Bike Navigation Assistant

Project Proposal

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Team #48

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1 Introduction

1.1 Objective

In today's world, it is quite difficult for people to use bikes in places that they are not very familiar with specific locations and directions. It can be a big hassle to use Google Maps or a similar application on your phone as it results in stopping frequently to check for directions. Moreover, there are numerous safety concerns regarding riding bikes, especially on crowded streets. In 2015 in the United States, there were a over 1000 bike-related deaths and 467,000 injuries [1]. Our project aims to counter the problem of bike navigation as well as improve bike safety by attaching a few modules to the bike.

For the bike navigation problem, data would be sent from the user's phone to a microcontroller using a bluetooth module. The microcontroller would then be connected to LEDs, a buzzer and haptic feedback mechanism on the handle bar. This module would work as follows: the biker will just need to input their destination on the phone. The GPS information from the phone would be sent to the microcontroller and whenever the biker approaches a turn that the biker needs to make, the LED lights on the that side of the handle bar will light up. In addition to the LEDs, a buzzer and haptic feedback mechanism will also be also be attached, in case the biker doesn't notice the LEDs.

In order to improve bike safety, we want to add a couple of features. Firstly, an ultrasonic sensor would be places at the front of the bike that would measure the distance between the bike and the vehicle in front. This would be used to alert the biker if they are too close to the vehicle using a red LED light that would also be placed on the handle bar. Secondly, blinkers would be added on to the bike, that will use the GPS information from the phone and will start blinking when a turn is about to be made and stop when the turn has been completed. This will eliminate the need for the biker to use their hands to indicate when they are turning and will allow them to keep both their hands on the handle at all times.

1.2 Background

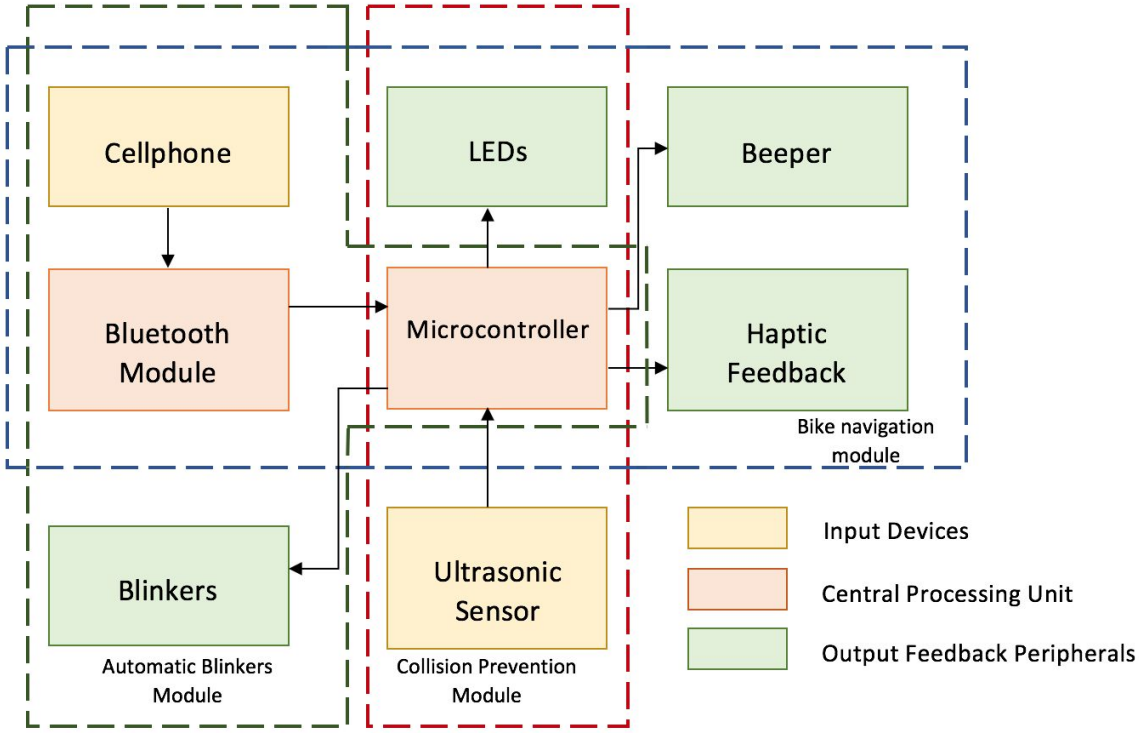
We believe our project is important and can have massive practical applications as it would significantly improve people's experience when riding bikes. In addition to people adding these modules to personal bikes for convenience and safety, this could be hugely beneficial if they are added to rental bikes in big cities. When people travel to new cities, they mostly use taxis to get from one place to another but if rental bikes had these features, they would attract more people. Overall, the bike industry has been pretty static for the past few years [2] and we hope that this will attract more people to the environment friendly practice of riding bikes and result in less bike-related accidents.

