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Feb 10, 2014

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
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Re: ENSC 440 Functional Specification for Safe Direction

Dear Dr. Rawicz:

The functional specification document of Safe Direction from Car Sense is attached to the letter. Our team is designing a blind spot detection system with parking assistant. Safe direction aims to provide users with safe driving experience by notifying them of the existence of an object at their blind spot, and help users to park safe and easy.

Functional specification document comprise of a set of requirements that will help our staff in designing and implementing The Safe Direction project. These requirements shall be followed in the phase of proof-of-concept and production phase. By following all the requirements, Safe Direction will be ready to hit the market and compete with any equivalent product.

The Car Sense team consists of five ambitious members who are striving to deliver Safe Direction with perfection. Khalid Almoammar, Aziz Mikwar and Keren Wang are majoring in electronics engineering, Angel Tian is majoring in computer engineering and shaham Shafiei-fazel is majoring in systems engineering. If you have any concerns please contact us by email at kalmoamm@sfu.ca or by phone at (778)-321-5551.

Sincerely,

Khalid Almoammar

Khalid Almoammar
Chief Executive Officer
Car Sense

Enclosure: Functional Specification for Safe Direction

Functional Specification of the blind spot monitoring and parking-assisting device
Safe Direction™

Executive summary

The number of cars on the roads is rising rapidly. With the population on the rise and the technology growing and becoming increasingly cheaper we see more and more cars on the road every day. Currently there are no Canadian based automotive companies hence most of the Canadian automotive industry consists of assembly plants of foreign automakers from countries such as United States and Japan. But regardless Canada is currently the eleventh largest auto producer in the world, producing 2.1 million cars per year. Considering this huge marketing opportunity and the growing concern for safety both from the consumers, we came up with the idea of Safe Direction from Car Sense. We all know how automotive companies over charge for options on the vehicles they provide. Since they make most of their profit on the car's options they tend to ask for a lot of money for any given option and sometimes in order to get an option you like, you might have to purchase a package of options which would cost thousands of dollars. In addition, this technology is fairly new and it is only being offered for certain luxury models in the past few years.

Here at Car Sense we make a product that can easily be installed on any vehicle no matter the make or the model for a convenient price. Our product includes blind spot monitors, for both sides, and sensors for parking assist.

This product is under development stage. An initial working proof of concept and model of the product will be ready for mid March which will leave us plenty of time for testing, troubleshooting and improvements.

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Glossary

ISO International Organization for Standardization

IHS A business information Company

SAE The Society of Automotive engineers

1 Introduction

Car Sense's Safe Direction is an electronic driving aid system that can be installed on any car regardless of the model. This product will be much cheaper than what automotive companies currently offer. Using sensors this system warns the driver of any objects in their blind spot in addition to the sensors on the bumper which help the driver to avoid hitting other cars and objects while parking. This document lays out the functional requirements of the Safe Direction system.

1.1 Scope

This document describes the functional requirements of the Safe Direction by Car Sense. These requirements will be the base of the design process throughout the project.

1.2 Intended Audience

The functional specifications will be used by all members of Car Sense. The requirements mentioned will be used by the hardware group to guide their design and implementation of the circuitry and the hardware. In addition this document will serve as a standard against in which the final system will be tested and the management will determine the success of the product based on this document.

1.3 Classification

Throughout this document the following convention shall be used to denote the functional requirements.

[Rxx-p]: A functional requirement.

Where **xx** is the functional requirement number, and **p** is the priority of the functional requirement as denoted by one of three values:

I. The requirement applies to the proof-of-concept system only.
II. The requirement applies to both the proof-of-concept system and the final production system.
III. The requirement applies to the final production system only.

2 System Requirements

General requirements applicable to the Safe Direction as a complete system are presented in this section.

2.1 System Overview

Safe Direction is a portable system, which can be installed easily by the user on various types of automobiles on the road. The system helps drivers by monitoring their blind spot and giving a notification when an object is within the driver's blind spot. In addition the system assists the driver by giving a notification when an object is at close range of the vehicle's front or back side.

