Adaptive Lean-Angle Headlights

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Design Review for ECE 445: Senior Design Spring 2016

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Group #21

Contents

Introduction

1.1 Title

Adaptive Lean-Angle Headlights

1.2 Motivation

The Adaptive Lean-Angle Headlight is an important step in the evolution of motorcycle safety. As it stands, there are not many tools for keeping a motorcyclist safe. There are no seat belts or airbags and there are only electronic driver-aids on very new and high-end motorcycles. We chose this project because we want to improve the safety measures for a large demographic of motorists, who are very much unprotected. Every year motorcyclists are 5 times more likely to be seriously injured and 26 times more likely to be killed due to poor visibility.[1] We hope that with this device, we can greatly improve the visibility of motorcyclists while riding, especially at night, thus making it safer for them to ride. This device will enable these riders to see more clearly as they are making turns, allowing them to effectively avoid road hazards and stay on the tarmac, making the roads a safer place for everyone. With a low cost per unit, this device will have a high scalability factor, allowing many consumers to get their hands on it without burning a hole in their wallets.

1.3 Goals

The ultimate goal of this project is to sense tilt angle of motorcycle and illuminate in the direction of tilt to aid riders that are making turns and going around corners at night.

1.4 Functions and Features

- Increase beam width as tilt angle increases
- Keep height of beam under 0.5m to avoid blinding other motorists
- Light up 2.5m~3.0m of road on either side of motorcycle
- Lights should be bright enough to illuminate the path of travel, but not bright enough to blind oncoming traffic
- Flash turn signals to warn drivers on the side of rider changing lane
- Ignore tilt angles when system is moving slowly or stationary

2. Design

2.1 Design Introduction

To implement the above system, we intend on creating a modular unit, one for the left side of the motorcycle and one for the right. Both units will function in identical ways except the logic to sense the tilt angle will be inverted. Each unit will consist of an array of LEDs that are mounted on the sides of the gas tank via a multi-use adhesive. Tilt-Angle sensors will sense the angle of tilt of a motorcycle from a user-calibrated initial rest position. A speedometer will also be present in the module to add a secondary input to the controller logic. A third input into the logic will be the turn signal indicators. In the final implementation, the module will tap the actual signal of the motorcycle, which will send a “1” to the logic when a rider activates a specific turning direction. With all these inputs in the controller, we will control the LED array according to the following specifications.

2.2 Block Diagram

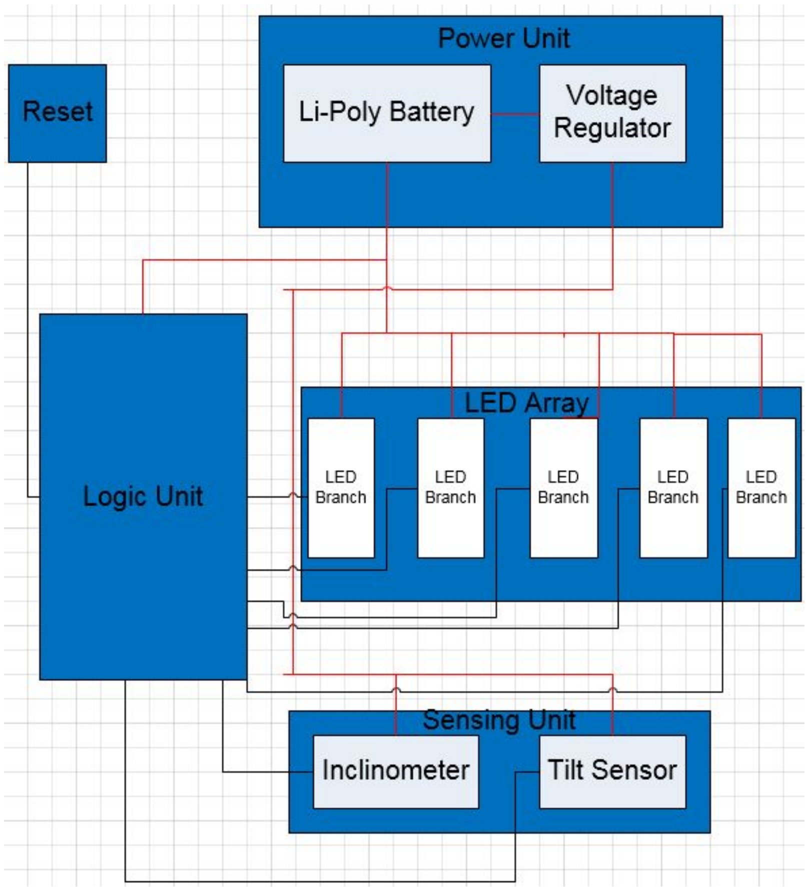


Figure 1: Block Diagram

2.3 Descriptions of Modules

LED Array

The LED array will consist of 5 columns and 2 rows of high power LED's (i.e 5 parallel columns of 2 LEDs in series) and 5 LED drivers. We refer to the column of 2 LED's and an LED driver as an " LED Branch" in the block diagram (figure 1). Since regular motorcycle headlights output about 3000 Lumens, we decided to limit our system to have equal or less luminous flux for safety reasons. Hence we decided to use this specification of 10 LEDs because each LED has an output of 227 Lumens and 10 such LEDs will be well within the limits that we set. The array will be mounted diagonally on the side of the bike, specifically on the gas tank. The array will output specific configurations of columns of LEDs based on inputs from the Logic Unit, such that the road is illuminated optimally based on motorcycle tilt angle. We have defined optimal lighting as 2.5 m of light on either side of the motorcycle because we do not want to illuminate too far into neighboring lanes. An interstate highway has a width of 3.7m so we believe that lighting 2.5m on either side of the motorcycle is reasonable, accounting for the fact that the rider might not be in the center of the lane.

In regards to the actual array, we chose LEDs over other light sources for a couple of reasons. Firstly it is power efficient. It does not suck up a huge amount of power and has a long lifespan (4.32W per LED bulb). This will keep the overall power usage of our device low, thus reducing heat dissipation as well as making the device long lasting. Furthermore, LEDs have a high Lumens to Watts efficiency ratio (30-90 lm/W) versus some of the other standard lights used such as halogen (16-24lm/W). Our bulb outputs 227 lumens giving it a efficacy ratio of 90 lm/W, placing it on the higher end of the efficacy ratio.

