CONTACT INFORMATION	Applied Sciences Group Microsoft Corporation One Microsoft Way Redmond, WA 98052	*Mobile:* +1-765-714-5223 *E-mail:* woosuk.lee@microsoft.com woosuk.lee@gmail.com *Website:* https://woosuklee.com

PERSONAL BRIEF Woo Suk Lee is an Electrical Engineering Researcher at Microsoft Applied Sciences Group, where he conducts multidisciplinary research and development for next generation computation and human-computer interaction technologies. Before joining the team, he worked at a research institute, standardization organization and earned the PhD degree in Electrical and Computer Engineering from Purdue University. He is interested in the design and implementation of embedded systems hardware and software to address the new challenges in emerging computation systems. His works have been published as several journal/conference papers, patents, and a book chapter, and some of them received several design contest awards in recognition of enabling new paradigms of debugging and communication technologies.

EDUCATION

Purdue University, West Lafayette, IN, USA
Ph.D., School of Electrical and Computer Engineering

- Specialization: Embedded systems hardware and software
- Dissertation title: Hardware Architectures for Low-power In-situ Monitoring of Wireless Embedded Systems.
- Advisor: Professor Vijay Raghunathan

Hanyang University, South Korea
M.S., Electronics, Electrical & Instrumentation Engineering, Feb 2009

- Specialization: Control networks
- Thesis Title: Design and Implementation of a KNX-ZigBee Gateway
- Advisor: Professor Seung Ho Hong

Hanyang University, South Korea
B.S., Electronics and Electrical Engineering, Feb 2007

- *Cum Laude*, with Honors in Engineering

RESEARCH INTERESTS

- Embedded Systems
- Medical devices
- Cyber-physical systems
- HW/SW co-design
- Dependability
- Energy harvesting
- Internet-of-Things
- Industrial networks
- Energy efficiency
- Energy-aware computing
- Human-computer interaction
- Building/Home automation

PROFESSIONAL /RESEARCH EXPERIENCE

Microsoft Applied Sciences Group, Redmond, WA, USA
Researcher **Oct 2016 ~ Present**

- Explore various aspects of human-computer interaction (HCI) devices.
- Devise system architectures for next generation first-party hardware devices.
- Generate key intellectual properties for devices business.

Purdue University, West Lafayette, IN, USA

Research Assistant **Jan 2011 ∼ Aug 2016**

– Research assistant at Embedded Systems Lab, supervised by Professor Vijay Raghunathan.
– Researched on various aspects of embedded systems with an emphasis on reliable system design, low power design, and micro-scale energy harvesting.
① Zero-power contact-less probing for implantable medical devices.
② Co-processor-augmented reliable embedded systems HW/SW architectures.
③ Biomedical implantable wireless sensor device lasting over several decades.
④ Micro-scale energy harvesting for perpetually operating embedded systems.
⑤ Transiently powered computer systems.

Microsoft Applied Sciences Group, Redmond, WA, USA

Research Intern **May 2015 ∼ Aug 2015**

– Proposed and designed a low power communication channel for a human-computer interaction device, Surface Pen.

Microsoft Applied Sciences Group, Redmond, WA, USA

Research Intern **Jun 2014 ∼ Sep 2014**

– Transformed an ASIC-based fixed-function input device to a MCU-based flexible device to support customizable extensive functionalities, while achieving lower power consumption and comparable form-factor.

Microsoft Research, Redmond, WA, USA

Research Intern **May 2012 ∼ Aug 2012**

– Research intern at SERG (Sensing and Energy Research Group), Microsoft Research, Redmond, WA, USA.
– Involved in the project CLEO for CO-GPS (Cloud-Offloaded GPS) technology.
– Developed a GPS-sensing hardware/software front-end suite that enables three orders of magnitude lower energy consumption compared to the conventional GPS solution.

Ubiquitous Sensor Network Research Center (USNRC), South Korea

Researcher **Feb 2009 ∼ Jul 2010**

– Focused on energy efficient smart-grid.
① DR (Demand-Responsive) for smart-grid.
② AMI (Advanced Metering Infrastructure) for smart-grid.
② Building/Home Wireless Sensor Networks (WSN) technology for Smart-grid.
③ Developed a redundancy master controller for industrial network Profibus DP for IGCC (Integrated Gasification Combined Cycle) power generation plant control.