The following drawing shows an overview of the system:

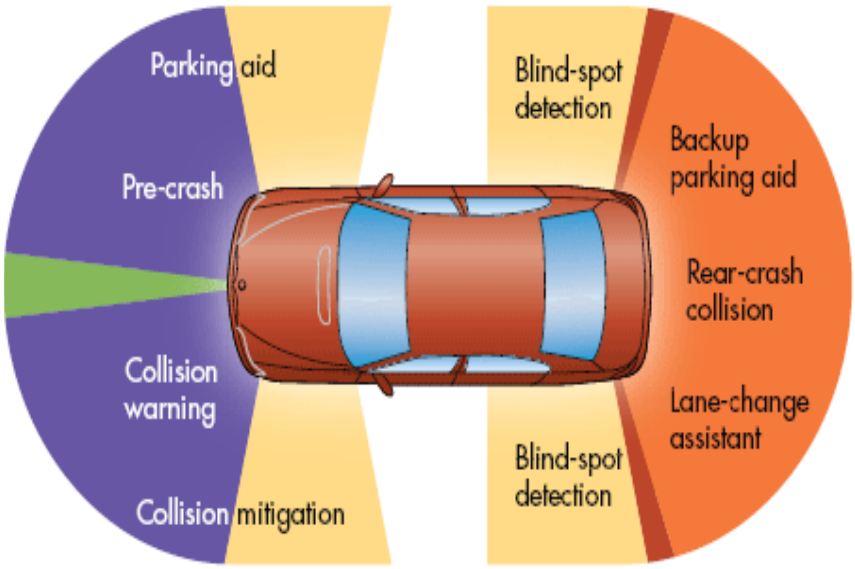

Figure 1: The System's Detection Overview [1].

The systems main components are: ultrasonic sensors, microcontrollers, LED lights and buzzers. LED lights and buzzers are connected to the main microcontroller, which sets them on and off depending on the data it receives through wires form the blind spot sensors and through wireless waves form the two other microcontrollers, one at the front of the car and one at the back. The front and back microcontrollers are connected to the parking assist sensors. Finally the main microcontroller receives the data from all the sensors in the system and processes them to determine whether a notification shall be given to the driver.

The following block diagram shows the system's functional process:

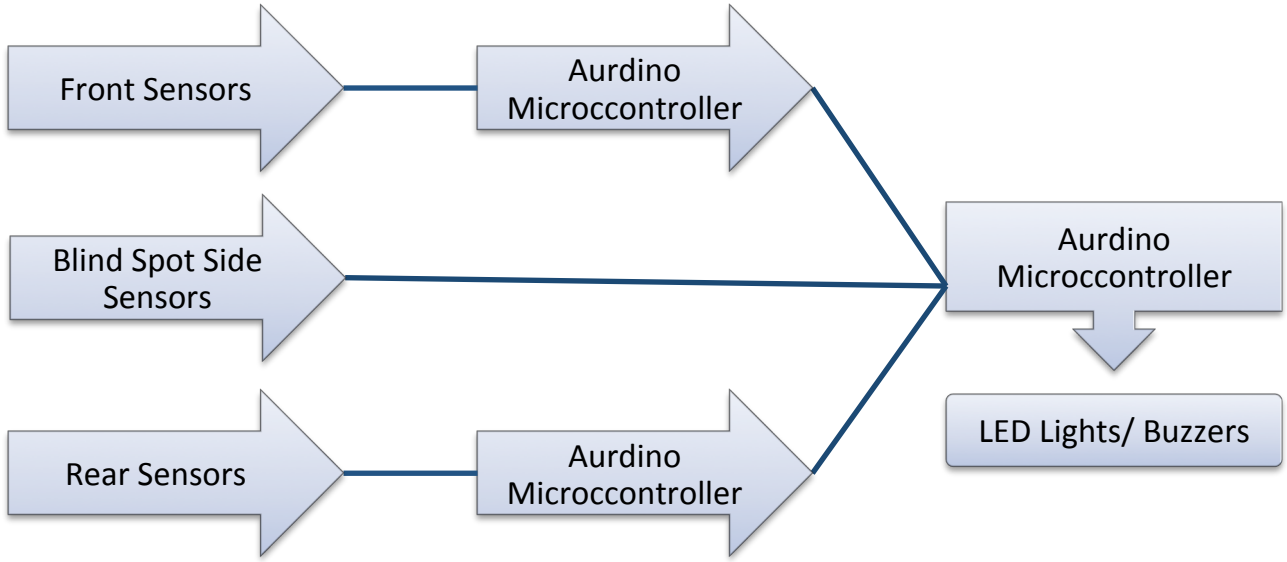

Figure 2: Block Diagram of the system.

2.2 General Requirements

[R1- II] The device should be applicable to the various types of automobiles.

[R2- II] The device shall be portable.

[R3- III] The parking assist part of the device shall be separable form the blind spot monitor system.

[R4- III] installation and setup shall be easy and may be assembled by the user without the need of a professional.

[R5- III] Retail price should be under 300 CAD.

2.4 Electrical Requirements

[R6- II] Parking assist components shall be powered by the attached battery.

[R7- III] Blind spot monitor system in addition to driver notification systems shall be powered by an adapter supplying 10 V DC and connected to the car lighter.

[R8- II] Each part connected to a power source shall be supplied with a voltage within the limits (7 – 12 V) [2].

[**R9- II]** The system shall be operated with a 500mA current supply.

[**R10- II]** The device shall not damage the car's electrical system.

[**R-11 II]** The device shall have protection against excess input current.

[R12- III] Blind spot monitor system in addition to driver notification system shall have the ability to be powered by a USB cable connected to a USB outlet.

[R14- II] Parking assist system's battery shall be easily accessed and replaced.

[R15- II] The power cord responsible for powering the system's main components shall have a minimum length of 1 m.

[R16- II] Wires connecting the blind spot monitor sensors and the main microcontroller should have a minimum length of 1.5m.

[R17- II] wire connections between each sensor and the corresponding microcontroller shall be easily accessed and replaced.

2.5 Mechanical Requirements

[R18- III] Sensors shall be stationary and located at specific locations indicated in the user manual.

[R19- III] Microcontrollers shall be located as the user prefers with a recommended location indicated in the user manual.

[R20- III] LED lights shall be located as the user prefers with a recommended location indicated in the user manual.

[R21- III] Buzzer shall be located as the user prefers with a recommended location indicated in the user manual.

[R22- III] Components shall not have an apparent affect on the vehicle's outlook.

2.6 Environmental Requirement

[R23- III] The device shall operate normally within a temperature range of -40C to 40C.

[R24- III] The device shall operate normally under heavy raining conditions.

[R25- III] The device shall operate normally under heavy snow conditions.

[R26- III] The device shall operate normally under strong windy conditions.

2.7 Standards

[R27-III] The system should obey the ISO 26262 standard (part 9) [3]

[R28-III] The system should obey the IHS standard.

[R29-III] The system should obey the SAE standard.

2.8 Reliability and Durability

[R30-II] The system shall operate normally under regular temperatures.

[R31-III] The system shall withstand different weather conditions, i.e. rain, snow, wind or sun.

[R32-III] The system shall be stable and not in any way affected by sudden car movements.

[R33-II] The system shall remain operating when connected to a 12V car plug.

[R34-III] The system shall detect any objects in the blind spots.

[R35-II] The corresponding LED should blink whenever an object is in the blind spots.

[R36-II] The buzzers sound shall go on whenever a car is within 1m of the front and back sensors.

2.9 Safety Requirements

[R37-III] The LED and buzzer sound shall not distract the driver.

