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February 19, 2017

Dr. Andrew Rawicz
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Re: Requirements Documentation for NoStress GPS

Dear Dr. Rawicz:

The attached document, *Requirements Documentation for NoStress GPS*, details the functionality as well as requirements that are to be followed during the development of NoStress GPS. We the team of NoStress aim to tackle the problem of distracted driving resulting due to conventional navigation systems by offering an innovative solution. NoStress GPS is a fully transparent HUD navigation system mounted behind the steering wheel. The transparency of the display allows the driver to clearly see the road ahead, even when using our product.

This document provides an exhaustive list of the functionalities and requirements that are to be followed during the development of NoStress GPS. It provides a set of requirements for the system's functionality for both the proof-of-concept and production phases of development. The NoStress team of seasoned engineers will use the attached document as the benchmark for further research, design, and implementation.

Our team at NoStress consists of extremely talented and dedicated Engineering Students: Evgeny Kuznetsov, Gur Kohli, Himanshu Garg, Mikael Saad and Svetlana Borkovkina.

Thank you for your time. For any questions and concerns about the proposal, please contact us by email at hgarg@sfu.ca.

Sincerely,

Gur Kohli

Gur Kohli
Enclosure: *Requirements Documentation for NoStress GPS*

Requirements Documentation for
NoStress GPS

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Abstract

Distracted driving is a leading cause of car crash fatalities in B.C. As per ICBC, on average 81 people die yearly in crashes primarily due to distracted driving. It is responsible for 27% of all car crash fatalities in B.C. [1] NoStress proposes to fix this problem by developing their product, NoStress GPS. Our product will offer a navigation system easier to use than conventional smartphone apps and more convenient and safe than conventional GPS. Our GPS will mount behind the steering wheel and will contain a transparent display that means the driver will never need to take his eyes off the road even for a split second. Connected with and controlled via our smartphone app, the GPS will always stay up-to-date. This document provides an exhaustive list of the functionalities and requirements that are to be followed during the development of NoStress GPS. It includes functional and nonfunctional requirements for proof-of-concept, prototype and the final product stages. It is intended to convey to the stakeholders, an exhaustive list of requirements that shall be followed and standards that shall be maintained during the development of the NoStress GPS.

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Introduction

Distracted driving is a leading cause of car crash fatalities in B.C. [1] Distracted driving is a form of impaired driving as a driver's judgment is compromised when they are not fully focused on the road. Talking on a cell phone, texting, reading, using a GPS, watching videos or movies, eating, smoking, personal grooming, adjusting the radio and playing extremely loud music, all qualify as distracted driving. One of the most common distractions behind the wheel is a mobile electronic device. People these days rely on some type of navigation system, either using a GPS Navigator or a smartphone for this purpose. However, reading or typing directions on a GPS while using a smartphone application for getting navigation instructions also cause drivers to take their eyes off the road. At NoStress, we would like to improve distracted driving by introducing our product “NoStress GPS”. NoStress GPS is designed to provide a safe and reliable alternative to the current competition and work around their limitations by offering a transparent display coupled with a simple and intuitive user interface, while being affordable to the average user. The primary objective of our product is to allow drivers to navigate while keeping their full attention on the road.

Several car manufacturers are trying to address this problem by integrating heads-up displays (HUDs) in the car itself but this is mostly available in newer high-end models at a premium price. [2] We are focused on creating an inexpensive GPS navigation system that offers a user experience of the same scale as the premium HUDs but at a much more affordable price.

With the NoStress GPS, users will be able to follow the navigation, get an estimated time of arrival to the destination and make decisions to change lanes well in advance all while keeping their eyes on the road at all times. NoStress GPS is designed in such a way that the transparent display only provides timely, relevant and useful information to the user resulting in a stress-free user experience. We plan to develop next generation GPS system that will provide more functionality than our competitors and will be available to average vehicle user. Our product incorporates a light sensor that sends information about the ambient light around the product to the display controller. The display controller that powers and buffers the display can use this information to effectively increase or reduce the brightness of the screen to stay consistent whether it’s day or night, an accelerometer coupled with a compass to accurately provide the car’s velocity used to offer lane suggestions to the user and to keep track of the car’s orientation, and programmable buttons to offer a quick way for the user to quickly use the GPS without even unlocking their smart phones.