International Electrotechnical Commission (IEC), Geneva, Switzerland

Delegate of Korea   **Aug 2006 ∼ Jul 2008**

- Standardized an industrial Ethernet protocol 'RAPIEnet' as an international standard IEC/PAS 62573.
- The IEC/PAS 62573 played a seminal role in subsequent standardization, and now (as of Dec 2018) 'RAPIEnet' holds several IEC standards.

Korean Agency for Technology and Standards (KATS), Gwacheon, South Korea

Organizing secretary   **Aug 2006 ∼ Jul 2008**

- Organized IEC National Committee (NC) meetings held in Korea.

Hochschule Esslingen, University of Applied Sciences, Göppingen, Germany

Participant for a summer school   **Jun 2006 ∼ Jul 2006**

- Studied theories and applications of industrial networks.

Hanyang University, South Korea

Research Assistant   **Mar 2006 ∼ Feb 2009**

- Research assistant at Ubiquitous Network Systems Laboratory.
- Researched on control networks to untangle the intricate nature of diverse communication protocols.
  ① Architecture and protocols of WSNs for home/building automation.
  ② Building/Home wired-wireless unified network solution for Smart-grid.

Republic of Korea Army, Seoul, South Korea

Enlisted soldier - Sergeant   **Jan 2002 ∼ Feb 2004**

- Served military duty for 26 months and discharged as a sergeant.

HONORS AND
AWARDS

- **ISLPED 2017 Design Contest Award** with "TeleProbe: Zero-power contactless probing for implantable medical devices."

- **VLSID 2015 Design Contest Award** with "Qube: An FRAM-based, Low Power, Modular Platform Architecture for IoT edge-devices."

- **ISLPED 2014 Design Contest Award** with a novel energy harvester based battery-less sensor node design, named "When they are not listening: harvesting power from idle sensors in embedded systems."

- **Microsoft Patent Award** for the inventive contribution of filing patents.

- **Scholarship for outstanding entering graduate students** awarded to the student at 1st place in entering exam to waive most of the tuition-fee for entire M.S. course.

- **Academic scholarship** awarded for outstanding GPA at Hanyang University, 2000, 2004, 2005, 2006.

- **1st Place Award** for outstanding performance during the summer school at Hochschule Esslingen.

Strong background in embedded systems development

– Concept and design of embedded systems architecture highly optimized for target applications, such as vision and speech processing neural network systems, human-computer interaction systems, biomedical systems, control network systems, *etc*.

– Strong hands-on skills in both embedded systems hardware (*e.g.*, PCB) and software (e.g., firmware) implementations.

– 10+ years of embedded systems design and implementation experience with a proven record of delivering dozens of academic as well as commercial devices.

– Practical understanding of how products are designed and manufactured (*e.g.*, joint development manufacturing (JDM), original design manufacturing (ODM), *etc*).

– Rapid prototyping of proof-of-concept (POC) devices including hardware design, bring-up, debugging, and characterization.

– Comfortable working in a multidisciplinary team environment by communicating various requirements from individual teams as a plan-of-record (POR) and devising an embedded electronic systems architecture incorporating the requirements.

Hardware design and implementation

– Proficient electrical engineering background for digital as well as analog circuits.

– Schematic capture and board layout for sophisticated devices, such as high-density, high-speed, and RF circuits, with EMI, ESD countermeasures.

– Proficient use of test equipment (*e.g.*, oscilloscopes, function generators, *etc*).

Software design and implementation

– Strong coding and programming methodologies for computer architecture-aware firmware/software programming in C.

– Operating systems fundamentals (memory allocation, memory mapping, threads, concurrency, task scheduling, *etc*).

– Hardware-optimized firmware/software programming for embedded peripherals such as, USB, I2C, SPI, DMA, MIPI, *etc*.

Programming languages

– C, C#, JAVA, Assembly, BASH, HTML

Numerical and Statistical Analysis

– MATLAB

Version Control and Software Configuration Management

– GIT, SVN, CVS

Operating Systems

– Windows, Linux, Embedded RTOS (*e.g.*, RTEMS, ThreadX, *etc*).