We also decided to use 10 LEDs in 5 columns of 2 each (each column represents a different angle of tilt) because 10 LEDs will give a maximum brightness that is just a shade under most typical motorcycle headlights. This was a threshold we wanted to keep so that the lights are not blinding for other motorists. The pin layout of each LED bulb can be seen in figure 2

Pin Out	
Pad	Function
1	Anode
2	Cathode
3	Cathode
4	Anode
5 [2]	Thermal

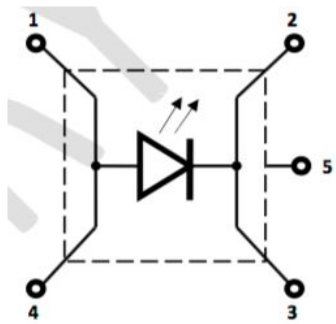


Figure 2: Pinout of LED, taken from Data sheet for LZ1-00CW02[2]

To control the LED's we will use LED drivers to supply each column of LED's with 1A of current. A "branch" of LED's will be two LED's in series. From the CS pin of the LED driver, we will use a resistor to force a 1A current through the LED's. The calculation for this resistor value is shown in figure 3

$$R_{SENSE} = \frac{200\ \text{mV}}{I_{LED}}$$

Figure 3: Component Resistor Calculation, taken from Datasheet for NCL30160[3]

With the denominator being 1A, we want the resistor calculated to be 0.2 Ω

Logic Unit

For the Logic Unit, we are using the AtMega328 chip, placed onto a PCB, with appropriate input and outputs soldered onto the PCB, including its SPI wire interface. This is, in large part, due to the familiarity of our team with programming the Arduino, which will cut down on development time. Additionally, the Arduino is able to handle the functions of the Logic Unit, such as controlling the LED Array, receiving the inputs, and handling the algorithm. The AtMega chip has 32 kb of memory, which will be sufficient size for the main program. We will store the Data-logger information in the EEPROM, which has 1kb of memory (arduino.cc)[4] . Each time a signal is initiated, the Arduino will record the timestamp, the angle measured from the position sensor, the speed, and which LEDs were activated. This will only be, at most 8 bytes of memory, so the AtMega will be sufficient. The Logic Unit needs to be able to control the LED array based on the inputs from the Sensing Unit. It will use an algorithm we will develop over the course of the project to accurately turn on the correct LEDs based on inputs from the sensing unit. During the testing phase of the project, the Logic Unit will need to act as a datalogger, and record the precise timing that data is received from the sensing unit, as well as recording the times outputs are given to the logic unit.

The Logic Unit needs to consist of a microcontroller (ATMega328), placed onto a PCB, with appropriate input and outputs soldered onto the PCB. When interfacing the ATMega with the sensor unit, we need to understand how the SpiWire interface functions. Figures 4, 5, and 6 give a description of how the inclinometer reads and sends data. We will use this in order to determine the tilt angle of the motorcycle. Figure 4 describes the timing for the Inclinometer, and includes fall and rise times for the signals. CS must be set low for the duration. For Din, a W/R’ signal is first given, then one frame pause, followed by the Address, then the data. The Dout is quite straightforward. Figure 5 shows the Din bit sequence, which is A[5:0]D[7:0]. Figure 6 describes how a read command looks. It is important to note the result comes out 1 clock cycle later.

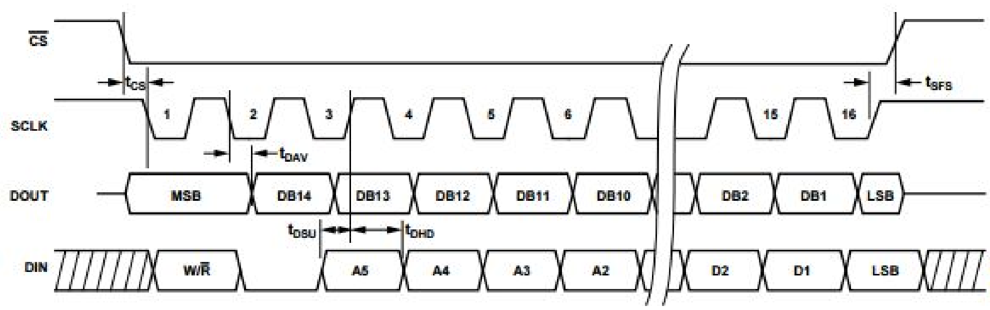


Figure 4: Timing Diagram of Inclinometer[5]

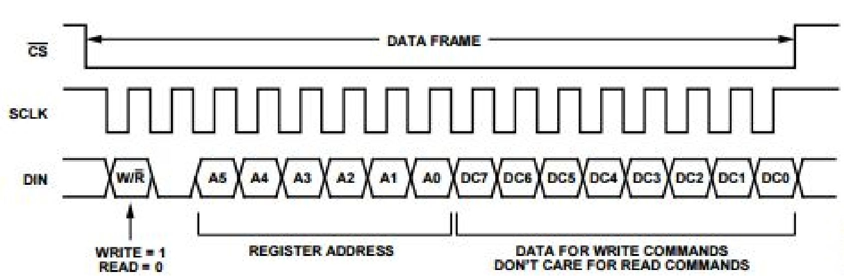


Figure 5: DIN Bit Sequence[5]

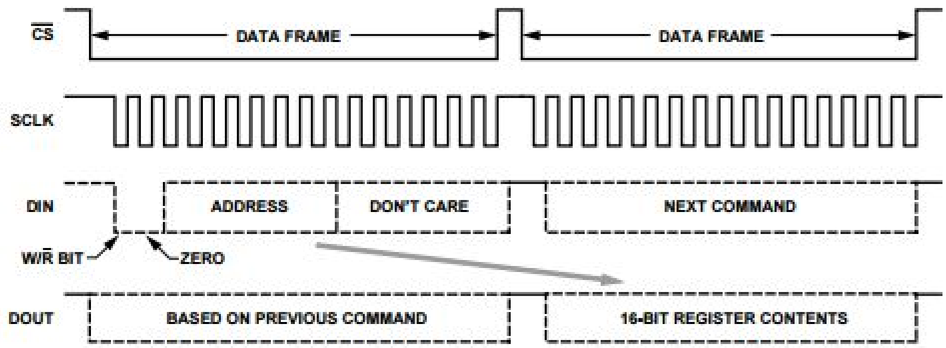
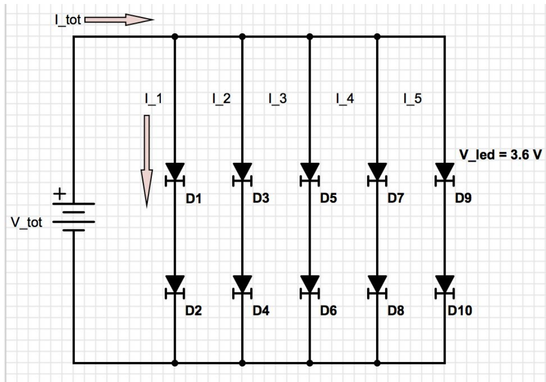


