SIGMOBILE FY'20 Annual Report

July 2019 – June 2020

The purpose of ACM SIGMOBILE is to promote research and development by bringing together researchers and practitioners and fostering interest in the mobility of systems, users, data, and computing. SIGMOBILE will address the above spectrum of topics, sharing one common theme - mobility. The group's technical scope reflects the emerging symbiosis of portable computers and wireless networks, addressing the convergence of mobility, computing and information organization, its access, services, management and applications.

In the past few years, mobile computing has developed into a fast moving, topical, and exciting area of computer science and engineering. Supporting the mobile computing and wireless networking research community, SIGMOBILE sponsors multiple successful conferences and workshops (e.g., MobiCom, MobiSys, MobiHoc, SenSys, UbiComp, PerDis, SEC, and HotMobile) that are well attended by its members, and generating high-quality and widely cited publications. These are valuable services for SIGMOBILE's members and the community, resulting in a strong Special Interest Group.

SIGMOBILE's Executive Committee (EC) in this period comprised of:

- Chair: Prof. Marco Gruteser (Google / Rutgers University, New Brunswick, USA)
- Vice Chair: Prof. Jason Flinn (Facebook / University of Michigan, Ann Arbor, USA).
- Secretary: Prof. Giovanni Pau (Sorbonne Universite, France)
- Treasurer: Prof. Falko Dressler (TU Berlin, Germany)
- Past Chair: Prof. Suman Banerjee (University of Wisconsin, Madison, USA)

The past 6 months have been like no other and significant effort has focused on mitigating financial risks due to conference contracts executed before COVID-19 spread, while maintaining continuity of our conference programming by shifting to virtual events for the remainder of the year. Still, many of SIGMOBILE's programs operated relatively unaffected.

Awards

SIGMOBILE has a number of awards that it bestows on community members. In addition to the Outstanding Contributions Award (OCA) for career-long achievements, the Rockstar award for early career achievements, the Distinguished Service Award for service to the community, the Doctoral Dissertation Award for best PhD work in the field, the The Test of Time award for papers that had a significant influence in the community, and various best paper awards at the leading conferences. In addition, SIGMOBILE also recognizes some of the best work in the current year, as identified by a selection committee, as the Research Highlights of SIGMOBILE.

Some of the notable award winners are mentioned below.

Outstanding Contributions Award: Marty Cooper, for seminal contributions to the conception, practice and adoption of portable telephony.

Distinguished Service Award: Prof. Eyal de Lara (Univ. of Toronto), for outstanding leadership in creating SIGMOBILE's GetMobile magazine.

Rockstar Award: Prof. Nic Lane (Oxford), for contributions to the understanding of how resource-constrained mobile devices can robustly understand, reason and react to complex user behaviors and environments through new paradigms in learning algorithms and system design.

Dissertation Award: Wenguang Mao (UT Austin) for the dissertation entitled "Acoustic Sensing on Smart Devices", Runner Ups: Yasaman Ghasempour (Rice) for the dissertation entitled "Next-Generation Wireless Systems for Joint Communication and Sensing in Millimeter-Wave and Terahertz Spectrum" and Elahe Soltanaghaei (Virginia) for the dissertation entitled "Sensing the Physical World Using Pervasive Wireless Infrastructure

The **SIGMOBILE Test of Time award** was selected by a committee chaired by Prof. Tanzeem Choudhury. The committee comprising Prof. Deepak Ganesan, Prof. Prabal Dutta, Dr. Ben Greenstein, Dr. Lama Nachman, Dr. James Scott selected the following article:

- Jason Flinn and M. Satyanarayanan, "Energy-aware adaptation for mobile applications", ACM Symposium on Operating Systems Principles (SOSP), 1999.
    - This paper describes how an OS and applications can collaborate to adapt energy use on a mobile device. While at the time this was new ground, the approaches it presents are now simply standard practise, in the devices and apps we use every day. It is remarkable how prescient this 1999 paper was, and how well its ideas have stood the test of time. For example, the hardware and software approaches to energy adaptation it proposes are now commonplace, and the applications it analyses (browser, voice recognition, video player and maps) are still ubiquitous. This paper presaged a huge amount of work in energy adaptation by both academia and industry, and the area remains of core interest to SIGMOBILE.

Research Highlight Papers

The SIGMOBILE research highlights committee chaired by Prof. Heather Zheng selected the following papers as papers that combine a broad appeal significant results.

