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April 13, 1999

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC
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Re: ENSC 370 Project Windshield Anti-Fog System Process Report

Dear Dr. Rawicz,

The attached document, *Windshield Anti-Fog System Process Report*, summaries our project process from design stage to implementation stage. The WAFS is a safety device that can be installed in automobiles to lower the risk of car accidents caused by decreased visibility as a result of the formation of fog on the windshield.

This document presents the current state of the device, deviations from our original plans, and our future plans for the device. In addition, we outline the budgetary and time constraints we encountered and explain the inter-personal and technical experience gained from working on the project.

The team members of ABEE Technologies Inc. are Edlic Yiu, Edwood Yiu, Angela Lee and Benjamin Lee. Please feel free to contact us via e-mail at ensc370-abee@sfu.ca should you have any questions on our document, or should you wish to comment on our project.

Sincerely,

Edlic Yiu, Team Leader
ABEE Technologies Inc.

Enclosure: *Windshield Anti-Fog System Process Report*

The **Windshield Anti-Fog System**

Process Report

Submitted by: *ABEE Technologies Inc.*
Angela Lee
Benjamin Lee
Edlic Yiu
Edwood Yiu

Submitted to: Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University

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Introduction

Driving with a foggy windshield is an unpleasant experience to a lot of drivers. The invention of the Windshield Anti-Fog System (WAFS) by ABEE Technologies Inc. must then be a rescue for the foggy situation to all drivers. When fog appears on the front glass, the WAFS will start the ventilation system in the automobile automatically so that air will be distributed to the windshield to blow away any fog formed. As a result, the visibility for the driver will be improved and he can concentrate on controlling the vehicle without being distracted by the appearance of fog.

For the past thirteen weeks, four motivated engineering students – Angela Lee, Benjamin Lee, Edlic Yiu, Edwood Yiu – worked closely together to invent the WAFS. This report re-examines the process that took this dream from concept to reality and documents the experiences of each of the four members.

Current State of the Device

The following figure illustrates the system overview block diagram. The current state of the device will be explained by reviewing each of the stages inFigure 1.

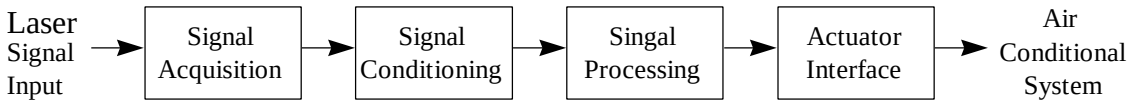

Figure 1. System Overview

The signal acquisition stage consists of a laser emitter and optical sensors. A laser ray is emitted on the surface of the windshield. Due to the scattering of the laser beam by the moisture on the windshield, the signal level of the reflected laser ray would go down as the amount of moisture increases. Hence, by sensing the intensity of the reflected laser ray, we would be able to determine how foggy the windshield is. The signal acquisition stage outputs the analog signal to the signal conditioning stage.

The signal condition stage consists of an analog-to-digital converter, which converts the analog signal to straight binary number used in the signal processing stage.

The signal processing stage consists of a microcontroller, which is responsible for analyzing the digital signal and commanding the actuator interface. Giving a logical high to actuator interface means turning on the blower.

The main element in the actuator interface is a relay. When a relay receives a continuous logical high or 5 V signal from the microcontroller, the actuator interface will switch power to the actuator – the ventilation system. As a result, air will be distributed to the windshield to blow away any fog formed.

We tested the system in a box with the moisture created by a steamer. The WAFS worked the same way as we predicted for over 15 minutes.

Deviation of the Device

Overall System

In terms of functionality, we achieved what we planned. Currently, our prototype consists of a laser pointer and three circuit boards. The laser pointer is attached under the roof near the windshield. The optical sensors are assembled in a small circuit board, which is placed on the front dash. The remaining circuit, except the actuator interface, is put on the main circuit board inside a plastic enclosure. For the demonstration purpose, we use the hair dryer as the ventilation system in the automobile. Hence, we needed to isolate the AC circuit, the actuator interface, from the rest of the circuit by a separated circuit board inside a metal enclosure.

