Environment Aware Bike Light

Team 31
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1 Introduction

1.1 Objective

To be safe riding at night, bikers use bike lights to illuminate dark streets.

The number of cyclists has been steadily increasing in major US cities such as New York, Chicago, Portland and San Francisco [1]. This means there is a greater requirement for safe, secure and well functioning bike lights in the market. The problem with bike lights in the market is that they do not offer enough environment awareness in order to influence their brightness. Adverse weather conditions, such as fog, pose problems in terms of visibility for the biker and can play a part in a lot of dangerous situations.

Our project aims to give an environment aware bike light to the biker, so that the biker does not need to keep adjusting his or her light while riding the bike. We would add LIDAR functionality to detect fog and turn on the bike light as well as a floodlight in order to allow others to clearly see the biker in the fog. This would provide a lot of flexibility in brightness for the bike riders while also ensuring their safety without loss of convenience.

We'll be taking a microcontroller based approach to implement this idea.

1.2 Background

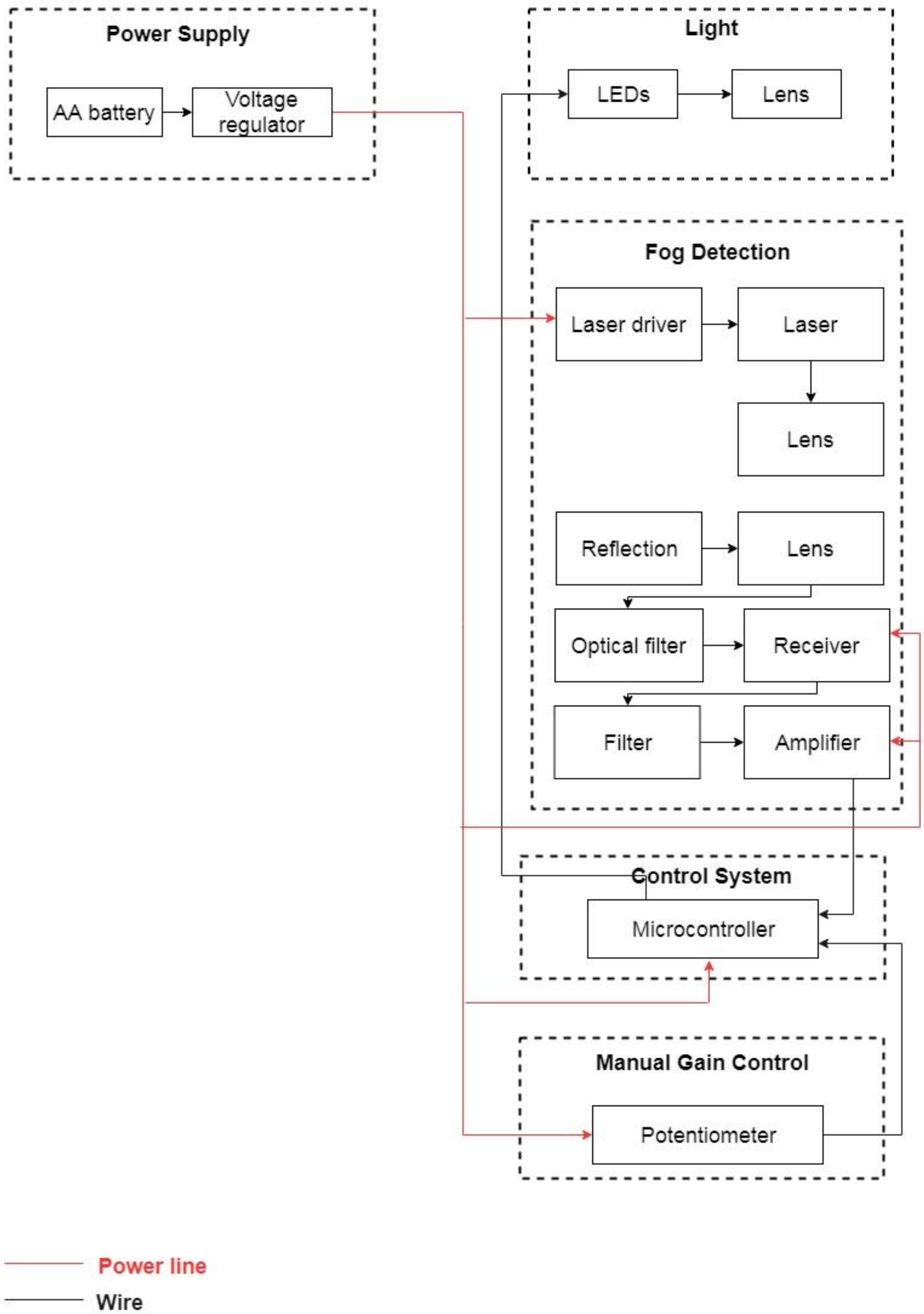
While there has been an increase in the number of bicycles sold and ridden across the US, there has also been a rise in accidents related to cyclists [2]. We believe that our idea can benefit the cyclist by increasing their safety as well as reducing the amount of power being used by the bike light. With more and more people switching to bikes as a viable mode of transportation, an environmentally aware bike light would become crucial for their use. We also believe our idea is unique and novel, as the only other self adjusting bike light we saw for sale in the market, was one which was dependant upon the velocity of the bike itself. Therefore, we can see a great potential for such a product in the cycling market.

