February 15, 2016

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

Re: ENSC 440W Functional Specification for Nav-B system

Dear Dr. Rawicz,

Please accept the following document as a functional specification for our Heads Up Display project (Nav-B system). Our main goal is to design and implement a cycling navigation system that makes biking a safer and more enjoyable experience for cyclists. The implementation of our design provides users with real time navigational information, distance covered, current speed and time of day.

The purpose of this document is to present an overview of the functional specification of our proposed product without dwelling into excessive design content. The key items covered include the breakdown of the various stages of development, functional requirements for each feature, our approach to sustainability and conformant with prevailing Engineering standards.

EVR Tech consists of five talented and hardworking senior engineering students:Saumya Sangal, Aakriti Arora , Toky Saleh, Alan Zuo and Liangshuo Guo. If you have any questions pertaining to our product, please feel free to contact our COO by phone at 604-780-0467 or by email at aakritia@sfu.ca. We are very eager to hear your feedback of our product.

Kindest Regards,

Saumya Sangal
Chief Executive Officer
EVR Tech

Enclosure: Functional Specification of Nav-B system

Functional Specification for NAV-B system

A smart and safe bicycle system

Project Team:

Saumya Sangal
Aakriti Arora
Toky Saleh
Alan Zuo
Liangshuo Guo

Contact Person:

Aakriti Arora - aakritia@sfu.ca

Submitted to:

Dr. Andrew Rawicz-ENSC 440W
Steve Whitmore- ENSC 305W
School of Engineering Science
Simon Fraser University

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Executive Summary

In today's day and age, technology plays a pivotal role in improving the quality of human life. Across every sector we can see the positive impact it has had on our lives, especially the transportation sector which has come leaps and bounds from the turn of the millennium, so much so that self-driving cars are now a reality. Among these modes of transportation, cycling has yet to become that much smarter. As a matter of fact cyclists play an important role in British Columbia's transportation system. Almost one hundred and seven thousand people use bicycles as their primary transport [1]. Within the city of Vancouver itself, the month of August 2014 saw 195,000 bike trips on the Burrard Bridge [2]. However, according to ICBC, in only lower mainland British Columbia, 20.79% of cyclists were involved in accidents with 100% injury [1].

EVR Tech's Nav-B system seeks to address this problem for cyclists by providing them with the latest in OLED and Bluetooth technology to provide them with a safer and smarter ride. Our Nav-B system provides cyclists with real time route information, thus removing any need to ask or check for directions. The user will be able to view a number of metrics including their speed, distance covered and time of day. Our product model consists of four key components - a microcontroller, display module, downloadable smartphone application and a mechanical holding arm.

The development for our product will take place in three stages:

- **Development phase I** - Build and connect a smartphone app with the microcontroller over Bluetooth technology as well as implement additional modules
- **Development phase II** - Display output to screen and construct the chosen mechanical design
- **Model testing and final integration** – Integrate the final product and test for reliability and user safety

During each phase of development, care will be taken to adhere to the required engineering standards. For more information on which standards apply, the following document may be referred to. It is of utmost importance to the members at EVR Tech that our products are sustainable and safe for our users. For that reason we seek to utilize only select materials and ensure that extensive testing and modeling is performed on the Nav-B.

The following document details the functional requirements and specifications regarding our Nav-B, a HUD product. It is meant to be utilized by members of EVR Tech working in the hardware, software and quality assurance departments.

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Glossary

ABS - Acrylonitrile-Butadiene-Styrene, is a low cost engineering plastic that is easy to machine and fabricate [1]

Android- An operating system used for mobile devices by Google

API- It is an application program interface, a set of routines, protocols and tools for building software applications [2]

Arduino - Open-source electronics prototyping platform for hardware and software usage

EVR Tech - A company called “Electronic Visual Ride Tech” specialising in designing HUD products for cyclists.

GPS- The GPS (Global Positioning System) is a "constellation" of 24 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. [3]

HUD/ Heads Up Display - It is a wearable device at the eye level that allows user to view data on a screen or glass.

ICBC- Insurance Corporation of British Columbia

iOS- An operating system used for mobile devices by Apple Inc.

