Technologies Inc.

School of Engineering Science
Burnaby, BC
V5A 1S6
veiro-ensc440-grp13@sfu.ca

February 19, 2007

Mr. Lakshman One
School of Engineering Science
Simon Fraser University
Burnaby, BC
V5A 1S6

Re: ENSC 440 Functional Specifications for a Motorcycle Headlight Correction System

Dear Dr. One:

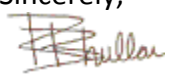
The enclosed document, *Functional Specifications for Motorcycle Headlight Correction System*, outlines our project for ENSC 440. The goal of our project is to design and implement a system to automatically correct motorcycle headlights, when a motorcycle is travelling along a curve, in order to optimize driver safety.

We are currently in the process of securing the remaining funds required to complete this project. The design and building aspects of the project are also commencing. The following document provides an overview of the parameters required by the Motorcycle Headlight Correction System. The various functions that are needed by the entire system will be described.

Veiro Technologies Ltd. consists of four highly capable SFU undergraduate engineering students: Christopher Martens, Raul Fernandes, Tania Kwan, and Reena Bhullar. Each of these individuals brings their own unique and valuable experiences to our team.

If you have any questions or comments, please do not hesitate to contact us at veiro-ensc440-grp13@sfu.ca.

Sincerely,



Reena Bhullar
Chief Financial Officer, System Integration Engineer

Enclosure: Functional Specifications for Motorcycle Headlight Correction System

Functional Specifications for a

Motorcycle Headlight Correction System

Project Team: Chris Martens
Raul Fernandes
Reena Bhullar
Tania Kwan

Contact Person: Raul Fernandes
veiro-ensc440-grp13@sfu.ca

Submitted to: Lucky One – ENSC 440
Steve Whitmore – ENSC 305
School Of Engineering Science

Issued Date: February 19, 2007

Revision: 1.0

Executive Summary

The staggering statistics of motorcycle injuries and fatalities when a rider is travelling at night and negotiating a curve implored the members of Veiro Technologies Inc. to investigate methods that would decrease the dangers associated under these scenarios. The innovative solution found by Veiro Technologies will vastly increase the safety of all riders, motorists, and pedestrians.

Veiro Technologies Inc. is currently in the process of producing a Motorcycle Headlight Correction System that automatically obtains data from the motorcycle while it's in motion and relays the information to the motors controlling the headlight. Whenever necessary, the system will cause the headlight to twist and pan. The structure of the headlight frame and motors will allow for the headlight to be positioned parallel to the road at all times. Thus, the rider's perception of his environment will immensely improve and glare towards other motorists will reduce.

When this proof of concept system is completed, it will show sponsors and the public the advantages and benefits of installing the Motorcycle Headlight Correction System on any sport bike. A working prototype of the device will be available for viewing at the time of the presentation and, if time permits, the prototype will be attached to a motorcycle to allow people to see firsthand the capabilities of the system.

Table of Contents

List of Figures

1 Introduction

The Motorcycle Headlight Correction System will increase motorcycle riders' vision at night and around curves; providing them with a better sense of their local environment and thus reducing the number of preventable motorcycle injuries and fatalities which may occur under these circumstances. This automated system will rotate the headlight by twisting and panning, such that the light emitted will maximize the path seen ahead of the rider. The system will also reduce glare that is normally observed by oncoming motorists and will vastly improve the safety of all road users.

1.1 Scope

This document describes the functional specifications that must be met by the Motorcycle Headlight Correction System prototype and the potential production model. The functional requirements for major components of this proof of concept device will be provided. Given that the project is currently under development, the final functional specifications may vary slightly from those provided in this document.

1.2 Glossary

Accuracy	The degree of veracity
Compass	A device which determines the absolute angle with respect to a magnetic field, typically used on the magnetic field of the earth
Gyroscope	A device which determines the change in angle
Headlamp	A system typically consisting of a reflector, a headlight, a lens and an enclosed case
Headlight	A light bulb, typically a Halogen or Xenon mixture
Precision	The degree of reproducibility
Resolution	The smallest change or increment in the measured quantity

1.3 Intended Audience

This document is intended for project managers, design engineers, marketing personnel and sponsors. It can be used as a guide for each department in their respective branches for planning, promoting, and designing the product. The following document will also provide an excellent reference for scheduling the project, as well as creating a feasible budget.

1.4 Convention

The convention for numbering and prioritizing the functional specifications in this document is shown below:

R[n/priority] Functional specification description

where, **n** represents the functional specification number. The convention for allocating the priority will be using letters A and B. A more detailed description of the prioritization is listed as follows:

A: Functional specification is required for proof of concept prototype.
B: Functional specification is required for production model.

The convention for numbering the system test plan will be as follows:

T[m] System test plan description

where **m** represents the test number.