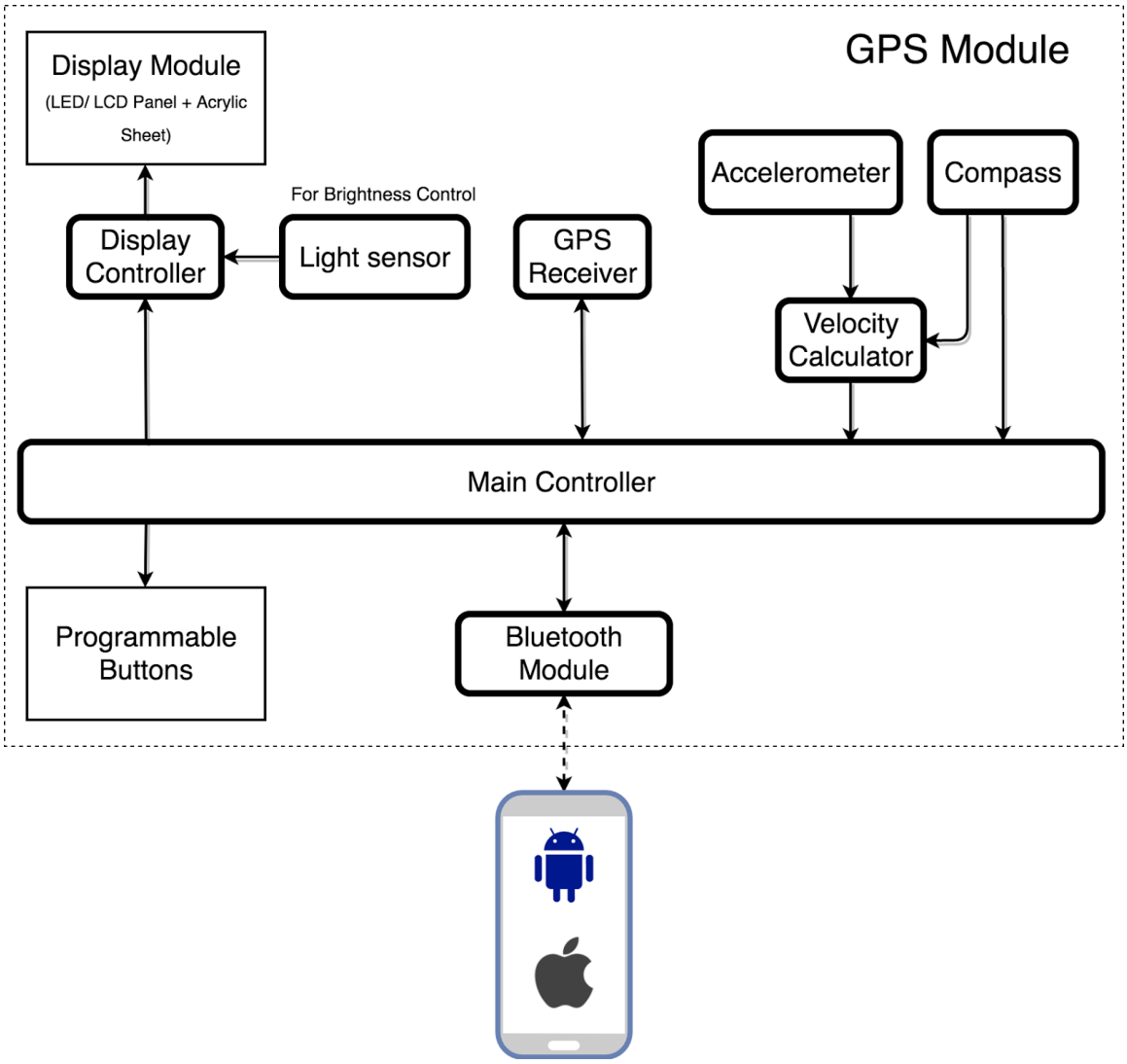

Figure 1 - High Level Diagram

Scope

The following requirements documentations details the functionality as well as requirements that are to be followed during the development of NoStress GPS. It includes functional and nonfunctional requirements for proof-of-concept, prototype and the final product stages. These requirements have each been given a unique identifier to facilitate future development.

