January 18, 2010

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British columbia
V5A 1S6

Re: ENSC 440 Project Proposal for an Intelligent Flame Extinguishing System

Dear Dr. Rawicz,

Please find attached our document, “Proposal for an Intelligent Flame Extinguishing System” which describes our ENSC 440 project goal. In the enclosed, we will outline several important sections – An introduction, the system overview, the design overiew, budgetting and funding, scheduling, and our company information.

To summarize, our ENSC 440 project goal is to design and create a working model of a system that is able to properly detect a flame and able to extinguish the flame using pressurized water. Our business goal, however, is to be able to minimize costs and physical size to the extent where it will be easily commercialized.

Our company, FlexiSys – Flame Extinguishing Intelligent System, consists of four, fourth year engineering students with expertise in different options. Kelvin Ho is studying computer engineering, Ken Zheng and Luke Dang are both studying electronics engineering, and Peter Zheng is studying Systems Engineering.

Please feel free to contact me if there are any questions or concerns.

Sincerely,

Kelvin Ho

President and CEO
ENSC440-fire@sfu.ca
604.780.3392

Proposal

Intelligent Flame Extinguishing System

Project Team: Kelvin Ho
Ken Zheng
Peter Zheng
Luke Dang

Contact Person: Kelvin Ho
Ensc440-fire@sfu.ca

Submitted to: Dr. Andrew Rawicz – ENSC 440
Steve Whitmore – ENSC 305
School of Engineering Science
Simon Fraser University

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Executive Summary

In almost every city in North America, there's something common in their building code for new residential constructions – the requirement to install a sprinkler system. Sprinkler systems, albeit a great invention, are unintelligent and cannot extinguish fires quickly enough. Their main purpose is to suppress the fire which, hopefully, will allow enough time for the firefighters to arrive. In addition, sprinkler systems have no control over the amount of water sprayed – a fire that may have been put out by human intervention will not stop the sprinkler system at all.

The problems of fires, however, do not simply exist only in residential housing. Industrial fires have a greater risk, as industry often contain flammable and toxic substances; firefighters have little they can do when an industrial fire has grown out of control. For example, in Austria, a cable car running from the base of a mountain to the top via a tunnel caught on fire en route. 170 lives were lost as the fires consumed the cable car and toxic fumes erupted.

In both situations, there arises a need for an automatic extinguishing system that is able to detect fires and extinguish them before the situation cascades out of control. This document will outline such a system that will be able to identify a flame and then proceed to extinguish it with pressurized water. While our working model may encompass a smaller subset of our ultimate business goal, it will pave the way to constructing a product that may have profound social impact.

Our team of four engineering students, all in their final year of studies, with varying specialities will combine their skills to see this goal to fruition. In addition, two of the group members have won the Ken Spencer business competition, a local competition at SFU which merges engineering and business students.

We estimate that our project will require approximately thirteen to fourteen weeks – this will include research, hardware and software development, testing, evaluation, and documentation. As of now, we aim to complete our project by April 9th, before our formal demonstration of the working model. Currently, the projected cost of our system is approximately $800 and we are in the process of obtaining funds for our vision.

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Introduction

Fire fighting has existed in this world for centuries in order to prevent enormous amounts of costs. A good fire fighting system is a system that minimizes the fire damage as much as possible, while also minimizing other damage caused by the fire fighting system itself. Taken from the U.S Fire Administration website, a fact about water damage in fire fighting is:

> *"Water damage from a sprinkler system will be much less severe than the damage caused by water from firefighting hose-lines or smoke and fire damage if the fire goes unabated. Quick response sprinklers release 8 to 24 gallons of water per minute compared to 50 to 125 gallons per minute released by a fire-hose."*

In North America, schools, offices, factories, and residential buildings have benefitted from fire protection systems such as smoke alarms and fire sprinklers. Smoke alarms will inform occupants if there is a significant amount of smoke. Fire sprinklers are mechanical, passive systems that activate when the temperature of the room reaches a certain point. At this point, the sprinkler head breaks, activates the system and will start spraying water in every direction. These sprinklers have no sense of where about the fire is, whether the fire has been extinguished or whether it is still burning, hence, they will keep sprinkling water until manually turned off.

Although fire sprinkler causes much less damage compared to a fire fighting hose, in places such as libraries or offices with many electronic devices, the water damage is still very significant and cannot be ignored.

An ideal fire protection would be a system that is able to locate precisely where the fire is and focus water on that area only. This system should be able to tell whether the fire still exists or not and respond accordingly. Much less water will be wasted and water damage from this system will be minimized, compared to the current fire sprinkler system. In our project, our goal is to create a system that will respond to fire and that will be able to extinguish it. In this proposal, we will give an overview of our project, outline product design, describe our available funding and project scheduling.

