Cyclist Health Alert

Design Review

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Contents

1.Introduction

1.1 Goals and Benefits

In the past, more than 24,000 exercise related injuries was reported each year. Safety is crucial and injuries should always be avoided. Currently, many cyclist protective system already exist. However, those systems primarily solely focused on awareness of others instead of reactive measures after accidents. A similar system called “Cycle Alert” was created by a British company that designed to prevent collisions with cyclists and increase driver awareness by making cyclists visible in vehicle blind spots. While the names of two projects are extremely similar, but the approach is different- one proactive another reactive. One of the few designs that was close to our project is the ICEdot Crash Sensor for Helmet. Similar to our project it detects critical impacts that may leave cyclist incapacitated. It also has a cell phone app serving as user interface. The difference of our design and ICEdot Crash Sensor for Helmet lies in the sensors. Our impact sensor will be installed on the bike; we will also include a pulse sensor and a pressure sensor. Our goal is to design a bicycle device that could detect the physical condition and will sent alert if the physical condition fell below a threshold.

1.2 Objectives

1.2.1 Goals and Benefits

- Notice the biker when they under poor physical condition
- Notice others if they are thrown off or in collision

1.2.2 Features and Functions

- Battery will provide power for all sensors
- The pulse sensor will be inside the bike handle in order to detect heart rate
- The pressure sensor will be built in the saddle and handle
- The accelerometer will be used for collision detection
- Users can use an app in their smartphone to control the system
- User should enter their age at the beginning in order to help the system to set the maximum heart rate
- The system will send the biker a warning if their heart reach the maximum value
- The system will consider that the person is thrown off the bike if all pressure sensors detect a small value and accelerometer receives a small value. The phone will ring in order to attract others for help.

