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September 17, 2012

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
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Re: ENSC 440 Project Proposal for an Automated High Beam System

Dear Dr. Rawicz,

The attached document, *Proposal for an Automated High Beam System*, provides an outline for our ENSC440 (Capstone Engineering Science Project) project. The goal is to build a system that automatically dims a vehicle's high beam headlights by detecting nearby vehicles through real-time video processing.

The purpose of the proposal is to present an overview of an Automated High Beam System. In the following attachment, we will provide a discussion of possible solutions, our projected budget and available funding, the proposed schedule, and the background of the individuals in the company. Additionally, we will analyze the product's market potential and its advantages over similar existing products.

Lumos Technologies consists of five talented and motivated engineering students: Alex Huang, Claire Liu, Linda Zhao, Sujin Lee, and Victor Mateescu. If you have any questions or concerns about our proposal, please do not hesitate to contact me by phone at (778) 233-8586 or by e-mail at lza28@sfu.ca.

Sincerely,

Linda Zhao
Chief Executive Officer
Lumos Technologies

Enclosure: Proposal for an Automated High-Beam System

Project Proposal

Automated High Beam System

LUMOS
TECHNOLOGIES

LUMOS TECHNOLOGIES

Proposal for an Automated High Beam System

Linda Zhao
Chief Executive Officer

Sujin Lee
Chief Finance Officer

Victor Matesccu
VP Research & Development

Alex Haung
VP Software

Claire Liu
VP Operation

Contact Person: **Linda Zhao**
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Submitted To: **Dr. Andrew Rawicz– ENSC 440**
Dr. Steve Whitemore– ENSC 305
School of Engineering Science
Simon Fraser University

Issued Date: **September 17, 2012**

Executive Summary

High-beam headlights are meant to assist drivers with a wider headlamp range to ensure safety during night driving. However, the direction and range of the high beam can be hazardous to the surrounding vehicles. Many drivers are either unaware of the BC Motor Vehicle Act 4.06 section 5 or they're simply too lazy to turn off their high beam.

[1] 4.06 (5) "A person who drives or operates a motor vehicle must not illuminate the upper beam of a headlamp if another motor vehicle is within a distance of 150 m from that vehicle, […] so that the high intensity portion of the beam does not strike or reflect into the eye of the other driver.

-BC Motor Vehicle Act, Motor Vehicle Act Regulations

Lumos Technologies has come up with a solution to counter poor driving habits by creating an automated head light adjustment system. Our goal is to develop a cheap and simple accessory that all drivers and auto shops can install in their vehicle. The system requires a car camcorder to record traffic, a microprocessor to detect vehicles within the headlight's range and some wiring to connect it all to the vehicle's headlight. The brain of the system is the microprocessor, which is responsible for analyzing the traffic video and determining if another vehicle is in the hazardous zone. When a vehicle is detected, it will automatically adjust the brightness of the headlights so that it is safe for both drivers.

Our current budget for this project is estimated to be around $900. The retail product will utilize parts already present in the user's vehicle, such as headlights, batteries, wiring, and more, to greatly reduce the cost. We estimate our product to retail at around $100-150. The funding for this project may not be an issue for now as we have already secured $700 from the ESSEF fund and will apply to the Wighton fund to cover any extra spending, if necessary.

The Lumos Technologies team has members who specialize in video processing, computer and systems engineering, and electrical hardware development. This device is developed by drivers who have all been troubled by similar issues. The solution will be simple in nature and easy to install. Unlike some high end car manufacturers' specialized headlights and in dash system, our product will provide the safety drivers need at a fraction of the cost.

Table of Content

List of Figures

Introduction

Proper use of high beams while driving has become a lost art. Although they are essential for improving visibility during night driving and poor weather conditions, they can temporarily blind other drivers. As a result, high beam-related accidents can occur by failing to toggle them properly in the presence of other drivers, or by omitting their use entirely out of sheer laziness.

The law in British Columbia states that high beams must be turned off when drivers in front are within 150 metres of their range [1]. Although seemingly straightforward, this micromanagement appears too daunting for the majority of drivers. Research shows that “drivers use their high beams less than 25 percent of the time in which conditions justify their use” [2]. The National Highway Transportation Safety Administration (NHTSA) reports that 42% of all crashes and 58% of fatal crashes occur at night, in spite of less traffic [2]. Evidently, safety during night driving is an issue that is only made worse by the absence or improper use of high beams.