Figure 6: SPI Sequence for Read Command[5]

Power Unit

To power our device, we have chosen to use a 7.4V, 3650mAh Li-Po battery. A Li-Po battery is a rechargeable battery of lithium ion technology in a package, which we chose for a couple of reasons. First, it packs enough power in its package to power entire device, including the LED array and the logic components. Secondly, it is rechargeable for the user so that he would not need to replace standard batteries every time they fully discharge (which for the purposes of this project was not powerful enough to drive the circuit, nor would it have lasted long enough even if we had put in a dozen of them)

The logic unit will require 7V to power the ATMega328, and as seen in the calculations below, the LED array will consume 36W (7.2V at 1A per “branch”) of power:



$$I_{tot} = 5 \times I_{column}$$
$$I_{column} = 1A$$
$$I_{tot} = 5A$$

$$V_{LED} = 3.6V$$
$$V_{tot} = 2 \times V_{LED}$$
$$V_{tot} = 7.2V$$

$$P_{tot} = I_{tot} \times V_{tot}$$
$$P_{tot} = 36W$$

Figure 7: Power Consumption Calculation for LED array

Figure 7 shows the power requirement of the LED array only. Each LED's recommended operating voltage is 3.6V at a forward current of 1A each.

Sensing Unit

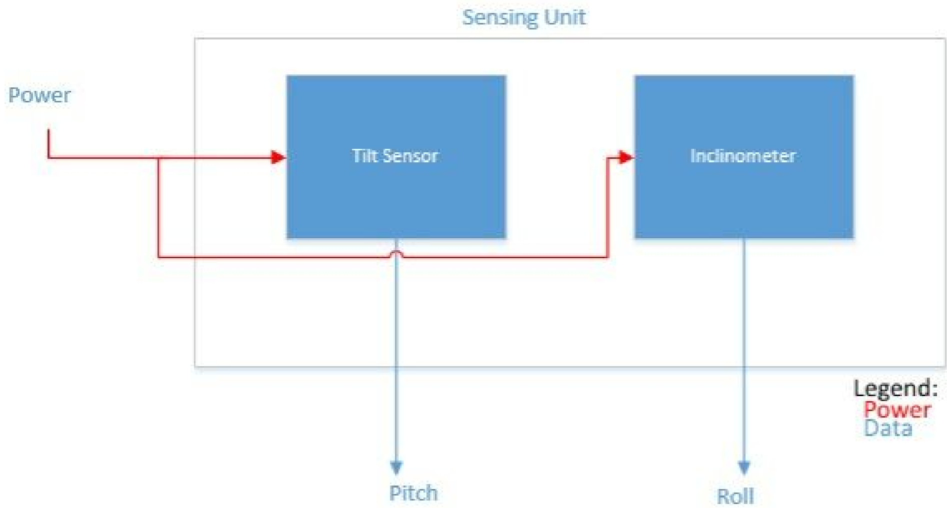


Figure 8: Block Diagram of Sensing Unit

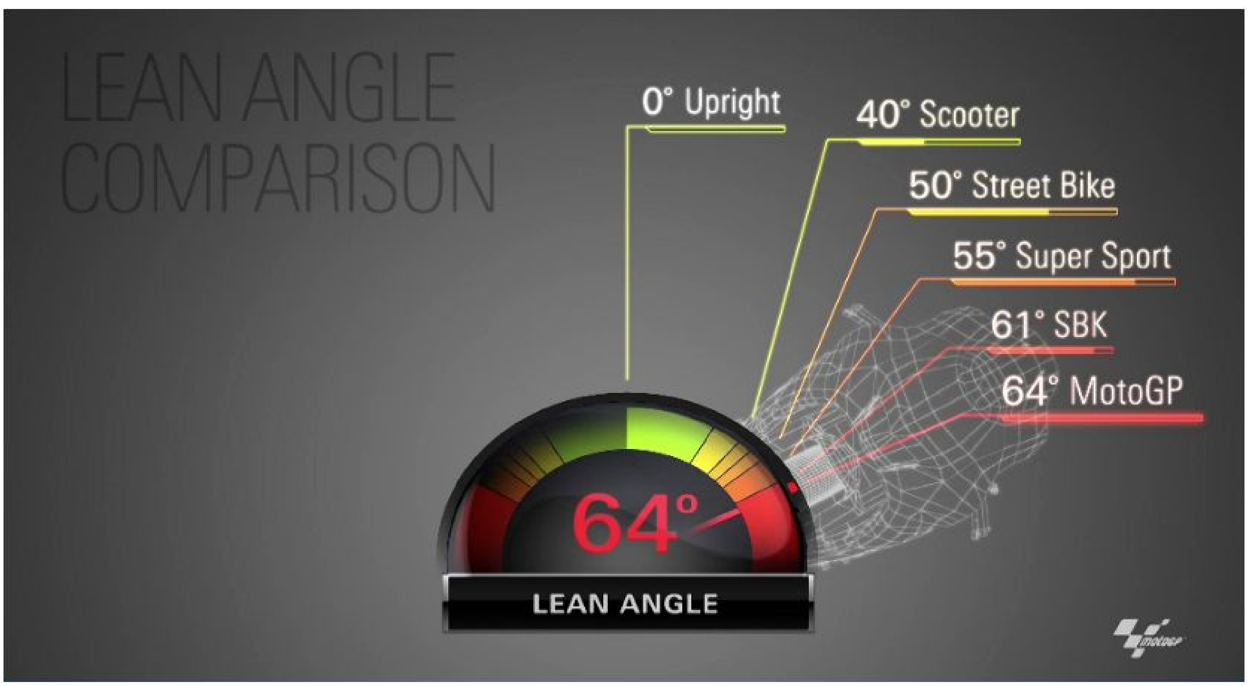


Figure 9: Lean Angle of a Motorcycle [6]