Signal Acquisition

The signal acquisition stage has not deviated very much from our original design. The only difference is that we used a laser pointer instead of a laser emitter. This change is due to the cost of the laser emitter, which costs about three times more than the laser pointer.

Signal Conditioning

The implementation of the signal conditioning stage has not deviated at all from the functional and design specifications.

Signal Processing

The implementation of the signal processing stage has not deviated very much from the functional and design specifications. We only added a crystal circuitry for the proper operation of the microcontroller.

Actuator Interface

Due to the costly blower, we employed the hair dryer as the ventilation system for the demonstration. The hair dryer is powered by alternate current; hence, we designed the actuator interface in such a way that DC and AC blowers are supported.

Future Plans

The Windshield Anti-Fog System has a great market value; however, further research and development is needed before putting it on the shelf. Here are some suggestions.

Overall System

- Infrared Laser Beam

  The invisible infrared laser emitter would be used rather than the visible red laser emitter because invisible infrared laser would not affect the driver's vision.

- Safety

  Some kinds of protection would be included which avoid direct eye contact with the infrared laser.

Signal Acquisition

- Numbers of Laser Sensors

  Additional laser emitters and sensors would be added to the system such that the whole windshield can be covered by the WAFS.

- Select a Better Sensor Package

  We use two sensors at a time to detect one spot on the windshield; however, it would be better if the two sensors are put into a single chip package rather than two separate ones. The change can eliminate the occurrence of different characteristic between a pair of optical sensors.

Signal Conditioning

- A comparator

  Because we plan to include more laser emitters and sensors into the system, some comparators are needed which output the lowest input value (the value of the foggiest spot among some optical sensors).

Signal Processing

- A Different Microcontroller

  A different microcontroller should be used in the future because as the number of sensor increases, more situations can be concerned and analyzed. The one we are using, PIC16F84, would not be enough to handle these intensive situations. In addition, PIC16F84 doesn't have enough I/O pins for future enhancement.

- Different Output Values from the Microcontroller

  A different algorithm should be used to implement the intensity of fog on the windshield, such that the blower distributes more air to the windshield when the windshield is very foggy.

Actuator Interface

- Support Different Levels of Blower Power

  The blower should be set to different power according to the output from the signal processing stage. So the power of the blower would not be maximum all the time while only little fog appears on the windshield.

All these additional features would be put into the system. The test would be carried out in an automobile such that we have better understanding of the exact situation.

Budgetary and Time Constraints

Budget

The following table illustrates the estimated cost and the actual cost of our project.

Table 1. Estimated Budget

Required Materials	Estimated Costs	Actual Cost
A/D Converter	$20	$20
Microcontroller	$15	$15
Monolithic Photodiode	$10	$20
Visible Red Laser Emitting Diode	$20	$30
Laser Pointer	Not included	$16
Relay	$9	$15
PCB Board	$10	$8
Operational Amplifier	$5	Not used
Crystal	Not included	$5
AC Circuit Components	Not included	$12
Circuit Boxes (black and iron)	Not included	$12
Voltage Regulator	Not included	$3
Total	$89	$156

Our project has been completed and demonstrated on March 30, 1999. Obviously, we had a little bit underestimated the cost. One of the main reasons is that we didn't include the AC circuit components and some required materials for the physical implementation. For the most parts, we ordered an extra one for back up while the estimated cost was enough for one only.

Time

The expected completion date was April 6, 1999. We finished our implementation and demonstration ahead of the schedule. The Gantt chart below illustrates the expected deadlines for various tasks in black and our completed time of various tasks in gray. We are glad that we accomplished the project on time and were the first ENSC 370 group to demonstrate on March 30, 1999.