The objective of this project will be to develop a system that automatically changes the intensity of a vehicle’s high beams based on the distance of other drivers. A video camera mounted on the front of the vehicle will provide input to the system. Video processing algorithms will be applied to the video feed to determine the location and distance of vehicles in front. The high beams will be dimmed accordingly to comply with BC driving law.

Adaptive high beams have already been integrated in recent high-end cars such as the 2009 Mercedes E-Class and S-Class [3], as well as the 2011 Volkswagen Touareg [4]. These models adjust each headlight individually to modify the distribution of light, thus minimizing glare on other vehicles. Our goal is to provide a simpler, more cost effective alternative that can be installed in any low-end vehicle.

This proposal will provide an overview of our system along with an estimate of the costs and a timeline of our development process. Various solutions will be taken into consideration to demonstrate the efficacy of our own. We also provide brief overview of the members of Lumos Technologies to illustrate our wide range of skills and capabilities.

System Overview

The Automated High Beam System utilizes a camcorder mounted on a vehicle's windscreen to provide input to a video processing system, which identifies vehicles and their distances. The system will dim the high beams when it detects another vehicle within 150 metres from the front of the user's vehicle, as illustrated in Figure 1. The system will revert the high beams to their original intensity when the high beam range is clear of other vehicles.

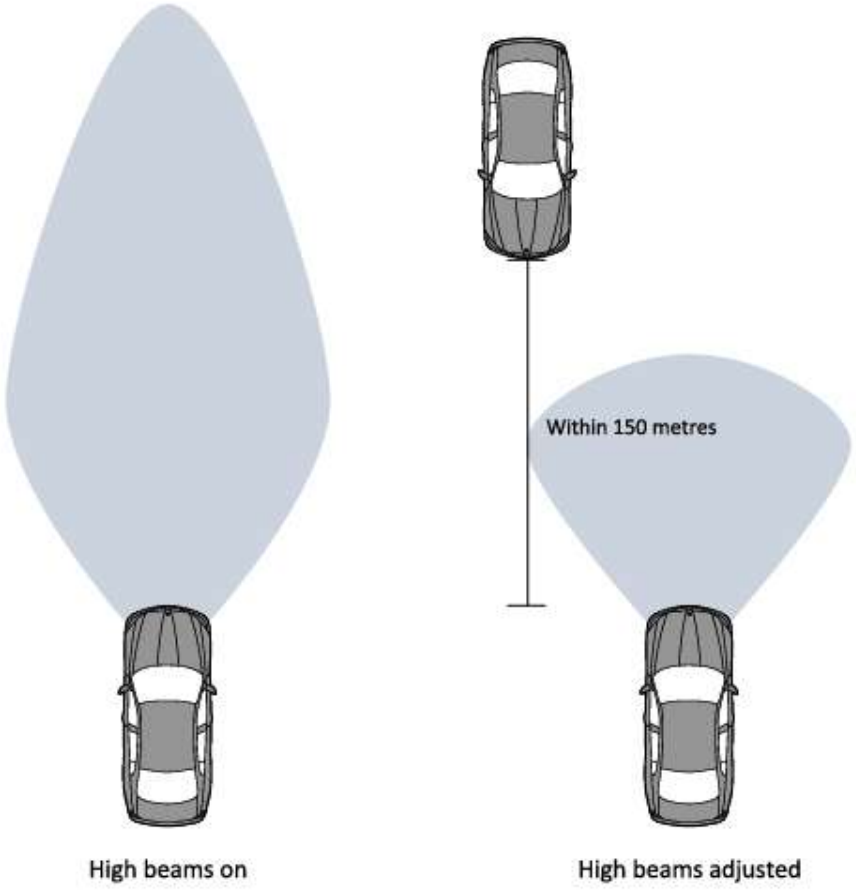

Figure 1: System Overview

The driver will have three options to control high beam headlamps: “on”, “off”, and “auto”. The “on” and “off” states are activated using the traditional headlamp controls available in every vehicle. This grants the driver manual control over the headlamps, thus completely overriding our system. The “auto” state activates the Automated High Beam System to control high beams automatically.

A high-level block diagram of the system is shown in Figure 2. When the “auto” state is on, the system is active and the camcorder will constantly record the front view of driver’s vehicle. The video processor receives the input video and analyzes it to detect vehicles ahead and provide an estimate of their distance from the front of the vehicle. As soon as an oncoming vehicle is detected within range, the video processor signals the high beam circuit to reduce the intensity of the headlamps. When the range in front is clear of vehicles, the circuit restores the headlamp intensity. Manually toggling the high beams on and off will automatically deactivate the system.