2. Design

2.1 Schematic

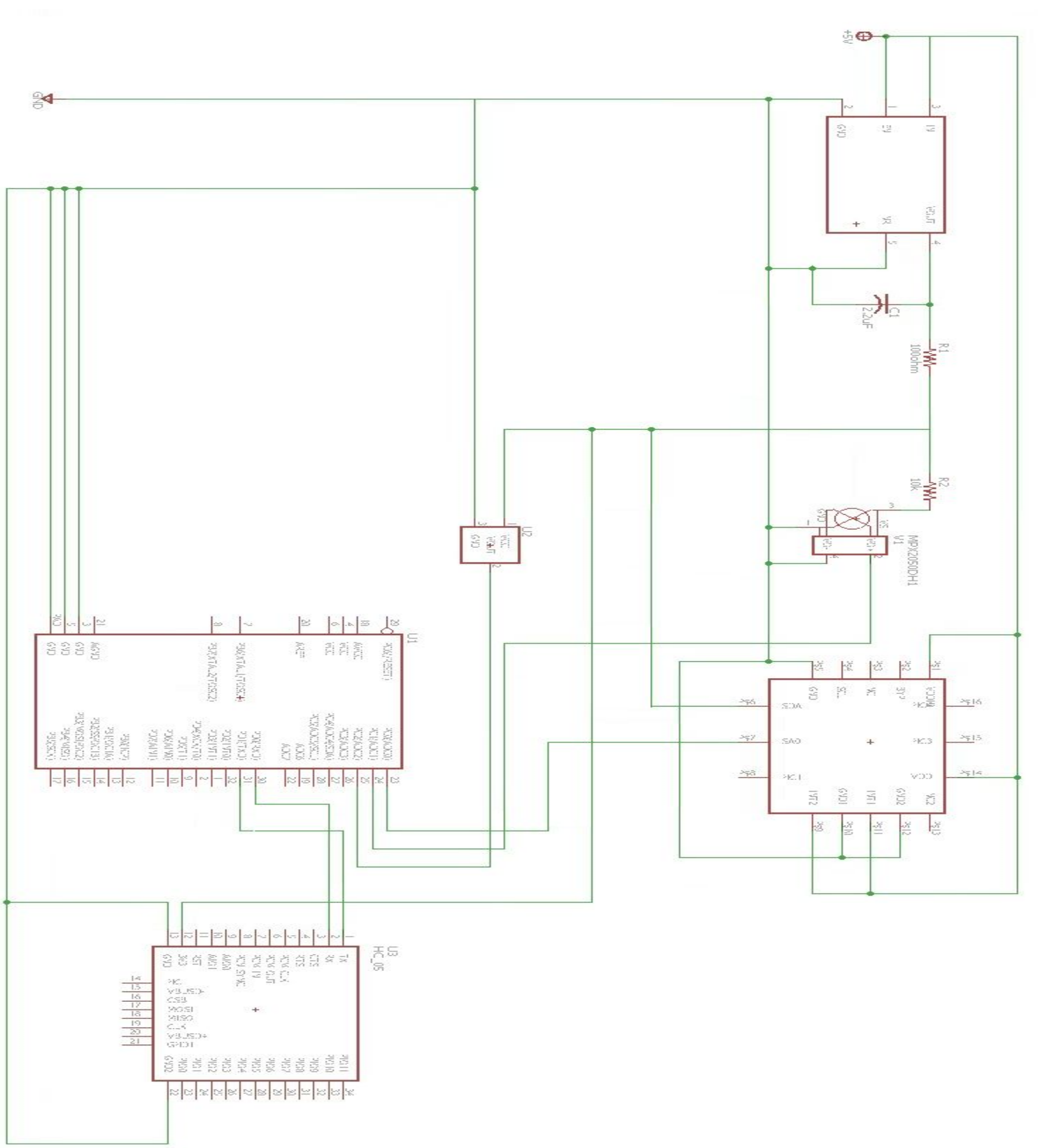

Figure 1: Schematic for Design

2.2 Block Diagram

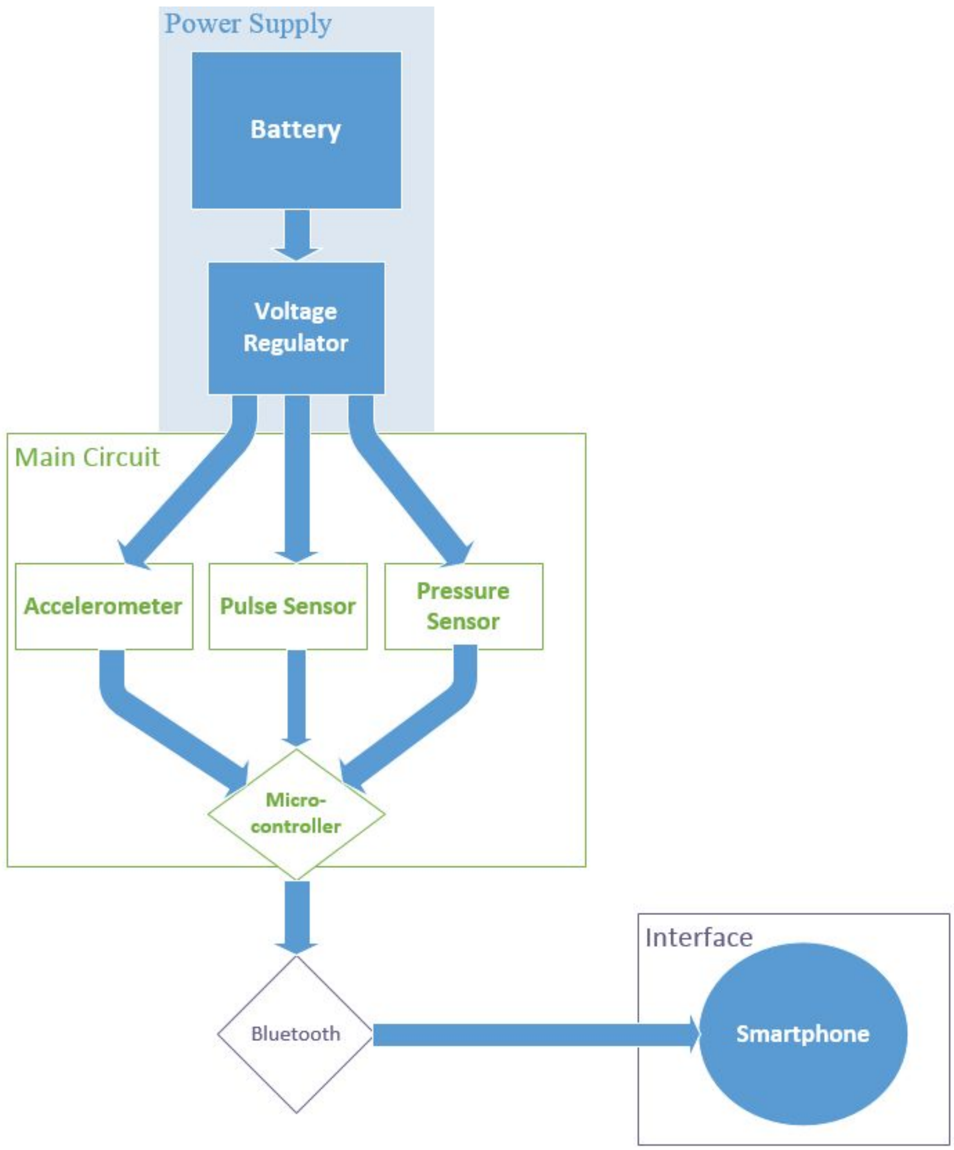

Figure 2: Block Diagram for the Design

2.3 Software Flow Chart

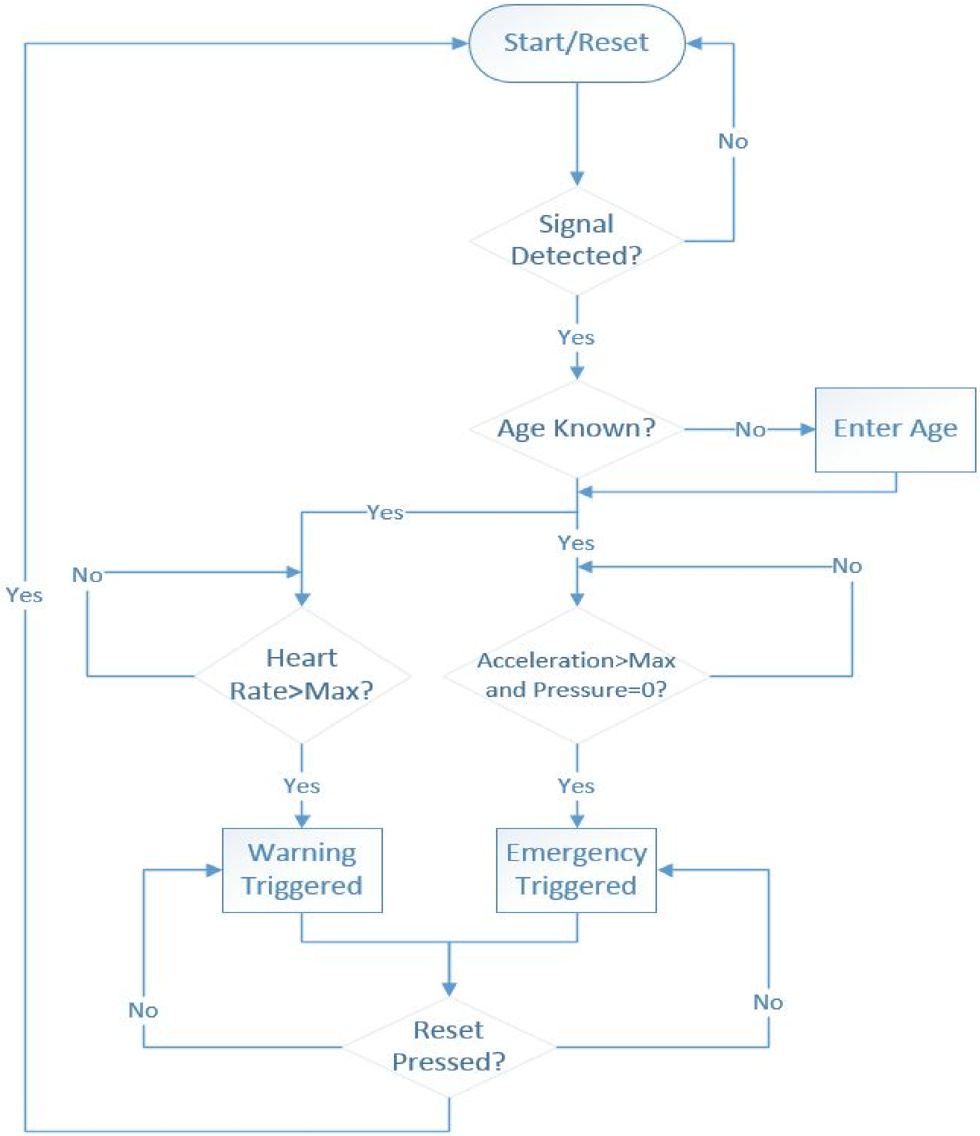

Figure 3: Flowchart for software

2.4 Parts Location

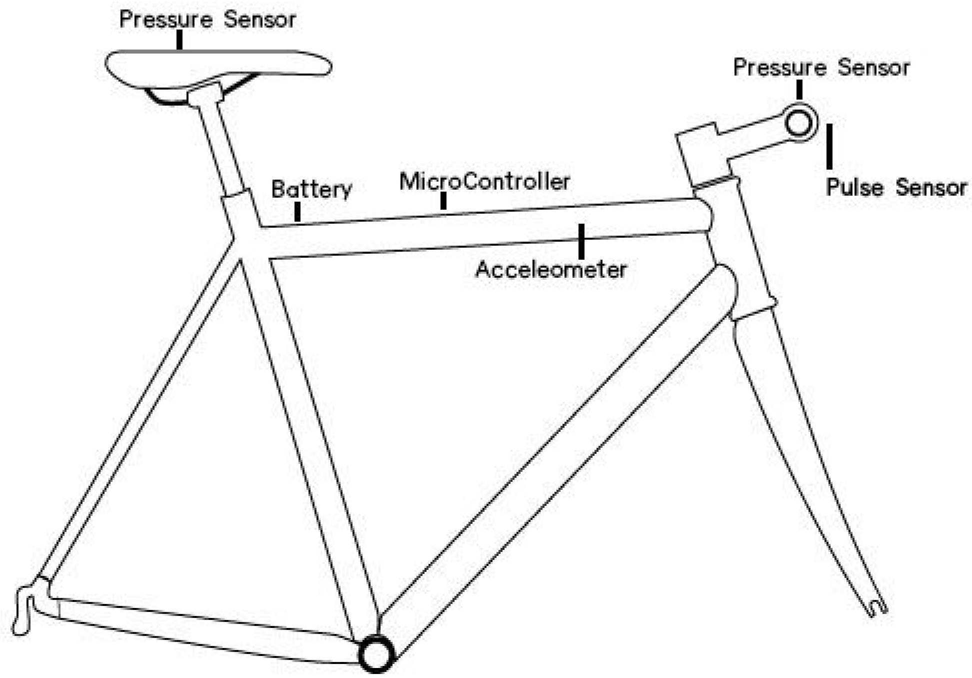

Figure 4. Location of Parts on Bike

3. Block Description

3.1 Battery

We will use a high-capacity portable charger with dual USB ports of rechargeable battery power. The output voltage is 5V DC. The output current 1 is 1A and the other output current 2 is 2.1A. One port is for sensors and the other is for microcontroller.