Lumineq - Lumineq Displays, a business unit of Beneq, is the world’s premier manufacturer and developer of thin film electroluminescent (TFEL) displays. [4]

OLED - Organic Light-emitting diode technology

Pla Plastic- (Poly Lactic Acid), It is a bio-degradable type of plastic that is manufactured out of plant-based resources such as corn starch or sugar cane. [5]

PlexiGlas- A trademark for a light, transparent, weather resistant thermoplastic. [5]

TFEL - Thin film electroluminescent displays [6]

USB - Universal Serial Bus used to connect computer to device.

1. Introduction

Cycling is an activity that is not just aesthetically pleasing for the health conscious individual but is also an affordable means of transportation. It has been observed that accident rates per kilometer are 26 to 48 times higher for two wheelers than for automobiles and nearly 44,000 cyclists have died in traffic crashes in the United States since 1932 [7]. Data from Canada suggests that provinces that have invested the most in cycling tend to have the highest rates of cycling and also the lowest rates of cycling mortality [8].

Figure 1: A sample HUD attached to a helmet [9]

The Nav-B, a product of EVR Tech, is a wearable HUD device that implements the latest advancements in OLED technology with a goal to make the ride for cyclists safer and more convenient. With our product, cyclists are better prepared on their travels as they no longer need to risk their safety by using their smartphones or pulling over for directions in unsafe and inconvenient locations. A sample HUD for two wheelers can be seen in Figure 1, where the route information and display is in the line of sight of the user. In order to use our product the user must simply download our app and enter their destination. Once the destination has been confirmed the user can attach the Nav-B onto their helmet and enjoy the benefits of hands free navigation and a range of metrics based on the user's performance.

1.1 Scope

This document describes the functional requirements and specification that must be met by the Nav-B heads up display. Among the key functionalities, it lists the requirements for the microcontroller, display module, smartphone application and the concerned mechanical design. Furthermore, this document provides a system overview, addresses the issues of sustainability and safety and documents standards that must be met at each stage of development. This document shall act as a resource for guidance during design, development and model testing of the Nav-B.

1.2 Intended Audience

The functional specification is intended for use by all members of EVR Tech. This document shall be referred to at each of the three stages of product development- development phase 1, development phase 2 and model testing and final integration. The functional requirements and the overall system overview will be used in both developmental phase stages by members assigned to hardware and software tasks. The sustainability and safety section and the standards section will aid the performance of the members assigned to quality assurance.

1.3 Classification

The following convention is utilized to number the functional requirement specifications in this document:

[R#-z]

Where ‘R’ is an abbreviation for requirement, ‘#’ is the functional requirement number and ‘z’ represents one of the following three stages of product development:

A. Development Phase 1
B. Development Phase 2
C. Model testing and final integration

As an example, [R45- C] would refer to functional requirement 45 and ‘C’ would refer to the Model testing and final integration stage of development.

2. System Requirements

2.1 Top Level Design

The requirements and specifications for the overall system are listed in this section. The working pipeline for the Nav-B system can be represented by the Top-level system diagram in Figure 2.