- Nam Bui, Nhat Pham, Jessica Jacqueline Barnitz, Phuc Nguyen, Hoang Truong, Taeho Kim, Anh Nguyen, Zhanan Zou, Nicholas Farrow, Jianliang Xiao, Robin Deterding, Thang Dinh, and Tam Vu, "eBP: A Wearable System For Frequent and Comfortable Blood Pressure Monitoring From User's Ear," ACM MobiCom 2019.
    - Frequent blood pressure (BP) assessment is key to the diagnosis and treatment of many severe diseases, such as heart failure, kidney failure, hypertension, and hemodialysis. Current "gold-standard" BP measurement techniques require the complete blockage of blood flow, which causes discomfort and disruption to normal activity when the assessment is done repetitively and frequently. Unfortunately, patients with hypertension or hemodialysis often have to get their BP measured every 15 minutes for a duration of 4-5 hours or more. The discomfort of wearing a cumbersome and limited mobility device affects their normal activities. In this work, we propose a device called eBP to measure BP from inside the user's ear aiming to minimize the measurement's impact on users' normal activities while maximizing its comfort level. eBP has 3 key components: (1) a light-based pulse sensor attached on an inflatable pipe that goes inside the ear, (2) a digital air pump with a fine controller, and (3) a BP estimation algorithm. In contrast to existing devices, eBP introduces a novel technique that eliminates the need to block the blood flow inside the ear, which alleviates the user's discomfort. We prototyped eBP custom hardware and software and evaluated the system through a comparative study on 35 subjects. The study shows that eBP obtains the average error of 1.8 mmHg and -3.1 mmHg and a standard deviation error of 7.2 mmHg and 7.9 mmHg for systolic (high-pressure value) and diastolic (low-pressure value), respectively. These errors are around the acceptable margins regulated by the FDA's AAMI protocol, which allows mean errors of up to 5 mmHg and a standard deviation of up to 8 mmHg.
- Haojian Jin, Jingxian Wang, Swarun Kumar and Jason Hong, "Software Defined Cooking using a Microwave Oven," MobiCom 2019.
    - Despite widespread popularity, today's microwave ovens are limited in their cooking capabilities, given that they heat food blindly, resulting in a non-uniform and unpredictable heating distribution. We present SDC (software-defined cooking), a low-cost closed-loop microwave oven system that aims to heat the food in a software-defined thermal trajectory. SDC achieves this through a novel high-resolution heat sensing and actuation system that uses microwave-safe components to augment existing microwaves. SDC first senses thermal gradient by using arrays of neon lamps that are charged by the Electromagnetic (EM) field a microwave produces. SDC then modifies the EM-field strength to desired levels by accurately moving food on a programmable turntable towards sensed hot and cold spots. To create a more skewed arbitrary thermal pattern, SDC further introduces two types of programmable accessories: microwave shield and susceptor. We design and implement one experimental test-bed by modifying a commercial off-the-shelf microwave oven. Our evaluation shows that SDC can programmatically create temperature deltas at a resolution of 21 degrees with a spatial resolution of 3 cm without accessories and 183 degrees with

the help of accessories. We further demonstrate how a SDC-enabled microwave can be enlisted to perform unexpected cooking tasks: cooking meat and fat in bacon discriminatively and heating milk uniformly.

