Cycle Bright Solutions

March 13th, 2014

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: ENSC 440 Design Specifications for a Bicycle Smart Helmet

Dear Dr. Rawicz,

Please accept the following document as a Design specification for our Smart Helmet project. We aim to design and implement a bicycle helmet that makes biking a safer and more enjoyable experience for the community. Our design consists of a helmet with mainly brake and turn signals that help bikers announce their presence and intentions to other road users.

The purpose of this Design specification is to present a detailed description of all technical aspect of the product. This document also includes charts and diagrams to further explain the different development stages of the product, along with methods and procedures that will be used to test the different components. Our team will use this document, through the completion of the product.

Cycle Bright Solutions consists of five determined and talented 4th year engineering students: Wael Jendli, Arta Ahrabi, Chakaveh Ahmadizadeh, Ahmed Medhioub and Ibrahim Appiah. If you have any questions, or concerns about our functional specification, please feel free to contact Ahmed Medhioub at 778-829-7307 or by email at amedhiou@sfu.ca.

Sincerely,

Wael Jendli

Wael Jendli
Chief Executive Officer
Cycle Bright Solutions

Enclosure: Design Specifications for a Bicycle Smart Helmet

Design Specifications for a Bicycle Smart Helmet

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Abstract

The objective of Cycle Bright Solutions is to provide cyclists with a safer and more enjoyable riding experience through the development of our smart helmet. An idea which is necessitated following reports by ICBC, declaring that there are on average 1400 accidents involving cyclists with a 100% injuries rate.

In this design document, we put forth our design specifications of the electrical, software and mechanical components required for the smart helmet. Our project consists of implementing turn signals and brake lights at the back of the helmet which would be triggered wirelessly by the cyclist. A distinctive feature of the smart helmet is the addition of Bluetooth capabilities and the ability to connect it to a phone or a music device.

This document dwells into the technical details of the electronic and mechanical components with emphasis put into the justification of the chosen parts. It also addresses the interaction between the various electronic components and provides a descriptive test plan utilized to ensure the success of the project.

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Glossary

A2DP	Advanced Audio Distribution Profile
Bytes	8 Bits
CH	Channel
Forward current	The drawn current when connected correctly
Func.spec.req	Functional Specification Requirement
GND	Ground
ICBC	Insurance Corporation of British Columbia
LED	Light-Emitting Diode
mcd	millicandela
mW	miliwatts
mA	miliamperes
photometry	the science of measurement of visible light
RF	Radio frequency
RGB	Red-Green-Blue
Wifi	Wireless Fidelity

1. Introduction

At Cycle Bright Solutions we aim to create a Smart helmet, which will replace the conventional hand signal that has been described in an article as inadequate and downright dangerous. It require the cyclist to remove one hand from the handle bar to perform hand motions that can throw them off balance and even then, they may be not even be feasible at times due to variety of factors such as grade or conditions of the road. Therefore, the smart helmet will increase the safety of riders by making it easier for cars and cyclists to communicate with each other especially in low light condition such as at night time. A concept model is present in the below figure:

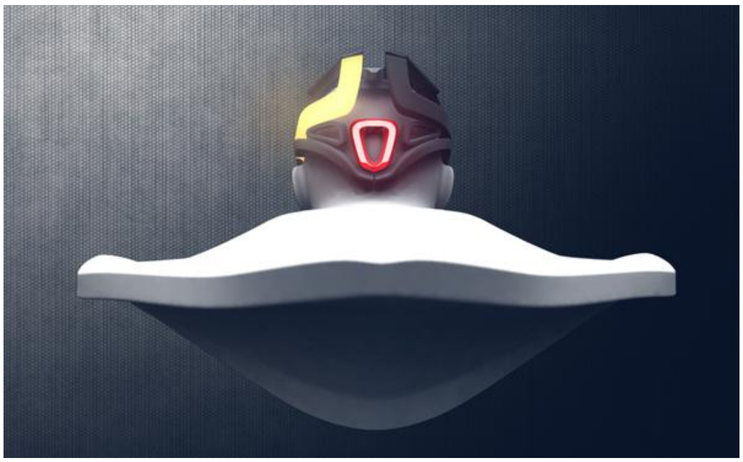

Figure 1: Concept Helmet proposed by Filczer [1]

The Smart Helmet by Cycle Bright Solutions features an RGB LED panel a the back of the helmet illuminates left and right signals as well as a brake signal to warn other driver of any sudden stops. This will aid the rider in signalling their intention without restricting them control of their bike.

The Cycle Bright Solutions offers an exclusive and unique product that will provide several useful features to outdoor-sport enthusiasts such as signalling, Bluetooth capabilities and potentially geo location services. The design solutions for this Smart Helmet, as proposed by the Cycle Bright Solutions, are described in this Design specification.

1.1 Scope

This design specification supports the previous *Functional specification for the Smart Helmet* document, by outlining the functional requirement of Cycle Bright Solutions' helmets. This document describes in detail the technical aspect of the system, which includes the Arduino microcontroller, LED light strips signals, the RF triggering circuit, accelerometer fall detection sensor, Bluetooth unit including the speaker and microphone, as well as the battery that provides the power. Also this document includes but is not limited to analysis of individual component performance, hardware design justification, communication protocols, and integration of subsystems. Lastly, the document proposes a system test plan for the Smart Helmet.

1.2 Intended Audience

The Design specification is intended for use by all members of Cycle Bright Solutions. Our team will refer to this document in every phase of development to guarantee that the final product meets the predefined technical requirements. This document will also be used to justify any design decision as well as serve as a template for future modification, if any issues are encountered during the testing and quality assurance stage before finalizing the product.

1.3 Background

Over the last year, cyclists in Vancouver were involved in 1400 incidents on average, with 100% injuries rate according to ICBC [2]. Most of those accidents were the consequence of miscommunication between cyclists and other road users especially when turning or changing lanes. Indeed, cyclists need to use hand signals while keeping the other hand on the handle which makes it hard to keep a straight line.

