UAB Grand Challenge

Name: Improving Healthcare and Personal Safety through Smart and Connected Wearables and Smart Sensing

Principal Point of Contact: Dr. Ragib Hasan, Associate Professor, Computer Science, UAB.
Email: ragib@uab.edu *Phone*: 205-934-8643

1. Description of the problem:

Problem: Healthcare and personal safety are major issues that affect the entire population. Timely interventions can protect the public against healthcare issues, diseases, or personal safety hazards such as traffic accidents, sexual violence and other assaults, or falls. Every year, hundreds of thousands of deaths occur due to such hazards or unexpected events. For example, according to the CDC [1], one in four Americans aged 65+ falls each year, and every 19 minutes, an older adult would die from a fall. Falls result in more than 2.8 million injuries and 27,000 deaths per year, and the total cost of fall injuries is more than $31 billion/year. Besides falls, many people also suffer from cardiac diseases as well as diseases affecting mobility. Similarly, sexual assaults are classified as a public health hazard by the CDC and 1 in 3 women and 1 in 6 men have experienced sexual violence involving physical contact at some point in their lives [2]. In the state of Alabama, in 2015, heart disease alone killed 12 thousand people while 1,988 rapes occurred[3]. Therefore, such personal health or safety issues are not only a local or statewide issue, but rather a national and global problem.

Proposed Approach: Early detection, fast response, and quick interventions are key factors that can help the victims of violence or patients suffering from falls or the onset of diseases. However, the victims of these adverse events often do not have the ability to seek help, due to being incapacitated, unconscious, or unable to reach a phone or other communication device.

We propose solving these public health hazards through the development of ***smart wearable technology***, including smart clothing, jewelry, shoes, hospital gowns, and smart beacon based hazard warnings. The goal is not to introduce new gadgets that many people may not be interested to adopt or wear, but rather equip our everyday objects with sensing and compute capabilities, and explore the science of automatically identifying health hazards through a combination of machine learning, big data analytics, and sensing via the Internet of Things. Once such an event is detected, appropriate interventions can be initiated including calling 911, or notifying physicians, family, or friends, even if the person is not able to actively seek for help.

Advantages: This approach has several advantages: 1) By incorporating sensing and compute capabilities to our everyday objects and wearables, we can significantly increase adoption and reduce barriers to use, especially by elderly users. 2) Multi-modal sensing that looks at the user's movements, struggle/abnormal movements, gait, heart rate and blood pressure, body temperature, and other vital signs, can rapidly identify onset of diseases or a sudden fall or violent assault. This would make the response to emergencies much faster, making help available even if the user is incapable of seeking help. 3) Machine learning and artificial intelligence can help automate the detection of abnormal and adverse events and the use of Big

[1] https://www.ncoa.org/news/resources-for-reporters/get-the-facts/falls-prevention-facts/
[2] https://www.cdc.gov/features/sexualviolence/index.html
[3] http://acar.org/statistics/

Data analytics can lead to better and early detection. 4) Research on this approach will benefit a significant part of the population in the State of Alabama as well as the United States, and will help support the United States' global leadership in innovation and technology.

Example Scenario 1: Alice is walking in the street in the evening. She is suddenly assaulted by an attacker. While she is struggling, she is unable to get her phone out and call 911 for help. However, Alice is wearing a smart bracelet which looks like an ordinary bracelet but has accelerometers and gyroscopes to detect sudden and rapid movements that can indicate assault. The bracelet detects the struggle and automatically calls 911 and sends her location. Police arrives quickly and saves Alice from the assault. Dr. Hasan has already developed a prototype of such a device[4], which is summarized in this UAB News Video (https://youtu.be/aUJ_7qAMCIE), and news release (https://www.uab.edu/news/research/item/9329-automating-personal-safety-with-wearable-smart-jewelry)

Example Scenario 2: Bob is a retiree who lives alone. One morning, he suddenly falls in the bathroom and is knocked unconscious. However, Bob is wearing smart shoes and smart clothing that detected the rapid fall and the change in his vital signs. It detected the fall and automatically notified 911 and Bob's doctor who are able to help Bob.

Example Scenario 3: Charlie has undetected early signs of heart disease and Parkinson's disease. He has not visited a doctor in six months and therefore the diseases have not been identified. However, he wears a smart shirt that has hidden sensors that can use accelerometers and heart rate sensors that can sense his heartbeat 24/7 and detect abnormal heart rhythms. He is also wearing a smart ring on his fingers that can detect tiny hand tremors that can indicate the onset of Parkinson's disease. In both cases, the smart shirt communicates the information to Charlie as well as his designated physician for immediate remedy.

3. Desired Outcomes and Plan of Work

Outcomes: At the end of this grand challenge, we will develop the *science* as well as *engineering* behind the development of a plethora of smart wearable devices that can be inconspicuously incorporated into clothing, shoes, jewelry, and other everyday objects. We will also design new sensors and develop algorithms for automated detection of assault as well as health issues, by leveraging machine learning and Big Data analytics. Finally, we will find techniques for creating such smart items very inexpensively (<$50) so that a vast majority of the population can afford them. In the long run, anonymized data from such devices can also give us valuable insights into the population as a whole.

Plan of work: In the first phase, Dr. Hasan will team up with UAB's healthcare researchers and School of Engineering researchers to form a team with diverse expertise. During the pilot study phase, a small number of prototypes will be developed and small scale user studies will be performed. After demonstrating the success of these devices to accurately identify the events with a very low false positive rate, the team will perform larger scale studies in the field, and

[4] J. Patel and R. Hasan, "Smart bracelets: Towards automating personal safety using wearable smart jewelry", IEEE CCNC 2018.

seek extramural funding. Finally, we will work with the UAB School of Business and UAB Bill Herbert Institute of Innovation to explore commercialization of the products.

List of potential team members (individuals and organizations) from inside and outside UAB

UAB

1. Dr. David Schwebel, Professor, UAB Psychology.
2. Dr. Pankaj Arora, Division of Cardiovascular Disease, UAB School of Medicine.
3. Dr. Mohammad Rafiqul Haider, Associate Professor, UAB School of Engineering.

Outside of UAB

1. Syed Ishtiaque Ahmed, Assistant Professor, Department of Computer Science, University of Toronto.
2. Md. Munirul Haque, Research Scientist, Regenstrief Center for Healthcare Engineering, Purdue University.