Intended Audience

The intended audience of this requirements documentation consist of the development team of NoStress, the board of directors, and NoStress' stakeholders. This documentation is intended to convey

to the stakeholders, an exhaustive list of requirements that shall be followed and standards that shall be maintained during the development of the NoStress GPS. The documentation is further intended for the development team to track their progress and as a validation tool.

Classification

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

Req_xx-P

Where,

xx: Functional Requirement Number

P: Priority (I = Proof of concept, II = Prototype, III = Final Product)

Glossary

GPS	Global Positioning System is a space-based radio navigation system that provides geolocation and time information.
LCD	Liquid crystal display, a type of display screen.
HUD	Heads Up Display.
API	Application Program Interface is a set of routines, protocols, and tools for building software applications.
Arduino	Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.
Raspberry Pi	Raspberry Pi is a low-cost, basic computer that was originally intended to help spur interest in computing among school-aged children. The Raspberry Pi is contained on a single circuit board and features ports for: HDMI. USB 2.0. Composite video.
LED	Light-emitting diode, a p-n diode that produces light when current is applied to it.
iOS	An operating system used for mobile devices manufactured by Apple Inc.
Android	An open-source operating system used for smart phones and tablet computers.
Open Source	Denoting software for which the original source code is made freely available and may be redistributed and modified.
Bluetooth	A IEEE 802.15 standard for the short-range wireless interconnection of mobile phones, computers, and other electronic devices.
PCB	Printed circuit board

System Overview

NoStress GPS combines functionalities of conventional Navigation systems into a transparent Heads Up Display (HUD) to minimize distractions while driving. User starts by connecting their smartphone to NoStress GPS module. The user then inputs the destination address into the Android/iOS application on their smartphone. The phone makes a request to a Geocoding API which responds with the latitude and longitudinal coordinates. These coordinates are then forwarded to "Open Source Routing Machine" [3] which responds with a list of waypoints which give the shortest route from Source to Destination. These waypoints are sent over to NoStress GPS via Bluetooth. At this point the device runs independent of the phone. The route is displayed graphically on the transparent screen using a Map Processing API and the coordinates are kept updated using the on-board GPS chip.

