ECE 445 Senior Design Project Proposal: Cyclist Sensing and Awareness

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Group 11
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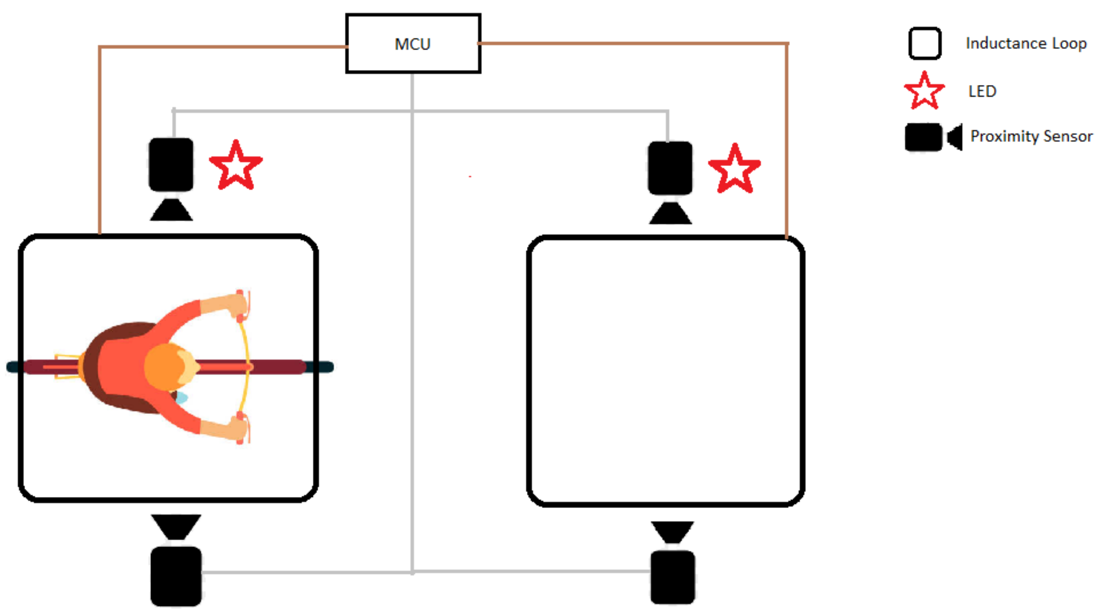
Introduction

Problem

Cycling accidents occur all over the world. In the United States alone, nearly 1,000 bicyclists die, and over 130,000 are injured in crashes that occur on roads in the United States every year.[1] Many of these injuries and deaths occur in locations that house large populations, cities and college campuses for example. From personal experience, members of our group have collectively seen over 20 near collisions between pedestrians and cyclists and one collision between a cyclist and vehicle. Many of these collisions occurring when a cyclist is incoming from the rear of a pedestrian. Despite the implementation of infrastructure such as bike lanes, infrastructure installed specifically for cyclist and pedestrian safety, these collisions continue to persist.

Collisions and near collisions continue to persist despite the best efforts of engineers and city planners. It is for this reason that our group is proposing a new way to combat cycling collisions. We aim to design, build, and present a system that both recognizes cyclists and illuminates lights to notify nearby pedestrians and cars that a cyclist is approaching. This will help notify pedestrians and drivers alike of the presence of a cyclist, thereby hopefully decreasing the amount of collisionsA experienced. Our project can also be applied to all major urban centers and campuses to increase overall road safety for cyclists, pedestrians, and drivers.



(Figure 1: Simple Visual Aid of Cyclist Sensing)

1. Centers for Disease Control and Prevention. 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 cdc.gov/injury/wisqars.

