URBAN WHEEL

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January 17th, 2013

Dr. Andrew Rawicz

School of Engineering Science
Simon Fraser University
Burnaby, BC
V5A 1S6

RE: ENSC Project Proposal for Blind Spot Detection System

Dear Dr. Rawicz,

This enclosed document is the proposal for ENSC440 Capstone Project, the Blind Spot Detection System. The team of Urban Wheel is proposing this project to design and construct a model to aid drivers when changing lane.

Our proposal provides a general view of the project, including aspects such as overall designing solution, budget, funding, and milestone.

Urban Wheel Inc is found by four innovative senior engineering students from SFU Engineering Science program: Howard Sun, Emmanuel Yang, David Cao, and David Zhong.

Thank you for your time for reading over our proposal. If you have any further questions or concerns, please feel free to contact me by e-mail or phone.

Sincerely,

Howard Sun
Chief Executive Officer
Urban Wheel Inc

Enclosed: *Proposal for Blind Spot Detection System*

Proposal for

Blind Spot Detection System

Urban Wheel Inc

Project Team: Howard Sun
David Zhong
Emmanuel Yeung
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Submitted to: Dr. Andrew Rawicz – ENSC440
Dr. Steve Whitemore – ENSC305
School of Engineering Science
Simon Fraser University

Issued: January 20, 2013

Executive Summary

Blind spot is a nuisance of everyday driving that causes a significant number of accidents every year. Many drivers get tired while having a long distance driving and forget to perform shoulder check when changing lane. Car manufacturer has developed a blind spot detection system to prevent blind spot related accident; however, it is only available on luxury branded cars as an additional package for thousands of dollars.

The goal of our project is to help the owners of low-end cars and commercial vehicles which are unable to obtain the blind spot option through factory. Our project costs less than 500 dollars and takes 3 months to develop and build, which is much cheaper compare to factory option. Our system also provide extra option such as video feedback, and vibration feedback all in one package. Our system will be a competitive alternative to the existing option from car manufacturer.

We foresee our system to be installed on at least 60% of low-end vehicles in the future. The blind spot detection device market for low-end vehicle in North America alone is approximately a $100 billion market. Our system can cover 1/1000 of the market in 20 years, and will be a 100 million dollars company in 2033 estimated. After we expand our market into developing countries, we will have a company worth of over 1 billion dollars.

Figure 1. Cyclist in a trucks blind spot

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1. Introduction

According to the NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION (NHTSA) in Washington D.C., there are approximately 840,000 side-to-side blind spot collisions with 300 fatalities every year in the United States [1].

Lane changing is the most frequent action that the drivers perform while operating a motor vehicle, and shoulder checking is an essential action in order to prevent blind spot related accident. Drivers are taught to perform shoulder check before driver's licences are issued to them. However, due to laziness ,carelessness, or other issues, some drivers might not follow safe driving regulations, and change lanes without performing shoulder check, resulting in accident which may be life threatening. The following figures illustrate the blind spots of a car and truck [2] [3].

