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February 15, 2016

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Re: ENSC 305W/440W Functional Specifications for *PortableHUD*

Dear Dr. Rawicz:

The attached document from SafeVision is the Functional Specifications for a Safety System for Snowboarders/Cyclists /Motorcyclists, *PortableHUD*. We are designing and implementing a Heads Up Display (HUD) which shows GPS information, speed, temperature, and time. With the *PortableHUD* mounted on helmets, users could get the required information without losing their focus on their current activities. The *PortableHUD* could also send an emergency signal and communicate via RF radio within a group.

Our functional specifications provide a set of detailed functional requirements for all the features provided by the system. The production phase, concept of the standards, sustainability and safety concerns are included. Our senior engineers will refer to this document as a guide for research, design and development activities.

SafeVision consists of six hard working, detail-oriented, and motivated fourth-fifth year engineering students: Pak Lun Hoi, Xuemeng Monica Li, Amina Qurban, Anastasia Suprun, Yifeng Xie, and Qing Zhuang. If you have any questions or concerns about the functional specification, please feel free to contact our CEO by phone at (778) 828-6433 or e-mail at aqurban@sfu.ca.

Sincerely,

Amina Qurban
President and CEO
SafeVision

Enclosure: *Functional Specifications for PortableHUD*

Function Specifications for PortableHUD

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1.1

Executive Summary

The engineers at SafeVision believe that distractions are one of the most preventable causes of accidents. As a result, we designed *PortableHUD* as a way to minimize the distractions while performing sports activities. The functionalities of *PortableHUD* offer time, location, speed, and RF communication. *PortableHUD* can be used a versatile mount for different types of helmets used for various activities such as snowboarding, motor biking and cycling.

The development of the *PortableHUD* follows three stages: proof-of-concept, prototype revision, and production of final product:

Development stage I:

- Implement the main functionalities of the device such as time, temperature, GPS, and group communication
- Display the features on LCD

Development stage II:

- Additional features are added on the device such as SOS signal and camera recorder
- Make the device attachable to the helmet with folding mechanism, so when not in use it is positioned back to its original place

Development stage III:

- Implement a PCB with all the sensors built into the same board
- LCD is replaced with a transparent HUD, so users could see through it

Due to the limitation of time and resources, the main objective is to meet the proof of concept requirements. If time permits we will try to fulfill other requirements for prototyping and final product.

Moreover, we discussed about the specific engineering standards that apply to *PortableHUD*. By following these standards and regulations, we could ensure that our product is safe when it is being used.

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Glossary

ABS: Acrylonitrile butadiene styrene

CSA: Canadian Standards Association

dB: decibel

GPS: Global Positioning System

HUD: Heads Up Display

IEC: International Experience Canada

IEEE: The Institute of Electrical and Electronics Engineers

LCD: Liquid Crystal Display

RF: Radio Frequency

1. Introduction

Helmets are commonly used in many sport activities such as snowboarding, motor biking and cycling as it provides protection for the user's head. However, some of the most preventable accidents in sports are caused by distraction such as looking at a mobile device. The goal of the SafeVision team is to produce an attachable device for helmets that could provide GPS location, speed, temperature, and RF communication. *PortableHUD* allows providing information while causing minimum distractions to the user. Our product is also aimed to be cheaper comparing to our competitors such as BMW, Recon, and Skully.

