUN-HWA KIM and CHEE SUN WON
(Dongguk University, Korea)

14 An ASMO method for CNN-based Occluded Object Detection
Tae-Ho Lee¹, Young-Gyu Kang², Soojung Ryu¹, and Hyuk-Jae Lee¹
(Seoul National University, Korea¹, Namuga Co., Ltd²)

15 Feasibility Study of Predicting Semiconductor Thin Film Thickness Based on 1D Convolutional Neural Network
Hyo-Bin Park¹, Kil-Taek Lim², and Kwang-Ju Kim²
(Koreatech, Korea¹, ETRI, Korea²)

PS2
14:15-15:00 Monday, November 2, 2020
Room: Sydney (2F)
Chair: Won Woo Ro (Yonsei University)

01 Modified Spiking Neural Networks for Intelligence Edge
Seongmo Park, Byoung Gun Choi, In Gi Lim, Seongeun Kim, and Kyunghwan Park
(ETRI, Korea)
02 Target Classification for Range-Doppler Map in Real Environment using Deep Learning
Sunjae Yoon¹, Sunghun Kang¹, Jaewook Park², Jonghwan Shin², Junehyune Park², and Chang D. Yoo¹
(KAIST, Korea¹, LIG Nex1, Korea²)

03 Deep Learning Based Heart Rate Estimation Using Smart Shoes Sensor
Suwhan Baek¹, Heesang Eom¹, Yuli Sun Hariyani¹, Gwangho Kim¹, Jongryum Roh², Sayup Kim², and Chelsoo Park¹
(Kwangwoon University, Korea¹, KIT, Korea²)

04 Self-Supervised Learning by Solving Rotation Puzzles
Hobin Ryu, Cao Nguyen-Van, Sunkyung Lee, Kookhoi Kim, and Chang D. Yoo
(KAIST, Korea)

05 Automatic Safety Management System Based on Object Detection for Electrical Transmission System
Minjeong Ju¹, Hobin Ryu¹, Sangkeun Moon², and Chang D. Yoo¹
(KAIST, Korea¹, KEPCO, Korea²)

06 Towards Accurate Low Bit DNNs with Filter-wise Quantization
Hoseung Kim, Kwangbae Lee, and Dongkun Shin
(Sungkyunkwan University, Korea)

07 Contrast Enhancement of Mobile Phone Camera Using Multi-Scale Feature Map
Sanghyun Byun, Heunseung Lim, Soohwan Yu, and Joonki Paik
(Chung-Ang University, Korea)

Minyeo Kim, Heunseung Lim, Soohwan Yu, and Joonki Paik
(Chung-Ang University, Korea)

09 Combined Classifier for Multi-label Network in Road Scene Classification
Tin Trung Duong, Tien Phuoc Nguyen, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

10 Accurate Real-Time Traffic Light Detection Using YOLOv4
Tai Huu - Phuong Tran, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

11 Object Detection with Deep Learning on Drive PX2
Duong Nguyen-Ngoc Tran, Huy-Hung Nguyen, Long Hoang Pham, and Jae Wook Jeon
(Sungkyunkwan University, Korea)
12 Enhancing Precision of ResNet-RRC with Pruning
Hyung-Joon Jeon and Jae Wook Jeon
(Sungkyunkwan University, Korea)

13 A Simple and fast method to detect garbage dumping using pedestrian attribute
Mi-seon Kang, Pyong-Kun Kim, and Kil-Taek Lim
(ETRI, Korea)

14 Visuomotor Steering angle Prediction in Dynamic Perception Environment for Autonomous Vehicle
Farzeen Munir, Shoaib Azam, and Moongu Jeon
(GIST, Korea)

15 Hand-eye Calibration using Images Restored by Deep Learning
Hyun-Su Kim¹, Tae-Yong Kuc¹, and Kwang-Hee Lee²
(Sungkyunkwan University, Korea¹, KIIT, Korea²)