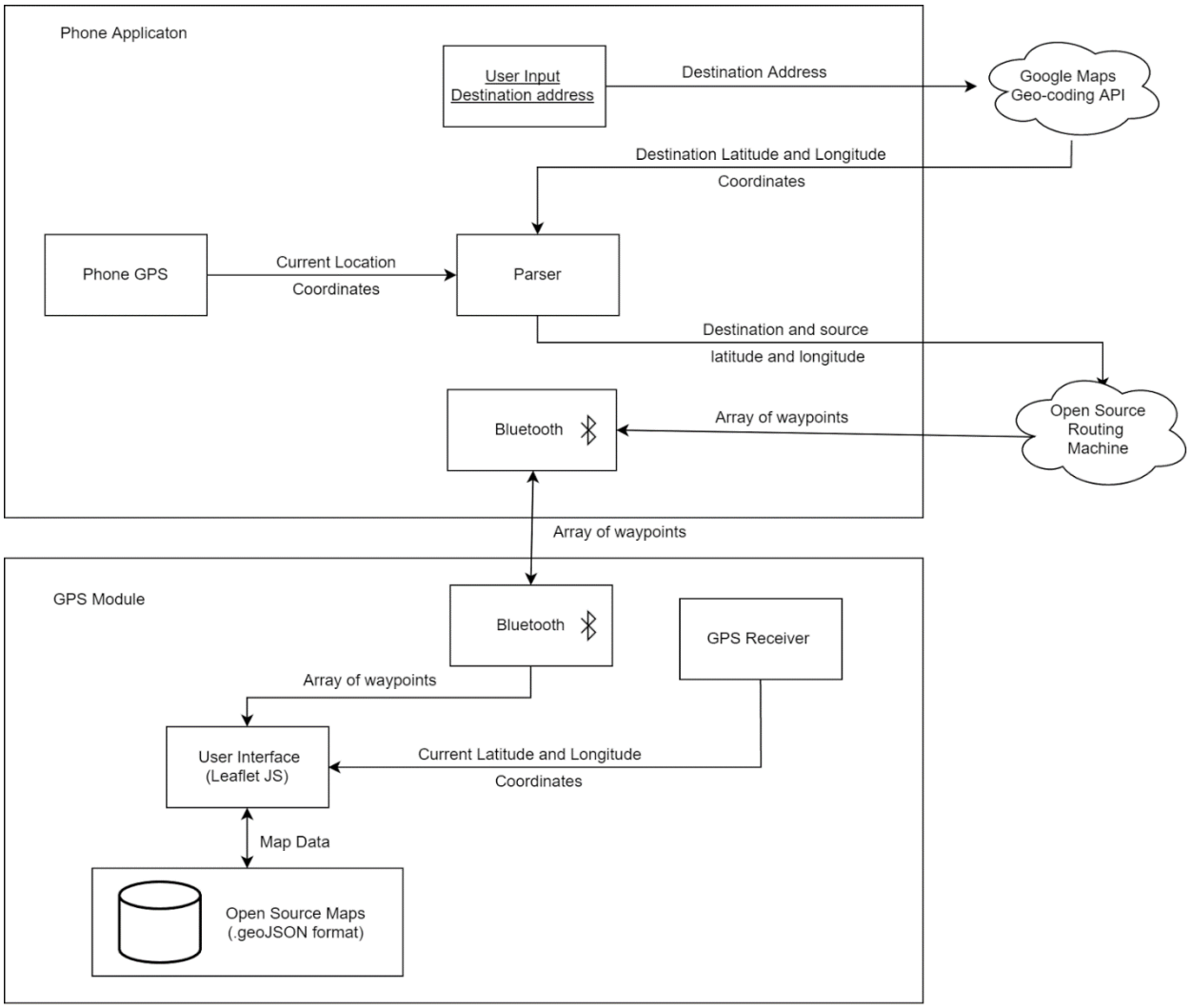

Figure 2 - High Level Data Path

1 System Requirements

For proof of concept and prototype version of the product, we will use a Raspberry Pi as main microprocessor and an Arduino for communication with the display. For production version, we will create a custom PCB that will contain all the modules necessary.

1.1 General Requirements

Req_1.1.1-III	The retail price of the product shall be under $300
Req_1.1.2-I	The driver is the intended operator of the product
Req_1.1.3-I	The device shall be used in an indoor environment

1.2 Performance

Req_1.2.1-II	After setting a destination on the phone application, screen shall display directions within 10 seconds

1.3 Electrical Requirements

Req_1.3.1-I	The product must be powered by a standard car charger capable of delivering at least 2.5A current at 5V.

1.4 Reliability and Durability

Req_1.4.1-III	The product shall last for at least three years without needing parts replacement
Req_1.4.2-III	The product shall withstand a fall from a height of one meter on concrete floor
Req_1.4.3-II	The product shall operate properly in temperatures between -10 to +40C
Req_1.4.4-II	Hardware parts shall be securely installed to prevent loose components
Req_1.4.5-I	The product shall gracefully shutdown in case of power failures.

1.5 Usability

Req_1.5.1-I	Basic functionality, like setting a destination, shall be intuitively understood by a user without the need for instructions
Req_1.5.2-II	The product shall be easily adjusted for different users after their height
Req_1.5.3-III	User manual shall be provided alongside with product upon purchase inside the product package.
Req_1.5.4-III	User manual shall be available on the company website in “pdf” format for downloading and printing.
Req_1.5.5-III	Company web page shall contain inquiry request prompt for user's question and support upon product release.