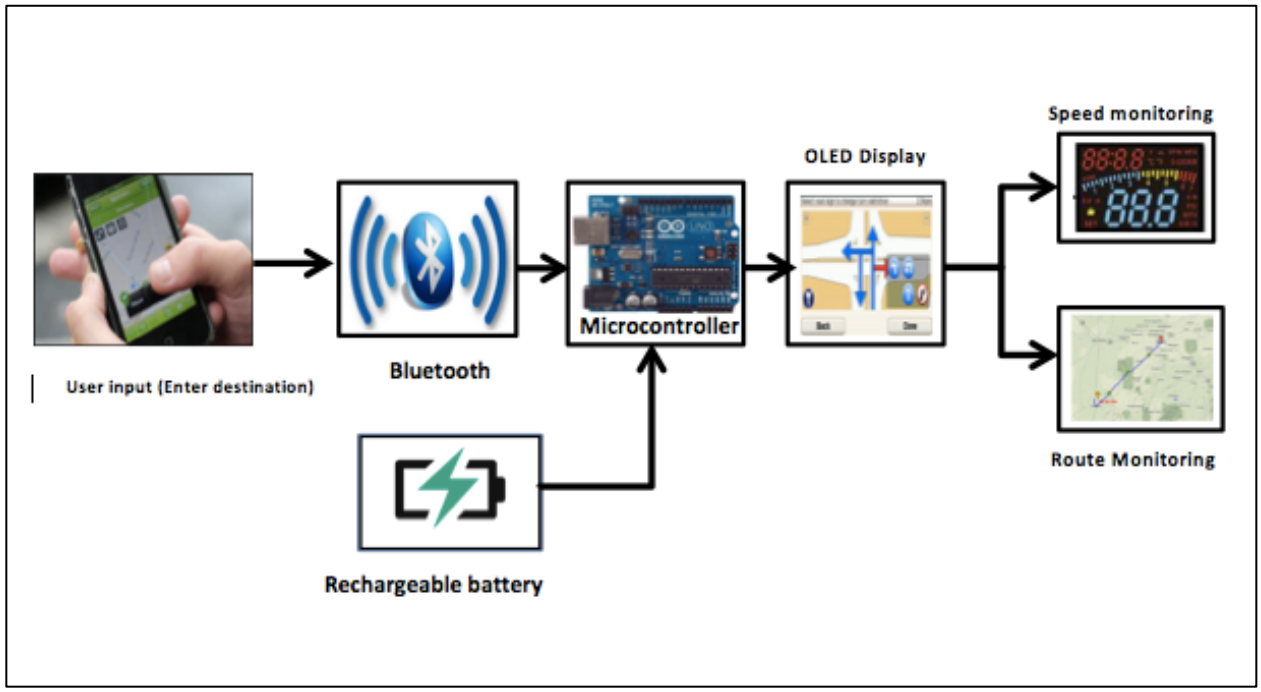

Figure 2: Top Level System Design

Nav-B consists of four primary working parts- the display module, a microcontroller, a smartphone application and the mechanical holding arm. The development and testing of each of these working parts is spread over the following three stages of development to give a linear and systematic pipeline.

2.1.1 Development Phase I

In order for the heads up display to provide any useful information to the user, the system must have user input in order to allow for the software to initiate the display process.To accommodate this, the first stage is concerned with the development of the app on the chosen platform. Figure 3 illustrates a sample user interface for the application, where the main functionality is to obtain the destination address from the user and transmit that using

Bluetooth technology. The route information is collected by the application using Google API services, which can be seen in Figure 4.

The data that is transmitted by the smartphone upon initialization of the application needs to be received and stored. For this purpose, the microcontroller will be designed at this stage with full Bluetooth and GPS capability.

At the end of this stage, there should be full connectivity between the microcontroller and the smartphone. The transmitted data from the smartphone should correspond with the stored data on the microcontroller and the current GPS coordinates calculated by the board should be displayed on the application user interface. Other metrics such as time travelled and distance covered are implemented at this stage to provide a secondary level of information.

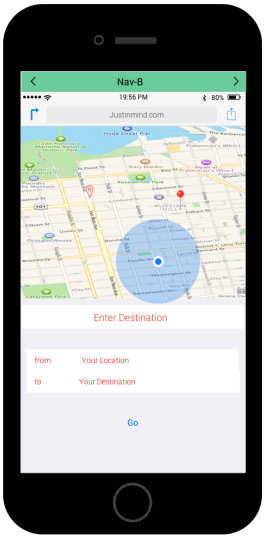

Figure 3: Smartphone application user interface

Figure 4: Google API functionality [10]

2.1.2 Development Phase II

The second stage of development concerns two primary components- the display module and the mechanical holding arm, the latter of which is implemented after the completion of the former. With the primary data collected and decoded by the microcontroller at the end of Stage 1, the display module is implemented with the necessary icons and data. Figure 5 provides a depiction of the link between the microcontroller and a sample display module.

