Project Proposal for ECE 445
Spring 2019

Project Title : Safe-Walk Hat for people with visually impaired

Team # 72
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Submission date : 02/07/2018

1. Introduction

1.1 Objective

There is a high chance that people with vision impairment or blindness would get involved with traffic accidents including collision accidents with bicycles. According to a research, Are Normally Sighted, Visually Impaired, and Blind Pedestrians Accurate and Reliable at Making Street Crossing Decisions written by Shirin E. Hassan, there are two decision variables to consider in order to cross a street safely; the time that it will take them to cross the street; the time available before the next vehicle reaches them[1]. Compared to people with normal vision, visually impaired people or people with blind disability recognized 12% fewer crossable gaps, and made 23% more errors by estimating a gap as crossable[2].

The chance that people with blind disability get involved with accidents has been increased since electric automotives, which does not make any noise even on the road, started to draw people's attention because global warming is one of biggest problems needed to be solved around the world. People with vision trouble will have more difficult time to safely cross a street as the number of electric automotive keeps increasing. For example, the number of electric automotive increased from 160,000 in 2016 to 280,000 in 2017 in the united states, and is estimated to keep increasing in the future[3]. Furthermore, the number of people using bicycles which poses a danger to people with blind disability in the U.S has been also increasing from 36 million to approximately 48 million since 2006[4].

1.2 Background

There are several ways to support people with vision trouble walking; First, a cane; Second, a guide dog and a cane. Of course, those two methods are also effective to walk around the outside, but the problem is that both of methods are just to detect unknown objects near a person who uses them. Both methods do not have an ability to prevent accidents from happening. There are many products of comfortable canes or of training a service dog, but there is no such products on the market that protect people with vision trouble from accidents and allow visually impaired people to cross a street safely and to walk around without exposing themselves to a danger. To protect people with visually impairment from any accident, we thought of a device that notifies people with visual impairment when an object with higher speed than people is approaching. Here is a brief explanation of the solution. The solution includes two components. First component is a hat integrated with six doppler radar sensors and six ultrasonic sensors, and facing six different direction, so that sensors can cover 360 degree. Second component is a bone conducting speaker located in the device. If an object with higher speed than people is coming

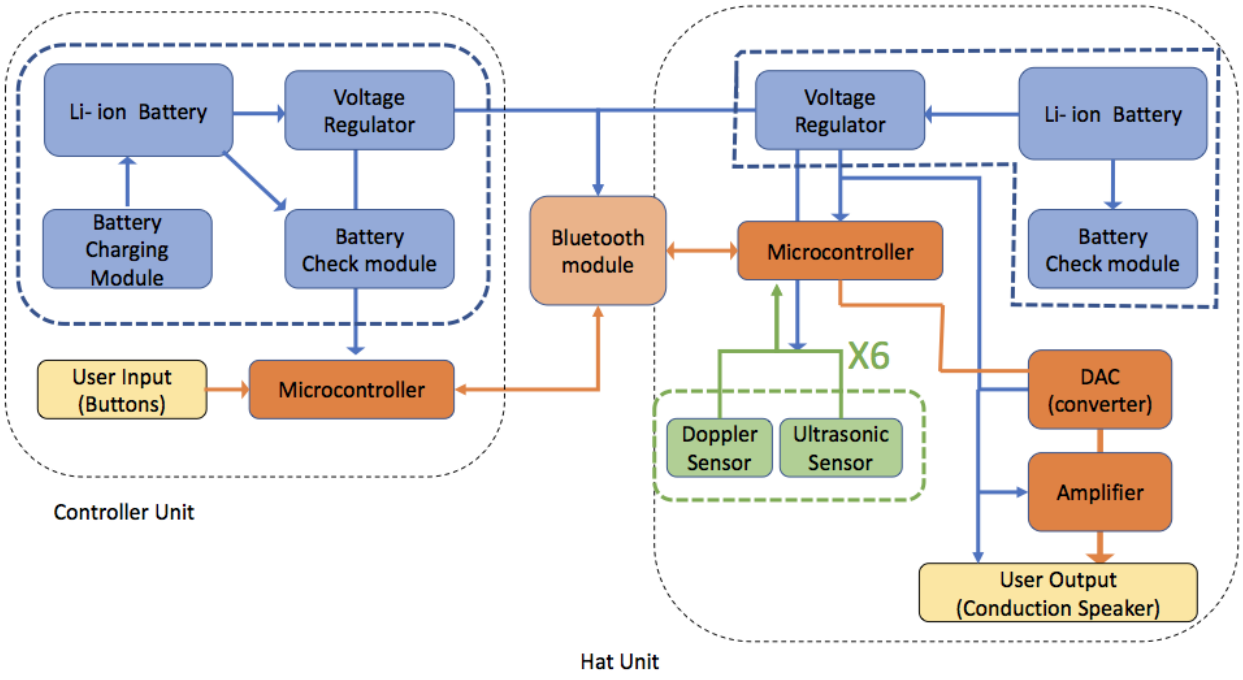
behind toward people with visual impairment, the device calculates the speed and direction of the object coming, determines level of danger, and sends a signal to the speaker to notify users.