PortableHUD does not require any modifications of the helmet nor glasses by mounting the product to the side of any helmet; thus, it makes our product unique. By using a Heads Up Display (HUD) attached to a helmet, SafeVision team is designing and implementing a device that would be portable and easily mountable to any type of helmets utilized for sports. *PortableHUD* consists of Master and Slave control panels, and extendable mount. The following Figure illustrates the CAD model of *PortableHUD* standalone:

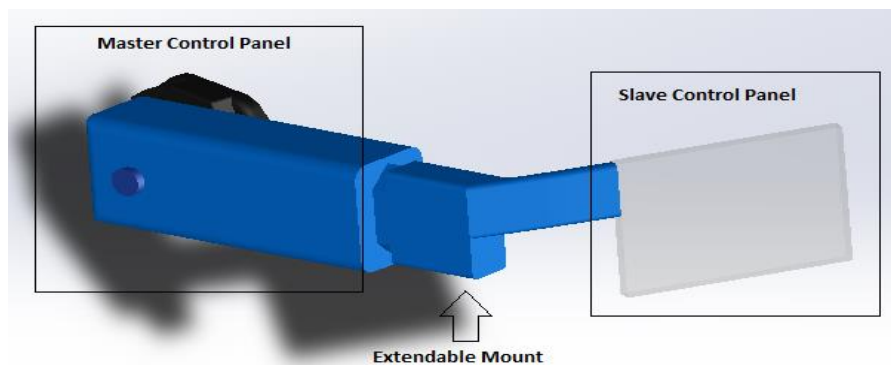


Figure 1: Front view of *PortableHUD*

As we can see from Figure 1 and 2, the Master Control Panel is located on the side of the helmet and the Slave Control Panel consisting LCD and located in front of the helmet.

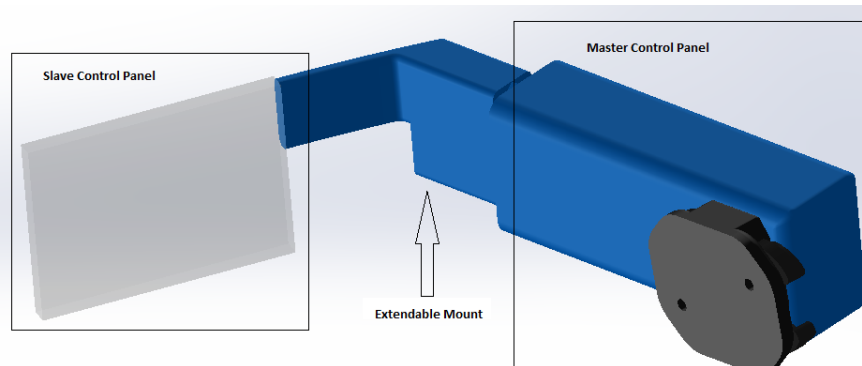


Figure 2: Rear view of *PortableHUD*

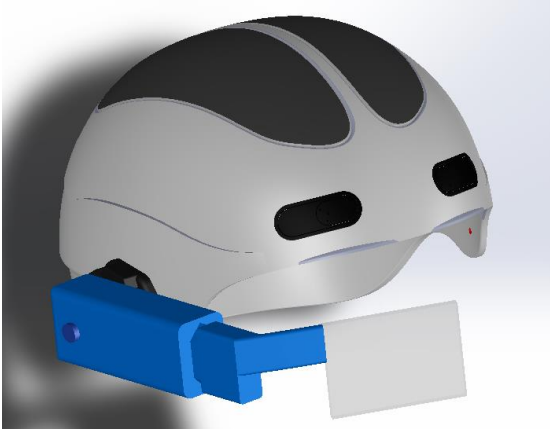


Figure 3: Front view when *PortableHUD* is attached to helmet

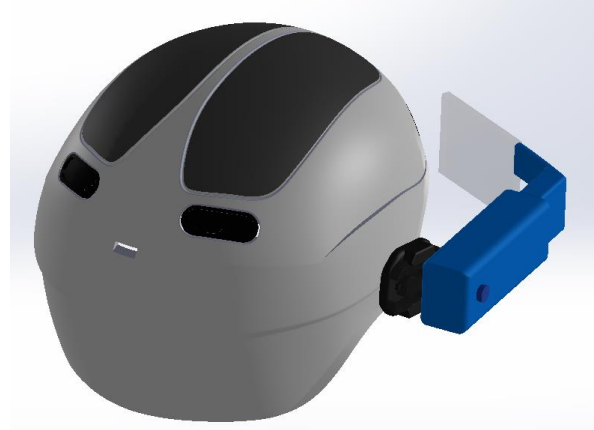


Figure 4: Back view when *PortableHUD* is attached to helmet

1.1 Scope

The following documentation provides details about the functionality of *PortableHUD*, which includes the requirements for the proof-of-concept, prototype and final product. The requirements are labeled accordingly through the document as a reference for future development and documentation.