A standard motorcycle generally tilts up to 45 degrees on normal road conditions while a racing motorcycle tilts up to 65 degrees in full blown racing conditions. Generally, the tilt angle of the motorcycle can be calculated as follows:

$$\tan\theta = \frac{v^2}{rg},$$
$$\text{where : v = speed of motorcycle, r = radius of turn, } \theta = \text{lean angle}$$

This says that the faster one turns, the more more the lean angle and the tight the turn (smaller r), the more the lean angle. Considering only static friction forces for standard non-sliding tires, the friction is proportional to the normal force.

$$F_{friction-max} = \mu_s N$$

Equating the frictional force with the centripetal force,

$$\frac{v^2}{r} = \mu_s g \rightarrow \tan\theta = \mu_s$$

Here μ_s is the static friction coefficient, which ranges between 0 and 1 typically. Hence we can see that the maximum tilt angle for a standard motorcycle is:

$$\theta_{max} = \arctan(1) = 45 \text{ degrees}$$

Due to these reasons and limitations, we have chosen to break up the degree of tilt into 5 'levels' that will correspond to various columns of the LED array lighting up.

Any tilt to the right, will be recorded as a positive tilt and any tilt to the left will be recorded as a negative tilt by the tilt-sensing sensor called an inclinometer. The inclinometer will output digital signals to an Arduino, with which it is interfacing using SPI wire, about the degree of 'roll', which we will print onto a console log to verify.

The system will also be inactive when motorcycle is not moving. Therefore, a sensor will be used to determined if the bike is in motion or not. We did not want to have a situation where lights are turning on and off while the user is simply resting his bike in the garage, transporting it on the back of his pick-up truck or even parked on an inclined surface. We have decided to use a tilt-sensor to determine if the motorcycle is moving, as a speedometer is unfeasible for the purposes of this project due to cost constraints. Since this sensor is binary (i.e it on when there is any tilt, and off when the sensor is level), once the motorcycle is in motion, there will be an initial tilt, followed by multiple other movements which will cause the sensor to always sent some form of a tilt. We will use a timing algorithm such as no movement in a span of 1 minute, to determine if the bike is still in motion, and thus whether or not to keep the system active.

Housing Unit

The housing unit will be the overall package in which the various modules will be housed. The unit will have to be designed to withstand certain conditions such as rain, wind and snow. It also will have to be slightly flexible so that it can fit on various motorcycles that have different shaped gas tanks or fairings (these are the plastic or metal trim bits of a motorcycle). We also will have a strong adhesive on the rear of our design package so that it will stick to the body of the motorcycle and not become loose, even at high speeds.

In order to do this, we are going to have a backing that is made of a silicon material that is semi-flexible so that it will fit onto various motorcycle makes. The base of the package that will stick on to the motorcycle will have a very strong one-time adhesive, and this will prevent the package from being damaged or removed at high speeds (wind-resistant). The physical cover to the package will be a plastic material that will be sturdy and waterproof. Just inside the cover, we will use aluminium reflectors to direct the light such that the light beams don’t shine too high (vertically) and will be more directed towards the road in general.