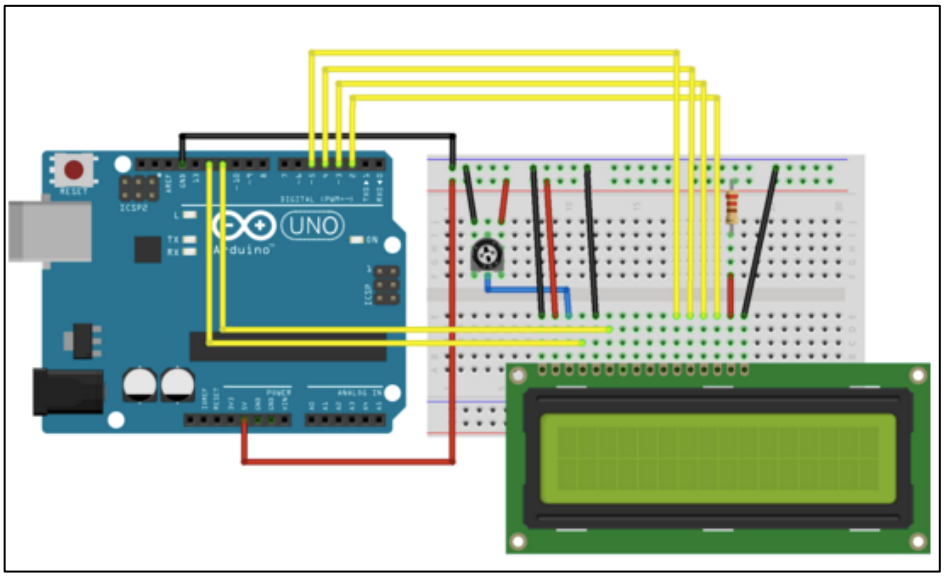

Figure 5: Display and microcontroller connectivity [11]

Upon completion of the display the mechanical design is implemented in order to connect each of the primary components to each other along with a rechargeable power source. Apart from linking the components, the main functionality of the holding arm is to be physically flexible so that the user may adjust the Nav-B such that it does hinder their view or cause annoyance.

At the end of this stage, there should be a fully functional display connected to the microcontroller and a mechanical holding arm designed to meet the proportions of the system components.

2.1.3 Model Testing and Final Integration

In the last stage of development the components are fitted into the mechanical holding arm and the product is tested at different angles and checks are run to ensure the design is not compromised. At this point, the Nav-B is clasped onto a helmet and is put through tests and safety procedures.

2.2 General Requirements

[R1-C] The Nav-B retail price shall be less than $250
[R2-C] The Nav-B shall be intuitive and easy to use
[R3-B] The Nav-B shall provide line of sight navigation
[R4-B] The Nav-B should be able to enhance the users' visibility on the road
[R5-B] The user shall be able to adjust the HUD
[R6-A] The Nav-B must be compatible with any smartphone (IOS and Android)
[R7-B] The user shall be able to track their performance speed
[R8-A] The Nav-B shall not interfere with other devices
[R9-B] The Nav-B shall have minimal wiring to the helmet and no outer protrusions
[R10-B] The Nav-B shall fit helmets of a generic size, shape and weight

2.3 Electrical Requirements

[R11-C] Power supply must be sufficient to power up all components in Nav-B
[R12-C] Rechargeable batteries shall be used to power the Nav-B
[R13-C] The power supply must last for up to 8hrs
[R14-C] Users can replace the battery easily, whenever battery replacement is required

2.4 Physical Requirements

[R15-C] The Nav-B shall be light weight and waterproof
[R16-B] The Nav-B shall be of adjustable size to fit almost every user
[R17-C] The Nav-B shall be fully compact and look appealing to the user
[R18-C] The Nav-B shall be comfortable and not bulky, fits securely and provides ample ventilation
[R19-B] The toggling mechanism should be small and easily accessible

2.5 Environmental Requirements

[R20-B] The Nav-B shall deliver the same performance regardless of the weather
[R21-B] The Nav-B should not obstruct the user's vision when wet
[R22-C] The Nav-B shall operate in extreme conditions such as heavy rains and strong winds
[R23-C] The display should be readable in any amount of sunlight