- Gyuhong Lee, Jihoon Lee, Jinsung Lee, Youngbin Im, Max Hollingsworth, Eric Wustrow, Dirk Grunwald, and Sangtae Ha, "This is Your President Speaking: Spoofing Alerts in 4G LTE Networks," MobiSys 2019.
    - Modern cell phones are required to receive and display alerts via the Wireless Emergency Alert (WEA) program, under the mandate of the Warning, Alert, and Response Act of 2006. These alerts include AMBER alerts, severe weather alerts, and (unblockable) Presidential Alerts, intended to inform the public of imminent threats. Recently, a test Presidential Alert was sent to all capable phones in the United States, prompting concerns about how the underlying WEA protocol could be misused or attacked. In this paper, we investigate the details of this system, and develop and demonstrate the first practical spoofing attack on Presidential Alerts, using both commercially available hardware as well as modified open source software. Our attack can be performed using a commercially-available software defined radio, and our modifications to the open source NextEPC and srsLTE software libraries. We find that with only four malicious portable base stations of a single Watt of transmit power each, almost all of a 50,000-seat stadium can be attacked with a 90% success rate. The true impact of such an attack would of course depend on the density of cell phones in range; fake alerts in crowded cities or stadiums could potentially result in cascades of panic. Fixing this problem will require a large collaborative effort between carriers, government stakeholders, and cell phone manufacturers. To seed this effort, we also discuss several defenses to address this threat in both the short and long term.
- Shichao Yue and Dina Katabi, "Liquid Testing with Your Smartphone," MobiSys 2019.
    - Surface tension is an important property of liquids. It has diverse uses such as testing water contamination, measuring alcohol concentration in drinks, and identifying the presence of protein in urine to detect the onset of kidney failure. Today, measurements of surface tension are done in a lab environment using costly instruments, making it hard to leverage this property in ubiquitous applications. In contrast, we show how to measure surface tension using only a smartphone. We introduce a new algorithm that uses the small waves on the liquid surface as a series of lenses that focus light and generate a characteristic pattern. We then use the phone camera to capture this pattern and measure the surface tension. Our approach is simple, accurate and available to anyone with a smartphone. Empirical evaluations show that our mobile app can detect water contamination and measure alcohol concentration. Furthermore, it can track protein concentration in the urine, providing an initial at-home test for proteinuria, a dangerous complication that can lead to kidney failure.
- György Kalmár, George Wittemyer, Péter Völgyesi, Henrik Barner Rasmussen, Miklós Maróti, and Ákos Lédeczi, "Animal-Borne Anti-Poaching System," MobiSys 2019.
    - Wildlife poaching is a critical driver of biodiversity loss and population decline. Poaching is a particular threat to high value, large-bodied species, such as elephants, that are slow to reproduce. Increasingly, GPS tracking collars serve as a key tool for studying the behavior and monitoring wildlife globally, including application to anti-poaching efforts. However, collars provide indirect information on poaching, such as immobility, that is often not available in real time. In parallel to collar development, acoustic gunshot detection systems have proliferated in the military and law enforcement. Static systems in wildlife areas have been deployed for detecting poaching, but such systems do not scale geographically. This paper explores the idea of fusing GPS tracking collars with acoustic shockwave detectors to create an animal-borne anti-poaching sensor. A real-time alert of gunshots near elephant groups would enable rangers to respond immediately to such events. The two main technical challenges to such a system are battery life and detection accuracy. The paper presents a prototype designed for elephants that has great promise in addressing these significant technical challenges.

Significant and Innovative Programs

The first half of the SIGMOBILE conference year featured a highlight with the 25th MobiCom anniversary gathering in Los Cabos, Mexico. SIGMOBILE supported community building and special programs at MobiCom and took advantage of the location in Mexico with a program that allowed local students to attend and receive community mentoring (further detailed under broadening participation).

After COVID-19 made it impossible to gather safely, the SIGMOBILE community reimagined the MobiSys conference originally planned for Toronto, Canada as its first virtual event. Given the novelty of the virtual format and that plans and contracts for an in-person conference were already in place, it took a special effort by the conference organizers, general co-chairs Eyal de Lara and Iqbal Mohomed, in consultation with the steering committee, SIGMOBILE, and ACM to make this shift a success. MobiSys opened for virtual attendance free of charge and a record 432 participants attended the conference opening session.

SIGMOBILE continues to invest in *GetMobile,* SIGMOBILE's significantly transformed quarterly publication, which is a revamped version of the ACM SIGMOBILE Mobile Computing and Communications Review (MC^2R). Each issue of GetMobile consists of a set of regular sections curated by a committed group of editors and has won a lot of praise from the broad community for improved quality of content and articles. GetMobile is catching up from COVID-induced delays and added several great young editors over the past few issues. The magazine's content remains excellent thanks to the editors' effort under the leadership of Landon Cox and the incredible staff of Donna Paris and JoAnn McHardy.

Based on a generally positive experience to date, the MobiCom conference continues its experiment with a multiple submission deadline model with a summer and winter deadline each year. Papers submitted to both deadlines undergo the same rigorous review process with decisions rendered at a technical program committee meeting after the reviewing phase for each deadline. Due to COVID, program committee meetings are being conducted remotely but the community is also considering meeting in person again.