16 Target Distance Calculation Method Using Image Segmentation
Yutaek Jung¹, Hyunjun Lee¹, Junho Shin¹, Jongwooa Lee¹, Yilin Hou², Nathaniel Moore², Youlim Ko², Shinhye Yun², Eric T. Matson², and Minsun Lee¹
(Chungnam National University, Korea¹, Purdue University, USA²)

17 A New Approximate Adder with Duplicate-Constant Scheme for Energy Efficient Applications
Hyoju Seo and Yongtae Kim
(Kyungpook National University, Korea)

18 Electromagnetic Field Analysis for Automotive Safety Door Systems Utilizing Non-contact Sealing Sensors
Kyubong Yeon and Duho Lee
(KATECH, Korea)

PS3
15:30-16:15 Monday, November 2, 2020
Room: Sydney (2F)
Chair: Jong-Ok Kim (Korea University)

01 Window Attention Network for Person Identification on Radar Domain
Dahyun Kim¹, Sunjae Yoon¹, Jaewook Park¹, Jonghwan Shin², Junehyune Park², and Chang D. Yoo¹
(KAIST, Korea¹, LIG Nex¹, Korea²)
02 Model-Parallel Learning of Generative Adversarial Networks and Its Implementation
Hojung Lee and Jong-Seok Lee
(Yonsei University, Korea)

03 Graph Neural Network with Multilevel Feature Fusion for EEG based Brain-Computer Interface
Youngchul Kwak¹, Woo-Jin Song¹, and Seong-Eun Kim²
(POSTECH, Korea¹, Hanbat National University, Korea²)

04 Multi-scale Adaptive Residual Network Using Total Variation for Real Image Super-Resolution
Keon-Hee Ahn¹, Jun-Hyuk Kim², Jun-Ho Choi², and Jong-Seok Lee²
(Ewha Womans University, Korea¹, Yonsei University, Korea²)

05 ElasticNet with First order Interaction of Specific Genes for drug response prediction using preclinical samples
JoongHo Lee, Kexin Qiu, HanBoul Kim, and Seokhyun Yoon
(Dankook University, Korea)

06 Deep Multi-Exposure Fusion Using Feature Boosting Weight
Yu-Bin Cho, Je-Ho Ryu, and Jong-Ok Kim
(Korea University, Korea)

07 Urban Traffic Prediction using Congestion Diffusion Model
Sung-Soo Kim¹, Moonyoung Chung¹, and Young-Kuk Kim²
(ETRI, Korea¹, Chungnam National University, Korea²)

08 An Automatic Database Generation Algorithm for Local Optimization of CNN Object Detector for Edge Devices
Joon-Goo Lee and Jang Woon Baek
(ETRI, Korea)

09 Single Image Deblurring Based on Auxiliary Sobel Loss Function
Jun-Pyo Hong, Sung-Jin Cho, Jeongmin Lee, Seo-Won Ji, and Sung-Jea Ko
(Korea University, Korea)

10 MPQ-YOLACT: Mixed-Precision Quantization for Lightweight YOLACT
Seungjin Lee and Hyun Kim
(Seoul National University of Science and Technology, Korea)

11 Re-Labeling for Real-time Semantic Segmentation in Specific Environments
HyeOk Choi, Yong-Suk Park, and Kyung-Taek Lee
(KETI, Korea)
12 Ternary classification for image aesthetic assessment using deep learning
Hyeongnam Jang and Jong-Seok Lee
(Yonsei University, Korea)

13 Pedestrian Detection Using Adaptive Switcher of Day and Night Model in Autonomous Vehicle
Duyoung Heo¹, Sangwon Kim¹, Byoung Chul Ko¹, and David M. Bevly²
(Keimyung University, Korea¹, Auburn University, USA²)

14 Double Prioritized State Recycled Experience Replay
Fanchen Bu and Dong Eui Chang
(KAIST, Korea)

15 Low-Light Image Enhancement for Autonomous Driving Systems using DriveRetinex-Net
Long Hoang Pham, Duong Nguyen-Ngoc Tran, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

16 Trade-Off in Implementation of P2P Energy Trading over Hyperledger Blockchain
In Hwan Park, Tae Rim Lee, and Ju Wook Jang
(Sogang University, Korea)