2.6 Reliability and Durability

[R24-C] The Nav-B shall be waterproof

[R25-C] The Nav-B shall be durable for everyday use

[R26-B] The Nav-B shall be relatively accessible to change the batteries

[R27-B] The Nav-B shall not have excessive heat dissipation

[R28-C] The Nav-B should be shock proof in an event

[R29-C] The mechanical arm should not bend or creak over time

[R30-B] The clasping mechanism should be firm and must not budge under stress

2.7 Standards

[R31-B] The Nav-B shall conform to CSA D113.2-M89 for cycling helmet [12]

[R32-C] The Nav-B shall conform to EU Directive 2001/95/CE [13]

[R33-B] The Nav-B shall conform to UL 8752/ULC-S8752 standard for OLED Panels [14]

[R34-B] The Nav-B Shall conform to ASTM E2641 - 09 standard practice for safe application of 3D imaging technology [15]

[R35-C] The Nav-B shall conform to the United Nations Economic commission for Europe (ECE) Regulation No.22 for marketing in Europe [16]

[R36-C] The Nav-B shall conform to SPE-1000 Canadian electrical code [17]

[R37-A] The Nav-B shall conform to National Electrical Safety Code (NFPA- 70) [18]

3. Microcontroller Unit Requirements

3.1 General Requirements

[R38-A] Microcontroller should be able to send data to smartphone via the latest bluetooth standards (up to v4.2)

[R39-C] Rechargeable battery is used to power the controller

[R40-B] Microcontroller will provide desired voltage to power up OLED display and bluetooth module

[R41-B] The microcontroller should be able to drive a segmented display with up to 15 segments or a screen with a resolution of up to 160x80 pixels

[R42-A] Microcontroller should not be easily reprogrammable

[R43-C] A pre-assembled board will be used for prototyping the system, however the final product will ship with a custom-designed PCB in order to minimize the electronics and prevent unauthorized used

3.2 Electrical Requirements

[R44-A] Microcontroller will be provided with 7-10 Volt power input

[R45-C] Rechargeable batteries will be used to power up Arduino up to to 6 hours

[R46-C] A Battery Elimination Circuit (BEC) will be used to power the electronics to their required voltage

3.3 Physical Requirements

[R47-A] Arduino will be used because of physical and specification requirements

[R48-A] Arduino will be connected via to the smartphone

[R49-C] Arduino will be mounted on helmet and should not cause any obstruction to the cyclist

[R50-C] The microcontroller compartment should be waterproof and resistant resistive to physical shocks

4. Smartphone Application Requirements

Smartphone applications are designed to get most from any device by focusing on user experience [19]. The application will be compatible with iPhone and will be connected via bluetooth, which will be connected to the Nav-B system. The user shall input the start and end location and routes will be provided on the HUD. The main purpose of this iOS application is to translate addresses to coordinates, calculate the best driving route, and send turn-by-turn instruction to the external display. Given the functions of this device we will design and test it such that it meets the standard requirements.

4.1 General Requirements

[R51-A] The application will run natively on iPhone newer than iPhone 4 models

[R52-A] The application will run on iOS version 8.0 or higher

[R53-A] The application will map user's current location

[R54-A] The application will save and display the list of addresses any given user has entered previously

[R55-B] The application will send instructions to the external display

[R56-A] The application will connect to the previous found bluetooth devices automatically once it is found

[R57-C] The application will display turn-by-turn instructions, distance to next turn and current speed on the screen

5. Display Requirements

5.1 General Requirements

[R58-B] The Nav-B will use TFEL display, which has a 360° viewing angle [7]

[R59-B] The display is 15 segmented [7]

[R60-A] The display should pair-up with smartphone via bluetooth standards (up to v4.2)

[R61-C] The display should be in the line of sight

[R62-C] The display will exhibit speed and route alerts

5.2 Electrical Requirements

[R63-B] Power consumption will be less than 3 Watts [7]

[R64-B] Power connector will be a mini USB [7]

5.3 Physical Requirements

[R65-B] The display will have glass size 55 × 62 × 2.2 mm [7]

[R66-B] The OLED display size is 50 × 57 mm [7]

[R67-B] Transparency of the display is greater than 80% [7]