System Overview

Figure 1 shows the basic conceptual overview of the intelligent flame extinguishing system. The infrared (IR) sensor is initially at the standby mode when there is no fire. Infrared is emitted from any object which is on fire. When the infrared enters the monitoring range of an IR sensor, the IR sensor will send a signal to the microcontroller informing that there is a fire. The microcontroller then directs the water gun to the location where the fire is by controlling two independent step motors. Once the water gun turns to the right location of the fire, the microcontroller switches on the water pump immediately to drive water to the water gun. When the fire is extinguished, the IR sensor will notify the microcontroller. In order to make sure the fire is totally extinguished, the microcontroller will keep the water pump on for extra two minutes after it receives the fire-off signal from the infrared sensor.

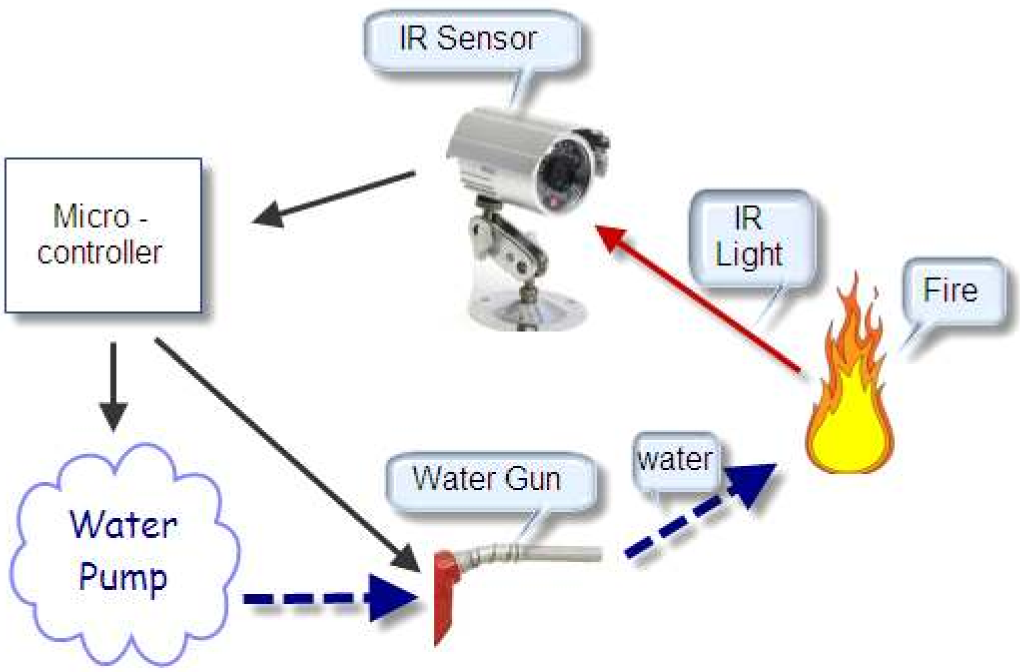

Figure 1: Conceptual Overview of our system

Possible Design Solutions

Although scientists, engineers and other people are working very hard to develop new technology and trying to apply the new technology to make our life better, the fire protection systems we are currently using are not really taking the advantage of the new technology we have today. The most commonly used fire protection systems are listed below:

Smoke Detection System

Although a smoke detector works very well in detecting smoke, it can only warn the people inside the building to escape out of the building. It is never able to extinguish the fire before the situation goes out of control. Hence, it can never save the building or the contents inside the building. Another problem with the smoke detector is it not only senses the smoke from real fire but also the smoke from cooking. If you ever live in a house with smoke detectors, you may have experienced the false alarm when you are cooking your delicious meal.

Fire Sprinkler System

Compared to smoke detection system, fire sprinkler system works a little better. Although it splashes water at the occurrence of a fire, its main purpose is to suppress the fire instead of extinguishing the fire due the limited amount of water splashes out from sprinklers. Poorly designed and placed sprinklers may even have blind spots, avoiding the source of the fire. Another disadvantage of the sprinkler system is water damage to the building and contents in the building due the water from sprinklers which splash water but no fire under them.

Proposed Design Solution

Due to shortage of existing fire fighting systems, our proposed solution is to build an intelligent flame extinguishing system that will replace the existing fire fighting systems. This system will turn on the alarm warning people inside the building to escape. Hence, it can replace the smoke detection system. At the same time, the water gun will aim at the fire position and only spay water to the fire instead of splashing water everywhere in the building. Hence, it can minimize the damage to the building. This is extremely important in building where there are a lot of paper documents and electronic elements, such as libraries and offices.

