

TAMIM SOOKOOR

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RESEARCH INTERESTS

I am broadly interested in programming language support for, and application development using Cyber-Physical Systems. I am especially interested in exploiting the computing and sensing resources that are pervading our world, in order to create smart environments that benefit their occupants. I have published in SenSys, ICCPS, IGCC, CONET, SESENA, and SIGBED Rev.

DISSERTATION TOPIC

For my dissertation, I investigated the effectiveness of the MacroLab macroprogramming language to CPS application development. I implemented and deployed three case studies of an occupancy-based HVAC control system in Python and compared them to MacroLab implementations. I have shown that MacroLab is sufficiently expressive to implement all three versions of the system, yet as the system-complexity increases, the freedom available for MacroLab to optimize the code decreases, resulting in a decrease in performance.

EDUCATION

2012	Ph.D. , <i>Computer Science</i> , University of Virginia, Charlottesville, VA.
Advisor	Kamin Whitehouse
Thesis	Application Development for Cyber-Physical Systems: Programming Language Concepts and Case Studies
2009	M.S. , <i>Computer Science</i> , University of Virginia, Charlottesville, VA.
Advisor	Kamin Whitehouse
Thesis	The Design of MDB: A Macrodebugger for Wireless Embedded Networks
2006	B.E. , <i>Computer Engineering</i> , Vanderbilt University, Nashville, VA.
Advisor	Xenofon Koutsoukos
Thesis	A Parking Space Finder Service using Wireless Sensor Networks

EXPERIENCE

Computer Scientist , <i>U.S. Army Research Laboratory</i> , Aberdeen Proving Ground, MD.	August 2012 – Present
<ul style="list-style-type: none">Developing a battlefield computation network composed of soldier-carried smartphones and High-Performance Computers (HPCs) mounted on Humvees and Unmanned Aerial Vehicles.<i>Collaborative research</i> with Prof. Radu Stoleru, Texas A&M University – Implementing reliable and secure battlefield computation networks and writing a paper on secure data caching in tactical networks.<i>Collaborative research</i> with Prof. Ellen Zegura, Georgia Institute of Technology and Prof. Mostafa Ammar, Georgia Institute of Technology – Computation ferries to enable computation offloading in battlefields.	

Graduate Research Assistant, University of Virginia, Charlottesville, VA.

August 2006 – May 2012

- Under the guidance of Prof. Kamin Whitehouse, lead **two research projects** which resulted in **six conference publications** [ICCPS '13, IGCC '12, SenSys '11, SenSys '10, SenSys '09, SenSys '08] (three as the lead author), and **three journal articles** [SUSCOM '13, SIGBED Rev. '12, IEEE Des. Test '12] (one as the lead author) in top Computer Science conferences and journals. Helped writing grants and advising students.
- *Collaborative research* with Prof. John Stankovic, University of Virginia (August 2006 – August 2007) – Worked on a project implementing a wireless sensor network for environmental research which resulted in a **conference publication** at a top conference (SenSys '07).

AWARDS AND HONORS

2010 – 2012 Department of Defense SMART Fellowship
2010 University of Virginia Engineering Research Symposium, Finalist
2010 Virginia Council of Graduate Schools Annual Graduate Research Forum, 1 of 5 students selected to represent U.Va.
2008 DuPont Fellowship, University of Virginia Graduate Fellowship
2006 Dean's Award for Outstanding Scholarship, Vanderbilt University
2005 Tau Beta Pi National Engineering Honor Society, Vanderbilt University
2005 Eta Kappa Nu Electrical and Computer Engineering Honor Society, Vanderbilt University
2004-2006 Vanderbilt University Deans List with High Honors, all semesters

RESEARCH SUMMARY

Cyber Foraging in Challenged Environments

The proliferation of computation platforms, such as smart phones, in environments such as battlefields and disaster relief sites has motivated my recent research. At the U.S. Army Research Laboratory, I am investigating the potential to augment the relatively lower computing capabilities of handheld computing devices by offloading computation to more capable machines as they become available. I am also investigating novel mobile computing platforms, such as battlefield vehicles and unmanned aerial vehicles retrofitted with High Performance Computers, to which mobile devices can offload computation.

