Developing Embedded Intelligence: Opportunities on the Edge

Only speakers can be listed here. Adding authors who are not presenting or exceeds the max limit may disqualify your submission for review.

Name
Moderator
Company
Contact info

Name
Panelist 1
Company
Contact info

Name
Panelist 2
Company
Contact info

Name
Panelist 3
Company
Contact info

Name
Panelist 4
Company
Contact info

Diverse Panelists
*All speakers and Moderator MUST be from different organizations

ABSTRACT

Tells us what your proposal is about.
*Must match what is in your submission

Do you marvel at the smart systems around us? From autonomous vehicles to healthcare wearables, have you wondered what are the growing challenges? Hear from women researchers and engineers as they share their views. The focus will be on the promising opportunities of shifting Artificial Intelligence onto edge devices. The technical discussions will prepare you for tomorrow's innovations.

AUDIENCE

Tell reviewers who will benefit most from this submission

This is an intermediate level technical panel. Junior researchers and industry professionals with engineering backgrounds will discover the state of art of technological development in embedded hardware in AI and IoT. The panel discussion is also accessible to beginners who are looking to understand this mega-trend and find inspirations for hardware and software co-design.

INTRODUCTION

We begin with an overview of smart systems and highlight the roles of embedded hardware. We analyze the challenges in developing edge devices and contrast. The strategies from each panelist. We dive into applications like autonomous driving and wearables for healthcare to offer concrete examples. We share with the audience technological opportunities in both academic and industry fields.

Any panel submission must have a specific core point of contention, and a clear indication of who will be taking which sides of that issue.

CORE POINT OF CONTENTION

The panelists hold different opinions on interactions and Dependencies between software and hardware in developing applications in complex systems. With their diverse background, our panelists debate on strategies to manage the scalability and reliability of systems like selfdriving fleet with smart edge nodes. They also share the concerns, such as network security and digital footprint of IoT devices.

PLAN OF ACTION

Short introduction to the topic:
Now, over 99 percent of computers are invisible in our modern lives. Hardware embedded in objects from toys to cars is the "unseen computer". Twenty years ago, say the word "computer" and you would picture the machine on a desktop. Ten years ago, "computers" took on richer meaning: devices that we carry in our pockets, the smart phones. However, the "computers" that are having the

biggest impact on our lives are the ones embedded in thousands of pieces of equipment that surrounds us every day, from the thermostats to the venting in this conference room, from the smart watch to flying drones. The embedded intelligence is exploding with capabilities and are racing to improve our quality of life. Our discussion today will focus on these "unseen computers" and see what comes next.

Our group of panelists work on variety of domains in embedded hardware and smart systems. Let's first go around the table to introduce them. We will start with names and institutions you are from. Please briefly explain what your current focus is in edge devices and smart systems.

Good submissions allow reviewers to clearly visualize how this session will go

[Mary Ann] introduces MEMS (Micro-Electro-Mechanical Systems). The small form factor, cost-effectiveness, and low power requirements of MEMS devices make them an ideal field for IoT hardware innovation.
[Miriam] explains her work of hardware accelerators in GPU and FPGA and the applications in medical imaging.
[Michaela] introduces her role in Xilinx Labs and her endeavors of Machine Learning support on FPGAs.
[Yan] summarizes her research on airborne networks, such as UAVs (Unmanned Aerial Vehicles).

We will start with the elephant in the room. Why do we need to talk about advancements and highlights in hardware of these intelligent systems, instead of software? As we can see in this conference and on the news, software is under the spotlight. It is no secret why: software is nimble, cheap, and limited only by one's imagination. So, what are the important roles hardware plays in this mega-trend of smart systems?

[Michaela] states that cheaper processor and cheaper memory are the driving force to change the product and device designs. She gives example that modern robots are much easier to deploy without centralized control. Hardware is the enabler.
[Mary Ann] emphasizes that the smart sensors have pervaded our daily lives. With voice, touch and gesture, or even rolling your eyes, we have all possible interfaces to surroundings. With the new environmental sensors in the market, your shirt may one day know more about your health than your doctor. She thinks hardware is leading the way.
[Yan] suggests that physical systems are still the tougher challenges for engineering problems this century, from access to clean water to advancing health informatics [1]. She summarizes that breakthrough in hardware is largely independent of progress made in software.
[Miriam] describes the fast expansion of hardware capabilities and the ease to collect abundance of data. Software in smart systems now actually becomes the bottleneck.
The panelists will debate which innovations in software or hardware are key milestones in fast growth of applications, e.g. IoT.

One smart system that is in the headlines a lot these days, the autonomous driving cars. We've heard a lot about Deep Learning applications like pedestrian detection and road signs recognition with 90% accuracy in research. But how far along are we from actually riding one, or even owning one?

Our panelists will take us behind the headlines and discuss
the biggest challenges in self-driving cars from their experiences in the field.
[Miriam/Michaela] On-board processing needs to meet real-time requirements. Cars need a network of ECUs (Embedded Computation Unit), GPUs and FPGAs to navigate, control and avoid collisions.
[Mary Ann] Fusion of sensor data from radar, camera and many more with different physical limitations [2].
[Yan] takes a very different view angle. She believes a massive and powerful vehicle-to-vehicle communication infrastructure could make sharing the road much efficient and safer.
The panelists will discuss emerging technology that will sink or float the driver-less future.