Thus, the objective of our project is to provide cyclists with a safer and more enjoyable riding experience through our smart helmet. In fact, we are designing and implementing turn signals and brake lights at the back of the helmet that can be triggered wirelessly without taking the hands off the handle. To make the helmet more attractive, it will have Bluetooth capabilities and the ability to connect it to a phone or a music device without the safety of the cyclists at risk. The helmet could be used as well for other activities s such as skate boarding or rollers.

2. System Overview

An overview of the system is described in this section; the smart Helmet consists of two main subsystems. Firstly the signalling unit, which consist of an RF trigger and receiver, accelerometer, Arduino Microcontroller and an LED strip of lights. Secondly the audio unit is composed of a Bluetooth unit, headphone speakers and a microphone, which is all displayed in figure 2. These systems will be designed, implemented and tested separately then further integrated. Due to the time and budget constraints, the proof-of-concept will be built through two development stages.

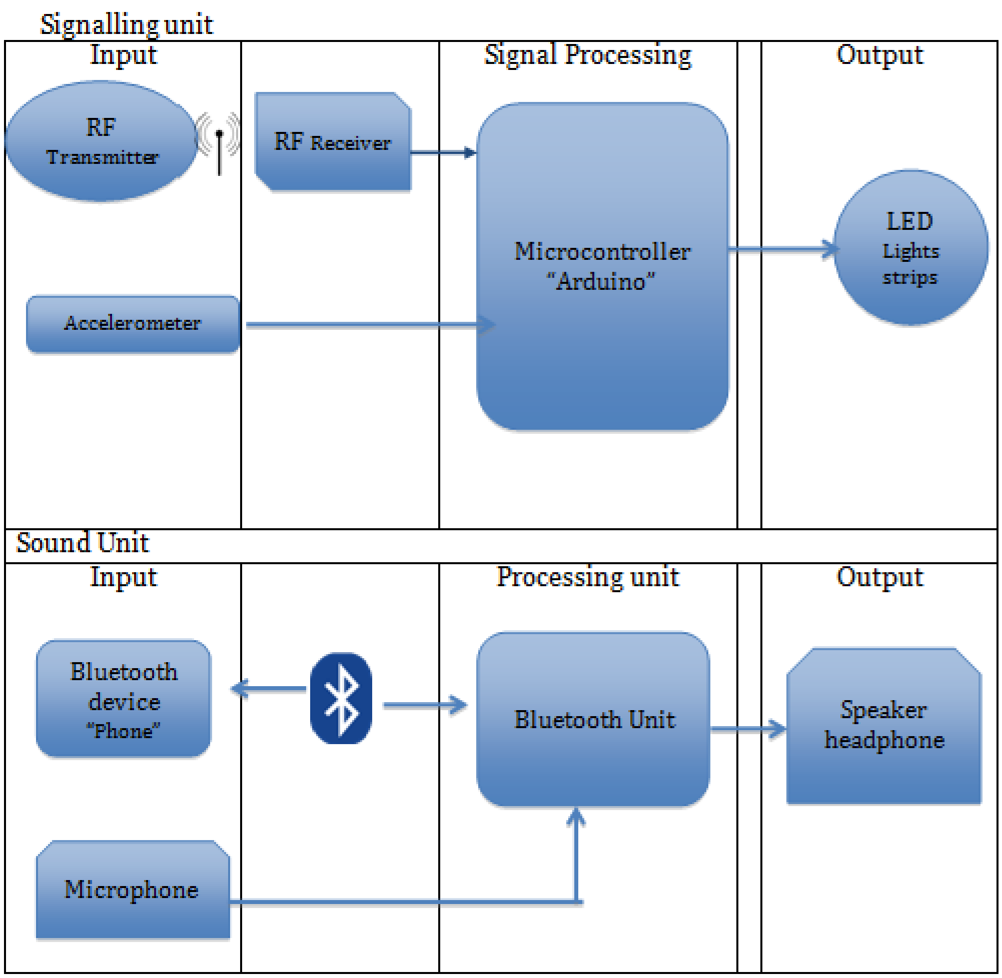

Figure 2: High Level Block Diagram of the Smart Hemet

The first stage of the development is designing and implementing the triggering RF circuit and its synchronizing it with the microcontroller, which will be responsible for turning on and switching off the LED signals as per the user request, for the turn signal functionality.

The user selects the direction of their intended turn via a self-explanatory control box similar to the one presented in figure below, the signal will be sent wirelessly from the control box via radio frequency.

For the second phase, adding the brake trigger, the fall notification system and the Bluetooth speaker will be achieved.

In fact, the brake trigger is integrated with the previous triggering circuit, when the user brakes, the corresponding LED signal should turn on and automatically turn off when the brake is released. In addition, the accelerometer should detect free falls when the user falls from their bike due to incident. This event results in a flashing state of the LEDs simulating the hazardous lights available on other vehicles. Finally for the speaker and microphone, using an already made module with Bluetooth takes into consideration noise interference. Note that the noise cancelling circuit and the transceiver is not shown in the above block diagram since it is implemented in the speaker and microphone unit.

The complete Smart Helmet will have a similar layout as the one illustrated in figure 3.

