Survival Wristband

ECE 445 Design Document Check

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1. Introduction

1.1 Problem and Solution Overview

Avalanches, mining collapses and landslides are regular occurrences that often result in loss of life for many of the individuals that are unfortunate enough to become caught up within these natural disasters. One of the major causes of death in these cases is suffocation as the people who get caught in these disasters are usually severely disoriented and do not know which direction to attempt to dig. Time is extremely crucial once buried underneath snow or other debris and any attempt to dig in the incorrect direction can waste this valuable time and cause suffocation. In order to maximize a person's chance of survival in the event that they become buried, they need to quickly and efficiently dig in the correct direction in order to avoid suffocation. Our solution is a wristband device that displays the approximate direction of shortest distance to the surface so that users will be able to know the direction that they need to dig in order to maximize their chances of survival. The survival wristband will be battery powered and correctly display the direction of the shortest path to the surface to some degree of accuracy at all times. The survival wristband will help to maximize people’s chance of survival in the event that they are buried under snow or other debris and lose their bearings.

Avalanches are a terrifying natural phenomena that generally causes more than 150 deaths each year. People that are unlucky enough to be buried underneath the snow are taught to thrust their hand or another part of their body above the snow surface as they are beginning to be buried. The issue is often times people are so severely disoriented and see endless white that they are told to guess where the snow surface is and try to get a body part to break the surface in an attempt to be rescued. This is similarly the case with mining collapses and landslides as people that are buried are blocked from the light and almost all of the time have no sense of direction. The survival wristband would be extremely useful in any of these situations as it would display the correct direction of the path of shortest distance to the surface so that the user is able to stick a body part in the correct direction and have a better chance of being rescued.

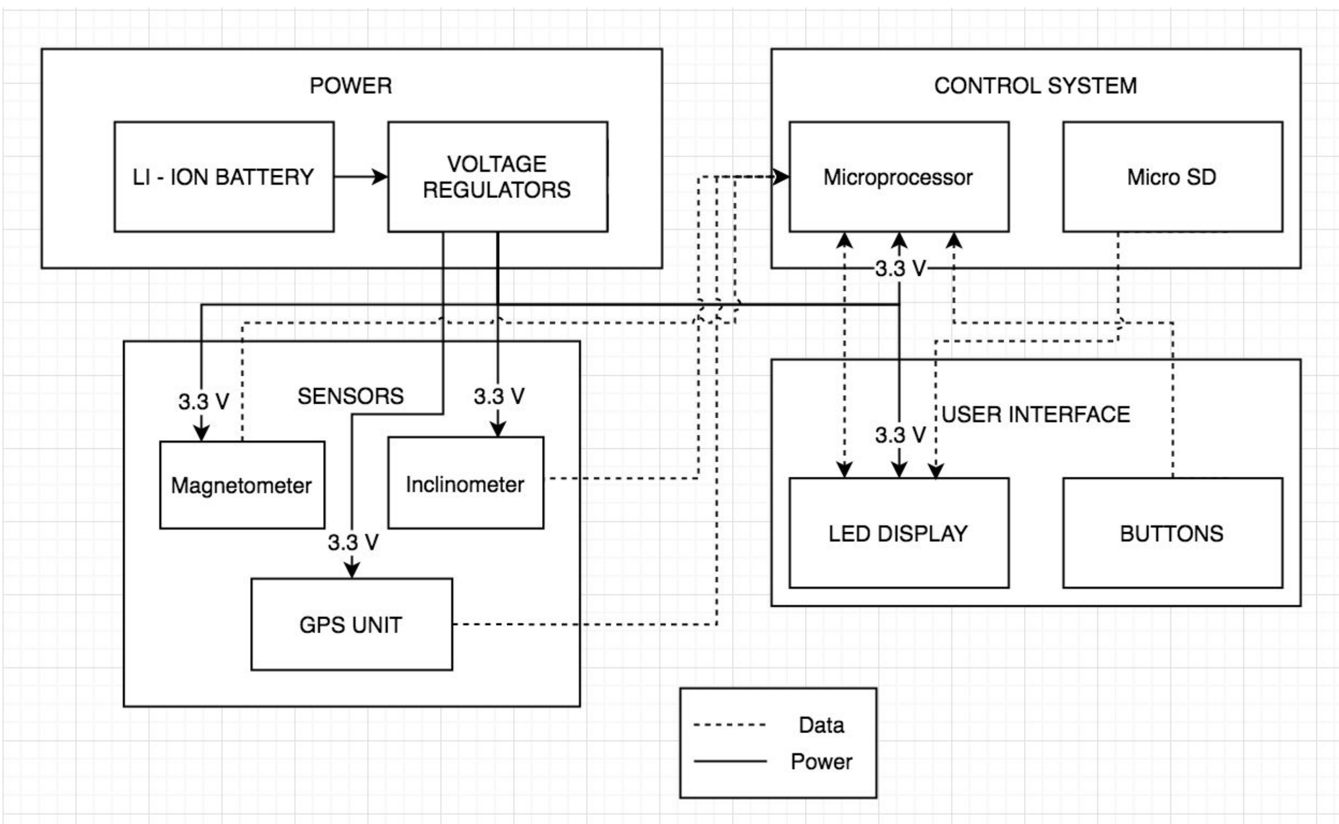
In the event that an individual is buried too deeply to be able to reach the surface with a body part, the survival wristband can still significantly increase the chances of survival. Time is extremely essential to avoid suffocation and death. If a person buried in an avalanche can be rescued within the first 18 minutes, the chance of survival is 91% and, in the range of 19 minutes to 35 minutes, the chance of survival drops significantly at about 34%. Suffocation and hypothermia are two of the leading causes of death from avalanches and both causes have the potential of being avoided if time is conserved. The survival wristband can increase the chances of survival for victims buried fairly deeply by pointing them in the correct direction to dig and conserving time. Similarly, suffocation is a cause of death in mining collapses and landslides and the survival wristband can also be used to determine the direction of digging by shortest path to the surface and thus saving crucial time that is likely critical to the victims survival.

