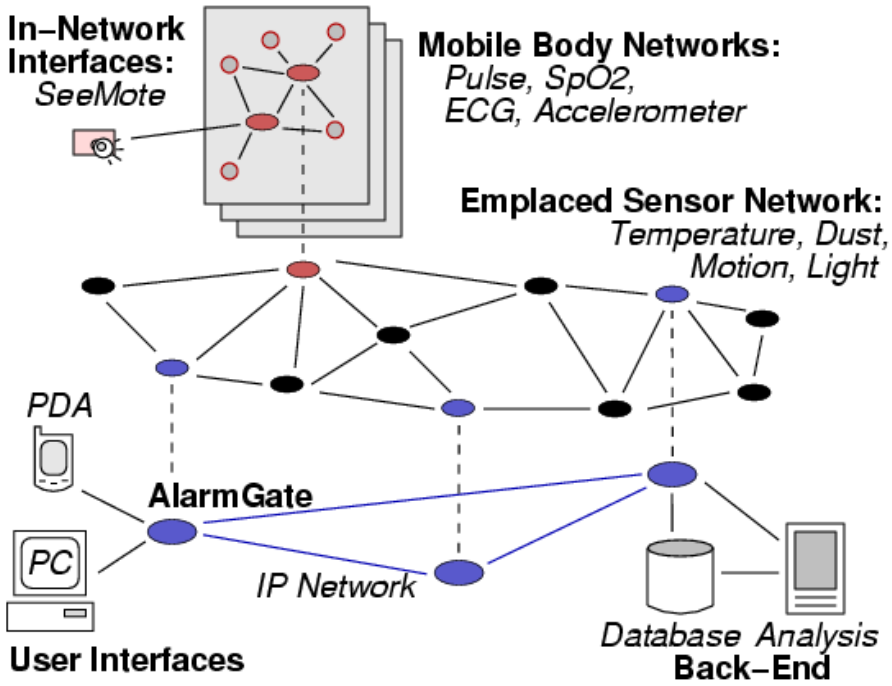
Cyber Physical Systems and IOT



My primary research interests are in the areas of cyber physical systems and the Internet of Things (CPS/IOT), and wireless sensor networks (WSN). In CPS/IOT, my group is primarily involved in mobile and wireless healthcare. This includes solutions for on-body and in-situ sensing and actuation systems. We have addressed various medical problems that include dementia, incontinence, asthma, epilepsy, depression, and obesity. In WSN we are investigating on-line validation, semantic anomaly detection, and system of system issues, including systems of system issues in smart homes, smart on-body apps, and smart cities. Applications such as military surveillance, environmental science, and saving energy in buildings have all been addressed in the past.

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"Almost all computer systems of the future will utilize real-time scientific principles and technology and be sensor rich."

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Cyber Physical Systems and the Internet of Things

With the increasing popularity of mobile computing, cyber physical systems (CPS) are merging into major mobile systems in our society, such as public transportation, energy, security, and wireless and mobile health (WMH). The majority of our work is on WMH. This includes creating a system framework that is easy to instantiate for different medical studies that can be deployed in homes or assisted living facilities. The framework, called, Empath, has been instantiated for studying home health care in three areas to date: dementia, depression and epilepsy. Our group also works to create smart applications such as AsthmaGuide (see sidebar). A new project under development is designing and implementing a home sensing and actuation system to detect family eating dynamics for obese families. This work is in conjunction with ECE at UVA and with two behavioral scientists at Univ. of Southern California.

Wireless Sensor Networks

It is now possible to develop large numbers of small smart components that combine computer power, wireless communication capabilities, and specialized sensors and actuators. These components or nodes may be deployed in thousands to achieve a common mission. However, the deployment of such a system can interfere with and be interfered by other co-located systems. Our work has been developing solutions that can detect and resolve system of system conflicts while the systems are operational. These solutions must work without prior knowledge of the co-located systems. This work has been applied to systems of systems in smart homes, in smart cities, and on human bodies. The relationships between these types of conflicts and the broader issues of safety and dependability are now being investigated.

RECENT RESEARCH DEVELOPMENTS

- **AsthmaGuide**: The AsthmaGuide system is a sensor rich smart phone and cloud based eco-system for asthma patients that collects physiological, environmental, and human inputs on a daily basis. It interfaces with both patients and their doctors and provides advice.
- **KinVocal**: This system uses the Kinect system to automatically detect verbal agitation of dementia patients including, asking for help, repetitive sentences, crying, laughing, screaming, unwanted sexual advances, cursing, and negativism.

RECENT GRANTS

- NSF: Smart Buttons: Bio-Enabled Wearable Devices
- NSF: Monitoring and Modeling Family Eating Dynamics (M2FED): Reducing Obesity Without Focusing on Diet and Activity
- NSF: Detecting and Addressing Adverse Dependencies Across Human-in-the-Loop In-Home Medical Apps
- DGIST: Safety for Dementia Patients

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