Figure 3: SolidWorks concept model of he production version of the smart Helmet

3. LED Unit

The LED lights notify the other road users of the intended direction of the cyclist. In other words, it provides visual feedback to the pedestrians and other motorists by illuminating LED’s to the right on the helmet when the rider signals to go right and to the left when the rider signals to go left. In addition, when the rider decides to brake, a red LED lights illuminates at the back of the helmet. This devices is crucial to the safety of the rider and to others road users. A descriptive diagram of the mounted LEDs at the back of the helmet is shown in figure 4:

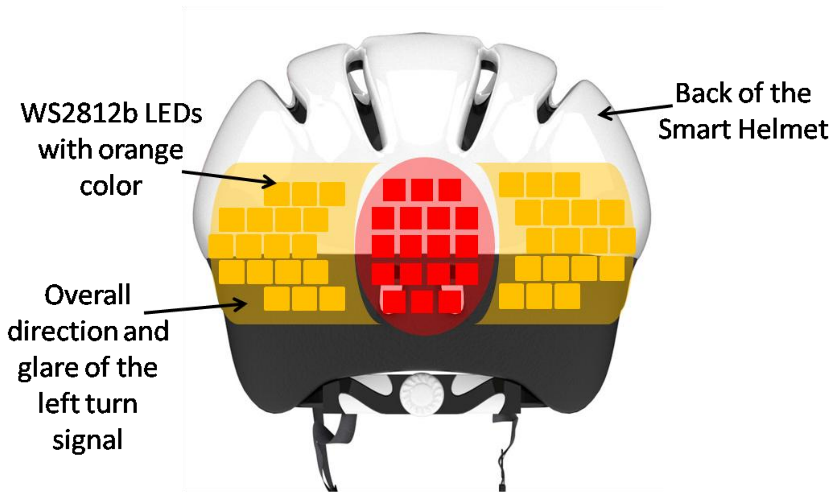

Figure 4: Rear view of the Smart Helmet illustrating the placement and color of the LED signals

To meet the LED requirements mentioned in section 4 of the functional specification, an integrated controllable LED is used. Indeed, the LEDs are individually addressable RGB color pixels in a form of a strip and based in the WS2812b LED drivers using a single wire control protocol.

3.1 Material and Fabrication

The WS2812b is a combination of an RGB LED 5050 and a control circuit integrated in a small chip made by Worldsemi with an operating voltage of 5 Volts [3]. For the proof of concept, those LEDs are assembled in a strip (30/meter) to create the turn signal animations without using multiple pins of the microcontroller. In later versions of the product, individual LEDs would be assembled in sections as illustrated in figure 4for enhanced aesthetic. The exact dimensions and pin configuration of a single LED chip are presented in the following figure:

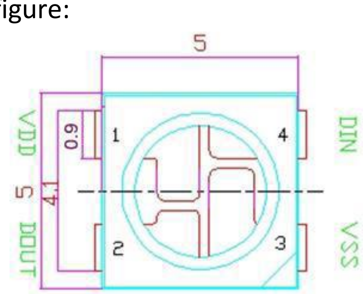

Figure 5: Pin configuration and exact dimension of the WS2812b LED [3]

The LED strip is enclosed in a silicon sleeve with IP65 waterproof rating to meet the requirement [R80-II] of having waterproof, flexible and robust LEDs [4]. Indeed, according to the IP65 rating, the LED strip is immune from rain and splashes but not to direct immersion in water [5].

3.2 Characteristics

In order to fully characterize RGB LED light sources, we need to assess its photometric properties such us the luminous intensity, wavelength and viewing angle as well as its electrical properties such as operating voltage and forward voltage for each current. In table 1 and table 3, the photometric properties and the electrical properties are respectively summarized.

Table 1: Photometric charcteristics of the WS2812b [3]

Emitting Color	Wavelength(nm)	Luminous intensity (mcd)	Viewing angle (degrees)
RED	620-625	390-420	120
Green	522-525	660-720	
Blue	465-467	180-200	

In the above table, luminous intensity is typically used for LEDs and it is a measure of the amount of light produced from the source and observable by the human eye [6]. For better comparison with the standard light bulbs, the luminous flux, which is a measure of the light power as observed by the human eye [6] can be computed using the following equation [7]:

$$luminous\ flux = luminous\ intensity\ \times angle\ of\ beam, \qquad \textit{Equation 1}$$

where the luminous intensity is measured in Candela (cd), luminous flux is measured in Lumens (lm) and the angle beam is measured in Steradian (sr).

Using the above luminous intensity values and equation 1 and considering that there is 30 LEDs/meter of the strip, the following Lumens values are obtained:

Table 2: Lumens values of the WS2812b

Emitting Color	Lumens (lm)
RED	36.7-39.5
Green	60.2-67.8
Blue	16.9-18.8

To have a better grasp of these values, it is wise to mention that a normal 4w bulb is rated approximately at 20 lumens [8]. Thus, the WS2812b successfully meet the requirement [R76-II] and [R78-III] of having a luminance comparable to standard bulbs with a wide beam angle.

In the following table, the electrical properties of the WS2812b LED are summarized:

Table 3: Electrical ratings of the WS2812b [9]

Emitting Color	Forward Voltage (V)	Forward Current (mA)	Power Dissipation (mW)
RED	2.0-2.2	20	40
Green	3.0-3.4		60
Blue	3.0-3.4		60

The above ratings will be used in the following sections for performance and power estimations.

3.3 Circuitry and Electrical connections

As mentioned in the above descriptions, the WS2812b is individually addressable, thus, a microcontroller is needed for the creation of different colors at different brightness. In accordance with the pin configuration of the LED illustrated in figure2, the following circuit is built for a proper functioning of the LEDs.