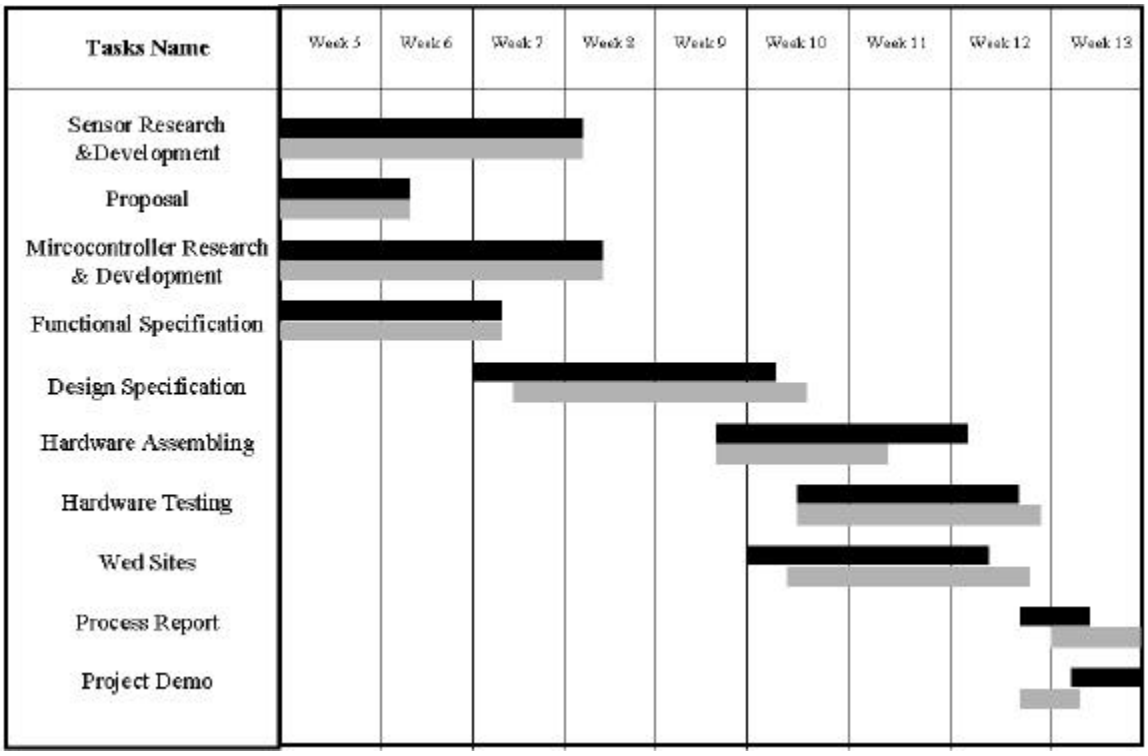

Figure 2. Gantt Chart for Various Tasks

Inter-Personal and Technical Experiences

Angela Lee

An engineering student acquires his primary and most precious experience on teamwork and a well-rounded view of engineering activities by building an innovative device that no one has thought of. ENSC 370 gave me this opportunity to fulfil such a dream.

In the past 13 weeks, I enjoyed participating in this group because the group members are dedicated, creative, considerate and humorous. We are close friends and are familiar with each other from first year. We believe that we would work very well as a group. In reality, we shared work and used our strengths to contribute effectively to the group in different ways.

I was appointed to be the project manager, which was the contact person with the course instructors and TAs. I am glad that we were able to follow the project schedule and completed the project as we planned. I have found that organization is very important in project management. Things will become messy and uncontrollable once we can not organize our responsibilities and duties. In addition, the weekly meetings were useful in remaining us the duties of each individual regularly.

My main responsibility was to design the actuator interface and construct it with help from my team members and lab instructors. From a technical perspective, I acquired knowledge of AC circuit, such as the safety consideration in AC circuit. Besides, I anticipated in various stage of the project. As working along with other group members, I also learned a lot about the microcontroller, analog to digital converter, and optic sensors.

Finally, I learned that you must ask whenever there is a problem. The engineering department has many knowledgeable people who can answer any kind of technical questions we have. Our department is the best resourcecentre.