1.3 High-Level Requirements

- The GPS information from the phone and the data from the ultrasonic sensor needs to be wirelessly communicated to the feedback peripherals on the bike.
- The LEDs, the haptic feedback mechanism and the beeper should always catch the biker's attention.
- The battery should be able to power these modules for a time period of at least 7-10 days after every recharge.

2 Design

2.1 Block Diagram



As can be seen in the block diagram above, our project will be divided into three modules and the microcontroller will the heart of all the three modules. The first module is the bike navigation module which will take in the GPS information from the cellphone and transmit information about when to turn using via the LED lights, the beeper and haptic feedback mechanism. The second module is the automatic blinkers module which will also take in the GPS information from the cellphone and make blinkers blink when approaching a turn and stop when the turn has been made. The third module is the collision prevention module which will take in information from the ultrasonic sensor and alert the biker if they are too close to the vehicle in front using a red LED light.

2.2 Physical Design

As shown in the figure above, at locations marked “1” on the handle of the bike, LEDs, buzzers and haptic feedback generators will be placed. At location “2”, the microcontroller, bluetooth module and power supply will be placed and these will go under the rider’s seat. At locations marked “3”, the turn indicators/blinkers will be placed and these will be both on the front and back of the bike. Lastly, at locations marked “4”, the ultrasonic sensors will be placed.

2.3 Functional Overview

2.3.1 The Microcontroller

The microcontroller will be the central processing unit of our system. All input data from the sensors on board as well as the data from the phone will be fed into the microcontroller and it will output the necessary data to the effectors. A microcontroller with multiple digital and analog I/O pins and support for some sort of communication protocol is required.

2.3.2 Bluetooth Module

The bluetooth module will receive the data from the user's phone and send it to the microcontroller. The data that would be received from the phone would be information on whether to turn left or turn right, how soon to turn and if the biker has reached his or her destination.

2.3.3 LEDs

The LEDs will be two arrays of LEDs, one of each side of the handle bar. These LEDs will provide the biker information on navigation. When a biker is approaching a junction in which a turn is necessary, the LEDs on the handle of which the biker is to make a turn to will start flashing. As the biker gets closer, the rate at which the LEDs are flashing will increase. When the biker reaches the destination, the LEDs on both handles will be constantly on to inform the biker that he has reached his destination.

2.3.4 The Blinkers

2 pairs of blinkers will be on the bike, one on the front and one on the back of the bike. These blinkers will be bright LEDs that receive data from the microcontroller. The blinkers will warn the nearby pedestrians, bikers and driver that the biker is about to make a turn.

2.3.5 Ultrasonic Sensors

An ultrasonic sensor on the front as well as one on the back of the bike will warn the biker of any incoming objects. The sensor on the back will warn the biker of any car of other biker that is closing in on the biker while the one in front will warn the biker that he is approaching an obstacle[3]. This is a safety mechanism for the biker as the biker may at times be focusing on the on board LEDs and may not be aware of the surroundings.

2.3.6 Buzzer and Haptic feedback.

At times, the biker will be not be looking at his LEDs or if the surroundings is too bright the sudden flashing of the LEDs may not gain the attention of the biker. Hence the main goal of these two effectors is two get the attention of the biker. Both of them will be placed on the bike handle and will be activated just as the LEDs start to begin flashing.

2.3.7 Power Supply

A portable power supply such as a battery pack will be used to supply power to all the devices on the bike. The power supply will have a voltage of 5V and should be rechargeable. The power supply must be compact for convenient placement and must be light so that it will not be a burden to the biker.