PCB design & simulation software and tools

– Altium, OrCAD, PADS, Eagle, PSpice, LTspice, Ansys Maxwell

Embedded processors
– MSP430 family from Texas Instruments ®
– 8051/8052 family from various vendors
– ARM family from various vendors
– AVR family from Atmel ®
– PIC family from Microchip ®
– DSP family from Texas Instruments ®

Communication protocols
– Building/factory automation control networks (*e.g.*, BACnet, KNX, Profibus, *etc.*)
– IEEE 802.3 (Ethernet)
– IEEE 802.11 (Wi-Fi)
– IEEE 802.15.4
– Medical Implantable Communication Service (MICS)
– Bluetooth Low Energy (BLE)

Hardware design
– High-speed and high-density multi-layer digital and analog/RF mixed circuits.
– Practical understanding about the hardware development process from PCB design to manufacturing to assembly to test.
– Understand what to optimize for cost and performance.

Documentation
– Microsoft office, Microsoft Visio, Doxygen, TeX (LaTeX, BIBTeX), Adobe Photoshop, Eclipse, OpenOffice.org, Google Docs

BOOK CHAPTER

[1] Younghyun Kim, Woo Suk Lee, Anand Raghunathan, Vijay Raghunathan, and Niraj K. Jha, "Reliability and Security of Implantable and Wearable Medical Devices," in *Implantable Biomedical Microsystems: Design Principles and Applications*, Elsevier, 2015.

JOURNAL PUBLICATIONS

[2] Jie Liu, Bodhi Priyantha, Ted Hart, Yuzhe Jin, Woo Suk Lee, Heitor S. Ramos, Antonio A.F. Loureiro Qiang Wang, and Vijay Raghunathan, "Energy Efficient GPS Sensing with Cloud Offloading," *IEEE Transaction on Mobile Computing (TMC)*, Vol. 15, Issue 6, pp. 1348–1361, June 2016.

[3] Hrishikesh Jayakumar, Arnab Raha, Woo Suk Lee, Vijay Raghunathan, "QUICK RECALL: A HW/SW Approach for Computing across Power Cycles in Transiently Powered Computers," *ACM Journal on Emerging Technologies in Computing Systems (JETC)*, Special Issue on Advances in Design for Ultra-Low Power Circuits and Systems in Emerging Technologies, Vol. 12, Issue 1, July 2015.

[4] Woo Suk Lee, and Seung Ho Hong, "Design and Implementation of a KNX-ZigBee Gateway," *Journal of Institute of Control, Robotics and Systems (JI-CROS)*, Vol. 17, No. 7, pp.720~729, Jul 2011 (Korean Journal).

[5] Woo Suk Lee, and Seok Chul Park, "Energy Saving in Building/Home Lighting Control Systems by using ZigBee," *Journal of Intelligent Building*, Vol. 1, No. 1, Jun 2008 (Korean Journal).

CONFERENCE
PUBLICATIONS

[6] Sang Ho Yoon, Siyuan Ma, <u>Woo Suk Lee</u>, Shantanu Thakurdesai, Di Sun, Flavio P. Ribeiro, James D. Holbery, "HapSense: A Soft Haptic I/O Device with Uninterrupted Dual Functionalities of Force Sensing and Vibrotactile Actuation," UIST'19 Proceedings of the 32nd Annual ACM Symposium on User Interface Software and Technology, New Orleans, LA, USA, Oct 2019.

[7] <u>Woo Suk Lee</u>, Younghyun Kim, and Vijay Raghunathan, "TeleProbe: Zero-power Contactless Probing for Implantable Medical Devices,"ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED 2016), San Francisco, CA, USA, Aug 2016.
(Best Paper finalist)

[8] Hrishikesh Jayakumar, Arnab Raha, Younghyun Kim, Soubhagya Sutar, <u>Woo Suk Lee</u>, and Vijay Raghunathan, "Energy-Efficient System Design for IoT Devices," IEEE 21st Asia and South Pacific Design Automation Conference (ASP-DAC), Macau, Jan 2016.

[9] Younghyun Kim, <u>Woo Suk Lee</u>, Vijay Raghunathan, Niraj Jha, and Anand Raghunathan, "Vibration-based Secure Side Channel for Medical Devices," *Design Automation Conference (DAC 2015)*, San Francisco, California, USA, June 2014.