1.2 Intended Audience

The intended audience of this document includes all the engineers involved in the development of *PortableHUD*, stakeholders and the board of the company. The senior engineers could use this document as reference for functional clarification; whereas, stakeholders are informed of the risks and progress through this documentation. The board of the company is provided this information to distribute resources and track the progress during the development period of *PortableHUD*.

1.3 Classification

Throughout the document, the following conventions are used to indicate the functional requirements:

[ReqX-P]

where X is the functional requirement number and P is the priority of the functional requirement denoted by one of the three values:

- I The requirement applies to proof-of-concept
- II The requirement applies to prototype revisions
- III The requirement applies to final product

2. System Overview

PortableHUD provides a way to combine some of the functionalities of the mobile device into a Heads Up Display (HUD) to minimize distractions. Users are able to communicate with their team members using RF communication components, look at the time, send a signal, check the current temperature, and monitor the speed. All the parts of *PortableHUD* are created to fit into a standard mount of a helmet to provide user with the flexibility to change helmets for different types of sports.

2.1 Top level Design

PortableHUD consists of two separate boards: Arduino Uno, Arduino Nano. The Arduino Uno shall be a part of the Master control panel for processing the majority of information received from the sensors. The Master control panel shall perform the calculation from the latitude, longitude, and altitude from GPS module when sending an emergency signal. The RF receiver is being handled by the Master control panel while the RF transmitter is being handled by the Slave control panel. The Arduino Nano shall be a part of the Slave control panel for displaying the information on the LCD and broadcasting the radio transmission through speakers. The block diagram of *PortableHUD* is demonstrated on the diagram below:

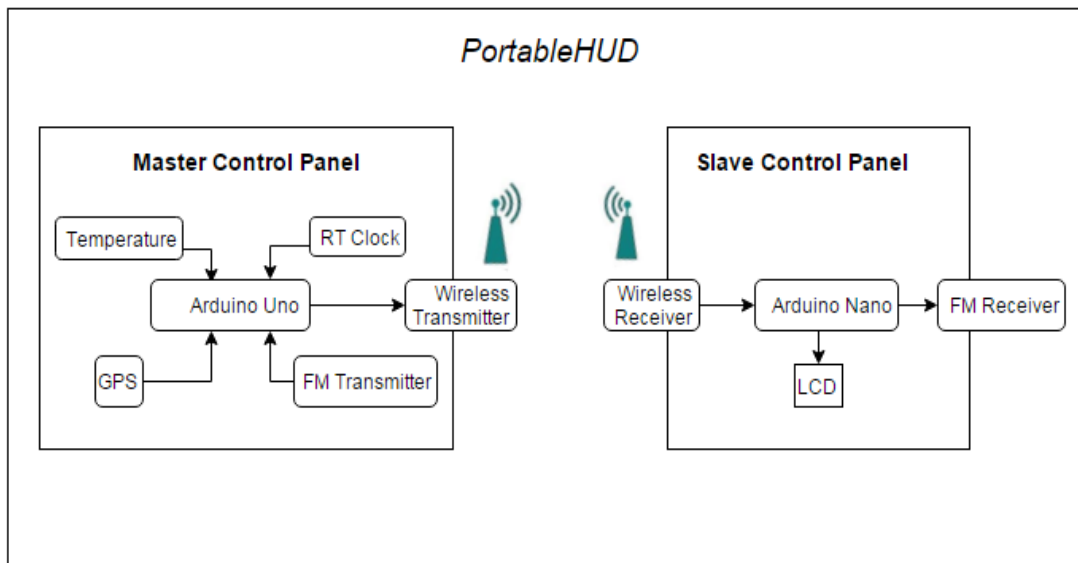


Figure 5: Block Diagram of *PortableHUD*

3. General Requirements

The following are the general requirements used for designing *PortableHUD*. It is used as a guideline to ensure that the functionality and specification are met when the project is being developed.