The estimated cost for this intelligent flame extinguishing system with one water gun is approximately $800. Since we can use the existing microcontroller and water pump, an additional fire extinguishing module costs around $500. For an average house with 12 rooms, the total cost to install a water gun in each room is around $6,300. According to Wikipedia, the cost of sprinkler system runs from $2 - $5 per square foot, depending on type and location. The size of an average house is around 2,200 square feet, and the total cost of the sprinkler system is around $4,400 - $11,000. Assuming that some of these costs are common between a passive sprinkler system and our system, our system costs may comparable to the higher end of a passive sprinkler system.

Due to the constraints of time and funding, we will just focus on a system with one water gun and will concentrate on the design of detecting fire instead of smoke. With more time and money, we would develop a more sophisticate system. For example, we can integrate a unit that will dial 911 to report a fire or dial any pre-stored telephone number and play the recorded message. The block diagram of this extended design is shown below.

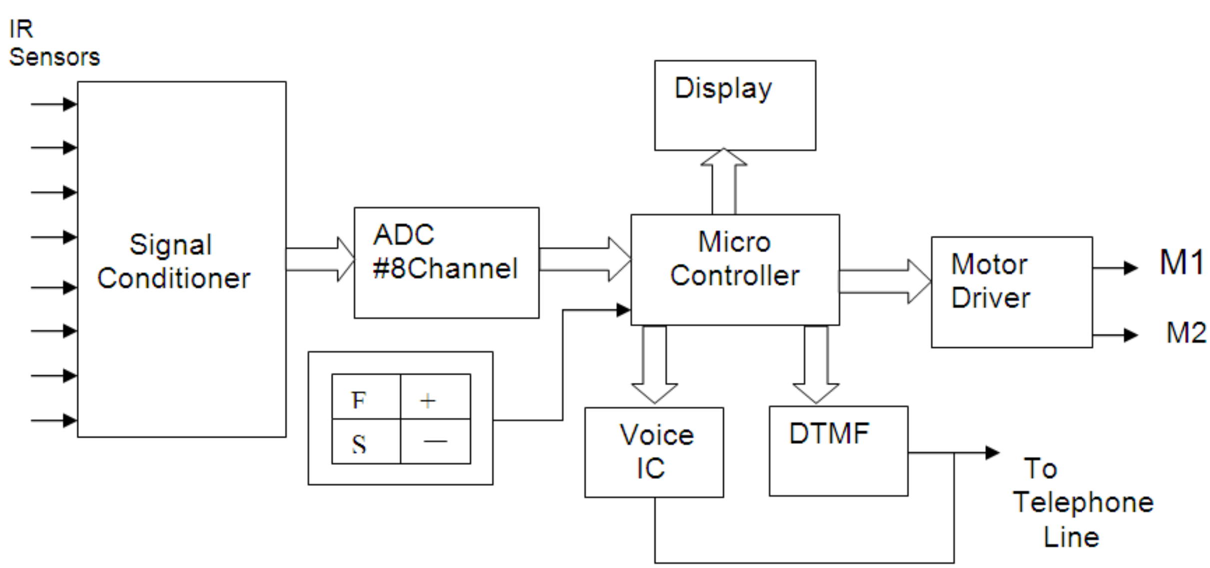

Figure 2: Block Diagram for the Extended Fire Fighting System

Budget and Funding

Budget

The system overview and the design overview above describe components involved in this project. Here, the costs will be listed again in Table 1. More information of unit costs, amount needed and total prices also listed. At the end of the table, a 15% contingency fund is also listed and added to total equipment cost.

Table 1: Estimated cost

	Quantity	Unit Cost (CAD)	Total Cost (CAD)
Motor Driver	1	56.64	56.64
Step Motors	3	52.74	158.22
ADC	2	8.21	16.42
Microcontroller	1	100	100
Piping system	1	50	50
Electronics misc. estimate	N/A	N/A	50
IR sensors	4	26.87	107.48
Water Pump	1	50	50
Case	1	50	50
Total without contingency			638.76
15% Contingency			95.814
Total			734.574

Funding

Although total cost above had been estimated with a 15% contingency fund, developing the prototype may result in actual costs that exceed our estimate. We will build our system to keep the cost as low as possible by avoiding false designs. In order to fund our project, we have applied for the Engineering Science Student Endowment Fund (ESSEF). Also, we are considering request funding from Vancouver Fire & Rescue Services since success in this project can possibly bring a new generation of fire fighting projections. In addition, our group have discussed and agreed to share the remaining financial cost of the project equally if the above funding is not enough.