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Room: Sydney (2F)
Chair: Jong-Ok Kim (Korea University)

01 Implementation and Analysis of a memory-semantic interconnect based on Gen-Z Protocol
Seokbin Hong¹,², Song-Woo Sok², Won-Ok Kwon¹,², and Myeong-Hoon Oh²
(UST, Korea¹, ETRI, Korea²)

02 Efficient Bokeh Effect Rendering using Generative Adversarial Network
Min-Su Choi, Jun-Hyuk Kim, Jun-Ho Choi, and Jong-Seok Lee
(Yonsei University, Korea)

03 Fast Object Detection Using a Frame Skip Method
Jin Woo Park¹, Jinsung Kim², and Hyuk-Jae Lee¹
(Seoul National University, Korea¹, Sunmoon University, Korea²)
04 Per-channel Quantization Level Allocation for Quantizing Convolutional Neural Networks
Seunghwan Cho and Sungjoo Yoo
(Seoul National University, Korea)

05 Distinctive Image Caption Generation Network using TF-IDF
Boeun Kim and Hyedong Jung
(KETI, Korea)

06 Towards Real-Time Vehicle Detection on Edge Devices with Nvidia Jetson TX2
Huy-Hung Nguyen, Duong Nguyen-Ngoc Tran, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

07 Training Spiking Neural Networks with an Adaptive Leaky Integrate-and-Fire Neuron
Mingyu Sung and Yongtae Kim
(Kyungpook National University, Korea)

08 Metric Optimization for Sound Event Localization and Detection
Sooyoung Park, Youngho Jeong, and Taejin Lee
(ETRI, Korea)

09 Exploring Group Sparsity using Dynamic Sparse Training
Geunhye Jo, Gwanghan Lee, and Dongkun Shin
(Sungkyunkwan University, Korea)

10 GPU Side-Channel Attacks are Everywhere: A Survey
Taehun Kim¹ and Youngjoo Shin²
(Kwangwoon University, Korea¹, Korea University, Korea²)

11 Study on Optimizing Block Ciphers (AES, CHAM) on Graphic Processing Units
Sang Woo An and Seog Chung Seo
(Kookmin University, Korea)

12 A Practical Differential Computation Analysis against Masked White-Box Cryptographic Implementation
Yechan Lee, Han Bit Kim, Sangyub Lee, and Hee Seok Kim
(Korea University, Korea)

13 Rail to Rail Input Buffer for Low power 12-Bit SAR ADC
Jin-Ho Kang, Young-Uk Kim, Sung-Jin Kim, and Kang-Yoon Lee
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<td>Yong Hyeon Kwon and Jae Wook Jeon</td>
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<td>Accelerating Image Processing on FPGAs using HLS and PYNQ</td>
<td>Han Sung Lee and Jae Wook Jeon</td>
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<td>Jung Rok Kim and Jae Wook Jeon</td>
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<td>Han Sung Lee and Jae Wook Jeon</td>
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<td>Mukhammadali Khayotov and Jong-Ki Han</td>
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<td>Jinwon Park¹ and Seung-Won Jung²</td>
<td>Hyundai Motor Company, Korea¹, Korea University, Korea²</td>
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10 **Highlight-Video Generation System for Baseball Games**  
Younghyun Lee, Hyunjo Jung, Cheoljong Yang, and Joonsoo Lee  
(NCSoft, Korea)

11 **Scent Emotion Evaluation Experiment for Multimedia Application**  
Yong Soo Joo and Sang-Kyun Kim  
(Myongji University, Korea)

12 **Correction Algorithm for False Depth Values in Generating Point Cloud**  
HyeonDeok Han and Jong-Ki Han  
(Sejong University, Korea)

13 **Structure-based Optical Logics Without Using Transistors**  
Jonghyeon Lee¹ and Taewon Kang²*  
(Sejong Academy of Science and Arts, Korea¹, Korea University, Korea²)

14 **A Radiation-Hardened Readout Integrated Circuits for Sensor Systems**  
Minseong Um¹, Duckhoon Ro¹, Ik Joon Chang², and Hyung-Min Lee¹  
(Korea University, Korea¹, Kyung Hee University, Korea²)