[R68-C] The display will be covered with Plexiglas [7]

6. Mechanical Design Unit Requirements

6.1 General Requirements

[R69-B] The electrical components will be covered in a rubber shell with a slider to cover ventilation holes in rainy conditions

[R70-B] The mechanical design will be fully adjustable in direction and length depending on the user's preference [22]

6.2 Physical Requirements

[R71-B] The Nav-B holder shall be made of rubber material to absorb shocks

[R72-C] The Nav-B will have a shield of Plexiglas on the display to protect the user's eye

[R73-B] The Nav-B arm is modular and flexible [20]

6.3 Environmental Requirements

[R74-C] The Nav-B shall be waterproof and weather resistant

[R75-B] The Nav-B box shall have ventilation holes for heat dissipation

[R76-C] The Nav-B arm shall operate at a maximum temperature of 75°C [21]

7. Sustainability and Safety

At EVR Tech, we seek to design products that enhance the quality of life of our customers. To do so, we value the ideals of sustainability and the safety of our customers as our highest priority. It is for this reason that we have approached each stage of development with caution.

In order to ensure the Nav-B is sustainable in nature, we have adopted the tenets of the cradle to cradle cycle approach- Ecology, Economy and Equity. From an ecological perspective, our display screen will be limited to the latest advancements in OLED technology. As per Zheng-Hong Lu, the Canada Research Chair in Organic Optoelectronics, OLEDs are very light, bendable and Environment friendly [23]. The material for our mechanical holding arm will consist of using both ABS and PLA plastic. While ABS plastic is the ideal choice, we shall use PLA plastic as well for certain parts. The rationale for this decision is that PLA plastic is bio-degradable since it is made from corn starch or sugar cane unlike ABS plastic [24]. The use of rechargeable batteries is a key aspect of our design as it prevents the cycling of batteries over the life span of the product. In terms of Economy, it has been noted that OLEDs have a simpler manufacturing process which leads to them being more affordable [23]. Similarly our choice of microcontroller is based on the fact that we do not wish to use a significant number of ports or functionalities provided and thus have restricted ourselves to using the most cost friendly solution on the market. The issue of equity can be addressed by noting that we are striving to provide a technological solution that is more affordable than its competitors on the market. The issue of safety is of prior importance to any cyclist and when coupled with the fact that our OLED screens will have a significantly brighter lighting solution [24], we can say that the quality of life for our consumers will certainly increase.

Each component of the Nav-B system has been designed keeping in mind the safety of its users. The display has been limited to using OLED screens to have a significantly brighter display [23]. Furthermore in order to ensure that the screen remains shatter proof, the screen will be covered by a thin film of Plexiglas to prevent any glass particles from causing harm to the user. The holding arm plays the most vital role in ensuring the safety of our customers. The majority of the arm will be designed using ABS plastic, which is both light and sturdy [26]. Rubber coating will be provided around the microcontroller housing unit to prevent any electrical discharge. The arm itself is designed such that it has a number of vents on the lower end that provide a route for heat dissipation. However, the most significant attribute of the holding arm is its flexibility, which allows a user to move the screen vertically in front of their eyes as well as move the screen closer and further away from their eyes.

8. User Documentation

The section below defines the user documents required in order to ensure regular operation of the Nav-B system.

[R77-C] The user manual will cover iOS platform
[R78-C] User documentation will provide general support and troubleshooting information
[R79-C] A detailed technical troubleshooting guide will be created for technicians and vendors
[R80-C] Customer Support information will be available to consumers through our website

9. Conclusion

The functional requirements and specifications listed in this document will serve as a road map for EVR Tech in the production and implementation of the Nav-B system. The developmental phase has been divided into three main stages- development phase 1, development phase2 and model testing and final integration. Doing so enables us to focus on each of the four primary components as a singular unit. During each stage of development our priority remains to adhere strictly to each applicable standard and meet out sustainability and safety goals.

The functional requirements stated in the document are tentative and should the opportunity arrive we would like to include additional features such as call and text notifications. At EVR Tech, our team is fully committed to transform cycling into a smarter and safer experience.

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