1.2 High-level Requirements List

- The refresh rate of the displayed arrow is such that it gets recalculated at least once every three seconds.
- The direction of shortest path to the surface is correctly calculated and displayed within a margin of error of +/- 15 degrees.
- The wristband must ideally be under 5 pounds of total weight.

2. Design

2.1 Block Diagram



2.2.1 Voltage Regulator

Requirements	Verification
1. With a supply voltage of 3.6 V to 4 V, output a voltage between 3 V and 3.3 V at a current of 0 to 250 mA. 2. Ensure that the operating temperature is 45 ℃ or under.	1. A. Use a DC power supply set between 3.6 and 4 V with a current limit of 250 mA as a voltage supply to the voltage regulator. B. Meter the output voltage of the regulator and ensure that the voltage is within the range of 3 V to 3.3 V. 2. A. While completing steps 1.A-B, use the IR thermometer to ensure that the temperature of the regulator remains at or under 45 ℃.

2.2.2 LCD Display

Requirements	Verification
1. Images on the screen must be clearly visible when the screen is tilted 60 degrees towards and away from the viewer. 2. The LCD display is able to display 27 unique directions utilizing 3D arrows. 3. The LCD display must be able to refresh in 3 seconds or under.	With the LCD powered on, and an image being displayed, tilt the wristband approximately 60 degrees towards and away from you and verify that the image is still clearly visible. Cycle through each of the 27 unique directions and ensure that all 27 can be displayed and that the time between displaying each direction is under 3 seconds.

2.4 Tolerance Analysis:

In order for this device to operate effectively within the high-level requirement range of +/- 15 degrees, there are two approximation calculations that must be analyzed that are practically entirely responsible for how accurate the the displayed arrow is in pointing to the correct direction:

1) Calculate the 3 planar angles of the surface relative to cardinal North and East.
2) Calculate the 3 planar angles of the device relative to cardinal North and East.

In problem one, we are using the output of a GPS to tell us the altitude, longitude, and latitude of the current position and the previous position recorded 15-30 seconds prior. Using these points, we calculate the slope of each plane of the surface using the pythagorean theorem and equirectangular projection. There are 3 potential bottlenecks in accuracy:

1) The tolerance of the outputs of the GPS may cause the calculation to produce a slightly off result.
2) The frequency of the data collection from the GPS may result in using two points that are too close to each other, and therefore may be used to calculate an anomalous slope that doesn't well represent the more general slope of the land. Or the two points are too far from each other, and therefore result in a slope that is too general and doesn't represent the slope the user is on within a reasonable proximity.
3) The method of calculating the distance between the two points may vary in accuracy depending on the method. For instance, equirectangular approximation, with respect to the haversine distance, is technically less accurate, but the error is considered negligible when dealing with small distances, which is what our device will be working with.

In problem two, we are using the output of the Inclinometer and magnetometers. In order to get measured tilts of the device that are comparable to the angles of the slope of the surface, the zero degree angles of the x and y axis must be aligned with East and North respectively. To do this, we plan to require a calibration step during operation. There are a few details to consider when determining the bottlenecks in accuracy here:

1) The tolerance of the output of the inclinometer is said to be orders of magnitude lower than our high-level requirement of accuracy of +/- 15 degrees, so this by itself is not a concern.
2) The tolerance of the output of the magnetometer must be further investigated.
3) The inclinometer may or may not be able to smoothly handle angles greater than 90 degrees since first calibration. This may be mitigated by perhaps recording previous calibrations, performing a new calibration after a certain degree has

been measured, and adding them up to get a full 360 degree measurement for each plane.

3.1 Cost Analysis

Some assumptions that need to be made for labor costs are that the salary of an electrical engineer involved with this project is approximately $40 per hour and the number of hours a week is, on average, 10 hours. With the course being 16 weeks long, the labor costs for 3 people can be calculated as:

$$Labor\ costs = \$48,000 = 3 * \frac{\$40}{hr} * \frac{10\ hrs}{week} * 16\ weeks * 2.5$$

Our parts and manufacturing costs are still undetermined as we are still discussing and finalizing the specific components that we are going to use for the survival wristband.