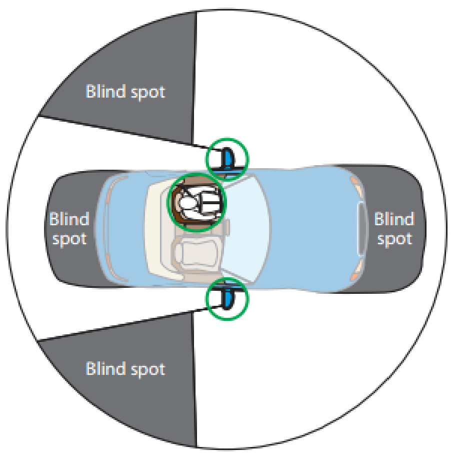

Figure 2. Blind Spot of a car

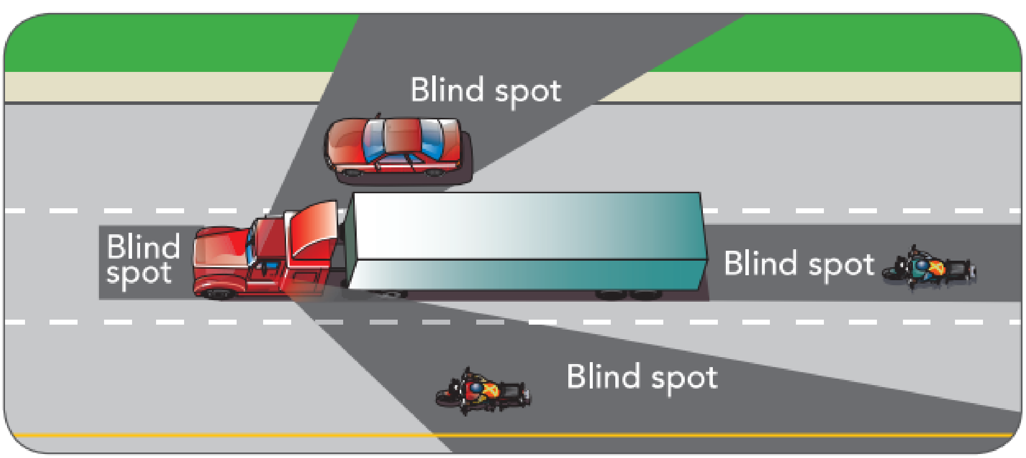

Figure 3. Blind spot of a truck covers larger area

1. Introduction (Con'd)

The objective of our project is to prevent blind spot related accident for all different types of vehicles. In order to achieve such goal, we intended to commercialize a blind spot detection system that will be available for the general public. Our system utilizes ultrasonic sensors for detection, which is the most suitable type sensor for our application. As for driver notifications, we utilize real time video, LED, vibration motor and a buzzer, covering both intrusive and non-intrusive feedback. Our system will be a lower cost alternative to factory pre-installed systems, and will be available for non-luxury branded vehicles and semi-trailer truck.

This proposal will illustrate our system design overview, explain the functionality in depth, estimate the cost and evaluate the time schedule constraints. In addition, the proposal will cover the future scope of our product.

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2. System Overview

Once the vehicle is started, our system will be turned on, and the non-intrusive warning (LED indicators) will be on if necessary. When the turn signal is engaged, the intrusive warning (audio feedback, tactile feedback and video feedback) will be turned on. Below shows the flowchart of the system.