1.3 High-Level Requirement List

- The range of detection component, including doppler radar sensors and ultrasonic sensors, will be approximately 4 meters.
- Six of the doppler radar sensors and six of the ultrasonic sensors must be able to detect an object in 360 degree.
- The doppler radar sensors must be able to detect a speed of an object from 5 m/s to 60 km/h

2. Design

2.1 Block Diagram



2.2 Block Description

2.2.1 Control Unit

a control unit manages the battery storage, checks the remaining battery, and sends the data over USART (Universal Synchronous/Asynchronous Receiver/Transmitter) to the Bluetooth module. A microcontroller controls the Bluetooth module, and provide a user interface with a button.

- Microcontroller : a microcontroller, chosen to be Atmega32, communicates with other microcontroller integrated in the hat unit by USART through the Bluetooth module. Also, it operates with voltage from 2.7v to 5.5v , which is suitable for our sensors.
Requirements :

1) Must be able to process the doppler signal to calculate the speed of an approaching vehicle. 2) Must be able to communicate with other units such as doppler sensor, ultrasonic sensors, and speaker 3) Must have sufficient number of available input/outputs for the controller unit.

- Bluetooth module : a bluetooth module, chosen to be HC-05, receives the user input from a microcontroller located in the control unit, and transmits the data to a microcontroller integrated in the hat unit using serial port. Operate from 1.8 to 3.6 V.

Requirements:

1) Must be able to send/receive data from hat unit to controller unit vice versa. 2) Must be able to communicate with the microcontroller we chose.

- Li-ion Battery : a rechargeable battery that supplies power to the microcontroller.
Requirement :

1) Voltage of the battery must be <5V and able to supply 20mA. 2) Last over 6 hours

2.2.1 Hat Unit

a hat unit manages the battery storage, checks the remaining battery, receives the data input from the Bluetooth module, and alerts the user by calculating speed and distance of an approaching object.

- Microcontroller : a microcontroller, chosen to be Atmega32, communicates with other microcontroller integrated in the control unit through the Bluetooth module using USART. Also, it operates with voltage from 2.7v to 5.5v , which is suitable for our sensors.
Requirements :

1) Must be able to process the doppler signal to calculate the speed of an approaching vehicle. 2) Must be able to communicate with other units such as battery check, bluetooth and user input from buttons. 3) Must have sufficient number of available input/outputs for the controller unit.

- Doppler radar sensor : Six HB100 has been chosen for doppler radar sensor. The doppler radar sensors detects the speed of an object approaching, and sends the data to the microcontroller.
Requirements :

1) Need average current of 1.2mA~4mA with 3 to 10 % duty cycle pulse at 5 V ± 5%. 2) Need accurate detecting range at least 60 degrees. 3) Must be able to measure an object that is at most 4m away from the device

- Ultrasonic sensor : a ultrasonic sensor, chosen to be HC-SR04, detects the distance of an approaching object, and sends the data to the microcontroller.

Requirements :

1) Need operate voltage of 5V and current 15mA. 2) Must be able to detect the distance of objects with acceptable measuring angle. 3) Must be able to measure an object that is at most 4m away from the device

- Li-ion Battery : a rechargeable battery that supplies power to the microcontroller.

Requirement :