2 System Requirements

2.1 System Overview

The following section will describe **what** the functional requirements are for the Motorcycle Headlight Correction System; a brief explanation of how the system works is given only to aid in understanding some of the functional requirements. The overall system block diagram is shown in Figure 2-1.

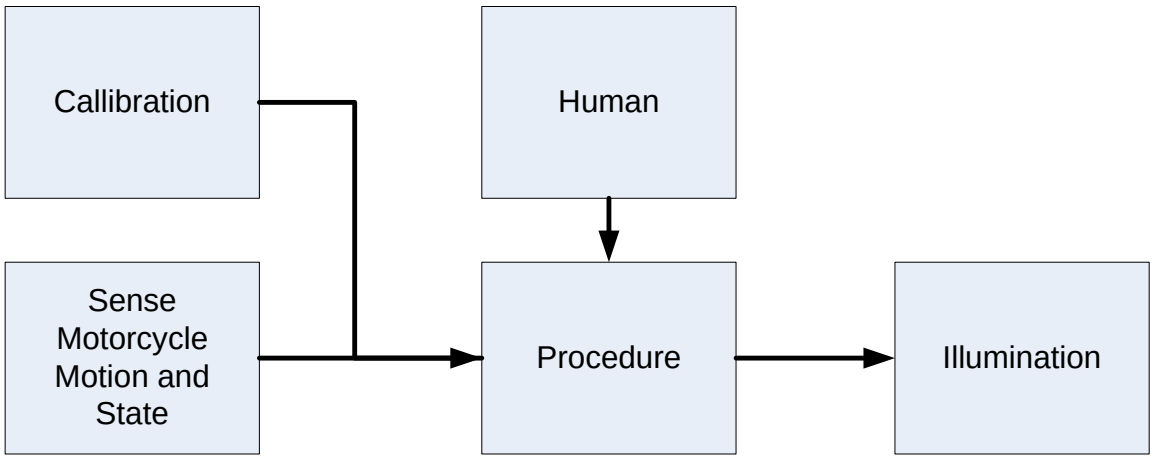


Figure 2-1: Block Diagram of System Overview

The detection of the position and orientation of the motorcycle is the first step of the process. The calibration of the headlight is completed by the motors associated with the corresponding rotations. This process will adjust the headlight such that the longer side of the headlight is parallel to the road, thus providing maximum visibility of the rider's surrounding environment. Note that the "Human" block of the system will allow the user to manually turn the system on and off.

A gyroscope will be used to sense the angular tilt of the motorcycle, a digital magnetic compass will sense the horizontal angular orientation, and potentiometers will sense the position of the headlight. The sensor inputs will be fed into a microcontroller that will decide the ideal headlight position for the given bike position. The microcontroller will then tell the motors connected to the headlight to move at the required speed to the desired position.

2.2 Physical Requirements

As the Motorcycle Headlight Correction System will be fitted in a sport bike, it will be extremely important to provide the headlight with adequate protection and room when it is being implemented in production. However, for the proof of concept model that will be developed, the most vital part of the construction will be to ensure that the frame encasing the headlight can withstand the motion of the motorcycle.

2.2.1 General Physical Requirements

R[1/A] The device must be small enough to fit into the chassis of the motorcycle. The maximum dimensions for the design shall be 11” x 7” x 6.5” (L x W x H).

R[2/A] The weight of the whole system must not be greater than 5 lbs.

R[3/A] The weight of the headlight will be no more than 2.5 lbs.

R[4/A] The headlight length shall be 6 inches.

R[5/A] The headlight width shall be 4 inches.

R[6/A] The headlight height shall be 4 inches.

R[7/B] The device should be secured in a weatherproof enclosure that holds the system’s components.

R[8/A] Friction in the device system must be kept to a minimum.

R[9/A] Aluminum components shall be used for the metal frame components of the prototype.

R[10/B] Treated steel or aluminum must be used for the metal frame components of the production model.

2.3 System Requirements

2.3.1 General System Requirements

R[11/A] The system should be able to be installed into various other sport bikes but with small adjustments where necessary.

2.3.2 Accuracy Requirements

R[12/A] The stepper motor should have an accuracy/error of ±0.1º (both motors).

R[13/A] The compass should have an accuracy ±0.2º.

R[14/A] The gyroscope should have an accuracy of ±0.5º.

R[15/A] The horizontal accuracy should be within ±0.2º of the correction position.

R[16/A] The vertical accuracy should be within ±0.1º of the correction position.

2.3.3 Resolution Requirements

R[17/A] The twist stepper motor should have a resolution of ±2.0º.

R[18/A] The pan stepper motor should have a resolution of ±3.0º.

R[19/A] The compass resolution should be ±0.2º.