- [Req 3.1-I] *PortableHUD* is designed to be used outdoors
- [Req 3.2-I] *PortableHUD* shall be compatible with mounts on the helmet
- [Req 3.3-II] Product shall be intuitive so that users can configure the system in less than 20 minutes
- [Req 3.4-II] Retail Price shall not exceed \$410
- [Req 3.5-II] The system shall be powered either using a 9V DC battery or a solar panel
- [Req 3.6-I] The power supply shall be sufficient to power all the modules including the main board and sensors for minimum 2 hours
- [Req 3.7-II] The power function shall be able to power the system under normal temperature range (-40°C ~+ 40°C)
- [Req 3.8-II] The dimension of the Master control panel for *PortableHUD* shall be less than 14cm x 6cm x 5cm
- [Req 3.9-II] The dimension of the Slave control panel for *PortableHUD* shall be less than 9cm x 7cm x 2.5cm
- [Req 3.10-II] The dimension of the extendable mount for *PortableHUD* shall be extended from 13cm to 18cm
- [Req 3.11-II] The weight of the system shall be at most 300g
- [Req 3.12-II] The GPS, temperature, time, speaker, microphone, transmitter, and radio receiver shall be mountable on the Master control panel
- [Req 3.13-II] The LCD shall be on the Slave control panel

3.1 GPS

GPS module provides altitude, latitude, longitude, speed, and time (time zone gets from the longitude). The module sends the coordinates of the user's location in an emergency situation. The following specification is from NEO-6M GPS module [1]:

- [Req 3.1.1-I] The GPS module shall be able to provide location information accurately with less than 2 meters error
- [Req 3.1.2-II] The module shall be able to track over 10 satellites
- [Req 3.1.3-II] The location update shall be at least 5 locations per second
- [Req 3.1.4-III] The power consumption for GPS module shall be lower than 0.5Watts
- [Req 3.1.5-III] The module shall be able to fit into the enclosure with antenna attached
- [Req 3.1.6-II] The sensitivity shall be 160 dBm

3.2 Temperature

Temperature sensor measures the current temperature and transforms the signal into temperature to display on the screen [2]:

- [Req 3.2.1-III] The measurable temperature range shall be -50°C to 60°C
- [Req 3.2.2-III] The accuracy shall be 0.5°C, with 10mV/°C scale factor
- [Req 3.2.3-II] The operating voltage ranges shall be from 4V to 30V
- [Req 3.2.4-I] The system shall be able to measure temperature linearly and nonlinearly

3.3 RF Communication

The radio frequency communication's primary function is to help group users to communicate with each other when they are exercising. Users could choose one of the radio frequencies out of seven. The following requirements reflect the guidelines prescribed by CSA, International [3].

- [Req 3.3.1-I] The communication range of the system shall be up to 1km
- [Req 3.3.2-I] The system shall have at least 7 available channels to be chosen from
- [Req 3.3.3-I] The volume of the speaker shall be adjustable between 30 dB to 70 dB
- [Req 3.3.4-I] The noise of microphone shall be lower than 20 dB when moving under 60 km/hour
- [Req 3.3.5-II] The control button shall be located conveniently on the Master control panel of *PortableHUD*

3.4 Wireless Data Transmission

The wireless data transmission is to establish a connection between Master and Slave control panels to prevent mechanical damage on wires.