Solution

As previously stated we aim to design, build, and present a system that both recognizes cyclists and notifies pedestrians and drivers of their presence using LED lights. We utilize proximity sensors on both sides of a bike lane pointing inward to detect the presence of a cyclist. In addition to the proximity sensors, we also will utilize an induction loop on the pavement between the sensors to serve as an additional check for a cyclist and prevent misreads. We then replicate this system approximately every five to ten feet. This depending on the location of the cyclist, the corresponding lights on the bike lane will light up, signaling pedestrians and drivers that a cyclist is inbound. A very simple visual aid is provided to represent our project in figure 1 above.

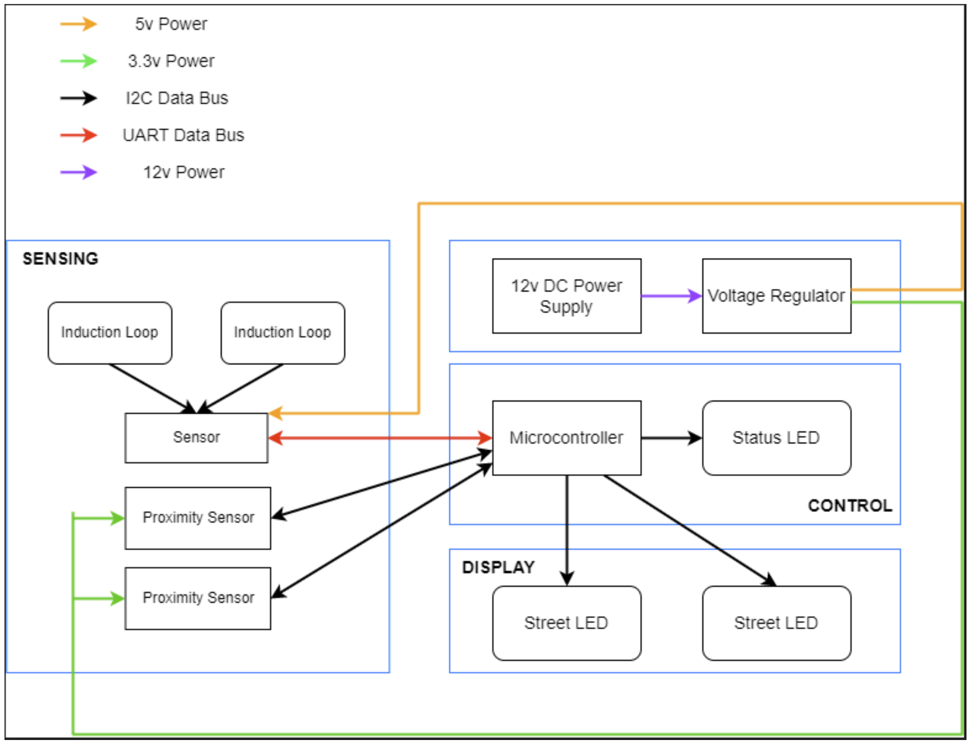
High-level Requirements

- Our project should be able to output approximately 3000 lumens during the day and approximately 2000 lumens during night to be adequately seen by users.
- Our project should be able to adequately recognize the presence of a bike in both the day and night, and be able to determine the speed of the rider.
- Our project should be able to accurately turn on/off LED lights in front of the bike at a rate that corresponds to the speed of the rider. We have determined the distance of the LED lights according to the following equation:

  d = v*0.55+v*0.1
  Where d = distance (m)
  v = velocity (m/s)

Design

Block Diagram Clean up/Clarify Block Diagram



Subsystem Overview **How to verify and quantify all subsystems,tolerance analysis, mathematical calc to prove working (brake time/acceleration calculation**

Sensing

1. The sensing unit utilizes proximity sensors and an inductive loop to detect the presence of a bicycle. These units send signals to the microcontroller, which controls the rate at which the LEDs light up.
   a. Proximity Sensors
      i. The proximity sensors detect when a cyclist is within the boundaries of the bike lane. It then communicates with the Microcontroller via UART the presence of said bicycle.
      ii. Requirement 1: The proximity sensors must be able to detect objects within a range of 1 m +/- 10mm.
      iii. The proximity sensor must be able to communicate over I^2S with the microcontroller.