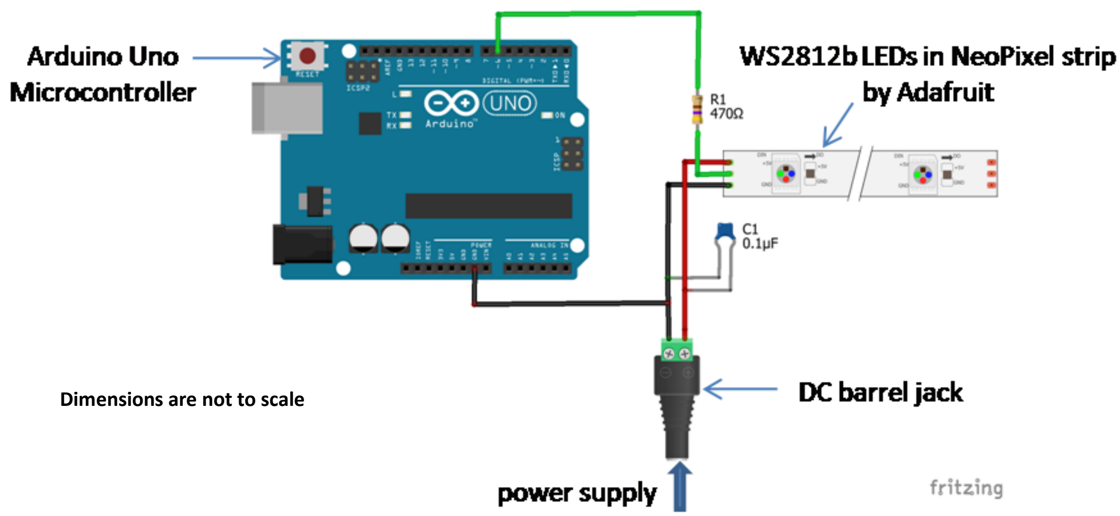

Figure 6: Proposed connection for the NeoPixel strip with an Arduino Uno generated with fritzing

In order to connect the WS2812b LED together in form of a strip or a chain, some guidelines need to be followed:

- A ceramic capacitor with a 0.1microFarads at 6.3Volts rating should be used between the power source and ground as a bypass capacitor in order to suppress noise or any initial current spikes [10]. In figure 3, only the initial capacitor is shown since such capacitance is already integrate in the NeoPixel strip between individual LEDs.
- A 470 Ohm resistor should be used between the microcontroller's data pin and the data input of the first LED in the strip to prevent a short spike in the current flow from damaging the LED [11].

3.4 Power and Performance estimation

For a portable and rechargeable helmet, power consumption is an important and a limiting factor for the design choices and solutions adapted. Indeed, driving multiple LEDs with the same power supply needs careful attention to the current needed for a good and well distributed lighting.

With reference to the Opto-Electronical graphs included in the appendix and the values in table 3, we can conclude that at full white brightness (all the LEDs are on), the LEDs will need about 60mA each or about 20-25mA in average knowing that the dominating color of the signals is Red or Amber/Orange. Therefore, the following estimations can be concluded with the assumption that we are using 45 LEDs:

Table 4: Current estimations to drive 45 LED at different Brightness levels

	Current Needed per LED (mA)	Number of Pixels	Total Current Needed (A)
Average brightness	20-25	45	0.9 - 1.125
Full Brightness	60		2.7

Using Ohms law to calculate power in watts, the following equation can be used [12]:

$$W = V \times I, \qquad \textit{Equation 2}$$

where W is the power in Watts, V the voltage in Volts and I the current in Amperes. Thus the below power rates are obtained:

Table 5: Power estimations using different voltage values at different brightness levels

	Voltage (V)	Power consumed (W)
Average brightness	3.7- 5.0	3.33-5.625
Full brightness		9.99-13.5

The above results will be used to make design decisions for the battery used for the whole system.

As discussed above, the strip of WS2812b needs a microcontroller to obtain different color levels. Thus, the values to be written need to be formed in the memory of the Arduino. Knowing that each color needs 8 bits [3], each WS2812b needs 3 Bytes of free memory. In this way, 45 LEDs will need 135 Bytes of free memory to be able to obtain 256^3=16,777,216 color possibility per single LED.

3.5 Motivations and Summary

In summary, the use of WS2812b LEDS in a NeoPixel strip is adopted for the following reasons:

- No need for separate driving circuit or a chip since it is already integrated in the each WS2812b
- LED light is more eco-friendly without decreasing the luminance of light with a long lifetime[13]
- LED WS2812b is operated by 5V which is conform to the func.spec.req [R15-II]
- LED WS2812b offer a wide angle and a wide range of colors to be tested for better visibility

4. Triggering Unit

The triggering unit is composed of various elements that constitute the main part of the user input to the system. Indeed, this unit contains:

- An RF transmitter to transmit the user commands to the RF receiver
- An RF receiver to receive the user commands and interface with the microcontroller to turn the corresponding LED signal light.
- Signals buttons that can be activated and deactivated to turn on or off the corresponding signal with some visual feedback to the user

4.1 Background on RF communications technology

RF technology is adopted for the Smart Helmet since it is a cost effective technology compared with Bluetooth or Wifi. In addition, its implementation can be achieved without the need of an extra microcontroller or complex communication protocols. Indeed, a careful choice of the frequency used for the transmission will satisfy func.spec.req [R64-II] regarding the maximum acceptable range of 1.5m.

RF communications is based on the fact that electromagnetic waves can travel over the air from a source to a receiver at a certain frequency [14]. In addition, the higher is the frequency the shorter is the wavelength, thus, the distance travelled from a source to a receiver without loss of the information [14]. For digital data, an encoder and a decoder need to be used to convert the data from a digital state to an analog state that can be transferred via electromagnetic waves. The following figure summarizes the RF communication for digital data with the inclusion of encoder and decoder stages.

Figure 7: Model of Transfer of digital data via an RF communications module

4.2 RF transmitter

For the proof of concept, a 315MHz 4 button key fob RF transmitter based on PT2262 by Princeton Technology [15]. Each button is connected to one channel to of transmission. Therefore, button presses can be encoded and then sent via the 315MHz wave. The 315 MHz frequency is categorized as an ultrahigh frequency which has a wavelength (distance of transmission) of 10cm-1m [16], which is conform of the functional specifications. In addition, the RF transmitter uses 2 coin cell batteries with an operating voltage of 4-10Volts which is in accordance with func.spec.req [R15-II].

For the production product, the PT2262 should be directly used in connection with the user interface discussed in the following sections to form a complete transmitter triggering circuit.