15 **FinFET Compact Modeling Considering TID Effect**  
Hyeonjae Won, Ilsik Ham, and Myounggon Kang  
(Korea National University of Transportation, Korea)

16 **Recent Advances in Flip-flop and Latch for Tolerance and Resilience to Radiation Induced Soft Errors**  
Soonbum Song and Youngmin Kim  
(Hongik University, Korea)

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**PS6**

09:45-10:30 Tuesday, November 3, 2020

Room: Sydney (2F)

Chair: Sangheon Pack (Korea University)

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01 **Segmented Polynomial Approximation for Controlled System Characteristic Estimation on Lightweight Edge Device**  
Minsung Kim, Jongheon Baek, Jiwoong Jung, Jisu Kwon, and Daejin Park  
(Kyungpook National University, Korea)
02 An Improved Adaptive Data Rate for LoRaWAN Networks
Arshad Farhad\textsuperscript{1}, Dae-Ho Kim\textsuperscript{1}, Daeyun Kwon\textsuperscript{2}, and
Jae-Young Pyun\textsuperscript{1}\textsuperscript{*}
(Chosun University, Korea\textsuperscript{1}, Green ENS R&D Center, Korea\textsuperscript{2})

03 A Routing Protocol Based on Multi-factor Decision in VANET
Zhenbo Cao, Muhammad Diyan, and Kijun Han
(Kyungpook National University, Korea)

04 Design of Solar Panels Efficiency Monitoring System
Soomin Lee\textsuperscript{1}, Sehyeong Lee\textsuperscript{1}, Laith Ellis\textsuperscript{2}, Anthony H Smith\textsuperscript{2}, and
Minsun Lee\textsuperscript{1}
(Chungnam National University, Korea\textsuperscript{1}, Purdue University, USA\textsuperscript{2})

05 On the Performance of Multihop D2D Communications in Cognitive IoT Networks with Energy Harvesting: A Deep Learning Approach
Toan-Van Nguyen\textsuperscript{1}, Thien Huynh-The\textsuperscript{2}, Kyusung Shim\textsuperscript{1}, and
Beongku An\textsuperscript{1}
(Hongik University, Korea\textsuperscript{1}, Kumoh National Institute of Technology, Korea\textsuperscript{2})

06 A 450-μW 8-bit PLL-based Frequency-to-Digital Converter for Digital Sensors with Wide Input Frequency Range
Jae-Ho Lee, Yun-ha Kang, Seung-Ah Choi, and Junyoung Song
(Incheon National University, Korea)

07 Bilateral Bus Information System in Smart City
Dibash Adhikari and Ju Hong Park
(POSTECH, Korea)

08 Performance Analysis and Management System: Architectural Design
Wooram Ann, Prabhat Awasthi, Jihun Chae, Jaegil Lee, Taeyoung Lee, and Jinyong Ahn
(Samsung Electronics, Korea)

09 Single-Shot HDR Imaging via a Multi-Scale CNN
An Gia Vien and Chul Lee
(Dongguk University, Korea)

10 Deep Residual Learning Approach to HDR Image Reconstruction from a Single Image
Hyunkook Park and Chul Lee
(Dongguk University, Korea)
11 **Computational Complexity of View Synthesis with the Number of Selected Images using Array Cameras**  
Geonwoo Kim, Jisu Kim, and Deokwoo Lee  
(*Keimyung University, Korea*)

12 **Brain Tissue Segmentation using Patch-wise M-net Convolutional Neural Network**  
Nagaraj Yamanakkanavar and Bumshik Lee  
(*Chosun University, Korea*)

13 **A New Holographic AR/VR Service System using 3D Volumetric Mesh**  
Kyung-Jin Kim, Ji-Won Kang, Byung-Seo Park, Jin-Kyum Kim,  
Dong-Wook Kim, and Young-Ho Seo  
(*Kwangwoon University, Korea*)

14 **A No-reference Image Quality Assessment based on Reference Generating Network**  
Sarala Ghimire, Nagaraj Yamanakkanavar, and Bumshik Lee  
(*Chosun University, Korea*)