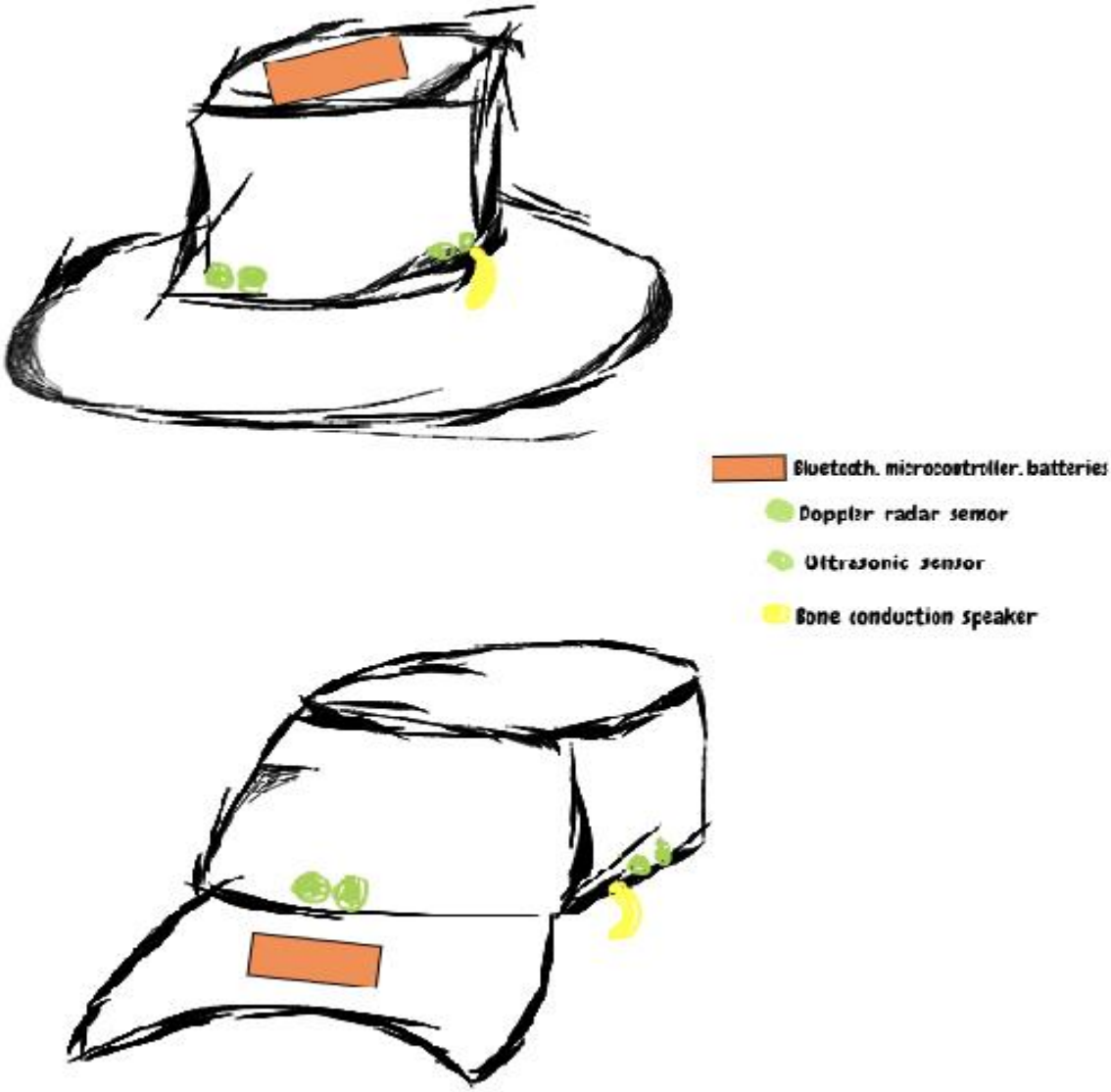
1) Voltage of the battery must be <5V and able to supply 100mA. 2) Last over 6 hours

- Speaker : a bone conduction speaker

Requirement :

1) Must be suitable size for hat.

2.3 Physical Design of the product



2.4 Risk Analysis

There are two blocks that pose the greatest difficulty to implement this project. First is finding an perfect angle in order to detect 360 degree. Second is a way to identifying joggers from bicycles and automotives.

Appropriate angle : it will be difficult to define perfect angles of doppler radar sensors and ultrasonic sensors that detect an approaching object toward users with minimum error.

Identification : it will be difficult to distinguish joggers from bicycles, automotives and bikes. Of course, average people walking pace is 1.4 m/s, but there is a special situation that some people sprint or run. Changing a range of speed detection of doppler radar sensors can solve the problem; there, however, is a case that a car, bicycle or bike is moving slowly.

3. Ethics

We, the members of IEEE, acknowledged the 7.8 IEEE code of ethics, and are not going to do any acts that violate the ethics code. The project is to protect visually impaired people from accidents occurring, to provide more safety to people with vision trouble, and to give them more mobility outside. We believe that out product is designed "to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger" the people with visual disability. (IEEE Code of ethics, #1) "To avoid injuring others, their property, reputation, or employment by false or malicious action," we will definitely address any possible risks, harms, or dangers to end users in details, so that our product does not put any people with visual disability in a harm's way. (IEEE Code of ethics, #9) In order to act in accordance with IEEE Code of ethics, #7, our team is also going to take notes thoroughly on the procedure of the development and implementation "to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others." Furthermore, to be more adhered to IEEE ethics code, every team members are willingly going to help each other even if it is not his own task to work on. For these reasons, we believe that there is no ethical concerns.

4. Safety Issue

Our project has few risks needed to be taken care of. The device is designed to be a outdoor-purpose device, dust and moisture could damage the device, which is consisted with microcontroller, several sensors, batteries, and a small circuit. In other words, the device for our project has to be dust and waterproof. That is the reason that the device will be designed under IP64 guideline, which is protected from total dust and protected from water spray from any direction. (source : http://www.dsmt.com/resources/ip-rating-chart/)

Another safety issue is concerned with rechargeable Li-ion batteries. Li-ion batteries may explode and cause fire if mishandled. If the batteries are mishandled when it is being used or being charged, internal short circuit can cause enough heat to damage the components around and even hurt users. To prevent possible safety hazards, batteries will thoroughly be checked and tested in the manufacturing process.

5. Citations and References (Not completed yet)

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