3.2 Voltage Regulator

In order to regulate the output voltage coming out of the battery, a regulator is needed. We will use NCP1086, which is a adjustable fixed output linear voltage regulator. The adjustable output voltage device uses two external resistors to set the output voltage within a range of 1.5V to 5V.

Input voltage: 5V
Output voltage: 3.3V
Output current: 1.5A

3.3 Accelerometer

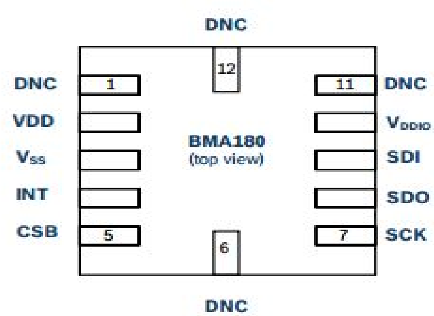

Figure 5: Schematic for accelerometer

For the accelerometer, we choose the BMA180 3-axis accelerometer sensor, which can provide a 14-bit digital output. The full scale measurement range can be set to 1g. Accelerometer will be used to detect the acceleration and deceleration if it reaches the maximum value, which is 9.8 m/(s^2), which can be considered that the bicycle is in collision.

3.4 Pressure Sensor

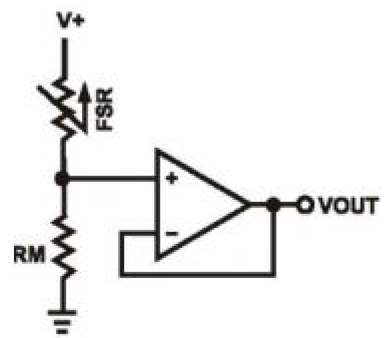

Figure 6: Schematic for pressure sensor

We will put two sensors on the handle and the other two sensors on the saddle. For the pulse sensor selection, we will be using FSR(force sensing resistor) 400 series. As shown in the figure, the resistance is proportional to 1/pressure, and the voltage will change respectively if resistance has changed.

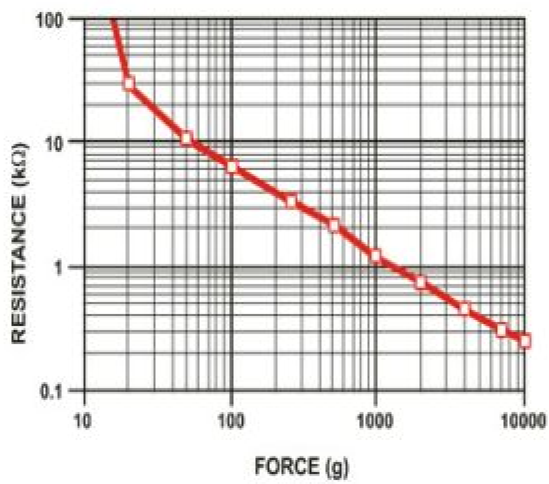

Figure 7: Force-Resistance Curve

3.5 Pulse Sensor

Figure 8: Picture of pulse sensor

The pulse sensor can be used to detect the heart rate. The biker will wrap the sensor on the finger in order to detect the actual heart rate.