4.3 RF Receiver

A corresponding 4 channel 315Mhz RF receiver should be used in order to receive and then decode the data transmitted by the transmitter. Thus, for better compatibility the PT2672 by Princeton Technology illustrated in figure 7 is used. The below table presents the key features of the receiver:

Table 6: Key Features summarized from the PT2672 Datasheet [17]

Key Features
Low power consumption
High noise immunity
Operating voltage 4-15 Volts

Even though, RF technology is simple and cost effective, it has some constraints such as the non existence of error check or acknowledgement of received packets. However, since the wavelength chosen is relatively short and there are no obstacles between the transmitter and receiver, such constraints will not affect the standard usage of the Smart Helmet.

4.3.1 RF Receiver Connections

The RF receiver is directly connected to the microcontroller. In fact, the operating voltage matches the 5 Volts provided by the Arduino Uno and each channel is connected to a digital port to detect any changes. The flowing figure illustrates such connections:

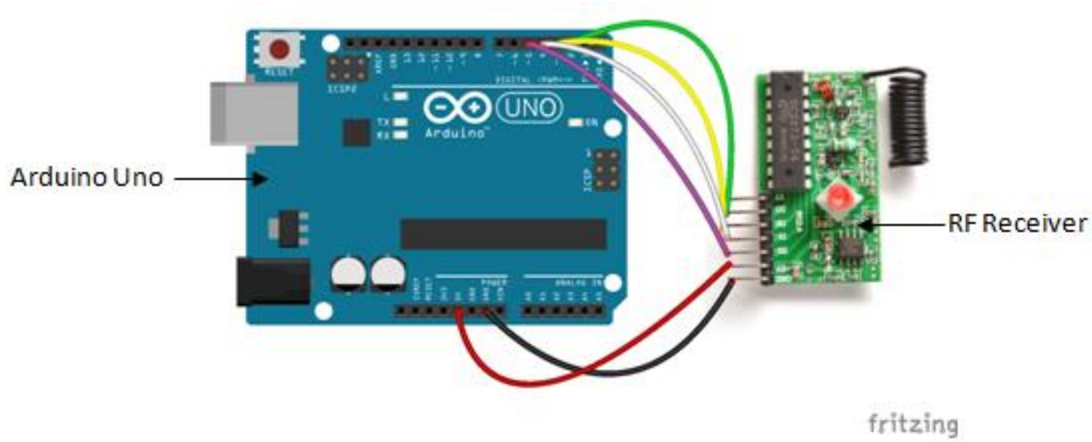

Figure 8: Proposed connection for the RF receiver with the Arduino Uno generated by Fritzing

4.4 User Interface

To meet the requirements of section 3 of the functional specification especially [R48-II], [R49-II] and [R51-II] regarding the use of self-explanatory buttons or switches with convenient visual feedback. The following design is based on a (ON-OFF-ON) Single Pole Double Throw (SPDT) switch.

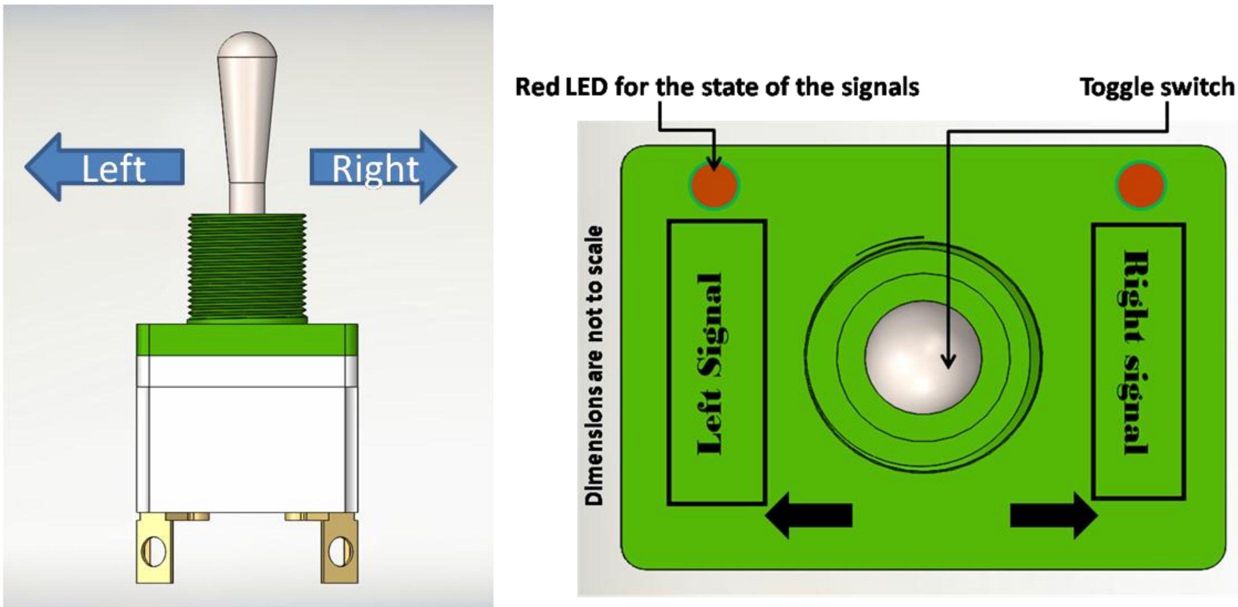

Figure 9: Front view and a top view of the user interface based on a SPDT SolidWorks design [18]

The user can choose the direction of the turn by flicking the toggle switch left or right, the Red LED will serve as an indicator confirm the state of the switch which is already self-explanatory in nature. The SPDT is a mechanical lever that is used to switch between poles as described below:

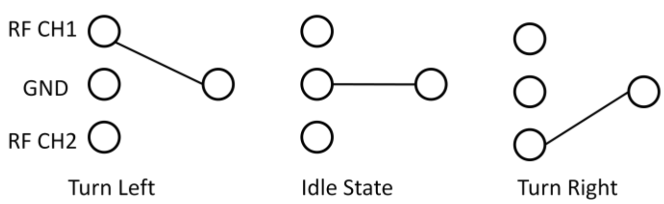

Figure 10: Internal mechanism of an SPDT with connections to the RF transmitter

4.5 Motivations and Summary

In summary, the use of RF technology and an SPDT is adopted for the following reasons:

- No need for a second microcontroller for the transmitter circuit since there is no complex protocols involved
- Both the transmitter and the receiver have an operating voltage of 4-15Volts
- The PT2672 receiver has a built in antenna
- A 315MHz frequency is used to have a limited range of 10cm-1m in order to avoid interference

5. Accelerometer

The ADXL 345 accelerometer by Analog devices is a 3 axis accelerometer, used to measure changes in accelerations to detect brake movements as well as any sudden shocks to detect falls. Being a lightweight and a low power device, the ADXL345 conforms to the physical requirements of the systems previously discussed in the functional specifications document. In addition, this particular accelerometer is used because of the following features:

Table 7: Specification of the ADXL 345 [19]

Parameter	Specification
Current draw	40 uA in measurement mode
Sensing range	± 16 g (g= gravity constant =9.81) [18]
Operating voltage	2.0-3.6 VDC
Interrupts	Free-Fall interrupt supported

In the Smart Helmet project, the accelerometer is used with the Arduino microcontroller to detect any falls in accordance to this following algorithm adapted from Analog Devices [19]:

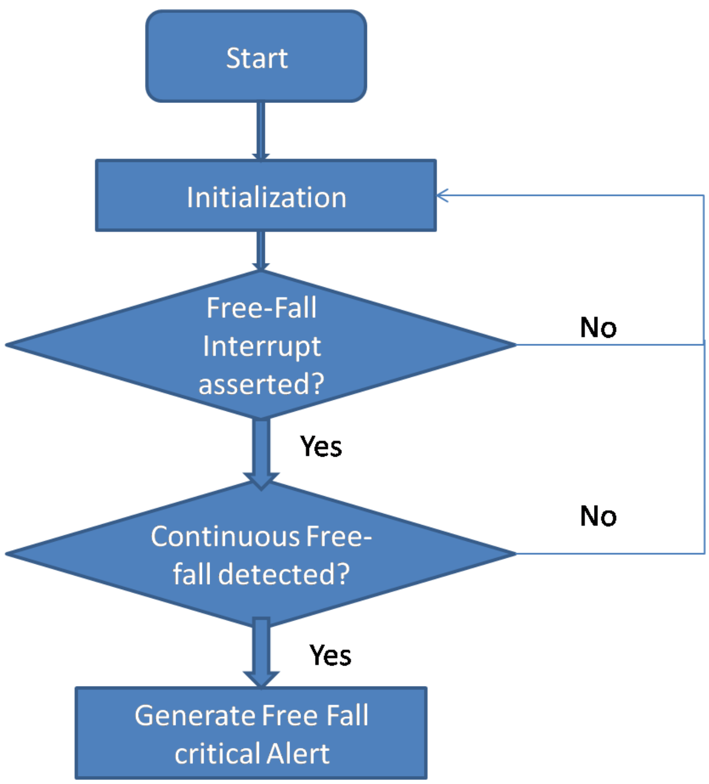

Figure 11: Flowchart describing the detection of a free fall by the ADXL345 [19]

In addition to the fall detection functionality, the ADXL345 is used in detecting brake movements by continuously sensing the acceleration and comparing the difference between each measurement to a preset threshold. If the calculated difference is smaller than the threshold, a drop in acceleration due to a brake can be detected as illustrated in the below flowchart.

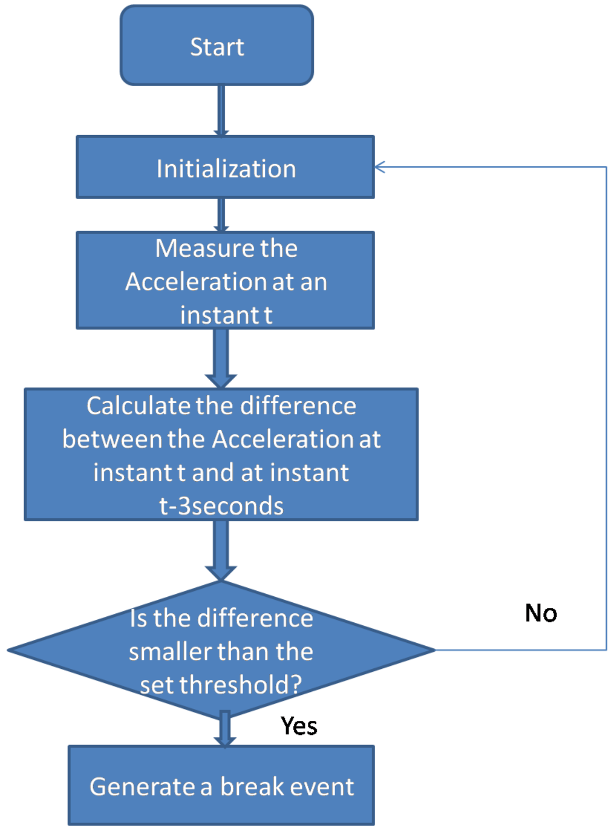

Figure 12: Flowchart describing the detection of a Brakeing event by the ADXL345

6. Microcontroller Unit

In the proof of concept product, an Arduino Uno will be used because of its properties of making prototyping easier and debugging more efficient. In fact, the Arduino features the following specifications:

Table 8: Arduino Uno chracteristics [21]

Parameter	Specification
Microcontroller	ATmega328
SRAM	2KBytes
Operating Voltage	5v
Clock speed	16Mhz
Number of digital I/O ports	14

The Arduino is a good design solution since it offers a large number of ports as well as a 2KB of RAM. As discussed earlier, 45 LED pixels need about 135 Bytes of free memory which constitutes only 7% of the available RAM. Therefore, there will be no shortage of memory, and the Arduino can comfortably drive other devices and include the needed libraries.