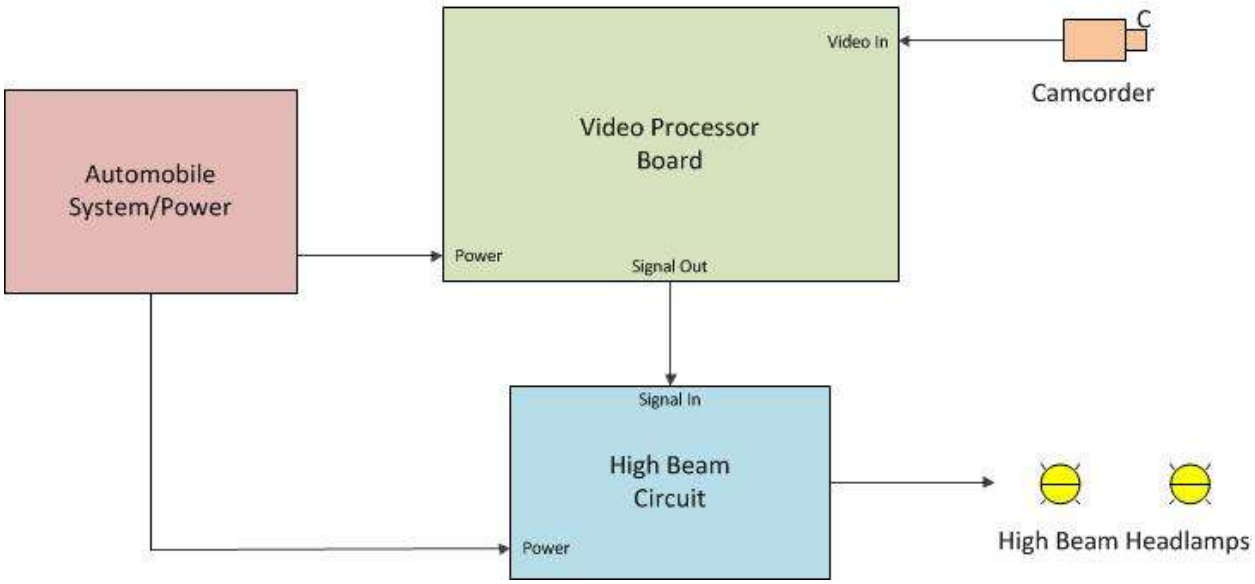

Figure 2: High-Level Block Diagram

Possible Solutions

Although drivers can simply obey the law and properly control their high beams, there are several solutions on the market designed to compensate for inattentive driving habits. However, these features are not considered as necessary accessories and the car buyers are often turned down by their prices.

1. **Autronic Eye**
   The Autronic Eye is the first automatic headlight dimmer developed by General Motors in 1952 on their Cadillac and Oldsmobile models [5]. This system uses photoresistors to sense the change of light intensity coming from a certain direction, such as the headlights of oncoming vehicles. The invention was applied and used for about 20 years before it was withdrawn from most of their models. One of the biggest issues they encountered came from unwanted reflections. The sensor often captures false inputs including the reflection from a stop sign illuminated by driver's own headlights.

2. **Adaptive High-Beam**
   A camera placed on the inside of the front windscreen is used for measuring the distance from other oncoming vehicles. These inputs then allow the system to continuously and automatically tailor the headlight range so the beam stops short of other vehicles ahead. This strategy not only maximizes visibility for the drivers, but also avoids blinding oncoming vehicles. Although Adaptive High-Beam Assistant was first introduced by Mercedes-Benz in 2009 [3], similar technology was announced by other luxury car brands such as Audi and BMW. The invention functions well although it is only available for high-priced cars.

3. **Glare-Free High Beam & Pixel Light**
   The Glare-Free High Beam is another camera-based dynamic lighting control system that selectively shades spots and slices out the high beam pattern to protect other road users from glare [5]. A similar technique called Pixel light was also developed by selectively blinding addressable LED emitters or light elements. This design was first successfully integrated in the 2011 Volkswagen Touareg as a “dynamic light assist” package. Much like the adaptive high beam system created by Mercedes-Benz, the cost for such complex technology involving real time response from microprocessors and actuators is considerably high.