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**PS7**

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<th>Authors</th>
<th>Institution</th>
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<td>01</td>
<td><strong>Optimal SNR Control Scheme for 5G Edge Cloud Computing Applying Queuing Analysis</strong></td>
<td>Wonsik Yang, Wonsuk Yoo, Seungwoo Seo, and Jong-Moon Chung</td>
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<td>Jaewook Jung, Changsung Lee, and Jong-Moon Chung</td>
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<td><strong>Multi-Access Edge Computing Caching Scheme Assisted by D2D Communication</strong></td>
<td>Minsu Choi, Junsung Kim, and Jong-Moon Chung</td>
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<td><em>ETRI, Korea¹, Pusan National University, Korea²</em></td>
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05 Analysis of UAV Deployment Optimization and its Application on FSO-based 6G Communication
Wonsuk Yoo, Wonsik Yang, Jusik Yun, and Jong-Moon Chung (Yonsei University, Korea)

06 Performance Analysis of Spectral Efficient Transmission based on Satellite DVB Standard
Pansoo Kim¹,² and Hyuncheol Park²
(ETRI, Korea¹, KAIST, Korea²)

07 Develop an EtherCAT and DeviceNet Gateway for a Smart Factory
Vinh Quang Nguyen and Jae Wook Jeon
(Sungkyunkwan University, Korea)

08 A Performance Evaluation Between Two Industrial Protocols: Mechatrolink III and SSCNET III
Vinh Quang Nguyen, Hoang Ngoc Tran, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

09 Flexible Time Division Multiuser Wireless Power Transmission System
Dayoung Kim and Heung-Gyoon Ryu
(Chungbuk National University, Korea)

10 Directivity and Axial Ratio Distribution of Orbital Angular Momentum Vortex Waves based on Circular Planar Yagi Antenna Array and Sequential Phase Shift
Dang-Oh Kim, Dae-Geun Yang, Seongjae Kim, Sang-Min Oh, Ju Yong Lee, and Dong Ho Cho
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11 An algorithm for compensating synchronization error in IoT-based wireless sensor networks
Namhoon Ha, Han-Seung Lee, and Songjun Lee
(Hanyang University, Korea)

12 A Channel State Information-Based Localization using One-dimensional Convolutional Neural Networks
Hyunwook Lee, Chaehun Im, and Chungyong Lee
(Yonsei University, Korea)

13 A 28 GHz I/Q LO Generator for 5G Wireless Communication in a 65-nm CMOS Technology
Yangji Jeon, Suyeon Lee, Geonwoo Park, Jinman Myung, Seungjik Lee, and Ilku Nam
(Pusan National University, Korea)
14 PIT Lookup Using Bloom Filter-based Architecture  
Saeyoung Jang, Hayoung Byun, and Hyesook Lim 
(Ewha Womans University, Korea)

15 Asynchronous Clock Generator and Logic for a 12-bit 
Successive Approximation Register ADC in 90nm CMOS for 
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Jung-Hyun Lee and Kang-Yoon Lee  
(Sungkyunkwan University, Korea)

01 Resource-efficient Stereo Matching Method for small-scale 
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Yongseok Lee, Sang-Seol Lee, Jonghee Park, and Sung-Joon Jang  
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02 Geometry-based Stabilization of Drone-Projected Image  
Joonhyung Lee and Byeungwoo Jeon  
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03 Multi-layer ceramic based surface mount device 
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Dong Yun Jung1,*, Hyun Gyu Jang1, Doohyung Cho1, 
Kun Sik Park1, Jong-Won Lim1, Yun Hwa Choi2, and Yong Ha Lee3  
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04 A Design of 8-Bit Dual-Sampling ADC for Convolutional 
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Kyung Do Park and Kang Yoon Lee  
(Sungkyunkwan University, Korea)