[10] <u>Woo Suk Lee</u>, Albert Kim, Babak Ziaie, Charles Powell, and Vijay Raghunathan, "Up-Link: an Ultra-Low Power Implantable Wireless System for Long-Term Ambulatory Urodynamics," *IEEE Biomedical Circuit and Systems Conference (BioCAS 2014)*, Lausanne, Switzerland, Oct 2014.

[11] <u>Woo Suk Lee</u>, Hrishikesh Jayakumar, and Vijay Raghunathan, "When they are not listening: harvesting power from idle sensors in embedded systems," *International Green Computing Conference (IGCC 2014)*, Dallas, Texas, USA, Nov 2014
(This is the full paper version of the research that received the ISLPED 2014 Design Contest Award)

[12] Hrishikesh Jayakumar, Kangwoo Lee, <u>Woo Suk Lee</u>, Arnab Raha, and Vijay Raghunathan, "Powering the Internet of Things," *ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED 2014)*, La Jolla, California, USA, Aug 2014.

[13] <u>Woo Suk Lee</u>, Bodhi Priyantha, Ted Hart, Gerald DeJean, Yan Xu, and Jie Liu, "Demo Abstract: The CLEO mobile sensing platform," *demo in the 10th ACM International Conference on Embedded Networked Sensor Systems (SenSys 2012)*, Toronto, CA, Nov 2012
(This is the demo version of the SenSys 2012 best paper named 'Energy-Efficient GPS Sensing with Cloud Offloading')

[14] Mohammad Sajjad Hossain, <u>Woo Suk Lee</u>, and Vijay Raghunathan, "SPI-SNOOPER: a hardware-software approach for transparent network monitoring in wireless sensor networks," *Proceeding of the 8th IEEE/ACM/IFIP International Conference on Hardware/Software Codesign and System Synthesis (CODES+ISSS 2012)*, pp.53-62, Tempere, Finland, Oct 2012.

[15] Seok Cheol Park, <u>Woo Suk Lee</u>, Se Hwan Kim, and Seung Ho Hong, Peter Palensky, "Implementation of a BACnet-ZigBee Gateway," *IEEE International Conference on Industrial Informatics (INDIN 2010)*, pp.40-45, Osaka, Japan, Jul 2010.

[16] Seok Cheol Park, <u>Woo Suk Lee</u>, Ki Myeung Kim, and Seung Ho Hong, "ZigBee Sensor & Actuator Configuration for Lighting Control Systems," *Korea Automatic Control Conference (KACC 2009)*, pp.866-869, Busan, Korea, Sep 2009.

[17] <u>Woo Suk Lee</u>, and Seung Ho Hong, "Implementation of a KNX-ZigBee Gateway for Home Automation," *IEEE International Symposium on Consumer Electronics (ISCE 2009)*, pp.545-549, Osaka, Japan, May 2009.

[18] <u>Woo Suk Lee</u>, and Seung Ho Hong, "KNX-ZigBee Gateway for Home Automation," *IEEE International Conference on Automation Science and Engineering (CASE 2008)*, pp. 750-755, Washington D.C., USA, 23-26, Aug 2008.

[19] D. K. Park, <u>W. S. Lee</u>, S. H. Hong, and Luca Domenico Luigi Mazzon, "Development of a KNX/EIBbased Lighting Control System," *KMITL International Conference on Engineering, Applied Sciences, and Technology (ICEAST 2007)*, pp.33-36, Bangkok, Thailand, Nov 2007.

[20] D. K. Park, <u>W. S. Lee</u>, S. H. Hong, and T. Y. Hwang, "Development of a KNX/EIB-based controller," *IEEK/KIEE Information and Control Symposium (ICS 2007)*, pp. 420-422, Jeonju, Korea, Apr 2007 (Korean).

PATENTS

[21] Flavio Protasio Ribeiro, Steven Bathiche, <u>Woo Suk Lee</u>, "Stylus Pen with Dynamic Protocol Selection for Communication with a Digitizer," US patent, US20170097695 A1, 2017.

[22] Younghyun Kim, <u>Woo Suk Lee</u>, Vijay Raghunathan, Niraj K. Jha, and Anand Raghunathan, "Vibration-based Secure Side Channel for Medical Devices," US patent, WO2016133813 A1, 2016.

MORE INFORMATION

More information and auxiliary documents can be found at
https://woosuklee.com