Safety Bracelet

Team 37 - Seth Katz, Samuel Sitzmann, and Sameeth Gosike

1 Introduction

1.1 Objective

Caretakers have a constant responsibility to keep track of whoever they are watching. Whether it be children, the elderly, or anyone else that needs constant supervision, keeping an eye on them can be a full-time job. If the caretaker looks away for even a moment they might lose track of their dependent and depending on the situation, this could be incredibly dangerous.

Our objective is to make this job easier by creating a device that will track and report location and situational information to the supervising person. Specifically, we want to be able to track a dependent using GPS, collect information about motion and impact using an inertial measuring unit, and use a sensor to detect water. These components will fit in a comfortable, tamper-proof wristband/bracelet for easy wearability and comfort. The information will be sent using RF communication at 915 MHz to a receiver possessed by the caretaker. The receiver will be able to view multiple linked dependents' information on a screen and therefore constantly keep track of the dependent or dependents within a large radius. Additionally, the caretaker can trigger a buzzer to sound on the bracelet for locating purposes or to call the dependent back.

Many GPS tracking devices on the market require a monthly subscription to a service because they utilize SIM cards for wireless communication almost anywhere. Other devices utilize Bluetooth for shorter range communication. Our device will utilize 915 MHz RF to be able to communicate over long distances without the need for a monthly service. Additionally, our device is not just for tracking location, but also sends situational information like water contact and motion information. This information can be important in understanding more precisely where a dependent is or information about an event that happened.

1.2 Background

According to NamUs, an organization that provides services to help locate missing people, over 600,000 people go missing each year in the United States and a lot more around the world [1]. With the availability of technology like GPS, it is possible to help lower these numbers by creating tracking devices for people who are susceptible.

GPS has been used for location systems and navigation for over 20 years. It has gotten so advanced that newer modules released in 2018 can locate to within 30 cm. Current tracking devices are either very short range or require an additional monthly purchase. Our idea is to create a long-range tracking system that can also provide situational information. This way a caregiver can feel less stressed about constantly watching their dependent. Whether at the park,

in a city, or even on ones own property, this device will be incredibly helpful to keep track of dependents and keep them safe.

1.3 High-Level Requirements List

- Bracelet must be able to detect dangers to child (falls from 1 meter or higher contact with water)
- Bracelet must be able to track location and communicate back to monitoring device for distances up to 500 meters
- Bracelet must be able to run for at least 4 hours on a small, watch-sized, battery

2 Design

2.1 Block Diagram

Our design consists of two parts, a bracelet, and a monitoring unit. The bracelet will contain a water detection sensor, which allows the bracelet to detect if the child falls into water, an IMU, to detect falls and other impacts, and a GPS module to keep track of general location. The data from these sensors will be processed by a microcontroller on the bracelet, then sent to the monitoring device via an RF transmitter. The monitoring device will receive the data and report it to the screen for a caretaker to see. The caretaker can also trigger an alarm/buzzer that will sound on the bracelet.

