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Report

**INTRODUCTION**

In the US there are upwards of 130k reported injuries associated with on-road bicycling that happen annually[1]. On top of this there are roughly 1,000 deaths on average that occur each year. Almost two-thirds of these deaths happen away from intersections in areas where vehicles can reach high speeds as well as where bicyclists do not have a clear view of what is happening behind them. Not only is this detrimental to the health of cyclists, it comes with great financial cost as roughly $23B is spent each year to cover things such as funeral costs, medical bills, as well as to cover time away from work not to mention repairs to bikes and vehicles.

In order to make the road a safer place for cyclists there are many routes to take such as placing responsibility on state agencies such as departments of transportation to improve city infrastructure to be more accommodating to cyclists, requiring vehicle manufacturers to engineer their vehicles to be more bicycle aware, as well as placing responsibility on the cyclists themselves. There are existing solutions in place that help to mitigate these accidents such as the On-Vehicle Image Detection System which was pioneered by Chen & Chen at the R & D Division of the Automotive Research and Testing in Taiwan. This concept is being used today in many vehicles to use sensors on either side of the vehicle to detect objects in a vehicle’s blind spot [2]. Another concept which uses an IoT-based paradigm to connect smart vehicles and bicycles in order to relay traffic and routing information as well as road conditions [3]. Another simple and modular approach is the Bicycle Blind Spot Detection System created by Johnston, Gordon, and May at the University of British Columbia [4]. This concept focuses on a simple and lightweight apparatus that can be attached to any bike helmet which uses a sonar on the rear side which detects any object within 15 meters and will activate an LED which dangles from the front of the helmet just within the FoV of the cyclist.

One commonality between all of these solutions is that none of them employ a mobile component to assist in their functionality. For this reason we decided to adopt a similar design to the latter solution, adding the concept of bluetooth connectivity to a mobile device. This not only complements the modular design of the blind spot detection system, but also expands the potential to be improved upon in future iterations.

**DESIGN & USE CASE**

The system we opted to go with is a relatively simple bicycle mounted system and includes two main modules: the proximity sensor module and a mobile phone with an associated application. The proximity sensor module is mounted to the bicycle’s seat shaft with an acoustic sensor facing the rear. The mobile phone will be mounted to the handle bars so as to provide visual prompts without impeding the user’s line of sight. There will be a bluetooth connection between the two modules so that the proximity sensor module can communicate to the mobile phone when an object enters the proximity. See the figure below. This modular system has a very simple use case: a cyclist first attaches the sensor module to the seat and sets their phone in the handlebar mount. Once they are set, the cyclist opens the application and a Bluetooth connection is initiated. The cyclist is then free to start riding around, during which time the sensor is constantly acoustically “pinging” the rear environment. Once an object comes within a certain distance of the sensor, a signal is sent to the phone for the application to handle by generating an alert, displaying it on the phone’s screen. At this point, the cyclist now has better information about objects near them and can make safer judgment in the manner that they are riding.



**TESTING**

A strong emphasis on testing the efficiency and reliability of the sensors is vital for our product; making sure that the sensors are responsive and accurate enough to be used on congested city streets. The device will need to be able to respond to different vehicles or objects that move through the cyclists’ blind spot. Since the device is based on ultrasonic sensing, it should be able to perform at the same efficiency at night as it does in the day. As this is a prototype, communication with the android device is not listed as a vital aspect at the time. Although the resources exist, we decided to focus on the sensor and controller elements.

Testing at a small scale yielded expected results. The small-scale test area was a cubicle-style desk, with a laptop, monitor, keyboard, mouse, and Arduino setup. The desktop test length was 90cm in length with hash marks at every 10cm, so adjustments to the Arduino code were made to handle this scale size. The sensor readouts were similar to the desktop scale. Several disadvantageous aspects of using ultrasonic sensors were noticed at this scale. For example, depending on the material or angle of the object being detected, the signal would be reflected away from the sensor; indicated by the serial monitor readouts being the max defined number in the code.

Testing at a larger scale was much more difficult in my given environment. The large-scale test area was in a room, in between a bookshelf (~36in x 72in) and a bed (~23in x ~74in). The width of the test area is approximately 40in. The sensor was placed at approximately 21in high, on a table facing the open test area. The length of the test area was at least 10 feet long, with intervals marked every 3 feet. Serial readouts were not possible as the location of the test area. This yielded inconsistent RGB indicator readouts such as a consistent indicator for objects in the blind spot, even when no object was moving in the location.

Preliminary testing on an android phone, paired with the ArduinoDroid application, allowed instantaneous code editing and uploading. It allowed quick modification of parameters for the distances and RGB output brightness. The built-in serial monitor had issues keeping up with the serial baud rate, 9600. It may have been due to the adapter that was used to test the application-platform interface.

**CONCLUSION**

Into the future, more testing would be needed to help correct the efficiency and sensitivity of the sensor. More environmental variation in testing would give more information on how the sensors would react to constantly changing surroundings. Adding more, or different, sensors or manipulating the code to check for consistency in object detection, may yield more accurate blind spot indications. One important environmental factor to test is the light availability. In theory, this shouldn’t affect the sensor, but the RGB indicator brightness and placement factor may need to be adjusted. Adding additional features to the future application would help with overall safety and efficiency. Features such as camera-based object detection, speed/direction metrics, accident/fall detection, or even something similar to the indicator for the cyclist, but intended for the object in the blind spot could help greatly increase the safety of all involved.

**REFERENCES**

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