1.3 High Level Requirements

- The battery should power all modules in a sustainable manner.
- The bike light should be sensitive to fog.
- The bike light should be safe for the humans in the vicinity of the bike light and the laser used should be safe for human eyes.

2. Design

2.1 Block Diagram



2.2 Component Analysis

2.2.1 Power Supply

Power supply module consists of two parts. First part is a power source which consists of multiple AA batteries. Second part is voltage regulator. Voltage regulator is a DC-DC converting circuit. It will maintain the voltage level of power source (batteries) and convert it into different voltage levels for other modules.

Requirement #1: Voltage regulator maintains the voltage level even when the battery voltage goes down.
Requirement #2: The batteries should power the bike light in regular mode for at least 2 hours.

2.2.2 Light

The light system consists of center LED and a series of LEDs surrounding the center LED with a reflector. Only the center LED is going to be used during regular operation. When the fog is detected, the series of LEDs surrounding the center LED would light up to provide additional brightness.

Requirement #1 : 250 Lumens or higher at regular full brightness.
Requirement #2 : 400 Lumens or higher at fog mode.
Requirement #3 : Minimum Forward Voltage is less than 3V.

2.2.3 Control System

The control system consists of a ATMega328p microcontroller. This microcontroller would be getting inputs from LIDAR system and depending on the values received by two photodiodes this would either turn on the fog LEDs or not.

Requirement #1: Microcontroller should have enough inputs for a photodiode and the potentiometer.
Requirement #2: At least 3 output channels would be needed for the array of LEDs.

2.2.6 Fog Detection

To detect fog, we are thinking of implementing a small Differential Absorption Lidar. The Lidar would be comprised of two parts, the transmitter and the receiver.

2.2.6.a Transmitter

For our transmitter, we are thinking of having a small laser with low power output to keep it eye safe and to minimize power consumption. The wavelength of the laser is going to be outside of the visible light range to prevent startling other driver. One is going to be on the absorption wavelength of water vapor and another slightly off. This laser would be driven by a laser driver and would be outputting a continuous wave of laser.

Requirement #1: Laser needs to stay within Class I.
Requirement #2: Minimum operating voltage less than 3V.
Requirement #3: Laser diodes outside of visible range.

2.2.6.b Receiver

We'll have a silicon photodiode since it provides good accuracy and we don't need a long range. This will be aided with a collimating lens and an optical filter to collect the radiations. The signal from the silicon photodiode is going to be filtered with a bandpass filter to only filter out the laser frequency.

This value would be fed to the microcontroller to determine how much backscattering has happened.

Requirement #1: Sensitive to low laser power, which is likely to be less than 0.5mW.

2.2.7. Manual Gain Control

Manual gain control consists of a potentiometer in series with a constant resistor. The potentiometer serves as a voltage divider. By increasing/decreasing the resistance, the voltage applied on it will also increase/decrease. This voltage signal will be sent to control system to change the brightness of lights.

2.3 Risk Analysis

Our highest risk is the fog detection part. We aren't sure about the signal to noise ratio of our LIDAR system. We aren't sure about how much difference in reflected laser energy we are going to get from our on-absorption and off-absorption wavelength. All members of this team are not experienced in remote sensing, but we plan to overcome this by doing more research.

3. Ethics and Safety

The major safety concern in our project would be the use of a laser. The use of a moderate or high powered laser can permanently damage the retina of the eye. Therefore, proper use of the laser is definitely needed. The wavelength of the laser needs to be safely decided and the power of the light needs to be low enough that it causes negligible or no damage. We plan to stay within Class 1 range of laser.

We’ll abide by the IEEE Code of Ethics and there are specific points from the Code that we would like to mention.

Since our design involves laser, we need to assure it will not cause any harm to people according to IEEE Code of Ethics #1 and #9 [3]. If we discover our design can cause damage to people, we will fix the issue and make it safe.

We also will make our judgements on safety as IEEE Code of Ethics #3 requires. We will be realistic to our safety claims and we will be honest about those concerns.

4. Citations

[1] J.Pucher, R. Buehler, and M.Seinen, “Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies, ” *Transportation Research Part A: Policy and Practice*, vol. 45, no. 6, July 2011. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0965856411000474. [Accessed Sep. 16, 2018].

[2] National Highway Traffic Safety Administration (NHTSA). Crashstats.nhtsa.dot.gov. (2017). [Online]. Available: https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812456. [Accessed Sep. 16, 2018].

[3] Ieee.org, "IEEE IEEE Code of Ethics", 2018. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: Sep. 16, 2018].