R[20/A] The gyroscope resolution should be ±1.0º/sec.

2.3.4 Performance Requirements

R[21/A] The system must withstand the vibration caused by sudden jerks due to unpaved roads, bumps and pot holes.

R[22/A] The headlight correction speed shall be relative to the rate of change of the orientation of the motorcycle.

R[23/A] The device should respond to any change in the motorcycle's orientation within 250 ms.

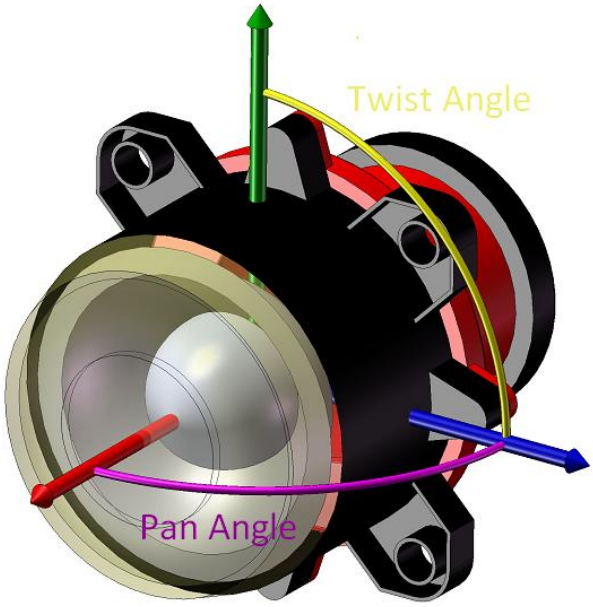


Figure 2-2: Twist and Pan Angles of Motorcycle Headlight

R[24/A] The maximum time for the headlight to obtain the desired twist and pan angles shall be 1.5 seconds.

R[25/A] The maximum speed of the headlight twisting shall be 90º/sec.

R[26/A] The maximum speed of the headlight panning shall be 40º/sec.

R[27/A] The maximum twisting range is ±60º with respect to position of the motorcycle, where 0º is when the headlight is perpendicular to the longitudinal axis of the motorcycle.

R[28/A] The maximum panning range is ±80º, where 0º is when the headlight is pointing straight forward.

R[29/A] The headlamp should have a maximum power of 60 watts to avoid glare towards other motorists.

2.3.5 Power Requirements

R[30/A] The prototype shall be powered by an appropriate off-the-wall voltage supply.

R[31/B] The production model must be powered by the motorcycle battery.

2.3.6 User Interface Requirements

R[32/B] The safety button (to enable/disable the device) on the production model must be accessible to rider while he/she is sitting on the motorcycle.

2.3.7 Maintainability Requirements

R[33/A] There should be no need for joint lubrication in any part of the device.

R[34/A] Headlamp replacement may be necessary depending on usage.

R[35/A] The device must be repairable and/or replaceable by a qualified technician.

R[36/B] The final model must be weatherproof.

R[37/B] The device housing may require cleaning.

R[38/B] Any mechanical and/or software upgrades shall be installed by a qualified technician.

2.3.8 Environmental Requirements

R[39/B] The average temperature range of operation shall be -10ºC to 50ºC. It will be unlikely for riders to ride in freezing temperatures due to the cold & icy road conditions and extremely hot temperatures because temperatures rarely reach that high after dusk.

R[40/B] A temperature controller shall disable the device if operating conditions are outside the operating range in order to prevent damage to the device.

R[41/B] The device must be able to operate in all weather conditions such as fog, rain, and snow.

R[42/B] The device must be able to provide adequate illumination in poor weather conditions.

R[43/B] The device must not cause interference with other mechanisms or components of the motorcycle.

2.3.9 Safety Requirements

R[44/A] There must be a safety button that will enable and disable the system.

R[45/B] There shall be minimal risk of the device causing additional damage in the event of a collision.

R[46/A] There must be a correction system in place to automatically recalibrate the device.

R[47/B] There should be a manual override option available in the system.

2.4 Marketing Requirements

R[48/B] Packaging must protect device from scratches and impact.

R[49/B] Packaging must be aesthetically pleasing.

3 Regulatory Requirements

Headlamps are extremely important devices on motor vehicles as they provide road illumination during periods of low visibility. The consequences associated with headlight failure are very severe; therefore these devices are heavily regulated by government bodies. In Canada, Transport Canada is responsible for "develop[ing] and administer[ing] policies, regulations and services for the best transportation system for Canada and Canadians — one that is safe and secure, efficient, affordable, integrated and environmentally friendly [1]". On headlights, "the low beams are adjusted such that when the vehicle is parked 7.6 metres (25 feet) away from a wall, the bright spot of the light on the wall is roughly five centimetres below the centre height of the headlight [2]". Below lists the headlight regulatory requirements set by Transport Canada.