Proposed Solution

Our proposed solution is a video camera-based intelligent system which automatically adjusts the intensity of high beams with respect to the distance to oncoming vehicles in the front. This system is meant to aid and correct drivers' inattentive habits in order to reduce the rate of car accidents. Although similar solutions are already on the market for high-end luxury cars, our solution is designed for any model of vehicles at lower cost.

Instead of using a light intensity sensor, which can often perceive false information, implementation of video processing provides more accurate and dynamic outputs. Video processing allows the system to differentiate and respond to all possible situations, such as the vehicles in the front as well as oncoming vehicles. Traditional high beam light bulbs are chosen in order to make the system eligible for any vehicle model. This solution will work as an add-on to all vehicles that lack automatic high beam controls.

Time and funding constraints are key concerns for this project. There are many difficulties in putting together such a complex system given our meagre funding and short time frame of less than three months. However, our goal is to construct a prototype-like model in time and eventually seek local automobile manufacturers for further possible collaborations.

The idea of combining video processing with automobiles is not only limited to high beam dimming systems. With more resources and time, further studies can be conducted to integrate features such as automatic braking, animal detection, and lane tracking. The combination of all these possibilities can essentially create a harmless driving environment.

Budget & Funding

Budget

The estimated budget required to build a prototype of the Automated Head Beam System is listed in Table 1.

Table 1: Estimated Project Budge

Components	Estimated Cost
Video Processing Development Board	$200
Car Camcorder	$150
2 Headlight Bulbs	$60
Battery	$150
Vehicle Accessories	$100
Other Components (wires etc.)	$100
20% Contingency Fund	$152
Total	**$912**

The equipment involved in developing a model of our system shown in Figure 2, i.e., development board, camcorder, bulbs, and battery, is absolutely essential and has the highest priority. Vehicle accessories are desired as we will be building a simplified version of an automotive system. Other components necessary include small tools such as wires and boards, and any unknown expenditures. A 20% of contingency fund has been included to account for unexpected costs.

Sources of Funding

The source of funding mainly comes from the Engineering Student Society Endowment Fund (ESSSEF). The Wighton Fund will be applied at the final stages of our project if we go over the projected budget. To minimize costs, we will search through auto junkyards, Craigslist, and other second hand sources for useful equipment and spare parts. In case of insufficient funding, Lumos Technologies executives have agreed to contribute equally for additional costs.

Timeline

The following Gantt chart shows the planned timeline for our project. Individual tasks are dependent on the preceding steps; therefore, extensive research in the early stages is crucial. Nonetheless, our main objective is to complete the prototype within the given time frame.

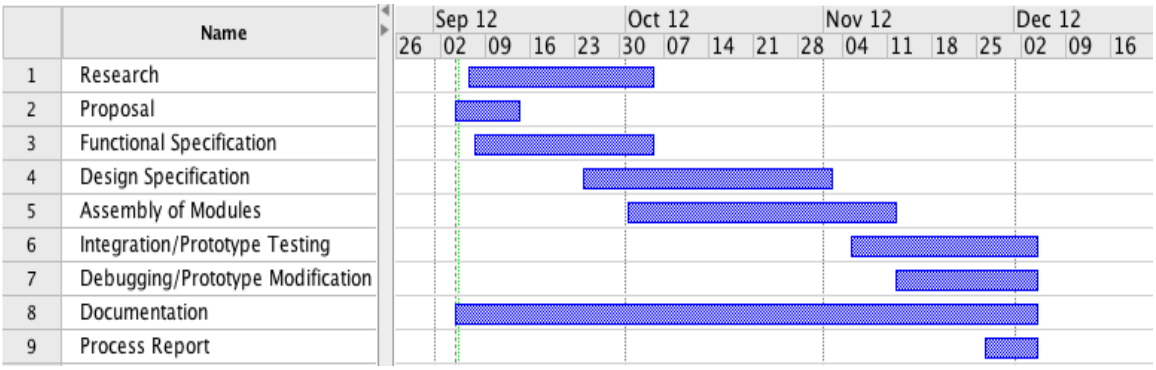

Figure 3: Gantt chart

Figure 4 illustrates the project Milestone of completion dates for assigned tasks in chronological order.

