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Dr. Andrew Rawicz
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RE: ENSC 340 Functional Specification for *AutoWake*[TM] Sleep Detector

Dear Dr. Rawicz,

Attached, you will find the technical specifications for *AutoWake Sleep Detector*.

The design of *AutoWake* is meant for alerting drowsy drivers who are at the brink of falling asleep at the wheel. This device is composed of an eyeglass frame and a main control board for user interface purposes [1]. The control board allows the user to activate the device when the frame is properly installed in front of the eyes. For convenience of use, adjustments are made by sales people to ensure appropriate positioning of the frame with respect to the eyes while in use.

The attached functional specification provides target specifications for the complete design and assembly of the first stage prototype. We estimate that we will reach this stage by December 2002.
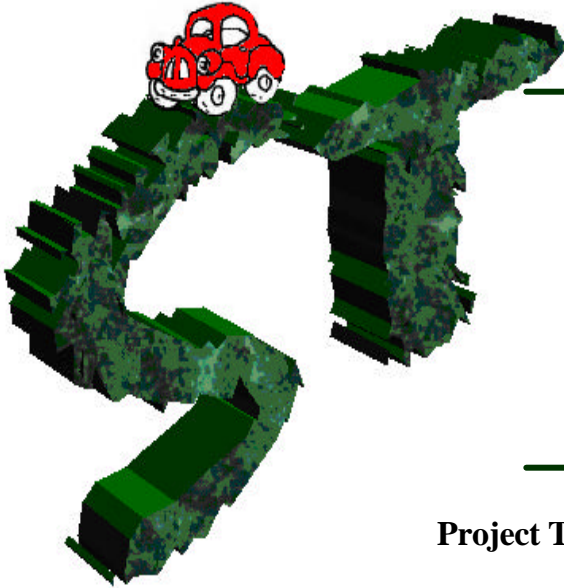
SecuriTeam members are: Nima Boostani, Azadeh Farzin, Ali Keyvani, and Nasim Morawej. If you have any further inquiries please do not hesitate to contact our Chief Excecutive Officer, Azadeh Farzin. She can be reached at afarzin@sfu.ca.

Sincerely,

Azadeh Farzin

Azadeh Farzin,
SecuriTeam Co.

Functional Specification for

AutoWake Sleep Detector

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Executive Summary

Statistics show a significant correlation between tiredness and car accidents, and thus, sleepy drivers behind the wheel are indirectly a dominant cause of death in North America, second only to heart disease and cancer [2]. *AutoWake* automatically "buzzes up" sleepy drivers thus saving many lives. *AutoWake*'s main purpose is to ensure safe driving conditions for drivers.

This device has the following features:

1. Friendly and non-invasive eye closure detection method.
2. Easy to use.
3. Easy to mount supplementary devices.
4. Reasonable cost.

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Table of Figures

1   Introduction

Have you ever wondered how good of a bed your car seat would be? If so *AutoWake* will set you straight.

AutoWake detects when a driver is on the verge of falling asleep. Since, in this state, the driver is losing control of the car, *AutoWake* responds by alarming the driver. This alarm is *AutoWake*'s primary alarm mechanism. If the primary mechanism is unsuccessful, *AutoWake* invokes a secondary mechanism to alert the surrounding drivers and pedestrians.

How beneficial *AutoWake* is really? Have a look at the scene in figure 1.1.

Figure 1.1: How else would they know?!

The first stage prototype will be completed by December 2002. Details of mass production of *AutoWake* are left for future investigations.

1.1   Scope

This document provides the functional details for the first stage prototype of *AutoWake*. Some discussions regarding a production prototype are interspersed throughout the document.

1.2   Acronyms

FAQ	Frequently Asked Questions
IR	Infrared
CPU	Central Processing Unit
LED	Light Emitting Diode
VDC	Volt Direct Current
dB	Decibels
AH	Amp Hour

1.3   References

[1] Proposal for *AutoWake*, *SecuriTeam Co*

[2] Rothsein Catalog On Disaster Recovery
    http://www.disastercenter.com/cdc/

[3] YOU AND YOUR VEHICLE, ICBC DOCUMENT
    http://www.icbc.com/Licensing/rsd_ch02.pdf

1.4   Intended Audience

Design engineers can use this document to gain more insight of the functionality of *AutoWake*.