Embedded hardware has less powerful computational capability than their desktop counterparts. To build smarter applications, for example AI, what are your strategies?

[Miriam] Hardware acceleration are critical to distributed real-time analytics in embedded devices, such as IoT. We are developing a scalable architecture for processing massive volumes data at an unprecedented velocity to support the IoT paradigm.

[Michaela] We work on range of hardware and software co-design innovations, such as quantization and compressions. For example, by pruning a trained deep learning inference network, the same accuracy can be achieved with 20% model reduction on specialized hardware [3].
[Mary Ann] Smarter designs at fabrication level that can be optimized in CAD (Computer Aided Design).
[Yan] studies integrated platform to better understand the deployment tradeoffs [4]. Panelists contrast their approaches from specialized solution to high fidelity modeling and simulation. They will debate on the pros/cons on these approaches.

Take another example of embedded system that is ubiquitous, the wearable devices, and getting smarter. It greatly impacts healthcare services and quality of life for everyone. What are the opportunities in this industry, especially the edge devices?

[Mary Ann] follows up with great examples on flexible MEMS devices. One of the biggest problems is to keep them powered. Solving the energy problem creatively is the key.
[Michaela] emphasizes the integration with cloud access on such devices for data collection and decision making.
[Miriam/Yan] discusses the difficulties to model and predict the system behaviors reliably.

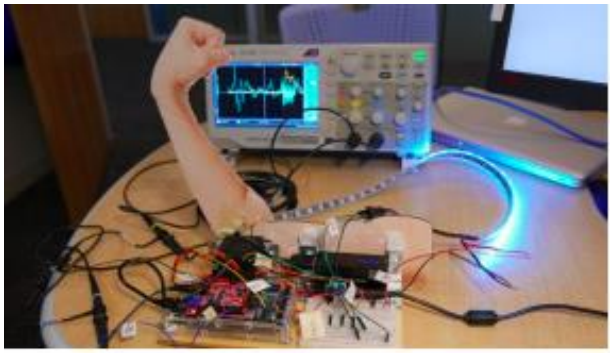

Figure 1: Analyze Electromyography (EMG) with Arduino

One issue rises from the wide use of embedded hardware and the network of them: Security. How do you address this challenge in your work?
[All] Security has an asymmetric nature—an attacker can compromise a system by discovering a single, unexpected vulnerability, while a defender must defend against all vulnerabilities. In embedded systems, there are several unique challenges: attack replications (hacked one, hacked all); dependability (service interruption has catastrophic consequences); long device life cycle and remote deployment. The panelists will discuss strategies to address these from their research [5].

One theme emerges from our conversation is the hardware-software convergence. So, what's the best way for an engineer to adapt and stay ahead the trends?
[All] Engineers looking to build the next generation of smart and responsive applications can approach the challenge from a broader viewpoint. A helpful way to look at this convergence is to think of today's software as doing more than "just running a program," and today's hardware as doing more than "just supplying the engine." Approaching a new project from a stance of multidisciplinary thinking will provide a tremendous opportunity for new insights and innovative thinking. Our panelists will give good examples and offer suggestions from their professional experiences.

A year from now, what will be the next big things with revolutionary hardware technology?
[Yan] Flying car for commuters.
[Mary Ann] Wearables become our wellness trainers.
[Michaela] Fusion of cloud and edge devices.
[Miriam] Privacy in IoT.

OUTCOMES/CONCLUSION

Audience members will leave this session understanding the challenges faced in the rapid growth of embedded hardware in its complexity and reliability. The panelists discussions on their first-hand experiences will present a wholesome view and amplify the wide range of opportunities in this domain. Concrete take-aways include:

- Specific examples of embedded hardware in academic research and commercial industry;
- System-level views of modern hardware systems and trends in the market;
- Problem solving skills in managing complexity, scalability, reliability and security in real-world systems;
- Research opportunities in embedded hardware, software and networked systems

PARTICIPATION STATEMENT

We, the five contributors to this proposal, are committed to attend the Grace Hopper 2019 conference in Orlando, Florida and will serve on this panel if accepted.

REFERENCES/BIBLIOGRAPHY

1. National Academy of Engineering Grand Challenges for Engineers, Website by National Academy of Engineering.
2. New Trends in MEMS Design with Implications for Modeling and Simulation, presented by Dr. Mary Ann Maher, SoftMEMS LLC, MathWorks Research Summit, 2017
3. Machine Learning for Embedded Systems, presented by Michaela Blott, Industry Keynote in Trinity College, Dublin, 2017
4. Up In the Cloud, UTA Inquiry, 2018
5. Massively Scalable Secure Computation Infrastructure Using FPGAs, Northeastern University News, 2017

This section is required and should not be solely based on personal experience.

BIO

Only speakers can be listed here. Adding authors who are not presenting or exceeds the max limit may disqualify your submission for review.

Moderator Name, Title, Company
Moderator Bio

Let us know if the moderator had any prior experience moderating a panel

Panelist 1 Name, Title, Company
Panelist 1 Bio

Panelist 2 Name, Title, Company
Panelist 2 Bio

Panelist 3 Name, Title, Company
Panelist 3 Bio

Panelist 4 Name, Title, Company
Panelist 4 Bio