2 Hardware Requirements

2.1 Enclosure

Req_2.1.1-I	The proof of concept shall have no enclosure.
Req_2.1.2-II	For the prototype, the enclosure shall be 3D printed.
Req_2.1.3-III	For the final version, the enclosure shall be made out of a mold for cheaper mass production.
Req_2.1.4-II	The enclosure length and width shall not exceed the length and width of the LED/LCD display by more than 5 inches.
Req_2.1.5-II	The enclosure thickness shall not exceed the thickness of Microcontroller + LED/LCD display by more than 10 inches.

2.2 Transparent Sheet

Req_2.2.1-II	The transparent sheet shall have a final size of at most 5” diagonally.
Req_2.2.2-II	The transparent sheet shall have a minimum thickness of 0.050 inches.
Req_2.2.3-II	The transparent sheet shall be made of a flexible clear material like acrylic or polystyrene.
Req_2.2.4-II	The transparent sheet shall be coated with an anti-glare coating.

2.3 LED/LCD Panel

Req_2.3.1-II	The LED/LCD panel shall have a minimum brightness of 900 Cd/m^2 to effectively project light onto acrylic sheet even on bright days.
Req_2.3.2-II	The LED/LCD panel shall have a minimum pixel resolution of 800 * 480 pixels.
Req_2.3.3-II	The LED/LCD panel shall be interfaced by a 40 pin TTL connector.
Req_2.3.4-II	The LED/LCD panel shall be connected to the micro controller via a 40 pin interface capable to buffer and refresh the LED/LCD panels at 60 Hz.

2.4 GPS Receiver

Req_2.4.1-II	The GPS receiver shall have a minimum update rate of 1 Hz.
Req_2.4.2-II	The GPS receiver shall triangulate and calculate the first lock within 30 seconds of being powered up.
Req_2.4.3-II	The GPS receiver shall then each subsequent locks within 3 seconds.
Req_2.4.4-II	The GPS receiver shall have a precision of +- 5 meters.
Req_2.4.5-II	The GPS receiver shall contain a minimum of 12 channels for faster triangulation.

2.5 Compass (Magnetometer)

Req_2.5.1-II The magnetometer shall be three axes to help the accelerometer provide an acceptable rotation accuracy.

Req_2.5.2-II The compass shall have a minimum update rate of 5 Hz.

Req_2.5.3-II The compass chip shall stay reliably accurate with a maximum tolerance limit of +- 2 degrees for long periods of time.

Req_2.5.4-III The magnetometer shall function reliably with a maximum tolerance of one "failure" in one month.

- A "failure" is defined as inability to provide data, providing bad data, significant delay in measurements or other failures relevant to a magnetometer.

Req_2.5.5-II A reset mechanism triggered by a button shall be implemented which, in the case of such failure, resets the magnetometer module.

2.6 Accelerometer

Req_2.6.1-II The accelerometer shall have a minimum sensitivity of +- 2g

Req_2.6.2-II The accelerometer readings shall be sampled at a time period of <100ms to calculate the speed of the vehicle with respect to each axis.

Req_2.6.3-III The accelerometer shall function reliably with a maximum tolerance of one "failure" in one month.

- A "failure" is defined as inability to provide data, providing bad data, significant delay in measurements or other failures relevant to an accelerometer.

Req_2.6.4-II A reset mechanism triggered by a button shall be implemented which, in the case of such failure, resets the accelerometer module.

2.7 Bluetooth chip

Req_2.7.1-II The Bluetooth chip shall reconnect with devices automatically.

Req_2.7.2-II The Bluetooth chip shall have adequate range with a minimum radius of one average car length (4.5 meters).

Req_2.7.3-III The Bluetooth chip shall be reliable with a maximum tolerance of one "failure" in one month.