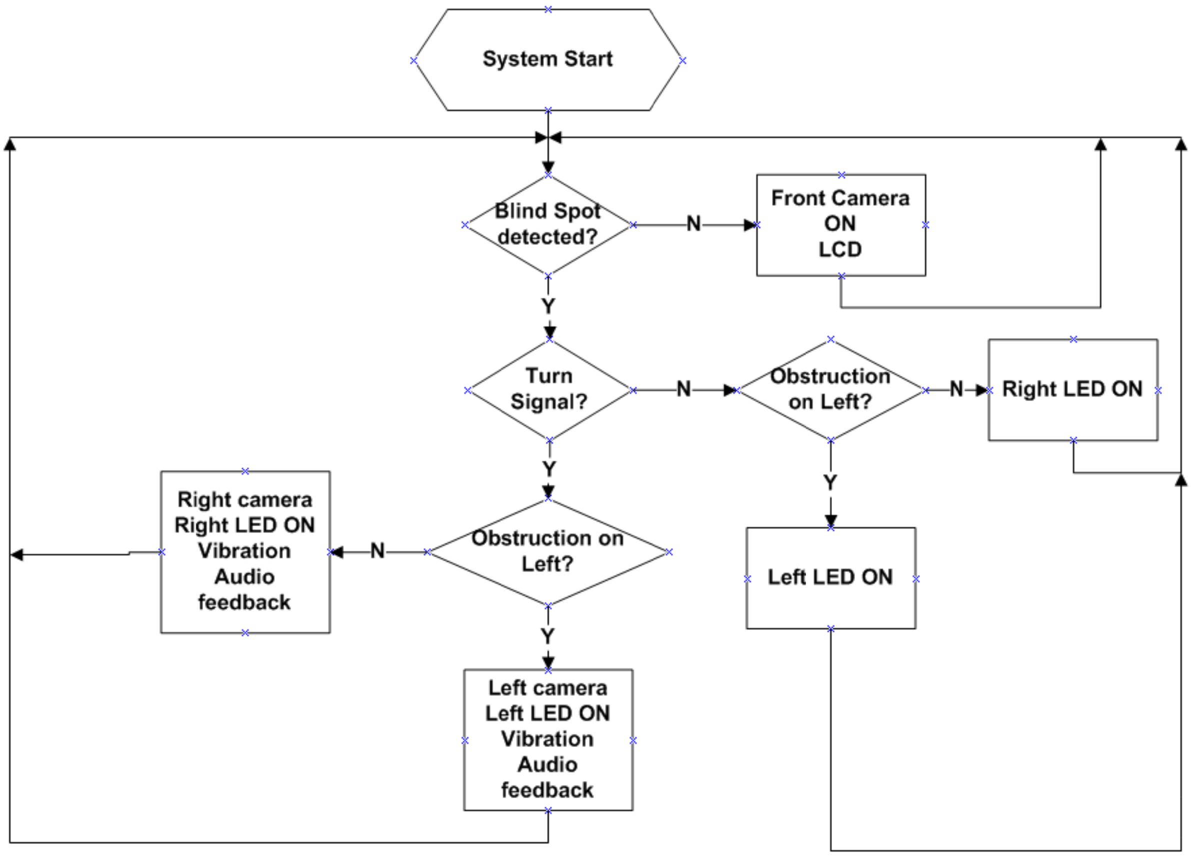

Figure 4. System flow-chart

3. Possible Solutions

In order to detect objects in the blind spot, proximity sensors are used to detect the distance between the user's vehicle and obstructions in the blind spot. There are many types of proximity sensors which have their own advantage and disadvantage. We consider the following proximity sensors for our blind spot project:

3.1 Ultrasonic proximity sensor

Ultrasonic proximity sensor send out ultrasonic wave and evaluate the reflected wave, the time difference between the sent wave and the received wave will determine the distance between the objects. With ultrasonic proximity sensors mounted on the side of the car, we need to precisely calculate the angle and location of the sensors to detect the blind spot.

3.2 Camera with image processing

Cameras are used as blind spot detection with image processing, as the camera is pointed to a desired angle, the system will compare the different video frames, and evaluate if there are obstruction on the blind spot. Cameras are usually installed under the mirrors, however it does not work well when visibility is poor, and require a lot of processing power.

3.3 Infrared proximity sensor

Infrared proximity sensor has the same working principle as ultrasonic sensors, which send and evaluate the reflected light to determine the distance. Infrared sensor costs less than other alternative, but it has limited range.

3.4 Radar

Radar proximity sensor has similar working principle as ultrasound and infrared, it supports long range and currently being implemented on several luxury branded vehicles. However the radar proximity sensor is very costly among the different options.

4. Proposed Solution

After comparing all the existing and possible solution, we decide to build our system as an add-on for all different kinds of vehicles, which will target a much wider audience, and eliminate the needs of negotiating with car manufacturer. The majority of the sensors will be attached to both side mirrors, sides of the door, and the two corners of the rear bumper. The notification or the feedback system will be installed inside of the car cabin to provide the driver warnings if required.

Our system will utilize two types of modules, proximity sensors, and cameras. For the proximity sensor, we have chosen to use ultrasonic proximity sensor after comparing different types of proximity sensor as mentioned as our possible solution. The ultrasonic sensor we choose has a range between 2 to 450 centimeters, and has a low detection angle of less than 15 degrees. The given specification is much desirable than sonar sensor or infrared sensor. Our system will utilize three proximity sensors on each side of the vehicle to provide maximum coverage and increased accuracy. As for the camera module, we will be utilizing infrared camera to provide night time visibility. The cameras will be mounted on both sides of the car, and one at the front.

As for the warning system, the system will have both intrusive and nonintrusive feedback. Vibration and audible buzzing are used as the intrusive feedback, and will only be enabled when the turn signal is engaged. Real time video feedback will be enabled and switch accordingly. When the turn signal is off, the LED mounted on both sides of the car cabin will blink when there are obstructions in the blind spots.