[R38-II] The LED and buzzer sound shall go on whenever an object is within their detection range.

[R39-II] The microcontrollers shall remain dry at all times.

[R40-III] The system shall be off when car is turned off.

[R41-II] The RF transmitter and receiver shall not interfere with other devices.

2.10 Performance Requirements

[R42-II] The front and back sensors shall detect objects within 1m of the car.

[R43-II] The blind spot system shall send a signal to the microcontroller to light up the LEDs or generate a sound when an object is detected with 5m.

[R44-III] The blind spot system shall detect any objects passing by with a speed difference of less than 20km/hr.

2.11 Usability Requirements

[R45-III] The system shall be easy to attach and remove.

[R46-II] The system shall be turned on/off easily.

[R47-III] The LEDs' intensity shall not be too high to avoid driver distraction.

[R48-III] The buzzers sound shall not be too loud to avoid driver distraction.

2.12 Luxury requirements

[R49-III] The system in general, including the LEDs shall be covered in a nice and neat casing.

[R50-III] The buzzer speaker shall be covered nicely.

[R51-III] The sensors shall not disfigure the car's design or style.

3 Sensors

Ultrasound Sensors are used to detect the surrounding objects. They will send the appropriate signal to the microcontrollers to process and warn the user of any obstacles and possible dangers. In this project, we plan to use 8 sensors, 3 on the front bumper, 3 on the back bumper and 1 on each side of the car.

3.1 General Requirement

[R52-II] The range of the sensors shall to be long enough to preform the desired detection.

[R53-II] The angle range of the sensor must cover the whole blind spot area [4].

[R54-II] Sensors must respond immediately with no delay [4].

[R55-II] Sensors must react in a very short period [4].

3.2 Physical Requirements

[R56-III] The sensors must be easy to install and uninstall.

[R57-II] Sensors shall work well in all extreme conditions such as rain, snow, fog, low temperatures and high temperatures.

[R58-III] Sensors need to keep the car looking good.

4 LEDs and Buzzers

Indicators in this project are LEDs and buzzers. The driver will be informed of any danger via LEDs and the buzzer. In order for the driver to differentiate between the features we are using a buzzer for the parking assist and LEDs for the blind spot monitor.

4.1 General Requirements

[R59-II] LEDs must remain off when there are no obstacles on both sides of the car's desired blind spot range.

[R60-II] LEDs must shine within 5ms of detecting an obstacle on the corresponding side of the car.

[R61-III] Within the sensor's range, LEDs need to shine at an increasing frequency as the object being detected approaches the car.

[R62-II] The buzzer must be off when there are no objects detected within the sensor's range.

[R63-II] Buzzers must sound within 5ms of detecting an object within the sensor's range at the front or in the back of the car.

[R64- III] Within the sensor's range, buzzers need to sound at an increasing frequency as the object being detected approaches the car.

4.2 Physical Requirements

[R65-III] LEDs and the buzzer must be easy to install and uninstall.

[R66-II] LEDs and the buzzer must work well in any extreme conditions such as rain, snow, fog, low temperatures and high temperatures.

[R67-III] LEDs must be visible during bright and sunny days [4].

[R68-III] The buzzer shall be loud enough to get the driver's attention.

5 Microcontroller

The microcontroller is the brain of the system. It will coordinate the detection system, RF communication and the driver alarm system. There shall be three microcontrollers. The first one is the main microcontroller which receives all the signals and organizes them to be sent to the output which signals the LED and the buzzer. The second microcontroller shall be attached

to the front sensors to transmit the appropriate signals to the main microcontroller whenever an object is detected. Finally the third microcontroller will be attached to the back sensors in similar fashion to the second microcontroller and the front sensors. Furthermore the microcontroller shall be powered with 12 V plug

5.1 General Requirements

[R69-II] The system shall shut down when microcontrollers are unplugged.

[R70-II] Microcontrollers shall remain dry at all times.

[R71-II] Microcontrollers shall output energy to power up sensors, LEDs and the buzzer.

