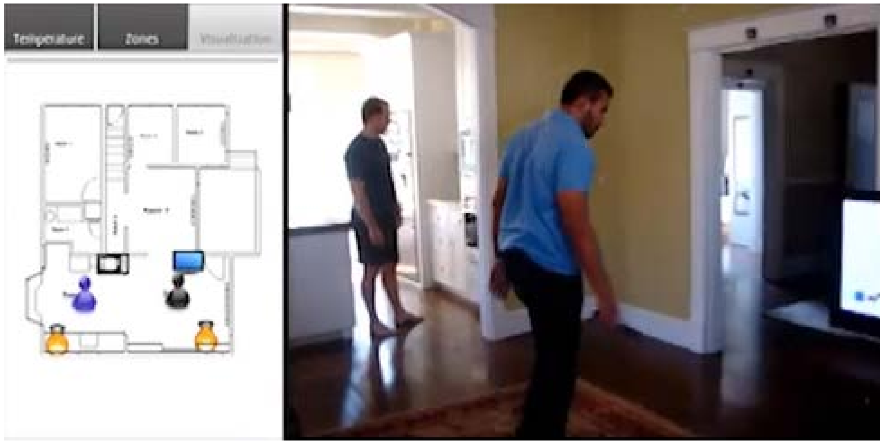
Whitehouse Research Group



Our group is creating smart building technology to improve building efficiency by using information about occupant locations and activities. Preliminary results using data from eight homes indicate that our approach can save 28% of HVAC energy with only $25 in sensors. As an extension of this work, we propose installing servers into homes, apartment buildings, and office buildings, and to use the exhaust heat as a primary heat source for the building. We are developing this technology, called the *Data Furnace*, in joint work with Microsoft researchers. This approach saves energy, money, and improves performance of Web applications. Additionally, we are creating tools for programming, debugging, testing, and analyzing Cyber-physical systems such as smart buildings to make software both easier to create and more reliable.

Kamin Whitehouse

Associate Professor
whitehouse@virginia.edu
www.cs.virginia.edu/~whitehouse/

Department of Computer Science
University of Virginia
Charlottesville, VA
434.982.2211

"Designing equipment and buildings to more quickly respond to occupant behavior."

Energy Efficient Smart Buildings

In the near future, intelligent buildings will autonomously monitor and respond to occupants to deliver comfort, lighting, and other services in a highly-efficient manner, strategically targeting the precise needs of building occupants to minimize energy consumption. These autonomous buildings will eliminate energy waste due to human operator error and coarse-grained, manual controls such as light switches and thermostats. Autonomous operation will also become important as new devices and technologies are introduced into buildings, making them too complex to operate manually. We are working to produce new sensing and modeling techniques to estimate both current and future occupancy, and new control algorithms to strategically deliver comfort and services efficiently as needed.

Programming and Debugging

Over the past ten years, we have created an evolving series of tools for programming, debugging, testing, and analyzing Cyber-physical Systems (CPSs) to make software easier to create and more reliable. We developed a system called MacroLab, which is a vector-based programming language modeled after Matlab that allows scientists to write a single program for an entire CPS. It automatically decomposes the program into node-local actions for each device, and the decomposition is optimized based on network topology, energy availability, or changing data patterns. The goal of MacroLab is to convert a CPS into a single programmable substrate, instead of a collection of individually programmed nodes, thus enabling a holistic analysis of the system. In parallel, we have produced an array of new debugging, testing, and analysis tools for CPSs. Our systems proved that severe limitations on energy, memory, and bandwidth do no preclude run-time visibility into software execution. For future work, we have begun to help bridge the gap between wireless embedded devices and the Web, in what is often called the Internet of Things.

RECENT RESEARCH DEVELOPMENTS

- The Doorjamb Tracking System
- The Smart Blueprints floorplan inference system
- The SunCast daylight prediction system

RECENT GRANTS

- NSF – Occupant Oriented Heating and Cooling
- NSF – Body Area Sensor Networks: A Holistic Approach from Silicon to Users
- NSF – Maintaining System Operation in Wireless Sensor Networks Over Long Lifetimes
- NSF – MacroLab: a Comprehensive Macroprogramming System for Cyber-physical Systems

SEAS Research Information
Pamela M. Norris, Associate Dean
University of Virginia
Box 400242
Charlottesville, VA 22903
pamela@virginia.edu
434.243.7683

University of Virginia Engineering