b. Induction Loop Sensor
    i. The Induction Loop Sensor measures disruptions to the magnetic field that is generated around a coil placed on the ground. The magnetic field should only be altered in the presence of metals (i.e. a bicycle's spokes).
    ii. Requirement 1: The Induction Sensor must be able to supply at least 10mA +/- 5% onto the inductive loop

Power

1. The power unit supplies power to all necessary components within the project. It also regulates how much voltage is supplied to the components to prevent under or over volting.
    a. Voltage Regulator
        i. Requirement: This subsystem must be able to supply 5v +/- 0.1v and 3.3v +/- 01.v of to their respective components.
        ii. Requirement 2: The voltage regulator must also be able to provide 10 - 250 kHz +/- 200Hz of alternating current

Control

1. The control subsystem is mainly centered around the MCU and the components on the PCB. It is responsible for taking input from the sensing subsystem, processing the data, and sending signals to the LED lights.
    a. STM32
        i. Requirement 1: The MCU must be able to receive data via UART for the proximity sensor
        ii. Requirement 2: The MCU must be able to read current values from the induction loop
        iii. Requirement 2: The MCU must be able to send a power signal to the LEDs after processing the data
    b. Power port
        i. Requirement: The power ports must be able to supply power to the MCU

Display

1. The display subsystem is responsible for the visual aspect of our project. It will be how the pedestrians on the street receive the appropriate information about incoming cyclists. It consists of two LED strips, with 3 MOSFET transistors each, all of whom are connected to three outputs from the control subsystem.
    a. LED
        i. must be able to receive 12V +/- 1v of power

ii. Must be able to receive RGB input values

Risk Analysis

We suspect that the Induction Loop portion of our project poses the greatest risk. This is mainly due to our lack of experience with this sensor type. Additionally, the sensitivity of the induction loop is something that we anticipate to take a lot of research and trial and error to fine tune. Acceptable tolerances for this interface would be the detection of any form of vehicle, cars, motorcycles, and bicycles. In a perfect world, our system would only detect a bicycle, however with how sensitive our induction loop is anticipated to be, it is expected to be very difficult to only detect bicycles.

Ethics and Safety

CSAS operates accordingly based on the IEEE Code of Ethics established by the IEEE Board of Directors. Our project aims to help prevent the injury of cyclists and pedestrians while trying to minimize the impact on their daily lives. We aim to accomplish our project with the highest quality and standards possible through continuous teamwork and mentorship, accountability for our team at every step, and respect and kindness for our teammates and end users. [4]

Our team's skill set is diverse and varying. Despite this, there are holes in our experiences. Constant peer to peer and peer to mentor (through course staff and TAs) is vital and essential for our group to succeed and maintain a high standard for our project. We accomplish this by following the schedule we set as a group and fully utilizing our weekly meetings with the course staff.

In order for our project to be successful, accountability for all of our members at all times is necessary. As stated before, following our schedule is the standard our group aims to meet. Continuous checks over work being done and tasks accomplished maintains the standard we set for our project.

Respect and kindness for our peers is also vital for a functioning project. Being respectful of our team member's time and efforts will keep morale high and keep the group as a whole on task to get our jobs done. Doing this through the utilization of Discord, Google Apps, and constant and clear communication has worked and will continue to be the standard for our team. Additionally, being wary and respectful of the intended end users is essential to remain within the IEEE Code of Ethics. Catering changes based on end user safety will always take precedence over easier options. CSAS directly influences the safety of cyclists, pedestrians, and drivers, and as such, we aim to produce the best possible product we can.

2. "IEEE Code of Ethics." *IEEE*, https://www.ieee.org/about/corporate/governance/p7-8.html.

Sources

Centers for Disease Control and Prevention. 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 cdc.gov/injury/wisqars.

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