[R72-II] Microcontrollers shall process the desired inputs and output the required signal.

5.2 Usability Requirements

[R73-II] Microcontrollers' reset button shall be visible and easy to access.

[R74-III] Microcontrollers shall not be reprogrammable.

[R75-II] Microcontrollers' on/off LED shall be visible.

5.3 Physical Requirements

[R76-II] Microcontrollers shall be connected securely to sensors, LEDs and the buzzer.

[R77-III] Microcontrollers shall be stationary and resistant to car shaking.

[R78-III] Microcontrollers shall be well attached to the car.

[R79-II] Microcontrollers shall not be physically damaged.

6 User Interface Unit

The user interface unit shall consist of set of buttons to control the functionality of the overall system. The user interface shall enable the user to turn the notifications of the whole system on or off. Also the user shall be able to individually turn the notification of parking assistance or blind spot monitoring off and on.

6.1 General Requirements

[R80-II] The user interface unit shall consist of push buttons to perform the desired actions.

[R81-II] User interface unit shall enable the driver to control the system's notifications by switching them on or off as desired.

[R82-II] The unit shall be easy to use by the user without the need for referring to the user manual.

[R83-III] Each button shall have a label next to it indicating its function.

[R84-II] The unit shall be connected to the main processor.

6.2 Physical Requirements

[R85-III] The unit shall be placed at the front dashboard where it is easily accessible by the driver.

[R86-III] The unit shall be within the driver's sight in order to not affect the drivers focus and driving style.

7 User Documentation

[R87- III] The user documentation shall include a user manual, website and product warranty.

[R88- III] The user manual shall be in English, French, Spanish, Portuguese, Chinese, Persian and Arabic.

[R89- III] The user manual shall include detailed instructions for the device installation, which can be understood by users with no technical experience.

[R90- III] Documentation shall include a website that shows information needed by the user, technical help and support.

8 System Testing Plans

The system testing will be separated into individual parts testing and product testing. The individual modules specifications will be tested followed by gradually combining the modules and testing them. At the final stage, the complete unit will be tested as a whole. Next stage will be the user likability test of the product based on the ease of use, usability and reliability. This testing plan will be based on the proof-of-concept. Considering the physical restrains of the system, dimensions and proper installation will be based on actual configuration and optimization after proof-of-concept and first stage testing.

8.1 Individual Testing

Ultrasonic sensor: Accuracy sensing range and width with respect to object size and distance.

Wireless module- Transmitter and receiver: Limitation of the signal distance, interference level, accuracy of transmitted signal.

Buzzers: Evaluation of the strength of the notification and adjusting it to the most comfortable level for the user.

LEDs: Test the functionality and the warning notifications provided.

Arduino UNO+ Transmitter and receiver: The wireless communication and accuracy of the board by using the cheapest wireless communication parts.

Arduino UNO+ Buzzer: Testing with variations of buzzer response time wirelessly and the level of notification that it provides.

Arduino UNO+ Ultrasound sensor: Testing the programmable limitation of the sensor and code.

Arduino UNO+ LCD + Ultrasound sensor: The reliability and the accuracy of the LCD displaying necessary warnings regarding the distance to objects.

Unit Testing:

Combining all individual parts and testing on real environments:

I) Ease of installation
II) Accuracy of the sensor
III) The possible interference
IV) Wireless delay

9 Conclusion

The functional specification document of Safe Direction demonstrates the requirements and standards that will help our staff in designing and implementing The Safe Direction project. Our team is working towards the proof-of-concept model that is expected to be ready by April/15/2014. The proof-of-concept model is designed to cover all the requirements marked with I or II.

10 References

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[3] Paul Garden,, DesignWare Technical Bulletin, Automotive Safety: Achieving ISO 26262 Comliance with Processor IP

[4] U.S department of energy, Use of occupancy sensors in LED parking lot and garage applications: early experiences. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_gateway_sensors.pdf oct.2012