3.6 Micro-controller

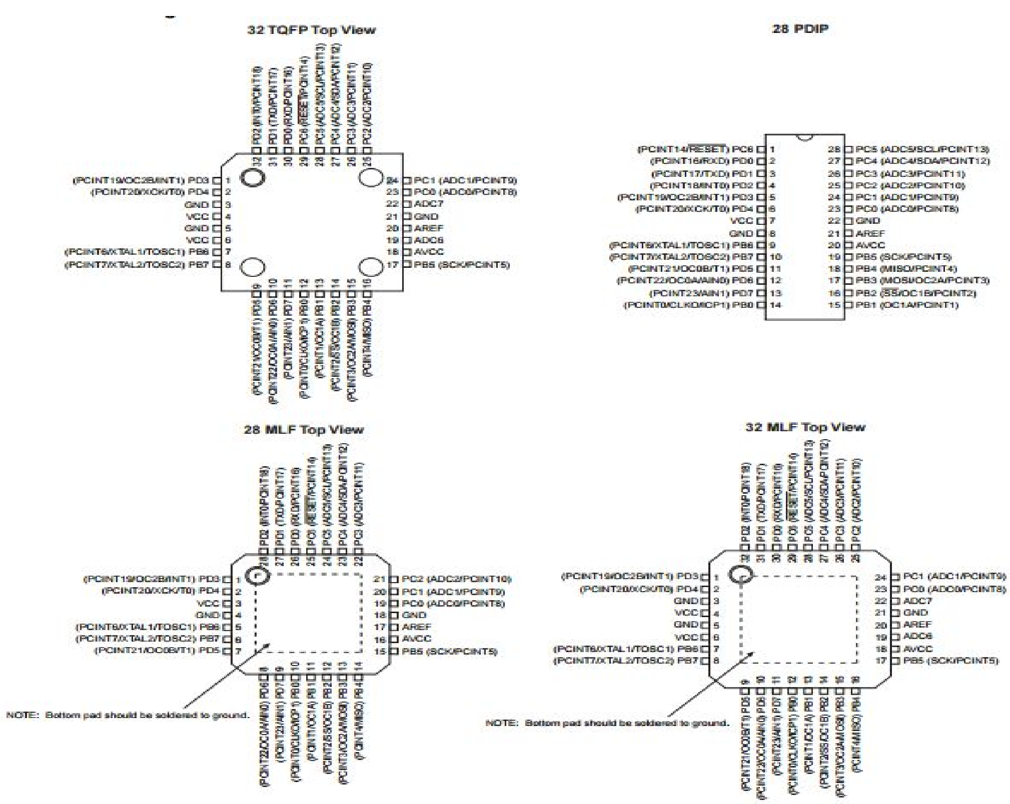

Figure 9: Pin configuration of avr

The microcontroller is AVR chip, the one we will use is *ATmega328*. The microcontroller will receive and analyze the data gathered by all sensors, the data will be refresh every second. It will be programed by C code and send the output value to the smart phone. The flowchart can be found in Figure 2 on Page (add the page number when finishing everything)

We will use the following equation to calculate the maximum heart rate.

Maximum heart rate = 211.415 - (0.5 * age) - (0.05 * weight in lbs) + 4.5

3.7 Bluetooth

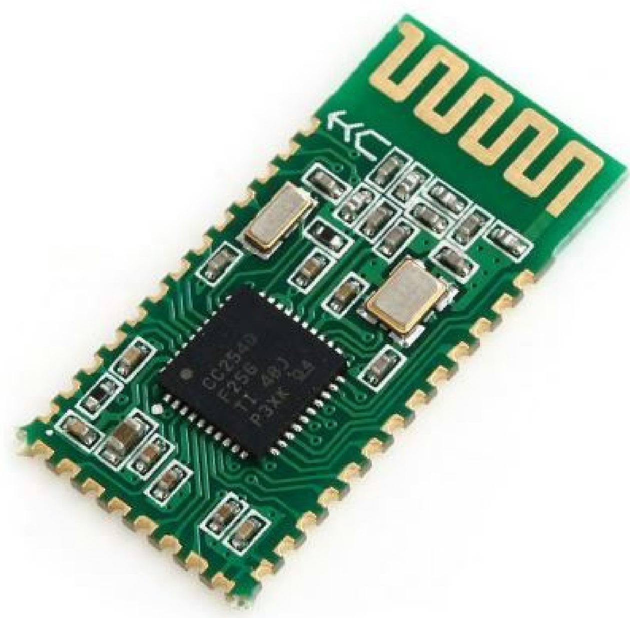

Figure 10: Picture of Bluetooth

We will use HC-08 bluetooth module for avr. Bluetooth is used for delivering the information from microcontroller (avr) to smartphone.

3.8 SmartPhone

Smartphone will be used as response system. We will implement an Android app to receive the data that has analyzed by microcontroller. The smartphone will respond differently when it receive warning signal or emergency signal.

3.9 Software

After microcontroller analyzing the data, it will send two signals to the smartphone via bluetooth, which is emergency and warning, and then Smartphone will give the response.