05 Design of 14-bit Digital Decimation Filter for 
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Pervesh Kumar, Muhammad Riaz Ur Rehman, Khuram Shehzad, 
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06 Low-Power Area-Efficient 8-bit Coarse-Fine 
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07 Multi-Core Gateway Architecture and Scheduling Algorithm for High-Performance Gateway Implementation
Chang Young Jo, Jae Wan Park, and Jae Wook Jeon
(Sungkyunkwan University, Korea)

08 DB-based Similar-Architecture SW Auto-Generation for ASCET Module
Chang Young Jo¹, Jae Wan Park¹, Tien-Hai Nguyen¹, Je Hyeuk Lee², and Jae Wook Jeon¹
(Sungkyunkwan University, Korea¹, Hyundai Autron, Korea²)

09 An Experiment of Sound Recognition using Machine Learning
Young-Jin Park and Hui-Sup Cho
(DGIST, Korea)

10 PLCA Experiment for 10Base-T1 Performance Verification
Chang Young Jo, Jae Wan Park, and Jae Wook Jeon
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11 Network Anomaly Detection Based on In-band Network Telemetry with RNN
Sukhyun Nam, Jiyoon Lim, Jae-Hyoung Yoo, and James Won-Ki Hong
(POSTECH, Korea)

12 Design of priority-based packet scheduler for P4NetFPGA
Zhenguo Cui and Steven Y. Rim
(Korea University, Korea)

13 Service Function Chaining on Programmable Data Plane
Gyuyeong Kim and Wonjun Lee
(Korea University, Korea)

14 Efficient Pipeline Scheduling on FPGA-based Programmable Data Plane
Seungbin Song and Hanjun Kim
(Yonsei University, Korea)

15 Automated Network Function Translator in Virtualized Programmable Data Plane
Hyeim Yang, Seokwon Jang, Sol Han, Hongrok Choi, Hohan Lee, and Sangheon Pack
(Korea University, Korea)
About Busan

Paradise Hotel Busan

Paradise Hotel Busan is located in Busan's Haeundae Beach, where the skies and ocean meet. As an affiliated company of the Paradise group, Paradise Hotel Busan opened as a first-class hotel in 1981 with 530 rooms. Through continuous efforts and competitive results, the hotel is loved as a domestic brand hotel representing Korea. The hotel invests heavily in facilities investments and in 2007, the hotel introduced new design management to the service, adding design contents to service products. The hotel is always pursuing new trends.

Haeundae Beach

Haeundae boasts an ideal wide, sandy beach and shallow waters with gentle ripples. At the mention of ‘Busan’, ‘Haeundae’ is the first to spring to mind, and it surely is the city’s representative spot. In particular, with the buildings and upscale hotels along the shoreline, the beach is well-known for its modern feel.

- Available period : June 1st-September 30th (4 months)
- Getting there: Subway line 2 to Haeundae Station (Exit 3 or 5) → 600m in the direction of Haeundae seaside.
Jagalchi Market

Jagalchi Market is a place where freshly caught fish is bought and sold. The first floor of the building is the fish market while the second floor has a raw fish center and a dried seafood section. Fresh fish can be bought for comparatively low prices, and an economical meal can be enjoyed by buying the fish from the market and then taking it upstairs to the raw fish center where it can be prepared for just a small additional cost to cover seasonings and maeuntang (spicy fish soup).

- Opening hours: 02:00-22:00
- Getting there: Subway line 1 to Jagalchi Market (Exit 10) → Jagalchi 1-gil → Entrance to Jagalchi Market

Gukje Market

Gukje Market is a reminder that Busan was once the largest trade city in Korea. Gukje Market is large in scale and including various foreign items, a vast array of goods are offered at bargain prices.

- Opening hours: 09:00-20:00
- Getting there: Subway line 1 to Jagalchi Market Station (Exit 7) → Nampo intersection → BIFF Square, 300m in the direction of Gwangbok-ro

BIFF Square

BIFF Square is the first Busan International Film festival in 1996 was the first of its kind in Korea. Since then BIFF has grown to become the world’s most dynamic film festival and Asia’s largest festival. The BIFF Square is at the center of the 4 movie theaters in Nampo-dong and is a combined entertainment space for movie-watching and shopping. It is also called ‘Star Street’ for its circular stage and the handprints of famous movie industry celebrities.