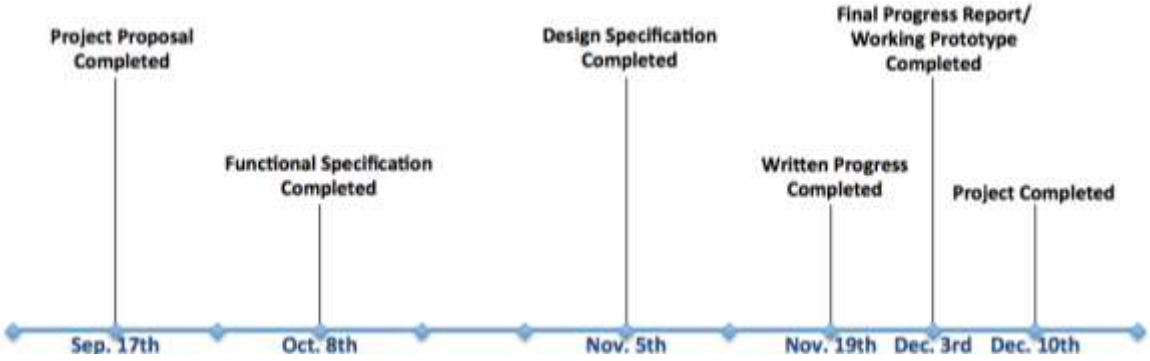

Figure 4: Project Milestone

Company Profile

Linda Zhao - Chief Executive Officer

Email: lza28@sfu.ca

Education: 5th Year Engineering Science Major, Concentration in Electronics

Skills:

- Experience with VHDL and MATLAB
- Experience with programming Lattice and Altera PLDs
- Experience with various lab equipment for testing and debugging, PCB design and modifications, bread boarding and soldering
- Developed excellent project management and record keeping skills through my involvement in multiple project in current hardware position at Fortinet
- Experienced with organizing and leading group events as an executive for 5 years on the Engineering Science Student Society
- Excellent communication skills, oral and written

Sujin Tom Lee – Chief Finance Officer

Email: stl9@sfu.ca

Education: 5th year Engineering Science Major, Concentration in Electronics

Skills:

- Experience with C/C++, assembly language, and VHDL
- Computer Software: Linux, MATLAB, SolidWorks, HSPICE, and Microsoft Office
- Hardware: familiar with electric circuits/components and engineering lab equipment
- Acquired a strong background of various circuit designs and time management skills throughout academic career

Alex Huang – Vice President Software

Email: tha25@sfu.ca

Education: 5th year Engineering Science Major, Concentration in Systems

Skills

- Experience with C++, Java, VHDL, and MATLAB
- Computer software: SolidWorks, HSPICE, and OpenGL
- Experience in mechanical design, motors, and various sensors and actuators
- Developed excellent time management, organizational, documentation, and hands on skills at previous research co-op, where time is sensitive for product development

Claire Liu – Vice President Operation

Email: csl12@sfu.ca

Education: 5th year Engineering Science Major, Concentration in Computing

Skills

- Experience with C/C++, Java, JavaScript, VHDL, and MATLAB
- Experience working with Linux and various open source software packages
- Strong background in algorithm programming and numerical analysis
- Experience with soldering and circuit design
- Developed excellent project management, time management, organizational, and documentation skills from co-op and course projects

Victor Mateescu – Vice President Research & Development

Email: vam2@sfu.ca

Education: 5th year Engineering Science Major, Concentration in Electronics

Skills

- Experience with C/C++, MATLAB, Perl, and VHDL
- Strong knowledge of video/image processing; currently doing research as an undergraduate in the field of visual saliency under supervisor Dr. Ivan V. Bajić
- Experienced in digital systems design with Altera and Xilinx FPGAs
- Excellent oral and written communication skills
- Strong background in research and experienced in writing for publication

Conclusion

Lumos Technologies is committed to tackling the issue of improper headlight use. Neglecting proper use of high beams can be hazardous to the driver and those in his surroundings. Our Automated High Beam System will improve visibility while driving during late hours or poor weather conditions. This safety will no longer pose a risk to others on the road; accidents caused by headlight glare blinding other drivers will be a thing of the past.

Our proposed solution will be a cost effective option for consumers who are unable to afford the luxuries offered by various high-end cars. In addition, the framework of this system can serve as a basis for the development of future standalone vehicle safety systems, such as automatic braking and lane control.

With our expertise and diligence in the field of engineering and thorough planning of time and costs, we will ensure a working prototype by the projected completion date. At Lumos Technologies, we are committed to delivering a high quality product that will create a safer driving experience.

References

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