2.4 Circuit Schematic

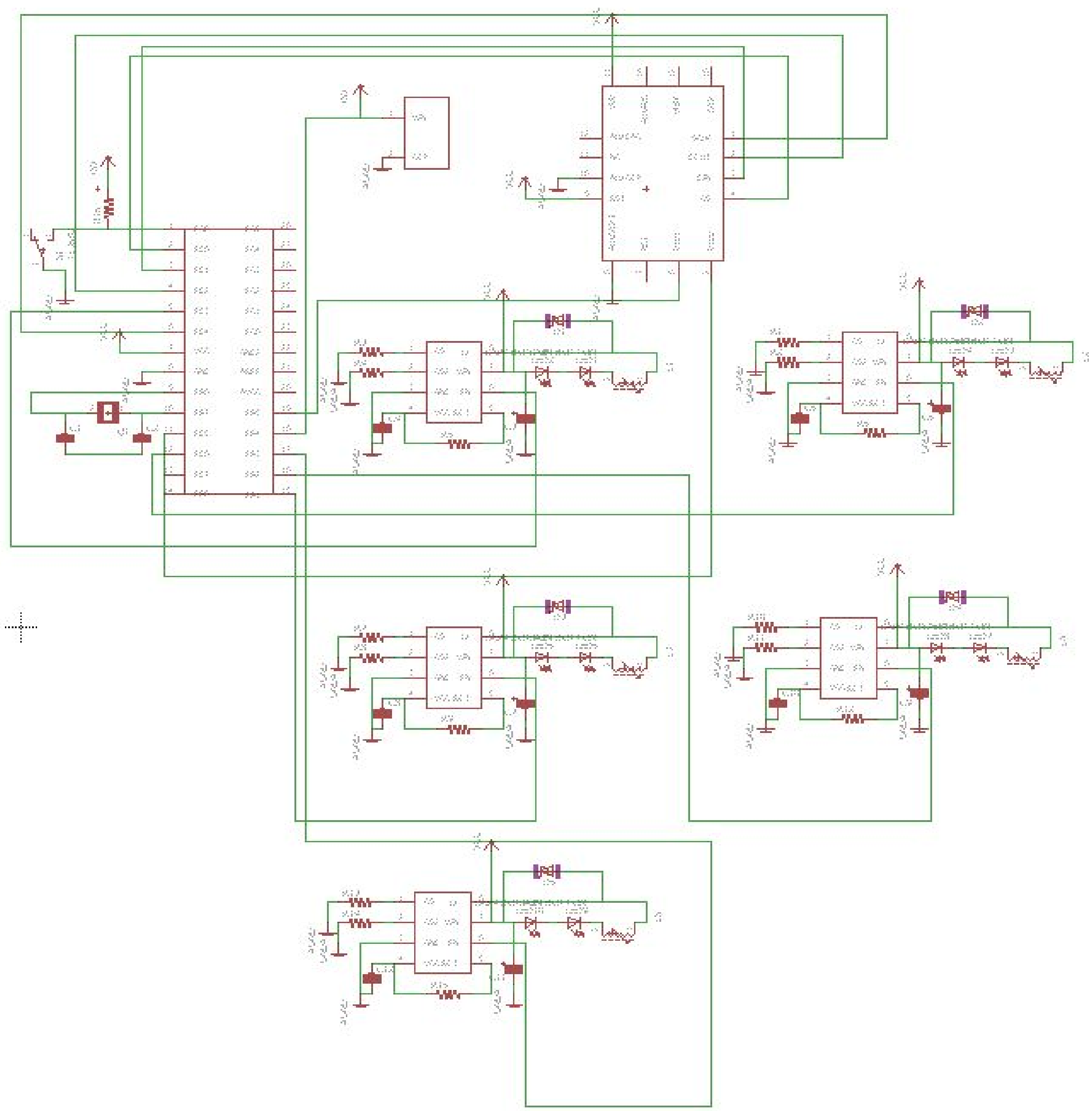


Figure 10: Full Circuit Schematic

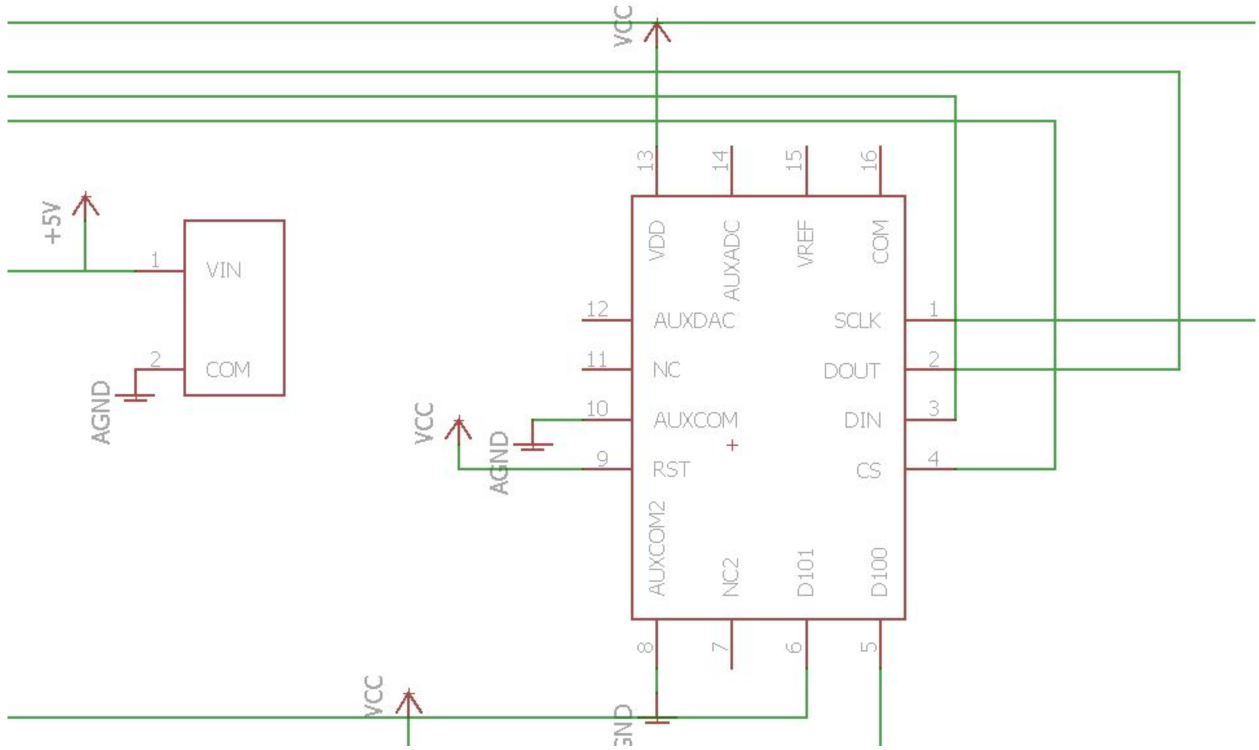


Figure 11: Circuit Schematic of Inclinometer

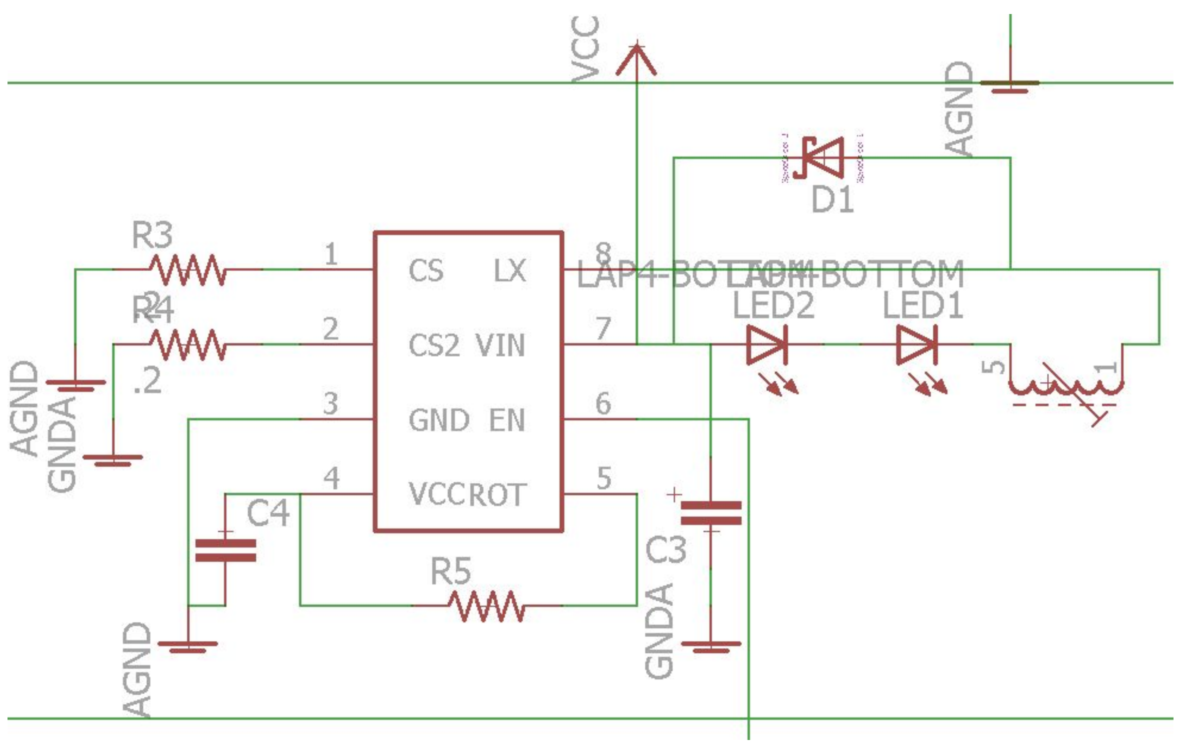


Figure 12: Circuit Schematic of LED Drivers powering 1 column of 2 LED's

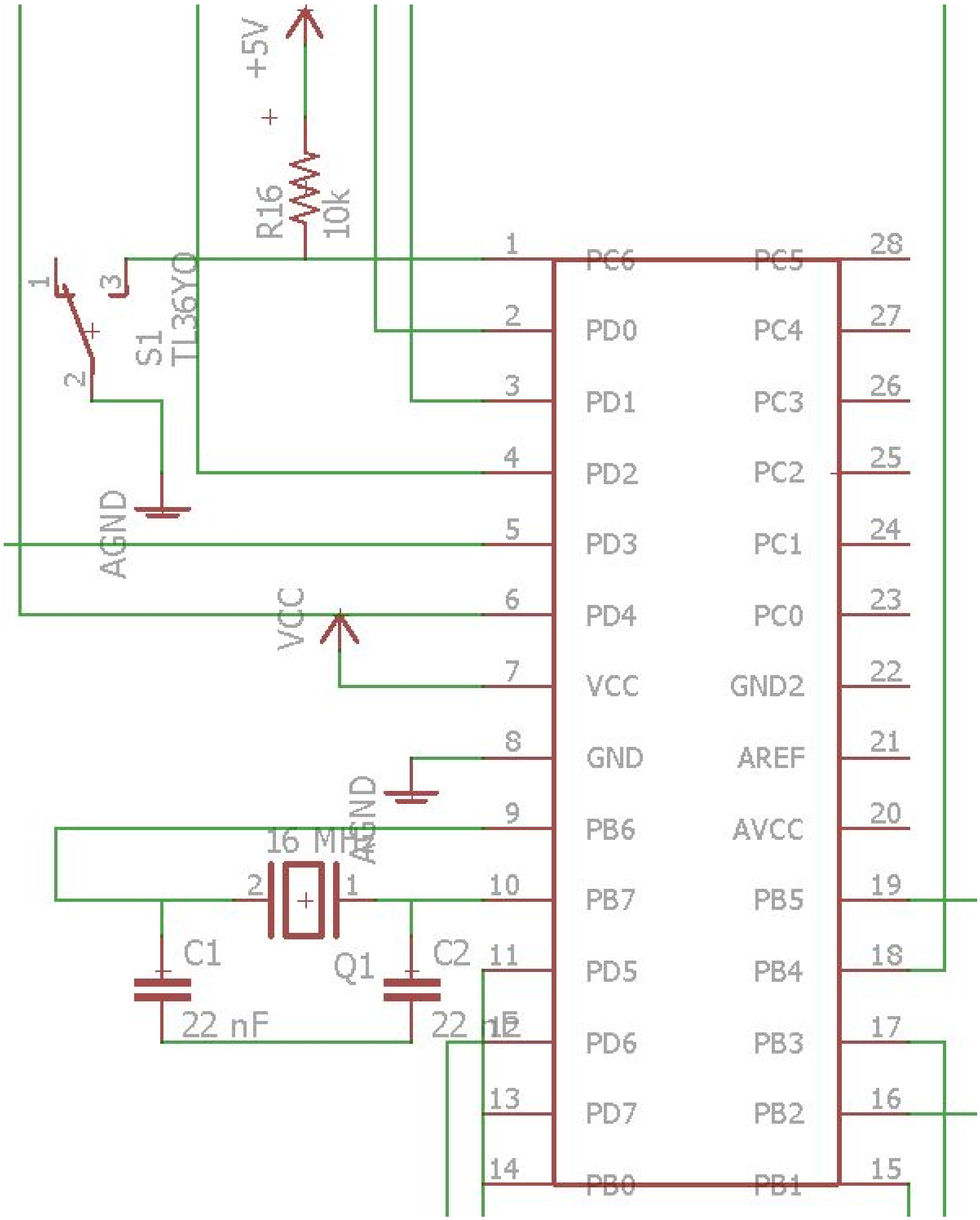


Figure 13: Circuit Schematic of ATMega328 Microcontroller

2.5 Technical Overview

We believe that this project will be doable this semester. Since the parts are not terribly difficult to get a hold of, and are readily available in the market or in the lab, we will have a working prototype of this device by the end of the class. Testing of our device will be done using standard laboratory equipment for the most part, so verification as well as any re-designs or re-engineering can be done quickly and efficiently. Only the final prototype testing will have to be done in real-life conditions (i.e on a motorcycle). We can guarantee the functioning of this device by the time the semester is up, however, we are not sure how good and compact a packaging design we will be able to come up with. Since we have durability considerations such as weather-proofing, we will design this device with a focus on functionality for the purposes of this class, and not attractiveness of design.

3. Requirements and Verification

3.1 High Level Requirements

Table 1: High Level Requirements and Points Allocated

Module Name	High Level Requirement	Points