2.4 Block Requirements

Requirements	**Verification**
Microcontroller should have enough digital and analog I/O pins and a support for a communication protocol so that it can handle all peripherals	Test all pins and functions individually with an oscilloscope to verify if the outputs generated are correct
The bluetooth module should be able to maintain a constant connection with the phone when both of the devices are moving with an almost zero relative velocity. The bluetooth module should be able to make a connection with most modern smartphones	Establish a simple connection between the bluetooth module and the phone and move them both together and ensure that the connection remains unbroken.
The LEDs should be capable of flashing with an intensity that will still be visible to the biker on a bright day	Ensure that the LEDs flash appropriately and increase the brightness of the surrounding to check if the flashing of the LEDs are still visible
The Blinkers should be visible to nearby drivers and pedestrians and should function when the biker is about to make a turn	Ensure that the LEDs in the blinkers are working by powering the blinkers and then at many corners, test if the blinkers will work as supposed to
The ultrasonic sensor should be be able to determine the presence of an object up to 5 meters away	Place an object up to 5 meters away from the ultrasonic sensor and check if the the sensors gives out a value on the oscilloscope

Buzzer should be audible to the biker even in a busy city and the haptic feedback should be sensed by the biker even on a bumpy road	Power both the devices and test them in varying situations and ensure that at least one of them is detected at any given situation
Power supply should give a voltage of 5V with enough current to power all devices with a variability of 10%	Measure the power supply with a multimeter and ensure that both voltage and current stay with intended levels

2.5 Risk Analysis

Effective communication between the mobile device and the microcontroller is the biggest risk to the successful completion of this project. Creating an application interface on the phone that helps the microcontroller interface with the Google Maps API will definitely be challenging since we need to ensure constant and accurate communication and we plan on accomplishing this through a bluetooth module on the microcontroller. Potential issues that may arise with this communication are the biggest risks for our project since if the issues are significant, our project as a whole will fail. As a group, we have limited experience working with microcontrollers and how they can communicate with mobile devices and it will require extensive research on our side to ensure that we are able to mitigate this risk.

3 Ethics and Safety

3.1 Ethics

The greatest ethical risk with our project is that people who are not familiar with our bike's navigation system can pose a potential risk to public safety since the LEDs, haptic feedback and other features incorporated can confuse them, thus resulting in accidents. To ensure that the IEEE Code of Ethics #1 "to hold paramount the safety…public or the environment" [4] is abided by, we plan on including a tutorial on the mobile application (that is communicating with the microcontroller) to explain how to use the navigation assistant, and also make users aware of some of the potential risks inherent with using the navigation assistant without prior experience.

Another ethical risk with our project is if someone was to hack into the users mobile application and change the final destination, it could lead to kidnappings or other malicious acts. To ensure that IEEE Code of Ethics #9 "to avoid injuring others….malicious action" [4] is abided by, we need to incorporate certain security measures that would help mitigate this risk.

Our project is an effort to contribute to intelligent systems and thus is an implementation of the IEEE Code of Ethics #5 "to improve the understanding….including intelligent systems" [4]. The other codes are not of concern to us due to the following reasons: we plan on working together as a group and bring up any concerns as and when they arise, we have an organized plan and timeline for the project and will work towards the project with integrity, we are not requesting sponsorship other than the $40 funding from the Electrical and Computer Engineering department, and lastly we hope to work closely with the course staff to deliver an impactful project.

3.2 Safety

There are two primary safety concerns with our project. The first is that our navigation assistant should not interfere with the normal functioning of a bike and that the user can safely ride a bike as he/she used to prior to adding this system. Additionally, ensuring that the user is familiar with the navigation assistant is of paramount importance since incorrect or uneducated use can lead to safety hazards for themselves and the public (as mentioned in section 3.1).

The second safety concern is not having clean wiring for the multiple sensors on the bike. Having messy wiring and potentially exposed electrical wires are a major safety hazard and we have to ensure that this does not happen.

4 References

[1] Centers for Disease Control and Prevention (CDC). Web-based Injury Statistics Query and Reporting System (WISQARS). Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Available at https://www.cdc.gov/motorvehiclesafety/bicycle/index.html. Accessed on 02/08/2018.

[2] NBDA.com, “Industry Overview 2015”, [Online]. Available at https://nbda.com/articles/industry-overview-2015-pg34.htm. Accessed on 02/08/2018

[3] Adafruit.com “Weather Resistant Range Finder”, [Online] Available at https://www.adafruit.com/product/1137. Accessed on 02/08/2018

[4] IEEE.org, "IEEE Code of Ethics", 2018. [Online]. Available at http://www.ieee.org/about/corporate/governance/p7-8.html. Accessed on 02/08/2018.