In order to read data from the sensors, two controller boards will be used, a SainSmart UNO and Raspberry PI board. The proximity sensors will be connected to the UNO, and the cameras will be connected to the Raspberry Pi. Below shows our system block diagram

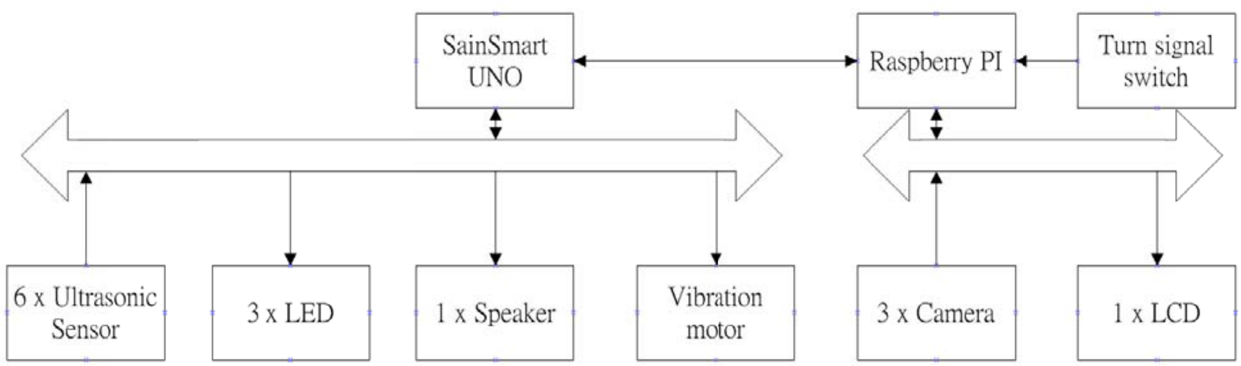

Figure 5. System block diagram

5. Budget and Funding

5.1 Budget

Table 1 outlines the tentative budget for our blind detecting system. All components costs are not final. Market price may vary. Small components such as motor are not included in the table due to their low cost. Shipping cost in Table 1 is a close assumption. Different shipping method will create different costs.

Table 1. Budget approximation table

Equipment	Cost per unit($)	Quantity	Estimated Cost($)
5V 2A Car Charger Power Supply	10	2	20
Monitor	30	1	30
Raspberry pi set	55	1	55
Small camera	32	2	64
Ultrasonic Sensor	30	6	180
Arduino	25	1	25
Shipping			50
Tax (HST)			50.88
Total			474.88

5.2 Funding

This prototype would not be sold for income. Currently, we do not have any external source of funding. Therefore, our group members are willingly to share the expense of the project. In the meantime, we had applied for the Engineering Science Student Endowment Fund (ESSEF), and the Wighton fund.

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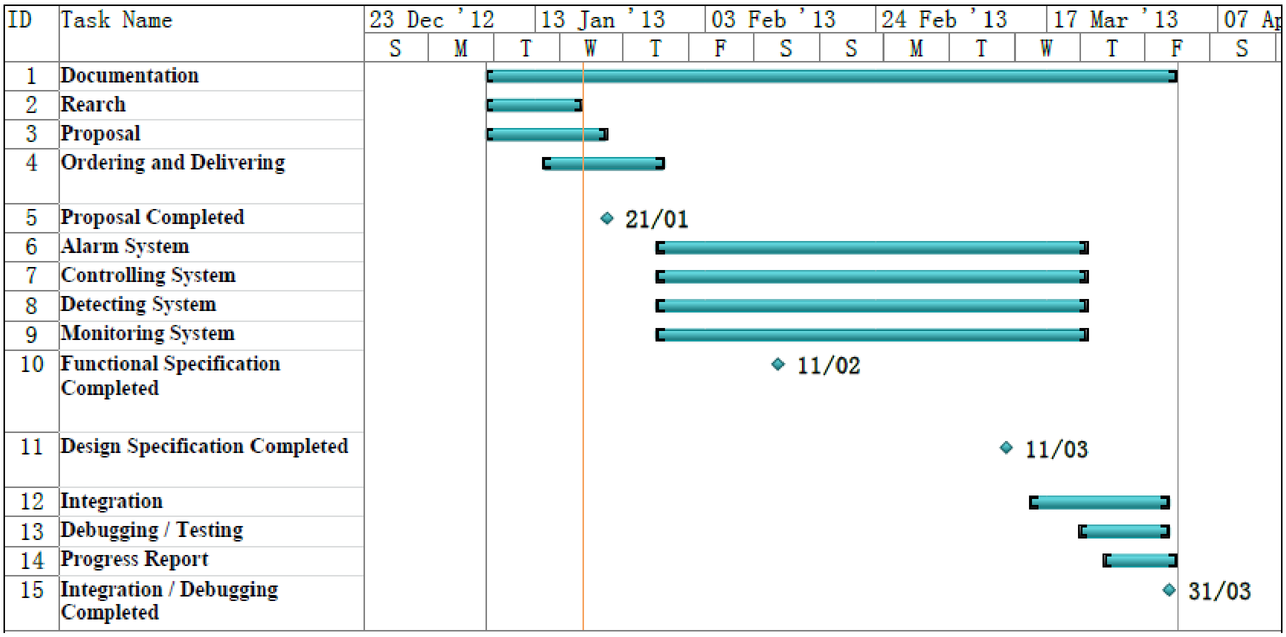
6. Schedule