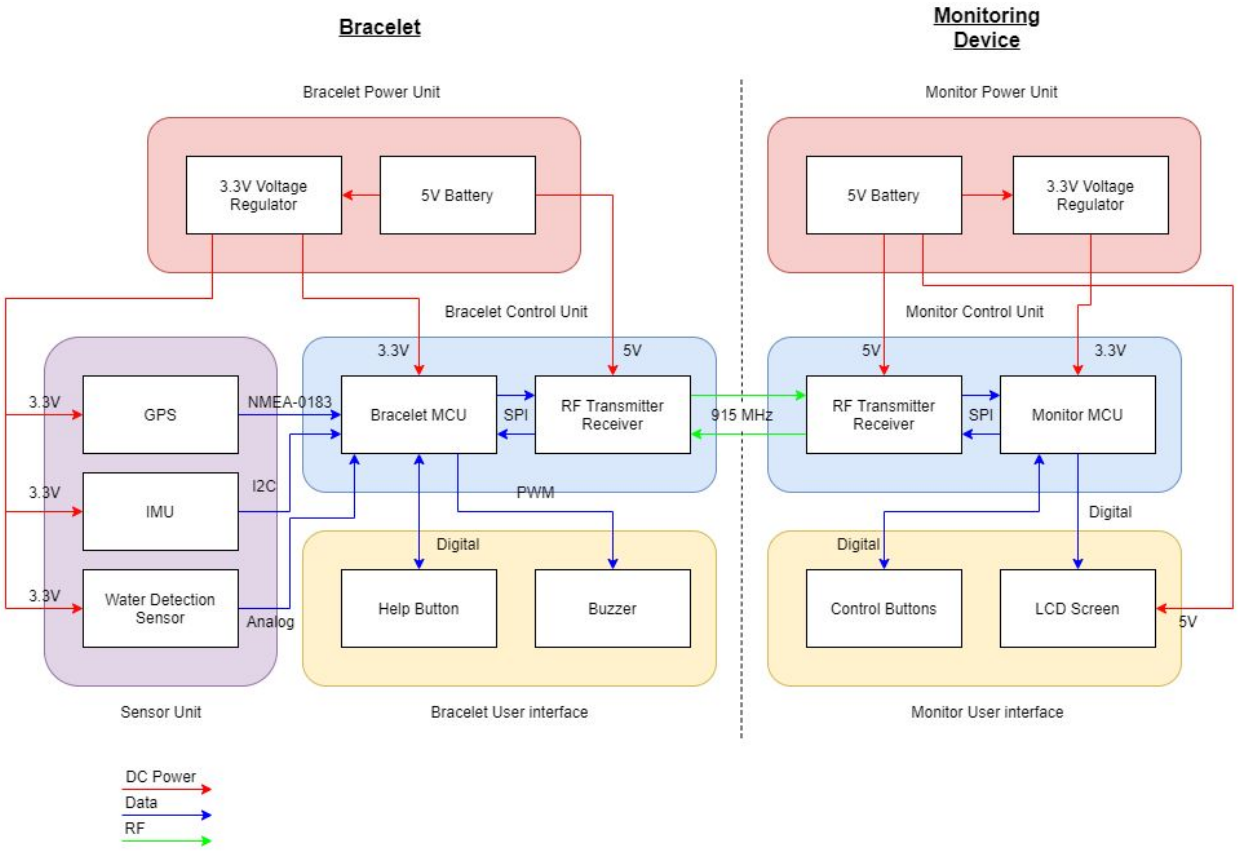

Figure 1. Block Diagram

2.2 Power Units

The power units supply power to the components of each device. Each bracelet and monitoring device will have its own power unit as the devices will be wirelessly connected.

2.2.1 5V Batteries

Two of these batteries will separately power the bracelet and monitoring unit. They will be easily accessible, and thus replaceable.

Requirement: Bracelet battery must be small enough to fit in a watch-sized bracelet, but be able to power the bracelet for up to 4 hours.

2.2.2 3.3V Voltage Regulator

One of these on each end will step down the 5V from the battery to the necessary 3.3V to power the controllers and various other components that require lower voltages.

Requirements: Bracelet component must be small enough to fit, and not draw too much power.

2.3 Bracelet Control Unit

This unit is where the processing and RF communication will occur on the bracelet.

2.3.1 Bracelet MCU

The MCU at the bracelet will take inputs from the sensor unit and will monitor a help button for user input. The MCU will process sensor information and reformat it so it can be sent over RF communication. The MCU also processes incoming messages from the bracelets RF receiver and can interpret messages to perform certain actions like sounding a buzzer.

Requirement 1: Must be small enough to fit in a watch-sized bracelet, but be able to process all data.

Requirement 2: Must draw no more than 10mA.

2.3.2 Bracelet RF Transceiver

The RF transmitter will send packaged data from the MCU at 915 MHz to the monitoring device. The receiver will receive packaged data from the monitoring device and to be processed by the MCU. The RF Transceiver will be connected to an antenna that is looped through the band of the bracelet.

Requirement 1: Must send and receive data at least once every 30 seconds.

Requirement 2: Must draw no more than 15mA.

