Heart Monitoring & Alert System

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Abstract

This project allows users to monitor their risk for a cardiac crisis based on their heart rate and the heat index of their surroundings. This data is collected using a portable monitoring device, and sent to a smartphone application over a Bluetooth collection. The data is also sent securely to the cloud, which opens the possibility for large-scale analysis. Users receive alerts when their readings are unsafe, and after prolonged unsafe conditions, a call may be made to an emergency contact.

Introduction

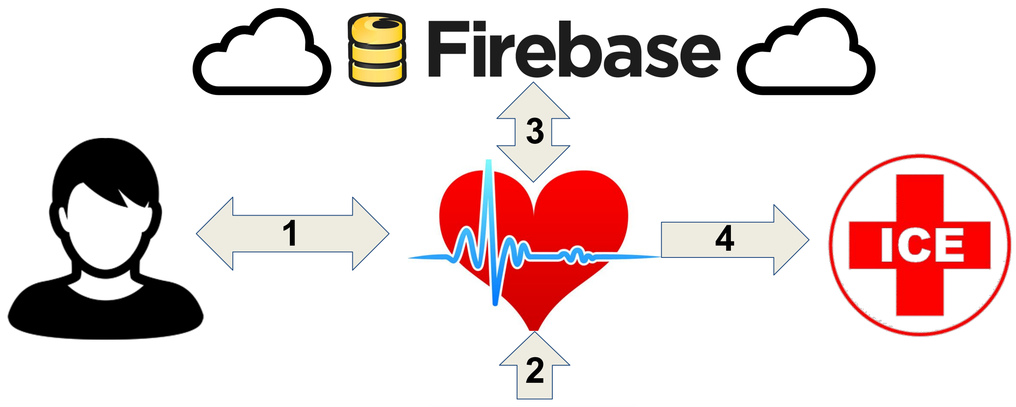
Heart problems are a prevalent cause of death in the United States. A correlation between heat index, heart rate, and the risk for cardiac arrest has been demonstrated. Heat-related heart risks include heat exhaustion, heat stroke, and the possibility for a heart attack. Some individuals may be at higher risk for heart ailments, and unable to anticipate their risk in real time.

Our task was to develop a wearable alert system for dangerous combinations of heart rate and heat index. This system was to be portable, practical, and provide a means for secure data transmission and analysis.

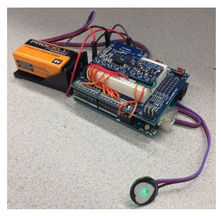
We aimed to accomplish this task using the knowledge acquired through previous coursework, as well as modern technologies covered in the Internet of Things course.

System Description

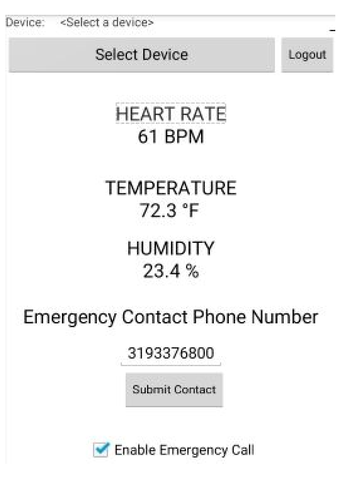
The diagram on the right provides a basic representation of the data flow through the health monitoring system. Once a user is authenticated, the Arduino circuit sends data to the mobile application, which is in turn displayed to the user and sent to the cloud. The application then places an emergency phone call if necessary.



1. *User – Application*: User provides credentials and emergency contact information, application displays current data and risk alerts.
2. *Device – Application*: Device transmits heart rate, temperature, and heat index data to application via Bluetooth LE.
3. *Application – Cloud*: Heart rate , temperature, humidity, and emergency contact data are exchanged between the application and cloud service.
4. *Application – Emergency Contact*: Emergency call is placed upon prolonged unsafe readings.



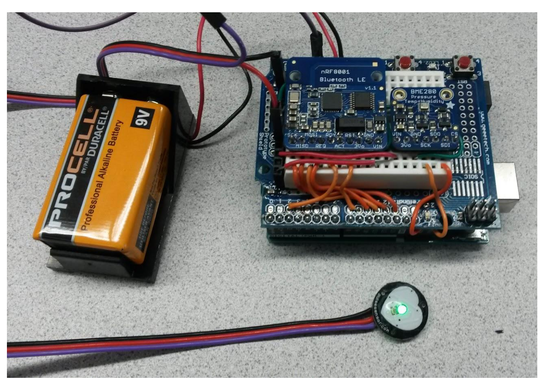
Software



The primary software aspect of this system is a simple Android application. Features of this application include:

- Authentication with Firebase cloud service
- Simple connection to the physical device and sensors via Bluetooth
- Real-time data display
- Notifications and alerts when unsafe heart and heat index conditions are detected
- Optional emergency phone calls to a specified contact upon prolonged unsafe conditions
- Real-time secure data transmission to the Firebase cloud service

Hardware



The hardware setup for this system is a portable and self-contained unit. Its components include:

- Arduino Uno microcontroller
- nRF8001 Bluetooth LE Module
- BME280 sensor for temperature and pressure
- Heart rate sensor
- Power source (currently 9V battery)

By connecting the Bluetooth LE (Low Energy) module to a smartphone, the user may carry this device on their person as the sensors gather and transmit data in real time. Since the sensors are low-power and Bluetooth LE was used, the 9V battery should be able to power this device for a long time. In the future, a rechargeable or longer lasting battery could be used.

Lessons Learned

- Hardware choices must be researched thoroughly in the planning stages, considering power requirements, physical setup, etc.
- A learning curve should be considered for technologies unfamiliar to group members.
- System-wide security from the hardware level to the cloud service is difficult to achieve.
- Collaborative development is aided greatly by the use of a repository such as GitHub.
- Form factor considerations must be factored into design when planning for a wearable device, and are difficult to achieve.

Conclusion

This project proved to be an opportunity to apply knowledge acquired from previous systems classes, and to integrate new and evolving technologies covered in the Internet of Things course. Our group successfully developed a mobile alert system to inform users in real-time of their risk for a cardiac episode due to heat conditions.

If this product were to be marketed, additional considerations would need to be given to its form factor, the user-friendliness of the mobile application, and how large-scale analytics could be applied to the data that is stored in the cloud.