Here attached the Gantt chart in Table 2 and the milestone chart of our project in Figure 6 :

Table 2. Gantt chart



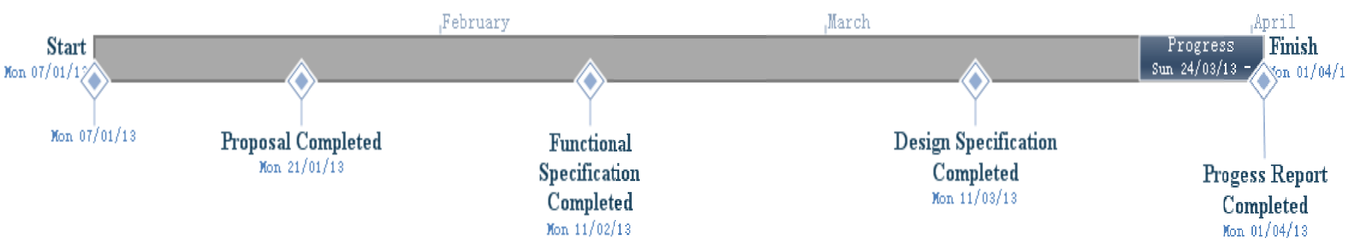


Figure 6. Milestone chart

Gantt chart shows duration of each important task of projects as well as important due dates. The milestone chart illustrates the due dates in clearer timeline style.

7. Team Organization

Urban Wheel consists of four senior engineering students. We have expertise in various engineering fields fitting the required knowledge and skills for this project. The specific skill sets of each member are outlined in the company profile section.

Each member of Urban Wheel is assigned a specific type of tasks. Howard Sun will be the Chief Executive Officer (CEO), responsible for administration of the company. Howard is also in charge of mechanical design of the system. David Zhong, our Chief Operating Officer (COO), is responsible for the daily operation of the company, as well as technical documentation of the project. David Cao will be our Chief Financial Officer (CFO), which manage the financial planning and data analysis of the company, also specializes on the project's hardware assembly and testing. Emmanuel Yeung will be designated as the company's Chief Technology Officer (CTO), focusing on the technical issues of the company, also in charge of the software design and programming. Below is the company organizational chart:

