Testing Environmental Sensors to Reduce Heat Ailments among First Responders
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Introduction
Over the last few years, there has been an increase in the number of deaths of the hazmat first responders mainly due to cardiac arrest, heat stroke, heat stress, lack of oxygen in the blood and inhalation of hazardous chemicals. National Fire Protection Agency (NFPA) statistics reveal the following:
• There were more than 30,000 firefighter injuries between 2010-2016.
• 42 percent of fatalities were caused due to physical stress and overexertion.
• The hazmat first responders face a 14 percent increase in cancer-related deaths (NFOSH).
Past research and interviews with various focus groups have indicated that there is a lack of real time health monitoring for first responders during a hazmat response. It is extremely important to monitor the health and environmental parameters surrounding the hazmat first responders in order to improve their safety and mitigate their deaths.
A decrease or an increase in the core body temperature of a hazmat first responder when exposed to extreme environmental conditions can result in adverse health effects such as heat stroke, cardiac arrest and heat exhaustion. Thus, my primary research goal is to monitor the temperature inside and outside the personal protection suit of first responder in order to improve their health and reduce risks associated when they are subjected to potentially harmful emergency hazmat situation. This can be achieved through Internet of Things (IoT) sensor technology.

Research Purpose
The purpose of this research is to:
• Monitor the health parameters of the first responders in an emergency hazmat response through IoT sensors.
• Improve their safety and reduce adverse health effects.
• Visualize the IoT sensor data for effective decision making.

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Research Questions
• Can IoT sensor technology be utilized effectively and accurately to monitor first responders’ core body temperature during a hazmat response?
• What is the best way to visualize IoT sensor data when monitoring first responders’ core body temperature during a hazmat response?
• What is the best way to effectively send alert notifications to the hazmat first responder wearing a PPE when core body temperature is too high?

Solutions
• The advancements in Internet of Things (IoT) in relation to wearable sensors has enabled communication between human and things in various areas such as health monitoring, intelligent transportation systems, safety/security, environmental monitoring etc.
• The increasing need for health monitoring and preventive medicine has given rise to the development of numerous wearable devices which can be used to monitor health parameters such as core body temperature, heart rate, blood pressure, blood oxygen and movement. IoT sensors can be incorporated into computed devices to measure these health parameters and can be comfortably worn on the body.
• For our research, we will be using a Texas Instruments CC2650 – an ultra low power Bluetooth sensor tag which has the following sensors: Temperature, Pressure, Humidity, Accelerometer, Gyroscope and Magnetometer.

Functionality
The functionality of the above diagram is described below:
• A low power TI Sensor Tag CC2650 is connected to a mobile device via Bluetooth low energy.
• The device pushes the sensor data onto the IBM Watson Cloud Platform via MQTT protocol.
• The sensor data is obtained in a real time environment and gets updated on the cloud platform every 3 seconds.
• Node is application connects the TI sensor tag data to the IBM cloud platform.
• Once the data is received on the cloud, a Cloudbent database such as dash DB is used to store and fetch the sensor data.
• A Node-Red app is used to analyze and react to the cloud sensor data. Various real time analytics and data visualizations can be performed using the Node-Red application.
• For our research we would be setting a threshold value for the core temperature and humidity; Thus if the threshold is met, additional data can be pulled from the Cloudbent database to send alert notifications to the first responder during a hazmat response.

Future Work
• Build a mobile application to visualize sensor data and send alert notifications to the first responder during a hazmat response.
• Test the quality and accuracy of the IoT sensor placed inside the protection suit of the hazmat first responder in a simulated environment.

References