- Getting there: Subway line 1 to Jagalchi Station (Exit 7) → Nampo intersection → BIFF Square, 300m in the direction of Gwangbok-ro
Busan Tower

Busan Tower The second highest lighthouse in the world, Busan Tower was erected in 1973 at an altitude of 69m and height of 120m. It was based on the design of a lighthouse, and the top of the tower was modelled after the top of Bulguksa’s Dabotap in Gyeongju. The observation deck affords spectacular views of the city, particularly at night.

- Opening hours
  - April-September: 08:30-22:00
  - October-March: 09:00-22:00
- Admission fee charged
- Getting there: Subway line 1 to Nampo Station (Exit 1) → 200m in the direction of Gwangbok-dong Fashion Street → Yongdusan Park → Take the escalator

Dalmaji Hill

Located just beyond Haeundae, Dalmaji Road is a small, serene walkway on the corner to Songjeong Beach (on the slope of Wausan, or Mount Wau) and has a treasure of beautiful cherry blossoms and pine trees. On the nights of the full moon the moon gently reflects off the sea, offering perfect views. The many modern art galleries and pretty cafes give the place its nickname of ‘Culture Street’.

- Getting there: Subway line 2 to Jungdong Station (Exits 5 or 7) → 500m in the direction of Mipo intersection

Nurimaru APEC House

Since the APEC Summit Meeting in 2005, the Nurimaru APEC House has been the host of high quality international conferences and today the popular tourist spot still sees a daily 4000-5000 visitors. The Korean name ‘nurimaru’
means ‘summit of the world’ and the building is modelled on the traditional Korean jeongja, or pavilion. Visitors can feel the presence of the summit meeting inside the building.

- Opening hours: 09:00-18:00
- Getting there: Subway line 2 to Dongbaek Station (Exit 1) → 800m in the direction of Busan Westin Chosun Hotel → Inside Dongbaek Park

World Unique Sightseeing Spots

Shinsegae Centum City Department Store

The Shinsegae Centum City Department Store is registered in the Guinness Book of World Records as the world's largest department store. Not only does it contain clothes stores and eateries, but it is also the only place in Busan where shopping can be enjoyed along with an indoor ice rink, golf range, CGV movie theater and Spa Land which offers relaxation in the middle of the city, with views of the Suyeong River and the sea. This is a combined shopping and entertainment complex which can be enjoyed throughout the year.

- Opening hours: Weekdays 10:30-20:00, Weekends 10:30-21:00
- Getting there: Subway line 2 to Centum City Station (Exit 12)

UN Memorial Park

The UN Memorial Park is the only cemetery honoring UN soldiers, commemorating the 2300 soldiers from 11 countries who sacrificed their lives during the Korean War for world peace and freedom. The park contained within has more than 600 types of trees.
Opening hours
- 9:00-17:00 (last entry 16:30)
- Summer (May-September) 9:00-18:00, (last entry 17:30)

Getting there: Subway line 2 to Daeyeon Station (Exit 3 and 5) → 600m straight in the direction of the UN Memorial Tower 600m until you see Busan Museum on the right → 400m in the direction of the UN Memorial Cemetery

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**Busan Cinema Center**

A place where cinema fanatics gather, the center has held special screenings of major directors and genres, introducing the public to high quality art house movies and at the same time bringing locally produced independent movies to people. The asymmetrical big tube cantilever roof with 120,000 LED lights and measuring 85m in length boasts spectacular night views.

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**Gwangan Bridge**

Gwangan Bridge stretches over 7.4km and is the largest bridge over the ocean in South Korea. The bridge showcases wonderful night views and the upper part of the bridge captures the scenery of the sea and nearby cities.

Getting there: Subway line 2 to Gwangan Station (Exits 3 and 5) → 700m in the direction of Gwangalli Beach
변화된 세상의 중심에 SK하이닉스의 첨단 반도체가 있습니다
생활 속 AI기술, 비대면 서비스, 첨단 인공지능까지 엔터프라인드의 중심에 첨단 반도체가 있습니다.