Project manager can use this document for information on project design and objectives.

Sales manager can use this document to obtain primary marketing information.

Users can use this document to gain a general idea of how to use the device.

1.5   Conventions

Requirements start with the annotation of *a***R[#]** where **[#]** denotes the logical order of each step, and *a* is any of the following:

P	Physical Requirement
S	System Requirement
C	Connection Requirement
RS	Reliability and Serviceability
UI	User Interface Requirements
R	Regulatory Requirement
DR	Documentation and Training

Functional requirements for first stage and production prototypes, first stage prototype only, and production prototype only are followed by **pf**, **f**, and **p** suffixes respectively.

2 System Requirements

2.1 System Overview

The information contained in this section describes the overall expected function of *AutoWake*. An eyeglass frame is set up in front of the driver's eye. As shown in Figure 2.1.a, in normal driving conditions, where the eyes of the driver are fully open, one of the two IR emitters casts IR light at the eyelid and the other sensor casts IR light at the eyeball. Two IR receivers detect the light that is reflected from the eyelid and eyeball respectively. The reflection from the eyeball is weaker than that of the eyelid. A CPU compares the signals from the two receivers. If the two signals are similar, then the CPU interprets this to mean that the eyelid has closed over the eyeball. However, if the two signals are significantly different, then the CPU interprets this to mean that the eyelid is not obscuring the light reflected from the eyeball as shown in figure 2.1.b. The CPU continually checks the status of the eye. It is not necessary to monitor both eyes, as very few people sleep with exactly one eye open and one eye closed. The CPU is capable of distinguishing between simple eye-blinks and the onset of sleep.

IR light,
emitter 1

IR light,
emitter 2

IR light,
emitter 1

IR light,
emitter 2

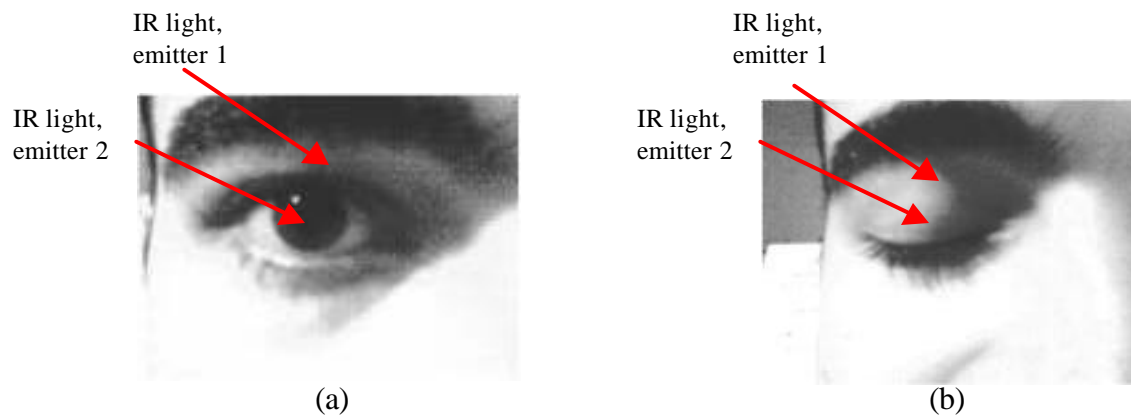(a)   (b)

Figure 2.1.1: (a) Different IR light reflections from the eyeball and the eyelid when eyes open (b) Identical IR light reflections when eyes closed