2.4 Monitor Control Unit

This unit is where the processing and RF communication will occur at the monitor.

2.4.1 Monitor MCU

The MCU at the monitor is responsible for processing information that is received from the bracelet. The MCU then can reformat the data in a way to display information on a screen. This information includes the location of a bracelet, motion data, water indication, and/or help alert. The MCU can also receive input from the user interface unit to interact with the screen and to trigger an alarm on a bracelet.

Requirements: Must process data received from the RF receiver within 2 seconds of receiving data.

2.4.2 Monitor RF Transceiver

The RF Transceiver at the monitor will send and receive data to and from the bracelet. It will receive packeted sensor and location data that will be processed by the monitor MCU. The RF transmitter will be able to send data to the bracelet as well, like an alarm message that will alert the bracelet wearer.

Requirements: Must be able to receive data whenever sent by the bracelet, at least once every 30 seconds.

2.5 Sensor Unit

There will be 3 sensors in the bracelet, a water sensor, an IMU, and a GPS.

2.5.1 Water Detection Sensor

This will detect when the bracelet comes into contact with water, allowing the bracelet to alert the guardian.

Requirements: Must fit inside the bracelet.

2.5.2 Inertial Measurement Unit (IMU)

This will allow the bracelet to detect large falls, when the acceleration abruptly changes, alerting the guardian.

Requirements: Must fit inside the bracelet, and be able to handle abrupt changes in motion (i.e. a child with swinging arms).

2.5.3 Global Positioning System (GPS)

This will allow the bracelet to know its location and update the guardian if the child is straying too far, or help the guardian find the child.

Requirements: Must fit inside the bracelet, and be accurate to the 10,000th of a degree.

2.6 Bracelet User Interface

This will allow the child to interact with the bracelet, using the help button and the buzzer.

2.6.1 Help Button

This will allow the child to alert the guardian to any sort of trouble, with a simple click of a button.

Requirements: Must fit on the surface of the bracelet.

2.6.2 Buzzer

This will allow the guardian to call the child back to them.

Requirements: Must fit inside the bracelet, and be somewhere where the child would hear/feel the buzzing.

2.7 Monitor User Interface

This will allow the guardian to monitor the child, seeing where they are, and their status with regards to falling, being in water, and if they've pushed their help button.

2.7.1 LCD Screen

This will display all of the necessary information for the guardian, showing the location and status of the child.

Requirements: Must be high enough resolution to show a small map.

2.7.2 Control Buttons

This will allow the user to interact with the screen. It will also allow the user to call the child back with the buzzer.

Requirements: Must fit with the LCD screen.

2.8 Risk Analysis

The RF transmitter and receiver units pose the largest risk to the successful completion of this project. The entire project relies on the ability to communicate between the bracelet and the

monitoring unit. If the two transmitters and receivers don't connect or communicate efficiently, the project will not be useful.

Additionally, even if they connect and work, range is a big factor in this project. If they lose connection within range, the child could be lost without warning to the guardian. To prevent this, we may need to attach an antenna to one or both of the RF units, to extend their ranges, at the cost of taking up more space.

3. Ethics and Safety

One potential safety issue this project has is that a child will be wearing a bracelet broadcasting their GPS location. To prevent strangers from intercepting and interpreting the RF signal, it will be encoded using a prior known key. We are responsible for protecting all the information traveling through our devices. Number 1 in the IEEE Code of Ethics states "to hold paramount the safety, health, and welfare of the public… to protect the privacy of others" [2]. We intend to do everything in our power to protect all information on both devices from outside interference.

Another safety concern is the use of electronics in a product for children. Although the power supply voltages are low, electrical shocks can still potentially occur. To protect against this, the bracelet will be tamper-proof and waterproof. This will prevent water and people from interacting with the electronics.

References

[1] The National Missing and Unidentified Persons System (NamUs). [Online]. Available: www.namus.gov/About. [Accessed: 16- Sep- 2020].

[2] Ieee.org, "IEEE IEEE Code of Ethics", 2020. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 16- Sep- 2020].