SIGMOBILE's YouTube channel has become even more impactful with the shift to virtual talks. With speaker approval, recordings from our major conferences and workshops are archived on this channel. This content is publicly available and anyone can now watch the talks from our conferences at their convenience, even if they were not able to attend the conference itself. Engagement on this channel is rising significantly, with a 20% increase in views and large increase in subscribers. Many of our viewers are from countries that are traditionally underrepresented at our conferences, including Asia and Latin America. This channel thereby allows us to reach many more constituents than our conferences and workshops currently do.

Events or Programs to Broaden Participation

SIGMOBILE operates a program to broaden participation that involves several key activities: workshops designed for underrepresented groups, informal lunch meetings and mentoring, and student travel grants. To ensure coordination and stewardship of resources, SIGMOBILE is advised by its broadening participation committee. The role of the committee is to:

- Advise organizers and SIG officers on best practices regarding broadening participation
- Prioritize broadening participation-related funding requests within a given budget
- Develop measurable objectives for our broadening participation program and track its progress
- Help publicize SIGMOBILE's activities (through website, email, Twitter, for example)
- Coordinate among the different activities and groups that SIGMOBILE sponsors

The committee members are Prof. Ana Aguiar (Univ. of Porto), Prof. Rajesh Balan (SMU), Prof. Katia Jaffres-Runser (IRIT), Prof. Robin Kravets (UIUC), and Dr. Thyaga Nandagopal (NSF).

SIGMOBILE took the opportunity to hold a version of a mentoring workshop started as the Asian Students Symposium on Emerging Technologies (ASSET) with MobiCom 2019 in Los Cabos, Mexico. About ~20 local students were selected for the workshop, coupled with significant SIGMOBILE travel grant that enabled the students to also attend the main conference and further network with the community. Under the leadership of Rajesh Balan, community members Min, Chulhong, Eric Rozner, Ganesh Ananthanarayanan, Tam Vu, Swarun Kumar, Robert LiKamWa, Shubham Jain, Aarathi Prasad, Ardalan Amiri Sani, Mariya Zheleva, and Vaishnavi Ranganathan mentored students at the workshop. Generally, the goal of ASSET is to empower students from developing countries and regional universities with technical writing, speaking, and presentation skills and also allow them to experience a top-tier research conference. Each ASSET participant usually prepares a short research project writeup, record a 30s elevator pitch research presentation video, and present a research poster. These artefacts were evaluated by faculty mentors (in small groups) and the students iterated their submissions based on this feedback. The feedback from the student participants was very positive and we plan to organize more such events, particularly also to broaden our reach to other continents.

In partnership with the N2Women group, we hosted an N2Women dinner meeting at MobiCom'19. We also frequently hold meetings at other main conferences, often in the form of a lunch meeting and occasionally as

a full day workshop. These serve as a forum for researchers from underrepresented groups to network and to discuss career questions. Meetings are organized by a graduate student under the mentorship of a senior researcher from the community. The graduate student is usually supported with a travel grant.

SIGMOBILE operates a student grant program that co-sponsors students travel costs to SIGMOBILE conferences. Conference organizers are asked to explicitly consider the goal of broadening participation when selecting travel grant awardees. The program only operated in the 1st half of the reporting period, due to the shift to virtual conferences in the 2nd half.

Budget permitting, SIGMOBILE also occasionally sponsors activities from partner organizations focused on broadening participation, such as the CRA-W conference.

Key issues facing the community

We were fortunate that the community came together around our virtual MobiSys event and that the financial losses due to the need to cancel existing conference contracts could largely be avoided thanks to the hard work of conference organizers with ACM and SIGMOBILE support. The key question surrounding our conference community is to what extent to plan for in-person conferences for 2021 and to what extent to continue in a virtual model. For potential in-person events, a further challenge is how to estimate attendance for such events.

Summary

Mobile computing and wireless networking are among the fastest growing fields within computer science and engineering, and as a result SIGMOBILE continues to be a strong, successful, well-supported organization. During the first half of this reporting period we hosted the anniversary MobiCom event in Los Cabos, Mexico that featured intensified broadening participation activities with a mentoring workshop focused on local students associated with special travel grants and a mentoring dinner in partnership with N2Women. The 2nd half of the year was focused on converting SIGMOBILE conferences to a virtual format and holding MobiSys 2020 as our first virtual event with record participation.

The SIG's conferences and workshops are well attended, creating a wealth of publications for the ACM digital library and the SIG's members. The community continues to create significant impact both technically and to the broader society through research, education, and other activities.