Benjamin Lee

The greatest achievement for me in this project is the knowledge of transducers – optical sensors – that I acquired. For our project, it was very critical to choose a rightoptical sensor. It not only has to coordinate with the circuit design, but also has to match the power of the laser emitter. In addition,a little variation in positioning of the optical sensors would disable the system due to the misalignment between the laser emitter and optical sensors. However, with our determination andperseverance, we were able to come up with the right solution to the problem. Although my mainduties in the group were to design the signal acquisition stage and the box for the demonstration, I had an opportunity to help other members, such as the design of the microcontroller. I really learnt a lot of different things in this project.

It is of great experience to do a project formally starting from writing aproject proposal, writing a function specification, writing a design specification to wrapping up by

finishing the process report. I think that it is very important to understand the process of how a project should be done in the engineering world and to organize ourselves to finish a project as a group.

I was very pleased with the progress of our project as it went. We set deadlines for each particular task so we knew where we should be and where we were heading to at a certain time. And the most important thing is that we were able to meet the deadlines we set. There were some difficulties due to the workloads from other courses, but we still managed to finish everything before the deadline because of a precise and well-planned schedule.

I was very lucky that I could work with my group members on this project. We had excellent understanding and communication. We were able to sacrifice for each other, as sometimes a person might have to do all the work on the project while others were struggling with their midterms and assignments. Each member has contributed to the group equally according to their skills on different sections of the project. It has been a precious experience to work on such an interesting project with my group members. Thank for the opportunity provided by ENSC 370.

Edlic Yiu

Since the formation of the group, I have the feeling that our project would be fun, cool and interesting. Each of the members in our team has different characteristic and strength. Some people have leadership abilities, some have creative ideas, and all of us have the same goal in mind. We all believe that our project will be successfully finished.

I was glad to be the team leader of this project. To become a good team leader, I identified the strength and weakness of each team member. This is very important from the viewpoint of efficiency. If I understand each member, I can assign different tasks to each member according to their knowledge and experience. In addition, I set the milestones of this project and deadlines of various tasks. This step is very important; the deadlines help the leader to identify the problems within the group, such as unbalance workloads within the group. Through this project as a team leader, I learned to ask when I have questions, listen when others have new ideas or suggestions, help when others need it, and be patient when others don't understand.

I involved in each part of the design ranging from the optical sensors, the A/D converter, the microcontroller, to the AC circuit design. I learned that a device needs not to be complex. Hence, we tried to simplify our design in the design stage such that we can easily implement the whole project. Besides involving the design of each part, the main responsibility for me is the implementation of the microcontroller. I learned how to program a microcontroller and control an A/D converter by a microcontroller. The experience with the microcontroller is very useful to my future despite many sleepless nights of programming.

Since my past co-op experience with AC circuit, I have an opportunity to teach other members. This is a very good experience for me to employ my knowledge and learn the way to teach.

I was very happy to work in this group. We worked very hard and tried our best to become the first team to finish the project. And we did it! We were all willing to help each other and sacrifice the time for each other. I, as a team leader, am very please with the performance and contribution of each member.

Edwood Yiu

I was really happy to work in this team because of the pleasant environment we created. Our group was well organized and each member used their strengths to contribute effectively to the group. In addition, we all helped each other as much as we could, so that we all have a good time in this project.

In terms of the hardware design, I was responsible for the design of the signal conditioning stage. I chose the correct A/D converters, such that the design of the signal conditioning stage is simple. Through this design process, I learned to read the data book, control the A/D converter, and communicate with other team members. Besides the design of the signal conditioning stage, I was also involved in the design of the other parts, such as MCU and AC circuit. All this experience brought me the insight of electronic. Through the electronic designing process, I have been explored and immersed to the stepwise process, which includes conceptual design, circuit analysis, schematic drawing, assembling, and final testing.

In addition to the hardware design, I was responsible for the design of our web site. Although the web site design is very trivial due to the past experience, it provides me an opportunity to energize my artistic cell.

I believe that we all had a good time in this project. It seems that the strengths of each member cover up the weakness of the others. This is one reason why our team is so efficient and we finished our project ahead of schedule. For the past 13 weeks, we all learned a lot in the technical perspective and interpersonally. I hoped that we could work together again in the near future.