4. Simulation

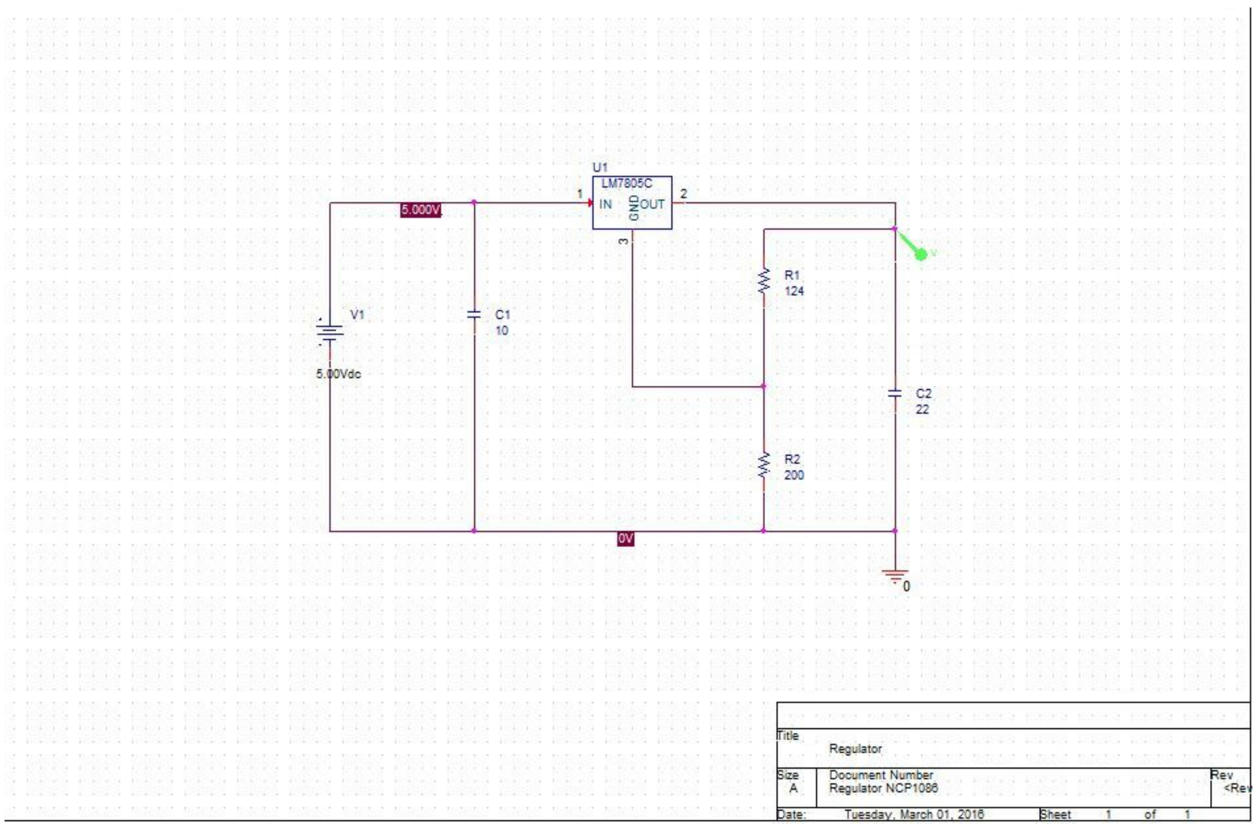

Figure 11: Schematic of Regulator

This is the schematic for the regulator circuit. The two external resistors divides the voltage properly. At first the input voltage is 5V, after going through the regulating circuit the output voltage becomes approximately 3.3V, which is shown in the plot.

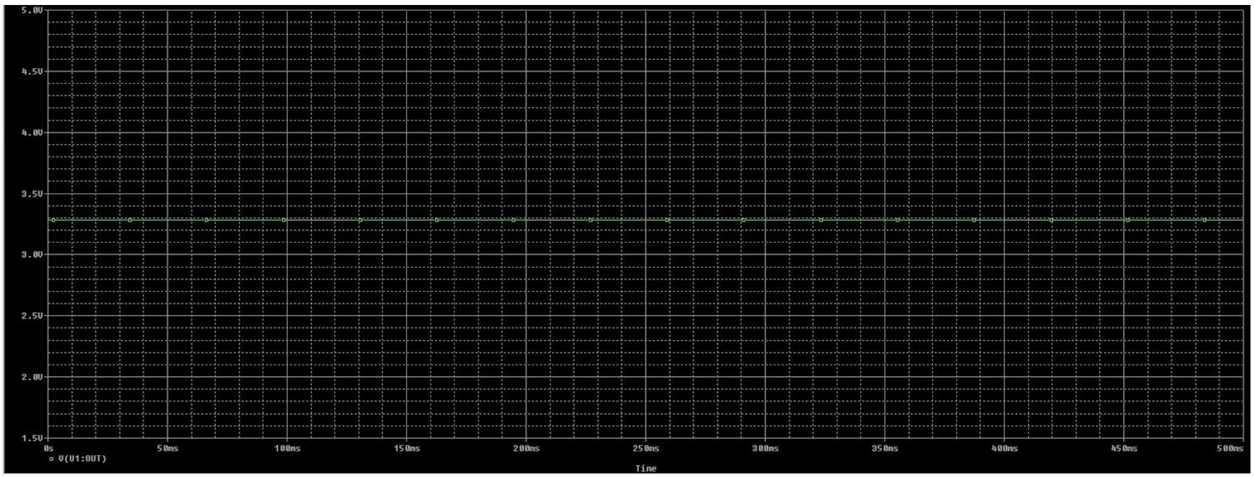

Figure 12: Simulation of Regulator

5. Calculation

In our design, the output voltage of our battery is 5V DC value. However, the desired voltage of our sensor system is at 3.6V maximum. So some sort of voltage regulating and converting is needed.