- A "failure" is defined as inability to be recognized by or connect to a smartphone, inability to be recognized by or connect to reverse camera, sudden disconnection from camera or other failures relevant to a Bluetooth chip or Bluetooth functionality.

Req_2.7.4-II A reset mechanism triggered by a button shall be implemented which, in the case of such failure, resets the Bluetooth module.

2.8 Buttons

Req_2.8.1-II	There shall be 5 push buttons.
Req_2.8.2-II	The buttons shall be accessible from outside the enclosure.
Req_2.8.3-II	The buttons shall be debounced to prevent multiple inputs.
Req_2.8.4-II	The buttons shall have a minimum lifespan of 500000 clicks.
Req_2.8.5-II	The buttons shall offer a 'click' feedback when pressed.
Req_2.8.6-II	There shall be a reset button at the back of the enclosure.
Req_2.8.7-II	The reset button shall reset and calibrate all sensors and restart the GPS module.

3 Mechanical Requirements

3.1 Display Mechanism

Req_3.1.1-II	The LED/ LCD Panel shall rest atop the enclosure at a tilt angle with the enclosure.
Req_3.1.2-II	The tilt angle shall be set such that the transparent sheet is optimally bright.
Req_3.1.3-II	The transparent sheet shall be placed at an obtuse angle with the enclosure to be at eye level of the user.
Req_3.1.4-II	The angle shall be set such that there is minimal glare from the LED/ LCD panel.

3.2 Affixing Mechanism

Req_3.2.1-II	The enclosure shall be affixed onto the dashboard via a 3M adhesive tape.
Req_3.2.2-II	A disk shall be affixed at the bottom of the enclosure.
Req_3.2.3-II	The disk shall be made of a flex plastic material.
Req_3.2.4-II	The disk shall contain a thick 3M adhesive tape at the bottom of it.
Req_3.2.5-II	The disk shall flex when the enclosure is attached, resulting in maximum adhesiveness to the dashboard surface.

4 Software Requirements

Android and iOS are mobile operating systems that run on a smartphone and some other electronics like TV. They make use of a modular approach to provide the user various functionality with modules also known as Applications ("apps"). These applications use the operating system APIs to connect user with the smartphone hardware. Furthermore, it allows users to connect remotely to other electronics by using the smartphone's RF modules. This section also includes the firmware side of the GPS module.

4.1 Mobile

Req_4.1.1-II	User shall install a smartphone application to interact with the product.
Req_4.1.2-II	Smartphone application shall connect to the product via Bluetooth.

Req_4.1.3-II	An input field shall be available for the user to enter destination address.
Req_4.1.4-II	The destination address shall then be converted to latitude/longitude by using any Geocoding API.
Req_4.1.5-II	This latitude/longitude information coupled with the current latitude/longitude obtained via the GPS of the phone shall be sent to “Open Source Routing Machine (OSRM)” [3].
Req_4.1.6-II	OSRM shall find the shortest trip using the inputs and provide the app with an array of waypoints.
Req_4.1.7-II	The array of waypoints shall then be sent to the product via Bluetooth.
Req_4.1.8-II	User shall configure the programmable buttons on the product via the app.
Req_4.1.9-II	There shall be a list of macros available for the user to choose from.
Req_4.1.10-II	The list of macros shall be thoroughly tested on each buttons.
Req_4.1.11-II	User information shall be stored locally on the device and shall persist even if the application is closed.
Req_4.1.12-II	In case of failure connecting with the product, troubleshooting steps shall be displayed on the app screen.

4.2 iOS Specific

Req_4.2.1-II	Application shall be available on the Apple App Store.
Req_4.2.2-II	The application must run on iOS 10.0 and above.

4.3 Android Specific

Req_4.3.1-II	Application shall be available on the Google Play Store.
Req_4.3.2-II	The application must run on Android v4.4 (KitKat) and above.

4.4 Software maintenance

Req_4.4.1-II	Firmware update of the GPS system shall be available to download on the smartphone device and transmitted to the product via Bluetooth.
Req_4.4.2-II	Software app on a smartphone shall be updated through the App Store and Google Play Store for iPhone and Android respectively.