Intelligent and Energy Efficient Buildings

One of my research goals has been utilizing cyber-physical systems to increase the energy efficiency of buildings, which studies have shown to be the greatest energy consumers in the United States. My work attempted to control the Heating, Ventilation, and Air Conditioning (HVAC) system intelligently in order to save energy without adversely affecting occupant comfort. My approach to achieve this was to utilize occupancy information obtained from inexpensive sensors, such as motion sensors. The goal was to build a system that homeowners can use to retrofit existing HVAC systems in order to improve their performance. I have evaluated an implementation of such a system called RoomZoner that demonstrated a 15% reduction in heating and cooling cost with only \$25 in hardware per home [ICCPS '13].

Programming and Debugging Cyber-Physical Systems (CPSs)

I am also interested in increasing the accessibility of cyber-physical systems as tools for domain experts, such as geologists and biologists, to aid them in their work. My early graduate work focused on the development of a macroprogramming language [SenSys '08] and debugger [SenSys '09], based on the widely used Matlab programming language that attempted to make it easier for scientists familiar with Matlab to program wireless embedded networks; I am interested in developing similar domain-specific programming abstractions in order to enable the widespread adoption of CPSs among non-computer scientists.

Wireless Sensor Network for Environmental Research

My first project at the University of Virginia was as part of a team that implemented and deployed a WSN on Hog Island, off the coast of Virginia for a group of environmental scientists who wanted to monitor the light levels under shrub thickets. I was in charge of implementing the subsystem to transmit the data collected by sensor from the island to our servers in our lab.

PUBLICATIONS

Total citations (Google Scholar): 400+, Peer-reviewed publications: 12 (7 conference papers [ICCPs, IGCC, SenSys], 3 journal articles [SUSCOM, SIGBED Rev., IEEE Des. Test], 2 workshop papers [CONET, SESENA])

Refereed Journal Articles (3 total)

- SUSCOM '13 **Tamim Sookoor**, Brian Holben, and Kamin Whitehouse. Feasibility of Retrofitting Centralized HVAC Systems for Room-Level Zoning, in *Elsevier Journal on Sustainable Computing, Informatics and Systems*, 2013. **Material for CS598tar, Spring 2013, University of Illinois, Urbana Champaign**
- SIGBED '12 Virginia Smith, **Tamim Sookoor**, and Kamin Whitehouse. Modeling Building Thermal Response to HVAC Zoning, in *ACM SIGBED Review, Special Issue on Networks of Cooperating Objects*, vol. 9, no. 3, pp. 39 – 45, September, 2012.
- Des. Test '12 Kamin Whitehouse, Juhi Ranjan, Jiakang Lu, **Tamim Sookoor**, Mehdi Saadat, Carrie Burke, Galen Staengle, Anselmo Canfora, and Hossein Haj-Hariri. Towards Occupancy-driven Heating and Cooling, in *IEEE Design & Test, Special Issue on Green Computing*, vol. 29, no. 4, pp. 17 – 25, July/August 2012. *Impact Factor: 1.62*

Refereed Conference Publications (7 total)