Linear Regulator

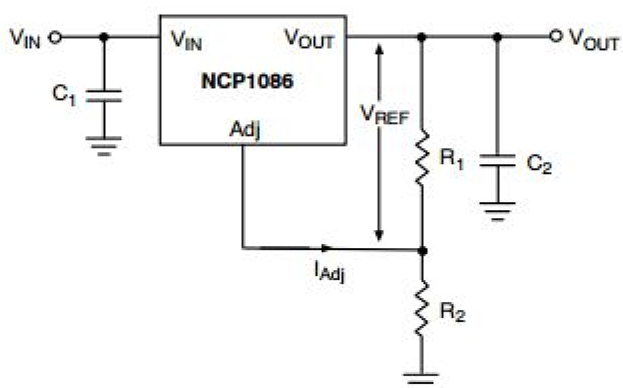

Figure 13: Schematic of Regulator for calculation use

The regulator we used has an external resistor divider sets the output voltage. The regulator maintains a fixed 1.25V reference voltage between the output pin and the adjust pin. Two resistors R1 and R2 cause a fixed current flowing to the ground. The adjust pin current is typically 50uA, and our output voltage can be computed using the following formula.

$$V_{out} = V_{REF} * (\frac{R_1 + R_2}{R_1}) + I_{adj} * R_2$$

Since

$$V_{out} = 3.3V$$

we can get the ratio of R_1 and R_2 :

$$\frac{R_1}{R_2} = 0.532$$

Then we can choose our resistor values accordingly. But R_1 must be chosen so that the minimum load current is at least 2mA.

6. Requirement and Verification

Requirement	**Verification**	**Points**
Power Supply (Battery) a. Supply of 5V +/- 0.25V with 1A +/- 0.25A	a. First use multimeter to draw 0A and measure the voltage. Then draw 1A and measure the voltage again. The values should be within the bounds. b. Place a load and measure the current delivered to the load.	5
Pressure Sensor (Force Sensitive Resistor) a. Can detect (> 150g) of force b. Accuracy measure force within +/- 25%	a. Set up a circuit with power supply (5V), pressure sensor, 1k resistor in series. b. Set up a voltmeter in parallel with pressure sensor. c. Apply 200g weight on the pressure sensor, record the value in voltmeter. d. Apply 500g weight on the pressure sensor, record the value in voltmeter. e. Apply 1000g weight on the pressure sensor, record the value in voltmeter. f. Plot the voltage vs. force, the voltage should decrease as the force increasing g. Apply a force of 100g to check for boundary sensitivity. Since the pressure sensor is only check for yes or no case, the accuracy range is	15

	only for the lower bound.	
Pulse Sensor a. Correct reading of heart rate b. Vin < 5V +/- 0.25V, I < 4mA +/- 0.02A	a. Clip the pulse sensor to earlobe or fingertip and plug it into 5V Arduino to get test results b. Measure the heart rate by using smartphone app Safe Health or other methods. Then compare the values. Theoretically two values should be nearly the same.	10
Accelerometer a. Can detect >1g of acceleration with error of +/- 5%	a. Power the microcontroller with 3.3 V and connect it to accelerometer b. Apply force to the device by body motion to test detection of acceleration	15
Bluetooth Transceiver a. Able to transmit signal from microcontroller to smartphone b. Must send data to the phone at 1 +/- 0.5kb/s	a. Put bluetooth and smartphone in a range of 0.5m so that they can pair up b. Sent out a signal from bluetooth transceiver and check to see if the app on the smartphone could receive the signal and react to the signal c. Send data from bluetooth to the phone and measure the time it takes	10
Microcontroller a. The operating voltage is between 1.8V to 5V b. The active mode current is 0.2mA(+/- 0.01mA), where the frequency is 1 Mhz and voltage should be 1.8V. c. Must react to the data sent to the chip and generate the correct output	a. Connect the chip to multimeter and measure the voltage to see if it is in the range of 1.8V to 5V. Also verify that the active mode current is approximately 0.2mA by setting the frequency to 1Mhz and voltage to 1.8V. b. At first, implement a simple computer program to test the input/output pins. c. Sending signals from sensor system and see if the microcontroller can react and produce the emergency and warning signal.	30
Smartphone a. Receive signal from bluetooth device within 20 seconds b. android system	a. First establish connection with bluetooth transceiver b. receive a test signal from bluetooth transceiver c. Check the signal detail using computer programs	5

Voltage Regulator a. Input Voltage is 5V +/- 0.1V b. Output Voltage is 3.3V +/- 0.1V	a. Connect the input to a 5 volt power source b. Use multimeter to measure the output voltage to check if its 3.3V	10

7. Tolerance Analysis

The output voltage after going through the regulator circuit will be 3.3V +/-5%. The accelerometer we are using has a voltage range of 1.62V to 3.6V. So as long as our voltage transmit to the accelerometer is above 1.62V, which should always be the case, the sensor will work properly.