- [Req 3.4.1-II] Transmission shall be between both control panels to send and receive data.
- [Req 3.4.2-II] The wireless data communicates with *PortableHUDs* and shall not cause interference for other products
- [Req 3.4.3-II] The transmitter is placed on the Slave control panel and the receiver is placed on the Master control panel

3.5 Liquid Crystal Display

All the features above are displayed on a LCD which is connected to the Slave control panel. The screen is adjustable using folded mounted mechanism. The LCD has different display modes to minimize the amount of information displayed at the same time.

The following figures illustrate the proposed design for different display modes:

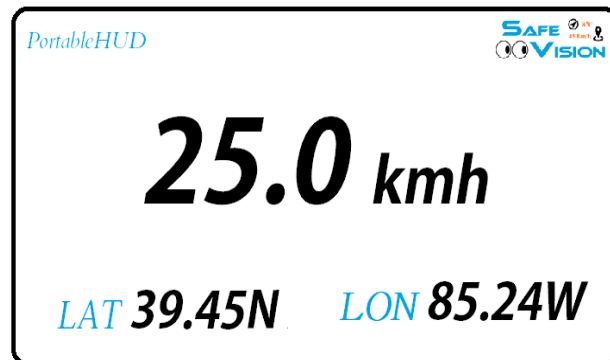


Figure 6: LCD displaying speed and location

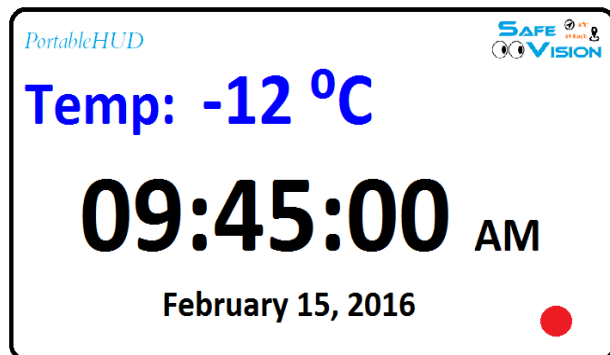


Figure 7: LCD displaying time, date, and temperature

- [Req 3.5.1-I] The LCD shall display required information without being distractive
- [Req 3.5.2-I] The display shall not have more than 2 types of data simultaneously so it is not distracting
- [Req 3.5.3-II] The display modes shall respond within 3 seconds
- [Req 3.5.4-II] The display shall be adjustable for user to set the most comfortable position
- [Req 3.5.5-III] The screen shall be see through so it does not block the users view

3.6 Extendable Support

The extendable support provides mechanism which contains all the circuitry and wiring. The mechanical support of *PortableHUD* is displayed in Figure1 of the introduction.

- [Req 3.6.1-II] The support system shall be mounted easily on different helmets
- [Req 3.6.2-II] The material shall be high impact plastic or ABS to provide reliable rigidity from falling down
- [Req 3.6.3-I] The system shall be able to move up and down on the helmet based on user needs
- [Req 3.6.4-I] Both the support system and the extension part shall be able to hold the position without slipping
- [Req 3.6.5-II] The dimension of the extendable support is 181mm x 40mm x 30mm when extended and 132mm x 40mm x 30mm without Slave control panel when folded.

4. Reliability and Durability

One of the aspects for the product to be successful on the market is to be reliable and last over a long period of time without the need of replacement:

- [Req 4.1-I] When *PortableHUD* is mounted to the side of the helmet, the helmet strap shall still withstand 19.6 J impact by dropping a 2 kg weight 1 m and shall not fail nor elongate more than 25 mm [4]
- [Req 4.2-I] *PortableHUD* shall operate properly at the extreme temperatures specified in [Req 3.7-II]
- [Req 4.3-III] At mass production acquisition and testing random *PortableHUD* samples in the independent laboratory of to verify compliance shall be passed
- [Req 4.4-I] *PortableHUD* shall not block peripheral vision by less than 105° from the helmet midline [5]
- [Req 4.5-I] Ventilation shall not be affected by *PortableHUD*
- [Req 4.6-I] The hardware parts shall be secured properly to prevent loose of components [6]