7. Battery and Power Unit

To power the Arduino, a Duracell 9V (6LR61) is used since it is within the range of operating voltage of the microcontroller and only weighs about 45 grams [22]. However, being rated at 500mAh, the Duracell 9 V cannot be used to power all 45 LEDs of the helmet since they need a minimum of 0.9A as stated in table 4. Thus, a Lithium Ion polymer rechargeable battery rated at 3.7 V, 2500mAh is used to power up the NeoPixel strip. On top of its nominal output power, the 3.7 Lithium battery is rechargeable, which meets func.spec req [R13-III]. In addition, it weighs only 50 grams which is in accordance with [R16-II].

The following figure illustrates the 3.7 lithium battery as well as its charging board.

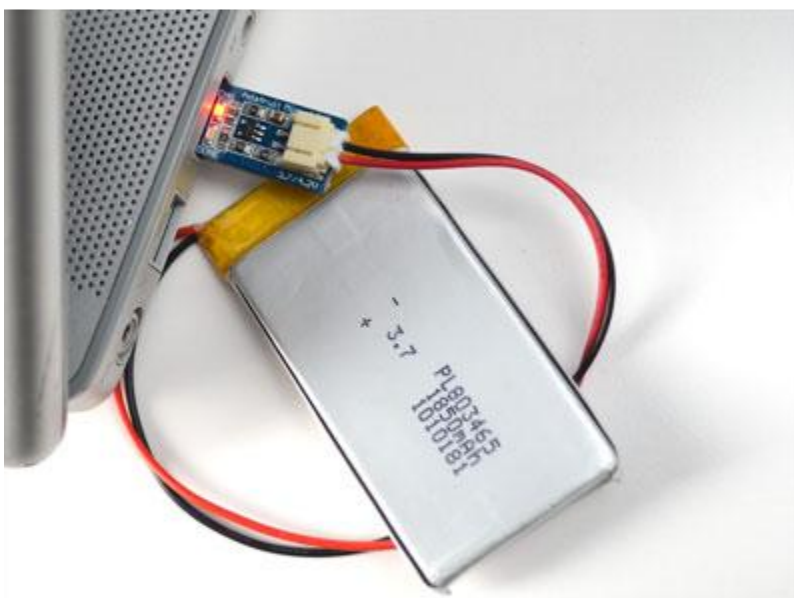

Figure 13: 3.7 Lithium battery connected to a usb port via the corresponding charging unit [23]

8. Speaker and Microphone Unit

For the time being, the Bluetooth boards for the Arduino microcontrollers don't support the A2DP protocol needed for the transfer of audio via Bluetooth connections [24]. Thus, an available XBTOMOTORCY of-the-shelve Bluetooth microphone speaker is used for the proof of concept. For the production units, an integrated microphone and speaker will be built in the Smart Helmet.

In addition, a single sided unit is the optimum solution since it is not recommended to wear headphones while riding a bicycle in Vancouver [25]. Indeed, a single sided speaker will offer the user the ability to interface with their audio devices without getting isolated from their surroundings. That way, the Smart Helmet will insure a continuous connectivity without endangering the safety of the cyclists and other road users.

The chosen Bluetooth headset has the following features [26]:

- Bluetooth V2.1.
- Supported Bluetooth profiles : A2DP, AVRCP, HSP, HFP
- Interphone operating range : 150m
- Charging time : 2 hours
- Battery performance of up to 5 hours of talk time, 8 hours of music listening time or 100 hours of standby time

9. System Test Plan

Our system is safety oriented since any errors or confusions regarding the signals can cause serious accidents as both the helmet user and other road users depend on accurate functionality of the system. In order to ensure high performance of the Smart Helmet and for easier debugging process, unit testing will be conducted, as well as regression testing after adding any modules to the system. For instance, after the first stage of the development, thorough testing will be conducted to ensure that the implemented features work perfectly as expected. Indeed, the triggering circuit should be able to send correct signals and the microcontroller should be able to decode the signal and switch on the correct LED section.

After the second stage of development, the whole system should be working without interference or degradation of the previously tested modules.

9.1 Unit Testing

Unit testing will be conducted on individual components separately as follows:

9.1.1 Triggering Unit Test Plan

- **Signal Buttons**
  - Use two LEDs: one turned on by flicking switch to right and the other one turned on by moving it to left.
- **Brake trigger**
  - Use an LED that will turn on if the brake is used
- **RF Transmitter**
  - Use the RF receiver and four LEDs. Each LED is turned on by one of the four combinations of sent signals

- **Integrated Triggering Unit**
    - Once the individual top components are working as described, the whole triggering circuit is assembled. Signal buttons or brake triggers should be successfully sent via the RF transmitter and the corresponding LED should turn on

9.1.2 LED Unit Test Plan

To test the LEDs, a software test framework should be written to simulate the triggering and choose different colors and different patterns of the LED strip.

When the above is tested, the LED and the triggering should be integrated and tested to obtain the first working stage of the proof-of-concept.

9.1.3 Microcontroller Unit Test Plan

To test the microcontroller unit and explore its full capability, sample projects will be run first to get used to the programming style and the connections of the unit. In addition, the microcontroller should be integrated with the LEDs and the triggering circuit to make sure that decoding is correctly done and that the MCU is capable of driving the LED unit

9.1.4 Speaker and Microphone Unit Test Plan

Testing the speaker and microphone unit can be done separately by pairing it with a Bluetooth capable audio device and making sure that audio can be received and transmitted without issues.