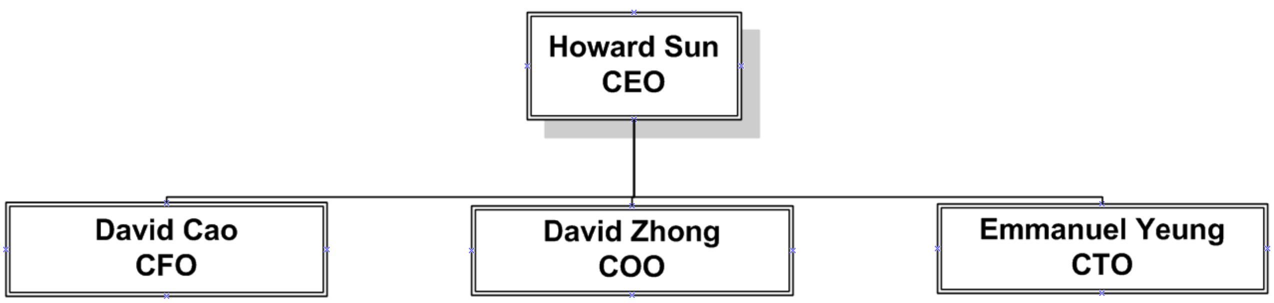


Figure 7. Organizational chart

Meeting are to be hosted at least three times a week in order to maximize team communication, and keeping track of the project developing progress. Non-scheduled meetings will be held when necessarily. Alternatively, group email is always open to all group members for any information sharing outside of the meeting.

8. Company Profile

Howard Sun (CEO) – 4th year Systems Engineering at Simon Fraser University. Having done a coop term at Research In Motion, my expertise is mechanical design of the overall feedback control system. I'm familiar with different kinds of sensors and actuators and apply them in a variety of fields. At school, I have worked on several projects involve FPGA boards and C/C++ programming under Linux Ubuntu and Visual Studio on Windows operating system.

Ruolei Zhong (David) (COO) – 5th year System Engineering student at Simon Fraser University. I am interesting using the technology as well as creating a new technology. My first co-op experience started with Dr. Shahram Payandeh. I designed the out layer and mechanical parts for the air-hockey robot by using Solidworks. For the second and third co-op experience, I worked for Research In Motion as Wi-Fi System tester. As a hardware engineer, I am familiar with electronics equipment such as oscilloscopes, function generators, digital multi-meter, spectrum analyzers. For software, I understand C, C++ and assembly language. Also, I am good for working on Windows, Visual Studio C++, and MATLAB.

LiLi Cao (David) (CFO) – 5th year Electronic Engineering student at Simon Fraser University. I am an enthusiastic for electrical products. I am familiar with C++ programming, VHDL coding as well as design and simulation software as PSpice. I am also good at doing data analysis using MATLAB and doing documentations using word processing software. Hardware designs and assembling with possible soldering processes involved are not considered hard for me. Working in a team environment makes me energized and more efficient.

Ho Ho Yeung (Emmanuel) (CTO) – 6th year Electronics Engineering. I am interested in keeping track of modern technology trends, computer technology and electronic gadgets. I have done all my coop terms at Research In Motion as an Embedded System Developer, so my expertise is on C programming and debugging. I am also familiar with VHDL programming utilizing various FPGA boards.

9. Conclusion

Drivers face hazardous situations that involve blind spots on a daily basis. Urban Wheel Inc. is dedicated on producing innovative technology and applying it to improve road safety. Our product, the blind spot detection system, utilize existing market technologies to create a system that incorporates visuals, audio, and tactile feedback that can be implemented to avoid blind spot related accidents. Our product is made available for vehicles that do not have such pre-existing factory options, and can be offered as a low cost alternative to current market options.

Our project will be finished on schedule referring to our planned timeline. With the strong work ethics and robust team experiences with hardware and software implementations, Urban Wheel will manage to create an adaptive and cost efficient product that can operate reliably. Urban Wheel will continue to improve and maintain the system in the future. We are willing to contribute to create a safer driving environment.

"Trust me, I did the math" - Engineers

10. References

[1] FIPS 81. "*DES Modes of Operation,*" Federal Information Processing Standard(FIPS), Publication 81, National Bureau of Standards, U.S. Department of Commerce, Washington D.C., December 1980.

[2] ICBC, (2012, Dec 08). *Tuning Up for drivers Manual* [Online]. Available FTP: www.icbc.com File: tuning_for_drivers_2.pdf January 18, 2013 [date accessed].

[3] ICBC, (2012, Dec 08). *Tuning Up for drivers Manual* [Online]. Available FTP: www.icbc.com File: tuning_for_drivers_7.pdf January 18, 2013 [date accessed].

[4] HTI Group, (2013, Jan 17). *Dode hoek Detectie en Signalerings Systemen (DDSS): Concepten van signalering* [Online]. Available: http://hti.ieis.tue.nl/node/3345