LED Array	• The LED array will light up to about 2.5 m in the direction of the lean and illuminate in a forwards position • The LED array will provide a sufficient amount of light such for safe operation	20
Logic Unit	• More columns of LED's on the array are illuminated as tilt angle of the motorcycle is increased, and in the direction of tilt	10
Power Unit	• Battery needs to supply enough power to drive the LED array within acceptable tolerances, as well as supply the sensing and logic units.	10
Sensing Unit	• Position sensor senses motorcycle tilt from 0 to 60 deg with accuracy of plus or minus 1 deg • Speedometer senses when speed exceeds 5 mph	10

3.2 Modular Requirements and Verification

LED Array

Table 2: Requirements and Verifications for LED Array

Requirements	Verification

1. Voltage delivered to LED's should be 3.7±0.5V
2. Illumination must not exceed 2.5m on either side of the motorcycle.
3. Max luminous flux must not exceed 3000 Lumens (headlight brightness). At 227 lumens per LED, we plan to use 10 LEDs
	1. A digital multimeter will be used to measure the voltage and current flowing into the array of LEDs (in each column) while the tilt sensor is active.
	2. Lean system from 0 deg to 60 deg at height of motorcycle tank
	    a. Check that beam width is kept under 2.5m throughout swing of tilt
	3. Visually inspect lights from a distance, making sure that they are not brighter than headlights.
	    a. Point LED and headlight in same direction and position
	    b. Walk away from LED and headlight to around 100 ft.
	    c. Compare brightness of two lights