Upon detecting the onset of sleep, the CPU alarms the driver by activating a buzzer. The alarm ceases, when the driver re-opens her/his eyes. However, the CPU continues the primary alarm and activates a secondary alarm mechanism if the driver fails to wake up. This secondary alarm will be the activation of a flashing lamp in the

first stage prototype, and the activation of the horn of the car in the production prototype.
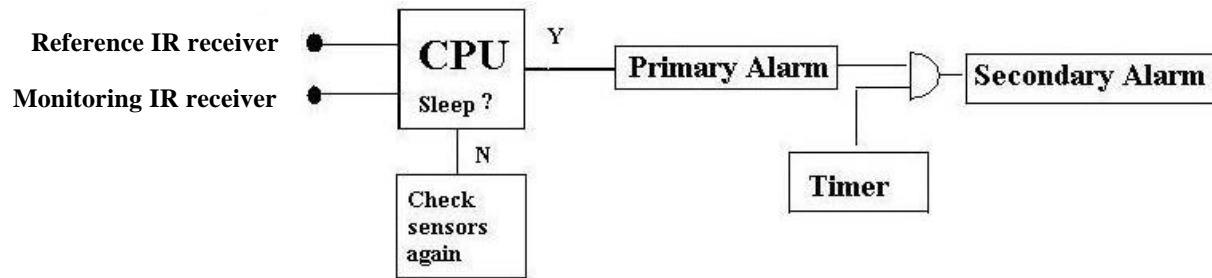

Figure 2.1.2: Block diagram of the design of *AutoWake* system

If the user wishes to stop/start using the device at any time, a stop/start button is available on the control board in the design of the first stage prototype.

2.2 Physical Requirements

The following list of physical requirements was derived after considering the operating environment for *AutoWake.* In general, *AutoWake* will be employed in the vicinity of a human eye while traveling at reasonably high velocities. As a result, we conclude that *AutoWake* must be lightweight, small, and should not have a sharp or jagged geometry.

PR[1] [p]   Light plastic eyeglass frame with wide range of view sight.

PR[2] [p]   Small IR emitters and IR receivers to prevent view blocking.

PR[3] [pf]   Thin light flexible circuit and wires for wiring the sensors out of the eyeglass frame to minimize any obstruction to the users field of view.

PR[4] [p]   Flexible wires for reliable connection between the frame and the control board.

PR[5] [p]   Small control board box (not larger than the size of a text book), compatible with the design of dashboard or seat of the car.

PR[6] [p]   Self dedicated power cord to connect to the cigarette lighter of the car.

PR[7] [pf]   Extra space near the control board for an alternate power unit.

PR[8] ᵖ   Safe mounting place for the control box as well as safe design of the frame in case of an accident to prevent damage to the passengers and the eyes respectively.

PR[9] ᵖ   Proper location for driver's status indicator LEDs to be used by other passengers.

PR[10] ᵖᶠ   Optimized positioning of IR sensors to minimize blocked view sight and distraction.

2.3   System Requirements

2.3.1   General

SR[1] ᵖᶠ   The system's operation shall be stable independent of the brightness of the environment..

SR[2] ᵖᶠ   The system's operation shall be stable independent of varying temperature environment.

SR[3] ᵖ   This system's operation shall be stable in reasonably normal humidity and pressure conditions.

SR[4] ᵖ   The control box cooler system shall keep the temperature of the CPU under 40 degrees.

SR[5] ᵖ   The operation of the system shall not be affected by convection currents inside the cabin.

2.3.2   Performance

SR[6] ᵖᶠ   Eye blinks shall be distinguished from sleepy eyes.

SR[7] ᵖᶠ   The alert systems shall stop automatically 2 seconds after the recovery from the sleep state.

SR[8] ᵖᶠ   The buzzer activation time shall be less than 2 sec from the time that eyes become closed.

SR[9] ᵖᶠ   Undesirable conditions shall be signaled via status indicator LED's.

SR[10] ᵖᶠ   The secondary alert system (horning) [2] shall start after 10 seconds from the activation of the primary alert system.

2.3.3 Sensitivity

SR[11] [pf] The device shall be sensitive enough to detect partially closed eyes.