The tolerance for force sensitive resistor is extremely large. We only need to know if the pressure sensor have body contact with the rider. The force sensitive resistor have a lower bound sensitivity of 100 g. The lower bound weight of hand and forearm is about 150g. The force sensitive resistor have a lower bound sensitivity of 100 g, which mean 100g is still below 25% error range. Since we are only testing for binary reaction, the allowed error range is +/- 25%.

The accelerometer have limited tolerance for its thresholds. Since the values are in scale of gravity(g), changes in 0.1g of acceleration is huge difference. This is why the error range for accelerometer need to be kept under one percent.

8. Cost and Schedule

8.1 Labor

Table 2: Cost for Labor

Name	Hours Invested	Hourly Rate	Total = Hourly Rate x 2.5 x Total Hours Invested
Sheng	150	$35	$13,125
Shi	150	$35	$13,125
Li	150	$35	$13,125
	450		$39,375

8.2 Parts

Table 3: Cost for purchasing parts

Item	Parts Number	Quantity	Cost ($)
Accelerometer	Kingduino BMA180	1	7.88
Battery	Jackery Giant+ Dual USB Portable Battery	1	23.99
Pulse Sensor	Asiawill® Pulse sensor	2	26.96
Force Sensitive Resistor	SEN-09376 ROHS	4	59.96
Bluetooth Transceiver	HC - 08	1	3.86
Voltage Regulator	L7805CV	1	5.05
Microcontroller	ATmega328	1	1.69
Total Cost			129.39

8.3 Grand Totals

Table 4: Total Cost

Section	Total
Parts	$129.39
Labor	$39,375
Grand Total	$81,206.5

8.4 Schedule

Week	Task	Delegation
2/8	Proposal	Li,Sheng,Shi
2/15	Prepare Mock Design	Li,Sheng,Shi
2/22	Start working on microcontroller	Li
	Start working on on regulator	Shi
	Start working on pressure Sensor	Sheng
2/29	Order microcontroller, battery and bluetooth Start working on coding for microcontroller	Li
	Order regulator Start working on developing the app on Android	Shi
	Order all sensors, test all sensors test bluetooth	Sheng
3/7	Debug the microcontroller Due: Soldering assignment	Li
	Debug the code on Androdroid app Due: Soldering assignment	Shi
	Lay out PCB in Eagle Improve R&V Table Due: Soldering assignment	Sheng
3/14	Finish coding on microcontroller	Li
	Finish coding on Android app	Shi
	Start to assemble breadboard to test the system Improve the R&V Table	Sheng
3/21	Spring BREAK!	Li
	Spring BREAK!	Shi
	Spring BREAK!	Sheng
3/28	Soldering PCB of microcontroller and debug after	Li

	finishing the all others parts of PCB	
	Soldering PCB of Bluetooth and essential part of microcontroller and debug after finishing the all others parts of PCB	Shi
	Soldering PCB of sensors and debug after finishing the all others parts of PCB	Sheng
4/4	Finish microcontroller part of PCB Connect PCB on the bike Test if microcontroller works correctly	Li
	Finish Bluetooth part of PCB Connect the smartphone terminal on the bike Test if Android works correctly	Shi
	Finish sensor part of PCB Connect all sensors on the bike Test if all sensors work correctly Due: Finish R&V Table (Final Version)	Sheng
4/11	Last test of microcontroller	Li
	Last test of Android app	Shi
	Last test of sensors	Sheng
4/18	Debug	Li
	Touch Up	Shi
	Optimization	Sheng
4/25	FINAL : Demos	Li
	FINAL : Demos	Shi
	FINAL : Demos	Sheng
5/2	FINAL :Presentation	Li
	FINAL : Presentation	Shi
	FINAL : Presentation	Sheng

9. Safety and Ethical Issue

9.1 Ethics

Our group members, do hereby commit ourselves to the highest ethical and professional conduct and agree the following rules:

1. *to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;*

We take all responsibility of the safety and health related issues, including any inflicted damage to ourselves as well as the others.

2. *to be honest and realistic in stating claims or estimates based on available data;*

We will make all claims based on solid evidence. There will be no fake data.

3. *to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;*

We will respect all criticism and advice, as well as taking it seriously. No advice will be ignored.

4. *to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;*

We will treat all team members with respect. No one's idea will be discredited due to race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender factor.

5. *to avoid injuring others, their property, reputation, or employment by false or malicious action;*

We will avoid injuring third party personal and properties during testing.

6. *to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.*

We will help each team member to follow the ethics code mentioned above.

9.2 Safety

We will test our design on a bicycle. Our group will buy a bicycle for the purpose of testing. We accept full liability to all happened to the bicycle. Our design testing will include human vehicle interaction. The testing would be performed by one of our team member. We accept any possible injury liability involved during testing. During test, the rider will wear long sleeve cloth and pants to protect elbow and ankle. The rider will wear bicycle helmets until all testing is complete to elimite ommitience. By design, our device will be exposed to natural elements. To protect the user, all wires and electrical component will follow IP64 code, which was designed to protect weathering damage such as snow and rain. During this project, we do not use any voltage greater than 5 volt. There is no safety issue with electrical shocks

10. Reference

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