Logic Unit

Table 3: Requirements and Verifications for Logic Unit

Requirements	Verification
1. Consecutive columns of LEDs turn on as the motorcycle tilt angle increases a. C1 for 5 ≤ 10 degrees b. C2 for 10 ≤ 20 degrees c. C3 for 20 ≤ 30 degrees d. C4 for 30 ≤ 40 degrees e. C5 for ≥ 40 degrees 2. Delay between tilt sensing and LED turn on must be less than 100ms (faster than human reaction time) 3. User should be able to calibrate tilt-sensor accurately 4. Recommended Input Voltage: 9V ± a 0.5 V	1. For accurate lighting logic - a. Plug ATmega data logger to output to screen b. Send software signals of varying levels of tilt c. Inspect that correct lights turn on 2. For time delay - a. create timestamp 1 when tilt signal is sent b. create timestamp 2 when light turns on c. measure delta in timestamp 3. Place Tilt sensor on level surface and calibrate a. Tilt sensor to the right in 2 degree increments b. Verify tilt from data logging console with protractor c. Repeat steps in left hand direction d. Hit reset button e. Measure tilt from calibrated f. Position and ensure correct lights still turn on 4. Use multimeter at input to ensure voltage requirements are met

Power Unit

Table 4: Requirements and Verifications for Power Unit

Requirements	Verification
1. Battery will supply 3.6V ± 0.5V to the LED module 2. Battery will supply 7 ± 0.5V to the Logic Unit to power microcontroller (ATMega328) and logic gates	1. Set up multi-meters and probes across module and monitor that 3.2 to 4.2 volts are achieved across the module 2. Measure voltage drop across respective modular units in the same manner as step 1

Sensing Unit

Table 5: Requirements and Verifications for Sensing Unit

Requirements	Verification
1. Inclinometer to sense tilt angle accurately (plus or minus 2 deg) from 0 to 60 deg such that the appropriate LED columns will be lit eg. a. C1 for 5 $\leq$ 10 degrees b. C2 for 10 $\leq$ 20 degrees c. C3 for 20 $\leq$ 30 degrees d. C4 for 30 $\leq$ 40 degrees e. C5 for $\geq$ 40 degrees 2. Tilt-sensor to sense when motorcycle is not in motion for one minute to turn off system. 3. Data from sensors can be transferred to ATMega328 via SPI wire.	1. Place Tilt sensor on level surface and calibrate a. Tilt sensor to the right in 2 degree increments b. Verify tilt from data logging console with protractor c. Repeat steps in left hand direction 2. Hook up tilt sensor to Arduino a. Move the sensor to keep system on and verify “1” is printed in control log window. b. Stop moving sensor and fire ‘0’ signal to control log window after one minute 3. Hook up sensors to SPI ports and print tilt-angle onto control log window.

Housing Unit

Table 6: Requirements and Verifications for Housing Unit

Requirements	Verification
1. Cold weather proof 2. Water Proof 3. Strong Adhesive	1. Put housing unit in freezer overnight a. visibly inspect housing unit for any cracks or imperfections that may have formed 2. Put a piece of liquid indicating paper inside the housing a. Place housing in shower 3. Drive the motorcycle at 40-50 mph to ensure housing does not become loose.

3.3 Tolerance Analysis

Critical Component

LED Array

Acceptable Tolerance

Our tolerance of the LED array will ensure that at both the minimum and maximum operating power range of the array, 2.5~3 meters of the road will still remain light up at sufficient luminosity (not above 3000 Lumens, which is the brightness of a HiD headlight, and not below 1500 Lumens), at all angles of tilt. We have identified that the minimum operating voltage of individual LEDs is 3.2V and the maximum operating voltage is 4.2V. As such, we will have a tolerance of $\pm$0.3V from the recommended voltage of 3.6V. The forward current also has a maximum rating of 1.2A. We will impose a minimum forward current of about 700mA, because according to figure 14 below**,** this forward current will output 80% of the relative light output of the LED. Therefore, we have defined 80% to 120% of the relative light output of the LED to be an acceptable range. To meet this light requirement, we will implement resistors so that the current and voltage does not exceed the recommended power rating. Furthermore, the LED should not have any reverse current since they are not designed to operate with a reverse-bias. To meet this requirement, we will install a high-threshold-reverse-breakdown voltage diode in the same direction after the system of LEDs to ensure no feedback current will seep into the LED.

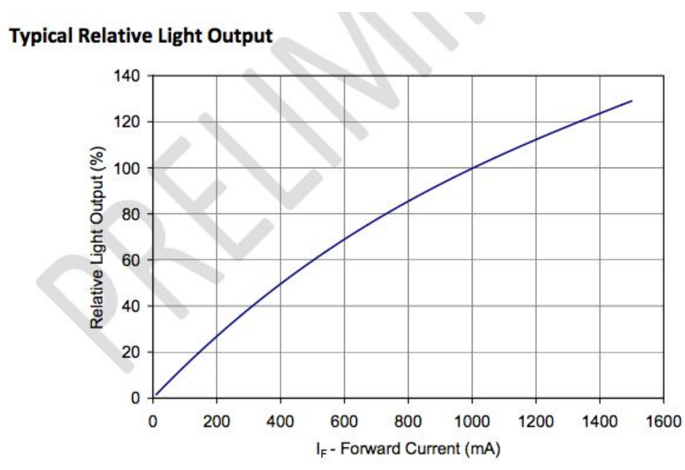


Figure 14: Light Output vs Forward Current of LED, taken from Data sheet for LZ1-00CW02[3]

Test Procedure

We will send it the minimum power requirements using a voltage controlled network (0.7mA at 3.3 V) to the LED array and measure the beam height, width and brightness at all angles of tilt to ensure they stay within the tolerable range.

We will send it the maximum power requirements, using a voltage controlled network (1.2A at 3.9 V) to the LED array and measure the beam height, width and brightness at all angles of tilt to ensure they stay within the tolerable range.

A digital multimeter will be used to measure the current and voltage going into the LED array as well as into each individual LED to while the tilt sensor signals are in the ON position to ensure the power requirements are met.

The test will be conducted with all levels of tilt, specified by the range in the requirements and verification table of the logic unit, and the corresponding LEDs that it lights up to ensure the correct LEDs are lit up. The granularity will be specified as follows:

- Level 1 for 5 ≤ 10 degrees
- Level 2 for 10 ≤ 20 degrees
- Level 3 for 20 ≤ 30 degrees
- Level 4 for 30 ≤ 40 degrees
- Level 5 for ≥ 40 degrees

Presentation of Results

Results of this testing will be reported in the form of a table with varying tilt levels, and the corresponding power delivered to the array which lights up a varying set of LEDs according to our proprietary algorithm. We will also use a light sensor to measure the luminosity of light being produced by our device to ensure it fulfills our requirements set above.

