COLLEGE OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING
UNIVERSITY OF MICHIGAN

Dissertation Defense

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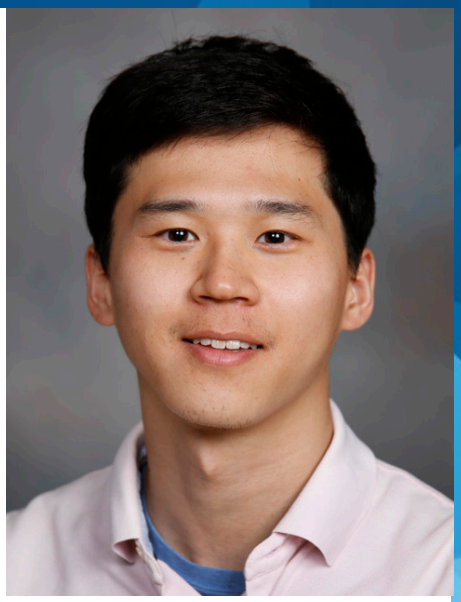

Thermal and QoS-Aware Embedded Systems

Friday, November 1, 2019
1:00 am – 3:00 pm
3725 Beyster Bldg.

ABSTRACT: While embedded systems such as smartphones and smart cars become embedded in every aspect of our lives, they face urgent thermal challenges. Extreme thermal conditions (i.e., both high and low temperatures) degrade system reliability, even risking safety; devices in the cold environments unexpectedly go offline, whereas extremely high device temperatures can cause device failures or battery explosions. These thermal limits become close to the norm because of ever-increasing chip power densities and application complexities. Embedded systems in the wild, however, lack the adaptive and effective solutions to overcome such thermal challenges. An adaptive thermal management solution must cope with various runtime thermal scenarios under a changing ambient temperature. An effective solution requires the understanding of the dynamic thermal behaviors of underlying hardware and application workloads to ensure thermal and application quality-of-service (QoS) requirements. This thesis proposes a suite of adaptive and effective thermal management solutions to address different aspects of real-world thermal challenges faced by modern embedded systems.

First, we present BPM, a battery-aware power management framework for mobile devices to address the unexpected device shutoffs in the cold environments. We develop BPM as a background service that characterizes and controls real-time battery behaviors to maintain operable conditions in the cold environments. We then propose eTEC, building on the thermoelectric cooling solution, which adaptively controls cooling and computational power to avoid mobile devices overheating. For the real-time embedded systems such as cars, we present RT-TRM, a thermal-aware resource management framework that monitors changing ambient temperatures and allocates system resources to individual tasks. Next, we target in-vehicle vision systems running on CPUs–GPU system-on-chips and develop CPU–GPU co-scheduling to tackle thermal imbalance across CPUs caused by GPU heat. We evaluate all of our solutions using representative mobile/automotive platforms and workloads, demonstrating their effectiveness in meeting thermal and QoS requirements

Chair: **Prof. Kang G. Shin**