9.1.5 Fall Notification Unit Test Plan

This is to test that the accelerometer combined with the algorithm can detect free fall and send appropriate signal to MCU. To be able to test this unit we have to make sure that the unit is shock resistant and will not be damaged by testing.

9.2 First Phase Regression Testing

The product of development stage I, the proof of concept performing our main system functionality as explained in the functional specification document, would be required to detect correct signal input through the triggering system, wirelessly transmit the input to MCU on the helmet, decode input and finally produce corresponding output by showing signals through LEDs.

Once the unit testing on all components is carried out, we will integrate units to ensure correct data transfer between them and ensure the functionality of the product as a whole is as expected. To achieve practicable debugging we will start by integrating small numbers of units and then putting the whole system together.

We will connect the Triggering circuit to MCU to ensure correct transfer of inputs to MCU through the RF module and to test the output produced according to the input received by MCU. Then we will add the LED unit to it to ensure that the output from MCU drives LED unit accordingly. At the end we will put all the systems in the helmet and test the whole system by giving all possible combinations of signal inputs through triggering unit and checking the resulted output for each. In this part of testing, the power unit is being tested to power all different units.

9.2 Second Phase Regression Testing

The second phase of product is after adding extra features to the first phase. The features we wish to add to the main functionality are: brake trigger, fall notification and Bluetooth speaker. Similar to phase one, after unit testing we will start adding one unit at a time to make debugging easier.

We will start by adding brake trigger to microcontroller unit and confirm their correct interaction. Then we will add them to the LED unit to check that braking would turn on brake signals on the LED unit.

In this part of testing we will integrate the accelerometer with microcontroller unit to test that free fall can be detected and correct output is produced after detection. Then we will add the LED unit and test that free fall would result in flashing of the brake signal. Then we will put all the units together, adding the Bluetooth speaker and put them in the helmet. Then we will test all possible combinations of inputs from triggering unit and check their results, we will test free fall of the helmet in addition to testing appropriate functioning of the Bluetooth speaker. The final stage would be installing the system on the bike to test usability in addition to correct functionality.

10. Conclusion

Cycle Bright Solutions is committed to providing an effective solution to improve the safety of cyclists. Our team is excited to propose the first Cycle Bright Solutions' product, the Smart Helmet. This product will introduce a safer way to communicate between cyclists and other vehicles and reduce the percentage of accidents.

Among the wide range of helmets already available on the market, our approach for this smart helmet is relatively inexpensive, safe and comfortable to use (fully integrated into the helmet, wireless and semi-autonomous) and we hope that it will kick-start a whole new generation of helmets.

The design specifications provided include specific information about individual components, their compatibility and a justification of their use. For instance, the Smart Helmet will have a strip of LEDs since its eco-friendly solution, individually addressable and arduino friendly. In addition, RF technology is used for wireless communication due to its simplicity and cost effectiveness. Furthermore, an accelerometer ADXL345 will be used for fall detection and brake events identifications. Finally, power options for the proof of concept are analyzed.

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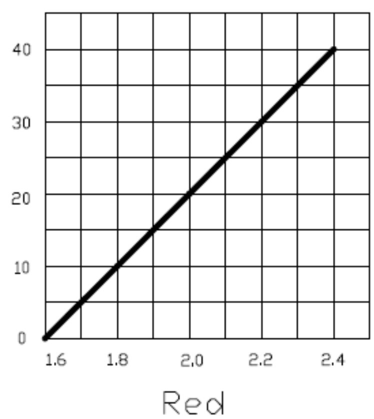
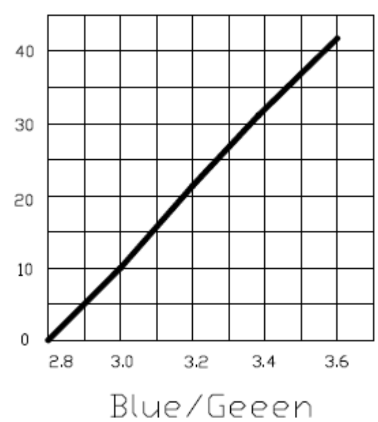
11. Appendix

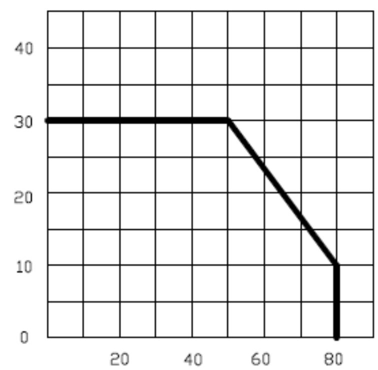
DREAMLAND

Technical data sheet
SMD 5050 RGB http://www.yuanlei-led.com

Opto-Electronical Characteristics:

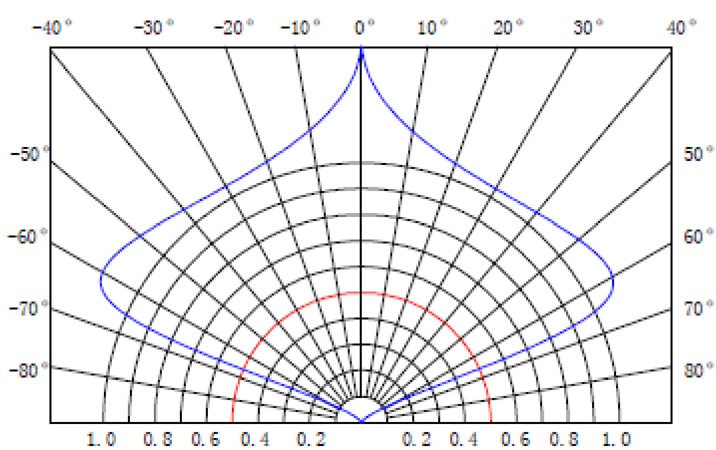






LED Chip Forward Current vs.Forward Voltage

LED Chip Maximum Forward Current vs. Ambient Temperature



Lighting Angle