2.3.4 Buzzer

SR[12] [pf] The loudness of the buzzer should be greater than 65 dB. (The upper limit is still to be determined. We estimate an upper limit of 85 dB)

SR[13] [pf] The operating voltage of the buzzer shall not exceed 12 VDC.

2.3.5 Alternate Supply

SR[14] [pf] The alternate power supply shall be 12 VDC 7 AH for reliable continuous operation of 1000 hr.

2.3.6 IR Emitter and IR Receiver

SR[15] [pf] The radiant intensity of the IR emitters shall not exceed 10 mW/sr.

SR[16] [pf] The current through the IR emitters shall not exceed 10 mA to prevent damage to the retina.

SR[17] [f] The IR emitters and IR receivers shall be 3mm IR LEDs to minimize view obstruction.

SR[18] [pf] IR receivers and IR emitters shall be positioned in black tubes to reduce the effect of ambient light.

2.3.7 Frame Wire Winding

SR[19] [p] An automatic cord winder shall wind the frame connection wire when the frame is not in use.

2.4 Connection and Setup Requirements

CR[1] [p] The IR emitters and receivers shall be connected to a flexible circuit which is on the frame.

CR[2] [p] The flexible circuit shall be connected to the control board via a stranded wire.

CR[3] ^p   The control board shall be connected to the cigarette lighter of the car via standard 6" 3A cord.

CR[4] ^p   Flexible circuit, IR emitters, and IR receivers shall be connected to the plastic frame permanently after adjusting, using super glue.

CR[5] ^p   Stranded wire from the frame shall be connected to the control board via a 4 pin PC header connector.

CR[6] ^p   alternate supply shall be connected to the control board via a 2 pin PC header connector.

CR[7] ^p   The control board shall be mounted under the driver's seat via ¼" screws or installed in a dashboard compartment.

CR[8] ^p   The control buttons shall be wired to the left side of the driver's seat and mounted at driver's hand level.

CR[9] ^p   The frame case and the cord winder shall be mounted on the right side of the driver's seat.

3   Reliability and Serviceability

The *AutoWake* operating system and control board shall be designed to ensure the most reliable operation possible. However, due to different shapes of human eye and eyelid that the system has to monitor, different reactions from the system may be obtained. The following requirements shall be met to expect a reliable functioning of the device.

RSR[1] ^p   In case of failure the unit must recover by cycling the power.

RSR[2] ^p   The Start/Stop button must have a duty cycle of at least 1, 000, 000.

RSR[3] ^{pf}   The unit shall be installed by trained technicians.

RSR[4] ^p   The unit shall be serviced by the technicians and not the user.

RSR[5] ^p   The unit must operate continuously for 2 days without failure.

RSR[6] ^{pf}   The unit must be able to reliably monitor young, middle aged, and old eyes.

4   User Interface

The following requirements should be met in order to ensure that *AutoWake* is user friendly.

UIR[1] [pf]   The Start/Stop button, mounted on the left side of the driver's seat, enables the user to start/stop the device at will.

UIR[2] [pf]   The status LEDs shall be placed at a proper position that can be viewed by all the passengers.

UIR[3] [pf]   The color and luminance of status LEDs shall be recognizable during the day, and night, in different weather conditions.

UIR[4] [pf]   The frame shall be reached easily by the driver.

5   Regulatory Requirements

RR[1] [p]   Horns shall be used to alert others of a danger and shall be used wisely [3].

6   Documentation and Training

DR[1] [p]   The manual for this product shall contain user instructions.

DR[2] [p]   The manual shall contain basic information of functionality.

DR[3] [p]   The manual shall contain customer service contacts for repair concerns and any encountered difficulties.

DR[4] [p]   The manual shall contain basic troubleshooting instructions.

DR[5] [p]   The manual shall provide a FAQ section[1].

DR[6] [f]   The device shall be calibrated and adjusted for users of the first stage prototype.

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[1] Section 2, System Overview, provides some answers to FAQ.

7   Final Notes

The user shall refer to the user manual for more elaborate instruction on using the device.

The user can also refer to our website at www.autowake.com for contact info and downloadable version of the user manual and functional specification documents.