4.5 General software

Req_4.5.1-II	The product have to display allowed speed limit for the current road in a corner of the display.
Req_4.5.2-II	Speed limit warning sign will turn red color in case speed sensor will detect that user have exceeded the allowed speed limit by more than 10 km/h.

5 Engineering Standards

We will be adhering to the following engineering standards during the development of NoStress GPS to ensure user safety and product reliability.

Req_5.1.1-I	The product must conform to IEC 61508 standard for functional safety of electronic safety-related systems [4]
Req_5.1.2-I	All materials used in the product must comply to Restriction of Hazardous Substances Directive (RoHS) [5]
Req_5.1.3-I	The product must conform to the IEEE 802.15 standard for Bluetooth communication [6]
Req_5.1.4-I	The product must conform to the RSS-210 radio-communication standard [7]
Req_5.1.5-I	The product must be in compliance with IEEE 139-1988 standard for not producing any harmful radiation from wireless or radio components [8]

6 Safety

The main purpose of NoStress GPS is to improve the safety of everyone on the roads. Thus, safety of use of the device is our main priority. We plan on delivering a product that does not cause any accidental damage to the user or people around the user by following below requirements:

Req_6.1.1-II	The product must not have any outside sharp edges that could cause harm to the user
Req_6.1.2-II	The product enclosure must not heat up above 82 C so it does not burn the user [9]
Req_6.1.3-I	Electronic components must be insulated from moisture and inaccessible to the user to prevent electric shocks
Req_6.1.4-III	The product shall not cause interference with the functionality of other devices
Req_6.1.5-I	The product shall not emit radiation harmful to people
Req_6.1.6-III	The product must be securely attached to the dashboard to eliminate the possibility of it moving without the intention of the user
Req_6.1.7-I	All materials used in the device shall be RoHS compliant, category 4: Consumer Electronics i.e. the product must be free of any heavy metals including lead-based electronic components
Req_6.1.8-III	The app must display a warning about the possible errors in GPS data encouraging the user to not follow the instructions if they do not seem safe

7 Sustainability

Req_7.1.1–I	NoStress GPS shall follow cradle-to-cradle design approach as closely as possible to ensure our product meets sustainability standards.
Req_7.1.2-I	All components used in the product must be obtained from companies with fair labor practices
Req_7.1.3-II	Encasing must be 3D-printed to ensure only the necessary amount of material is used and no waste is produced in the process of manufacturing
Req_7.1.4-II	Materials used shall be sourced from recycled materials where possible
Req_7.1.5-II	After completion of the prototype, it must be taken apart and all components must be used in other projects
Req_7.1.6-III	At the end of life of the production version of the device, components must be recycled, precious materials must be recovered where possible
Req_7.1.7-III	User manual must include information about proper disposal of the device

Conclusion

Distracted driving is one of the leading causes of deaths and permanent injuries for drivers, passengers, and pedestrians on the road all over the world. These distractions have caused the government of BC to place a ban on using a cellular phone while operating a vehicle. However, navigation systems have proven to be equally dangerous to operate which driving. These systems have also proven to have a large share of the total fatalities due to distracted driving. [1]

Our product, NoStress GPS, takes care of the problem of distracted driving. With NoStress GPS, drivers will be able to follow the navigation, get an estimated time of arrival to the destination and make decisions to change lanes well in advance, all while keeping their eyes on the road at all times. NoStress GPS is designed in such a way that the transparent display only provides timely, relevant and useful information to the user, resulting in a stress-free user experience.

The requirements document clearly lists the functional and non-functional goals of NoStress GPS. Furthermore, the priorities shall allow the team of NoStress to accurately prioritize each stage of the design and development to create a quality product.

At No Stress, our goal is to take a large portion of the market share by a simple intuitive user interface at an affordable price. With the release of NoStress GPS, we believe we will sweep the market of existing GPS systems and “drive” our product to every household.

References

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