Deep Learning Based Design and Simulation Methodologies for HBM (High-bandwidth Memory Module) in Artificial Intelligence (AI) Server Computers

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Abstract: Recently, we are facing a newly emerging technology and industrial transition, named as 4th Industrial Revolution, which is based on artificial intelligence (AI), big data platform, and cloud system. Especially, emergence of artificial intelligence is aided by availability of big data, deep learning algorithms, and high performance GPU computing machines. Accordingly, demands for advanced performance of terabyte/s bandwidth computing performance are rapidly increasing. However, continuously growing gaps between GPU performance and DRAM I/O data bandwidth are becoming the critical barrier to limit the AI computing performance. In order to meet the pressing needs of higher data transfer bandwidth, High Bandwidth Memory (HBM) computing systems are becoming key solutions using TSV, Si interposer technologies, and stacked memory architectures.

In this presentation, we will introduce innovative deep learning methodologies for the design and the simulations of HBM AI computing systems including the TSV, high-speed channel, interposer, cooling structures, and PDN networks, considering signal integrity, power integrity and thermal integrity. The deep learning algorithms are the core part of the machine learning methods, and can give us outstanding opportunities for the estimation of the signal integrity, power integrity and thermal integrity analysis, as well as the design optimization process. They can provide us fast, and efficient design and verification process with less computing time, less computing power, and less memory resources. We will present basic concepts of the deep learning algorithms, and demonstrate the applications including channel performance evaluation, PDN impedance estimation, and thermal design analysis in HBM systems using DNN(Deep Neural Network), and CNN(Convolutional Neural Network). Also, we will discuss the possibility of RNN(Recurrent Neural Network) and GAN(Generative Adversary Network) methods. In addition, we will show applications of EMI suppression and design optimization of the PDN in HBM using reinforcement learning methods. Finally, we will propose future directions of the deep learning methods for system designs and optimization called as “ADA(All Design by AI).”

Bio: Dr. Joungho Kim received B.S. and M.S. degrees in electrical engineering from Seoul National University, Seoul, Korea, in 1984 and 1986, respectively, and Ph.D degree in electrical engineering from the University of Michigan, Ann Arbor, in 1993. In 1996, he moved to KAIST (Korea Advanced Institute of Science and Technology). He is currently professor at electrical engineering department of KAIST. Since joining KAIST, his research centers on EMC modeling, design, and measurement methodologies of 3D IC, TSV, Interposer, System-in-Package, multi-layer PCB, and wireless power transfer (WPT) technologies. Especially, his major research topic is focused on chip-package-PCB co-design and co-simulation for signal integrity, power integrity, ground integrity, timing integrity, and radiated emission in 3D IC, TSV and Interposer. He has authored and co-authored over 527 technical papers published at refereed journals and conference proceedings. He published a book, “Electrical Design of Through Silicon Via,” by Springer in 2014. Currently, he is the director of Samsung-KAIST Industry Collaboration Center.

Dr. Joungho Kim was Conference chair of IEEE EDAPS 2015 in Seoul. And he was the conference chair of IEEE WPTC (Wireless Power Transfer Conference) 2014, held in Jeju Island, Korea. And he was the symposium chair of IEEE EDAPS Symposium 2008. He is also an associated editor of the IEEE Transactions of Electromagnetic Compatibility. He received Outstanding Academic Achievement Faculty Award of KAIST in 2006, KAIST Grand Research Award in 2008, KAIST International Collaboration Award in 2010, and KAIST Grand Research Award in 2014, respectively. He was appointed as an IEEE EMC society distinguished lecturer in a period from 2009-2011. He received Technology Achievement Award from IEEE Electromagnetic Society in 2010. Currently, he is an IEEE fellow.