- ICCPs '13 **Tamim Sookoor**, and Kamin Whitehouse. RoomZoner: Occupancy-Based Room-Level Zoning of a Centralized HVAC System, in *The 4th International Conference on Cyber-Physical Systems*, pp. 209 – 218, Philadelphia, PA, USA, April 2013. *Acceptance Rate: 23%*
- IGCC '12 **Tamim Sookoor**, Brian Holben, and Kamin Whitehouse. Feasibility of Retrofitting Centralized HVAC Systems for Room-Level Zoning, in *The 3rd International Green Computing Conference*, pp. 1 – 10, San Jose, CA, USA, June 2012. *Acceptance Rate: 30%*
- SenSys '11 Timothy Hnat, Vijay Srinivasan, Jiakang Lu, **Tamim Sookoor**, Raymond Dawson, John Stankovic, and Kamin Whitehouse. The Hitchhiker's Guide to Successful Residential Sensing Deployments, in *The 9th ACM Conference on Embedded Networked Sensing Systems*, pp. 232 – 245, Seattle, WA, USA, November 2011. *Acceptance Rate: 19.5% (35 citations)* **Material for multiple courses, including CMPSI 691X, Spring 2013, University of Massachusetts, Amherst**
- SenSys '10 Jiakang Lu, **Tamim Sookoor**, Vijay Srinivasan, Gao Ge, Brian Holben, John Stankovic, Eric Field, and Kamin Whitehouse. The Smart Thermostat: Using Occupancy Sensors to Save Energy in Homes, in *The 8th ACM Conference on Embedded Networked Sensing Systems*, pp. 211 – 224, Zurich, Switzerland, November 2010. *Acceptance Rate: 17% (85+ citations)* **Material for multiple courses, including CS598tar, Spring 2013, UIUC**
- SenSys '09 **Tamim Sookoor**, Timothy Hnat, Pieter Hooimeijer, Westley Weimer, and Kamin Whitehouse. Macrodebugging: Global Views of Distributed Program Execution, in *The 7th ACM Conference on Embedded Networked Sensing Systems*, pp. 141 – 154, Berkeley, CA, USA, November 2009. *Acceptance Rate: 17.6% (35+ citations)* **Material for multiple courses, including CSE703, Spring 2010, University at Buffalo, The State University of New York**
- SenSys '08 Timothy Hnat, **Tamim Sookoor**, Pieter Hooimeijer, Westley Weimer, and Kamin Whitehouse. MacroLab: A Vector-based Macroprogramming Framework for Cyber-Physical Systems, in *The 6th ACM Conference on Embedded Networked Sensing Systems*, pp. 225 – 238, Raleigh, NC, USA, November 2008. *Acceptance Rate: 16% (50+ citations)*

SenSys '07 Leo Selavo, Anthony Wood, Qihua Cao, **Tamim Sookoor**, Hengchang Liu, Aravind Srinivasan, Yafeng Wu, Woochul Kang, John Stankovic, Don Young, and John Porter. LUSTER: Wireless Sensor Network for Environmental Research, in *The 5th ACM Conference on Embedded Networked Sensing Systems*, pp. 103 – 116, Sydney, Australia, November 2007. *Acceptance Rate: 17% (170+ citations)*

Posters, Demos, and Refereed Workshop Publications (5 total)

CONET '12 Virginia Smith, **Tamim Sookoor**, and Kamin Whitehouse. Modeling Building Thermal Response to HVAC Zoning, in *The Third International Workshop on Networks of Cooperating Objects, Co-located with the CPS Week 2012*, pp. 39 – 45, Beijing, China, April 2012.

SESENA '10 Timothy Hnat, **Tamim Sookoor**, Pieter Hooimeijer, Westley Weimer, and Kamin Whitehouse. A Modular and Extensible Macroprogramming Compiler, in *Workshop on Software Engineering for Sensor Network Applications, in conjunction with ACM/IEEE International Conference on Software Engineering (ICSE '10)*, pp. 49 – 54, Cape Town, South Africa, May 2010.

CompSust '10 **Tamim Sookoor**. Saving Energy Using Occupant-Oriented Control (OOC) Techniques for Smart Thermostats, in *2nd International Conference on Computational Sustainability*, Cambridge, MA, USA, June 2010.

SenSys '09 Timothy Hnat, **Tamim Sookoor**, and Kamin Whitehouse. Demo Abstract: Macrodebugging with MDB, in *The 7th ACM Conference on Embedded Networked Sensing Systems*, Berkeley, CA, USA, November 2009.

SenSys '08 **Tamim Sookoor**, Timothy Hnat, and Kamin Whitehouse. Demo Abstract: Programming Cyber-Physical Systems with MacroLab, in *The 6th ACM Conference on Embedded Networked Sensing Systems*, Raleigh, NC, USA, November 2008.

PATENTS PENDING

Kamin Whitehouse, Jiakang Lu, **Tamim Sookoor**, Vijay Srinivasan, and Jack Stankovic. The Smart Thermostat. U.S. Provisional Patent Application Submitted August, 2010.