5. Safety Requirements

Safety requirements are highly important when it comes to the mass production. The following section covers safety requirements that have to be considered while designing *PortableHUD*:

- [Req 5.1-I] Integrity of the helmet shall not be compromised due to the presence of the *PortableHUD*
- [Req 5.2-I] Positional stability or "roll off" test shall be passed [6]
- [Req 5.3-I] Helmet with *PortableHUD* shall pass turn upside down and drop onto an anvil test with accelerometer inside the head form registering less than 300 g's during the impact [6]
- [Req 5.4-I] *PortableHUD* shall not cause destructive interference with the functionality
- [Req 5.5-I] Electronic components shall be isolated from the exposed parts of a body due to the heat dissipation
- [Req 5.6-I] The edges of the mechanical support for the display shall be harmless to a user
- [Req 5.7-II] The noise level of the HUD shall be lower than 40 dB to prevent noise health effects [7]

6. Sustainability

Based on the idealized concept of cradle-to-cradle, in SafeVision, we are focusing on making sure the products have as little negative impact on the environment as possible.

- [Req 6.1-II] The system shall only use RoHS compliant materials under category 4: Consumer Electronics [8]
- [Req 6.2-II] *PortableHUD* shall be produced using highly recyclable support and outer enclosure
- [Req 6.3-II] The electrical hardware shall only contain lead free components and solder
- [Req 6.4-II] The components of *PortableHUD* shall follow cradle-to-cradle methodology

7. Engineering Standards

The following are the engineering standards used during the development of *PortableHUD* to make a reliable product and to ensure the safety of customers.

- [Req 7.1-II] The device shall be in compliance with IEC 60065:2014 safety standard for providing audio and video information on electronic devices [9]
- [Req 7.2-II] The device shall be in compliance with IEEE 139-1988 standard for not producing any harmful radiation from wireless or radio components [10]
- [Req 7.3-II] The device shall be in compliance with CSA Z263.1 standard for keeping the safety functionality of the helmet by not altering it [11]

8. Luxury Functions

The following extra features can be introduced to broaden the *PortableHUD* functionalities to interest wide range of users:

- [Req 8.1-III] Folding mechanism of the LCD back to base position shall be automated by introducing an additional button
- [Req 8.2-III] Camera recorder shall be installed on the Slave control panel with possibility to store taken pictures/videos on a flash memory
- [Req 8.3-III] GPS coordinated shall be sent to the cloud database in order to track the location of the user

9. User Documentation

This section describes the requirement for the user documentation that will be provided with *PortableHUD*.

- [Req 9.1-III] User manual shall be provided with detailed explanation of *PortableHUD* functionalities
- [Req 9.2-III] Installation section of the user manual shall be provided for mounting the device on a helmet
- [Req 9.3-III] User documentation shall be provided on most common languages to satisfy product language requirements for international market
- [Req 9.4-III] User documentation should be accessible through company's website

10. Conclusion

The statistics presented in the SafeVision proposal suggests that accidents are caused by distractive driving. As a result, SafeVision team goal is to build a portable Heads Up display to as an attachable device for various types of helmets. *PortableHUD* is an alternative way to view information without needing to change focus, which would increase the safety of the individual. With the flexibility to mount on different types of helmet, users are able to use it for different activities such as cycling, motorcycling, and snowboarding.

The functional specification report presents an overview of the main objectives of *PortableHUD* and lists the requirements of development goals for the design process of the product. The requirements are listed with different priorities so that SafeVision team can have a clear idea on which parts are the most important for the specific design stages.

Some luxury functions are listed to improve a safety aspect and add more selling points for the *PortableHUD*. SafeVision has a clear vision of our main goal provided in this report and we understand the different priorities during each design stage. Also, we have the confidence in finishing the *PortableHUD* and we can deliver the product on time for the demonstration.

References

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