4. Schedule and Cost

4.1 Cost Analysis

Table 7: Cost Labour Analysis

Name	Hourly Rate	Total Hours Invested	Total = Hourly Rate x 2.5 x Hours Invested
Philip Davidar	$35.00	150	$13,125
Abheshek Kothary	$35.00	150	$13,125
Prithwi Roy	$35.00	150	$13,125
Total	$105.00	450	$39,375

Table 8: Cost Parts Analysis

Part	Part Number	Unit Cost	Total
LED	LZ1-00CW02-0055	4.13	41.65
Atmega328 chip	Atmega328	1.95	1.95
Li-Poly Battery	CU-J827	29.15	29.15
Inclinometer	ADIS16203CCCZ	44.57	44.57
Tilt Sensor	T000190	4	4
Housing	N/A	10	20
Smart Charger	3P10-L1008	28.00	28.00
Total			169.32

4.2 Schedule

Table 9: Schedule

Week	Task	Responsibility
2/7/15	Complete Proposal	Philip Davidar
	Create Testing Headlight	Abheshek Kothary
	Create Testing Circuit Driver	Prithwi Roy
2/14/16	Create Logic Unit	Philip Davidar
	Design and Create Sensor Module	Abheshek Kothary
	Design and Create LED Array	Prithwi Roy
2/21/16	Program and Test Logic Unit	Philip Davidar
	Test Sensor Module	Abheshek Kothary
	Test LED Array	Prithwi Roy
2/28/16	Design Housing Unit	Philip Davidar
	Finish Design Review	Abheshek Kothary
	Order and Test Power Unit	Prithwi Roy
3/6/16	Order Housing Unit	Philip Davidar
	Mount Unit on Motorcycle	Abheshek Kothary
	Test Unit on Motorcycle	Prithwi Roy
3/13/16	Create Testing Unit	Philip Davidar
	Create PCB for LED Array	Abheshek Kothary
	Test Unit in Simulated Highway Conditions	Prithwi Roy
3/20/16	Refine Algorithm for Logic Unit	Philip Davidar
	Verify and Finalize Final Design	Abheshek Kothary
	Test Unit in Simulated Weather Conditions	Prithwi Roy
3/27/16	Refine Housing Unit	Philip Davidar

	Test Prototype for NITSA requirements	Abheshek Kothary
	Road Test Unit	Prithwi Roy
4/3/16	Create Final Prototype	Philip Davidar
	Test Prototype Calibration	Abheshek Kothary
	Test Prototype Logic Array	Prithwi Roy
4/10/15	Test Prototype Sensor Unit	Philip Davidar
	Test Prototype for Simulated Weather Conditions	Abheshek Kothary
	Test Prototype in Simulated Highway Conditions	Prithwi Roy
4/17/15	Test Prototype Power Unit and Consumption	Philip Davidar
	Road Test Prototype	Abheshek Kothary
	Finish Final Testing	Prithwi Roy
4/24/15	Prepare Presentation	Philip Davidar
	Prepare Final Paper	Abheshek Kothary
	Prepare for Demo	Prithwi Roy
5/1/15	Complete Presentation	Philip Davidar
	Finish Final Paper	Abheshek Kothary
	Continue Project Into Business	Prithwi Roy

5. Safety Statement

Safety Gear

The rider of the motorcycle will wear gloves, jacket, pants that cover from waist to ankle, boots, and a DOT approved helmet at all times when operating the motorcycle.

Motorcycle Maintenance

The rider will make sure that the following motorcycle components are functional before every time the motorcycle will be used:

- Low beam headlight
- High beam headlight
- Turn signals
- Horn
- Front brake
- Rear brake
- Brake light

The rider will make sure that the tires have enough tread such that there is proper traction

While operating the motorcycle:

The rider will be stop the testing on the motorcycle if:

- A chemical or burning odor is sensed
- The motorcycle becomes uncomfortably hot
- Any liquids are leaking from the motorcycle
- The gears are slipping or not shifting smoothly
- The clutch is not engaging properly
- The throttle is not acting linearly (“bucking”, jerky delivery of power)
- Smoke is coming from anywhere on the motorcycle
- Steering is compromised by tension in the steering rack

Circuit Safety

We are using high current components for our project, so general lab safety will be followed as well as some extra precautions. We will make sure that power sources will not be punctured, as we intend to use a Li-Poly battery. Li-Poly batteries explode if they are punctured. Also we will make sure that extreme care is taken while soldering components, as the soldering iron is very hot. Lastly, we will make sure that our circuit is isolated from any water or high humidity. If the lighting housing is emitting any smoke or hissing noises, or if the housing is inflating or very hot, we will stop cut power and stop testing immediately. Once the package stops smoking, hissing, inflating, or converges to room temperature, we will disassemble the housing and assess what components must be thrown out and re-designed such that no more problems occur.

LED Safety

The LED’s we are planning to use are very powerful. They output around 227 Lumens Each when operating under suggested forward voltage and current. Therefore, we will take extreme care so that we do not blind ourselves when using these LED’s. We will wear polarized sunglasses or tinted lab goggles when testing the LED’s. We will also make sure that no other students are in close proximity when testing the LED’s. Even with eye protection, we will make sure that we do not look directly at the LED’s when they are powered.

6. Ethical Considerations

Motorcycle Fair Use

We intend to test our project on a motorcycle. The motorcycle we intend to use is a red 2013 Honda CBR500r. The owner of the motorcycle is Prithwi Roy (one of our group members). Prithwi Roy accepts full liability of all damages to the motorcycle should anything happen to it, and accepts that his safety and well-being is in his own hands, and the University of Illinois will not be at fault should anything happen to Prithwi or his motorcycle.

Rider State

Prithwi will not operate the motorcycle if he hasn’t received enough sleep or had any substances that would alter his mental and physical state (cough medication, alcohol, pain medication). Furthermore, Prithwi will not operate the motorcycle if he is injured in a way that would affect the safe operation of the motorcycle (eg. broken limb that hinders mobility).

Testing Environment

The testing on a motorcycle will not be done on public roads, as the the lights have not been reviewed for legality. Therefore we will test the motorcycle in a parking lot with very few cars. We will only test in parking lots that we have been given permission to use.

Signature:  Date: 3/1/2016

References

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