R[50/B] The calibration should be permanently fixed.

R[51/A] The gradient of cut-off shall not be less than 0.13 at either 2.5º left and 2º right [3].

R[52/A] The width of beam shall not be less than 2º [3].

R[53/A] The horizontal accuracy of the headlight beam should be within ±0.2º of the correction position [3].

R[54/A] The vertical accuracy of the headlight beam should be within ±0.1º of the correction position [3].

R[55/B] The device must be exposed to 60ºC for 24 hours, then -40ºC for 24 hours, and then finally returned to room temperature and then must be able to have the same accuracy of ±0.2º (horizontal) and ±0.1º (vertical) [3].

4 Documentation Requirements

As most motorcyclists have not come across a device such as the Motorcycle Headlight Correction System before, providing superior quality documentation is essential for their safety and welfare. If motorcyclists do not entirely understand the purpose of this device, they will not be inclined to utilize it to its full potential. The following requirements were set with user comprehension and service personnel training in mind.

R[56/A] A user manual shall be provided for the motorcyclist that will explain the functionality of the device.

R[57/B] An installation manual shall be provided for service personnel.

R[58/B] An electronic version of all documentation shall be provided on the company website.

R[59/B] An installation manual shall be included in the packaging.

R[60/B] Troubleshooting shall be part of all documentation.

R[61/B] A detailed description of the warranty shall be in the user manual.

R[62/B] Multi-Language versions of all documentation shall be made available on the company website.

R[63/B] The company website shall have Frequently Asked Questions (FAQs) available for viewers.

5 System Test Plan

The Motorcycle Headlight Correction System is a proof of concept device. It is essential to test for accuracy during the development and integration phases of the device in order to produce the best product results. The individual components will first be tested before the entire system integration phase begins. The testing of the aforementioned phases and those for a production model device are listed below.

5.1 Prototype Testing

5.1.1 Mechanical

T[1] Testing to ensure the smooth movement of the frames and headlight.

T[2] Testing shock resistance to verify handling of rough roads.

T[3] Testing of the limits of motion of the headlight.

5.1.2 Electrical

T[4] Testing of electrical components to ensure the achievement of safety standards.

T[5] Testing of noise immunity to sensitive devices and radiation emission from all components.

5.1.3 Firmware

T[6] Testing the reliability of the microcontroller's data retention.

T[7] Testing the interrupt service routine time, and firmware crash prevention system.

5.1.4 System Integration

T[8] Testing the accuracy of reading from sensors.

T[9] Testing the accuracy with which the headlight assembly can be controlled.

T[10] Testing of system response to the change of motorcycle orientation.

5.2 Production Model Testing

T[11] Testing weather resistance such as temperature and humidity.

T[12] Testing excessive usage conditions.

T[13] Testing failure and system break point analysis.

T[14] Testing to ensure the satisfaction of the Canadian Standards Association's Canadian Electrical Code

6 Conclusion

Motorcycle safety is an important issue for riders, other road users, and pedestrians. In recent years, motorcycle popularity has been increasing and so has the number of injuries and fatalities of riders as they negotiate a curve and ride at night. The purpose of the Motorcycle Headlight Correction System is to improve a motorcycle rider's perception of the road and his local environment. This document provides the details of how this device will operate and it also lists the descriptions of the functional specifications of vital components of the device. Through twisting and panning rotations, the headlight will be adjusted in order to bring the horizon of the emitted light level with the road and pointing in the direction of travel. As mentioned in the project proposal, the Motorcycle Headlight Correction System is to be designed to address lighting issues incurred by the rider and the most vital code of the APEGBC Code of Ethics: *"Hold paramount the safety, health and welfare of the public, the protection of the environment and the promotion of health and safety within the workplace [4]"*.

7 References

[1] Transport Canada, "About Us," [Online document], 2007 Jan, [cited 2007 Feb 14], Available HTTP: http://www.tc.gc.ca/aboutus/menu.htm

[2] J. Kerr, "Headlight Aiming", [Online document], 2007 Jan, [cited 2007 Feb 11], Available HTTP: http://www.canadiandriver.com/articles/jk/050420.htm

[3] Motor Vehicle Standards and Research Branch, Transport Canada, "Lamps, Reflective Devices and Associated Equipment," [Online document], 2001 May, [cited 2007 Feb 11], Available HTTP: http://www.tc.gc.ca/roadsafety/mvstm_tsd/index_e.htm

[4] Association of Professional Engineers and Geoscientists of British Columbia, "Code of Ethics," [Online document], 2004, [cited 2007 Jan 20], Available HTTP: http://www.apeg.bc.ca/library/actbylawscode.html