ADVISING EXPERIENCE

Undergraduate students (*All undergraduate mentees supervised while at the University of Virginia.*)

2009 – 2011 **Brian Holben**, Collaborated on a successful journal article (SUSCOM '13) and two successful conference submissions (IGCC '12, SenSys '10). Built a desktop rig for evaluating the efficiency of wirelessly controllable HVAC vent designs, and evaluated and improved upon first generation vents.

2011 – 2012 **Virginia Smith**, Collaborated on a successful journal article (SIGBED Rev. '12) and a successful workshop submission (CONET '12). Developed, and evaluated, a mathematical model for the thermal response of rooms to HVAC zoning. Currently a doctoral student at UC Berkeley.

2010 **Karl Leswing**, Implemented first generation of wirelessly controllable HVAC vents as senior design project, currently employed as a software engineer.

Graduate students

2013 **Brian Swenson**, Mentored as an Oak Ridge Institute for Science and Education (ORISE) Student Research Participation Program at the U.S. Army Research Laboratory during the summer. Helped define summer research project, which was the simulation of computation offloading algorithms for battlefield environments, and conducted daily meetings inspired by the Agile software development method's Scrum. Co-authored a technical report.

2013 **Felipe Jovel**, Co-mentored as an ORISE summer intern at the U.S. Army Research Laboratory. Helped define, and carry out, experiments to evaluate the performance of Ad-Hoc networking on Android devices.

TEACHING ASSISTANTSHIPS

All teaching experience gained while at the University of Virginia.

- 2006 **CS 201, Software Development Methods**, Led weekly lab and office hours, and administered and graded exams.
2007 **CS 457, Computer Networks**, Graded, led office hours, and substituted for the professor when necessary.

SERVICE

Paper Reviewer

- Ele. Pow. '13 Elsevier International Journal of Electrical Power and Energy Systems 2013
AutoCon '13 Elsevier Automation in Construction 2013
UbiComp '13 ACM International Joint Conference on Pervasive and Ubiquitous Computing 2013
TOSN '12 ACM Transactions on Sensor Networks 2012
ICCPs '10 International Conference on Cyber-Physical Systems 2010
INSS '09 International Conference on Networked Sensing Systems 2009
SECON '09 Conference on Sensor, Mesh, and Ad-Hoc Communication and Networks 2009
IOT '08 Internet of Things Conference 2008
TMC '08 IEEE Transactions on Mobile Computing 2008

Departmental Service

- 2008 – 2010 **Computer Science Day / SEAS Open House**, Demonstrated research to the general public.
2009 **Piedmont Futures' Computer Technologies Career Academy**, Program funded by a Google RISE award where I presented hands-on demonstrations of my research to 53 middle school students (50% female or minority).

CONFERENCE AND WORKSHOP PAPER PRESENTATIONS

- ICCPs '13 RoomZoner: Occupancy-Based Room-Level Zoning of a Centralized HVAC System, in *The 4th International Conference on Cyber-Physical Systems*, Philadelphia, PA, USA, April 2013.
IGCC '12 Feasibility of Retrofitting Centralized HVAC Systems for Room-Level Zoning, in *The 3rd International Green Computing Conference*, San Jose, CA, USA, June 2012.
SenSys '09 Macrodebugging: Global Views of Distributed Program Execution, in *The 7th ACM Conference on Embedded Networked Sensing Systems*, Berkeley, CA, USA, November 2009.

GRANT WRITING ACTIVITY

Office of Emerging Frontiers in Research and Innovation (EFRI), EFRI-SEED: Occupant-Oriented Heating and Cooling. Award Number 1038271. Principal Investigator: Kamin Whitehouse. Awarded: September, 2010. Amount: \$1,999,642. A subset of this grant proposal was based on my work that was published in SenSys '10, SenSys '11, IGCC '12, SIGBED Rev. '12, IEEE Des. Test '12, ICCPS '13, and SUSCOM '13. I prepared figures and graphs and assisted with proofreading and editing the proposal.

NSF Computer and Network Systems (CNS), NeTS: Small: Time Travel Debugging for Wireless Embedded Networks. Principal Investigator: Kamin Whitehouse. Unawarded. This grant proposal was based on my master's thesis and SenSys '09 publication. I wrote the first draft and contributed significantly to underlying ideas and proposal text.

REFERENCES

Prof. Kamin Whitehouse (*advisor*)

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