Scheduling

The following Gantt chart illustrates the expected time to be spent in the various tasks involved with our project. We are expecting a certain amount of iterations in our design such as calibration of the sensors. Figure 3 shows the milestone chart of our project.

Table 2: Gantt Chart

		January				February				March					April		
ID	Task Name	4	11	18	25	1	8	15	22	1	8	15	22	29	12	19	26
1	Research																
2	Proposal																
3	Functional Specification																
4	Design Specification																
5	Detection of Fire																
6	Motor Control																
7	Casing design																
8	Integration Testing																
9	Debugging and Modification																
10	Documentation																
11	Process Report																

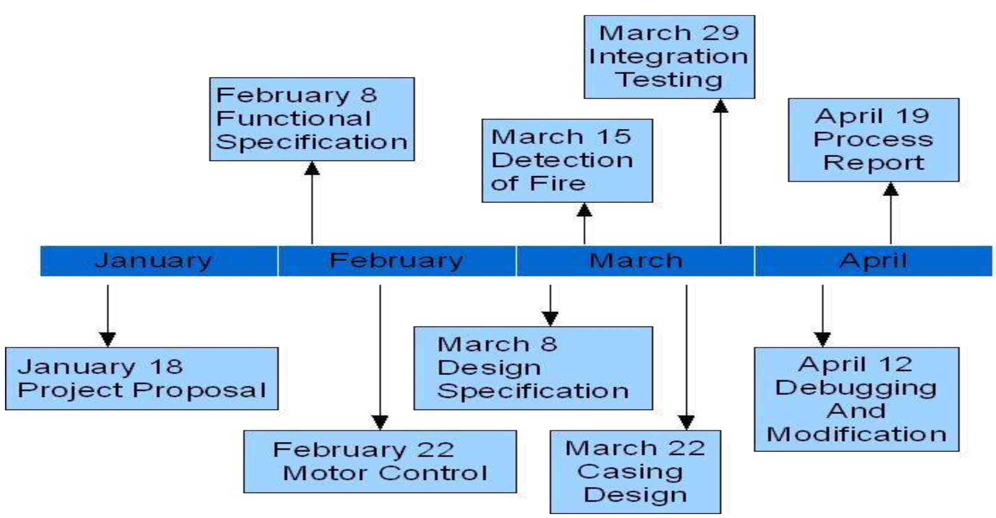

Figure 3: The milestone chart

Company Info

Kelvin Ho – President and Chief Executive Officer (CEO)

I am a fourth year computer engineering student at Simon Fraser University with extensive experience in both software and hardware design. My area of focus is into network engineering as I have completed 4 semesters of co-ops in the telecom industry. My software skill set includes, but is not limited to: Assembly, C, Objective C, C++, MATLAB, and Java. My hardware skill set includes EAGLE, VHDL, and SPICE. Communication in both the technological and social world is my interest and forte.

Peter Chuan Zheng – Senior Mechanical and hardware Engineer

I am a fifth year System Engineering in Simon Fraser University. My strengths are with mechanism design, robotics and aerospace engineering. I have worked for Dr. Sharam Payandeh in the field of robotics and for RIM as a protocol tester. I have experience troubleshooting and fixing household electronics such as hotpot machine, playstation controller, stand alone computers and many more hardware. During my time at Simon Fraser University, I have developed signal conditioning circuits, robotic mechanism, filter, and software to test the evaluation board used in one of the Engineering courses offered at SFU. Moreover, I am good a modeling mechanism using SolidWorks and building PCB using Eagle.

Luke (Tue Le Minh) Dang – Chief Software Engineer (CSE)

I am a fourth year Electronic Engineering student at Simon Fraser University with software work experience for Simon Fraser University Engineering Robotic Lab, Broadcom Corporation and Sparks Robotic Institution. My strengths and interests focus on software development. Both my coop experience at Simon Fraser University Engineering Robotic Lab and Sparks Robotics gave me extensive knowledge in object-oriented, GUI, real time and embedded systems programming. From my work experience and Simon Fraser University Engineering courses, I gained knowledge in Assembly, C, C++, Perl, Python, TCL which will serve well in this project.

Ken Zheng – Engineering Manager

I am a fourth year Electronics Engineering student at Simon Fraser University (SFU). I also finished the Electrical and Computer Engineering diploma with honour at BCIT. My strengths lie predominantly on analog and digital circuit design. During my school at SFU and BCIT, I have designed a temperature controller, a marble sorter and filters. Before I started my school at SFU, I was working as a manufacturing technician at Verathon Medical Canada, where I built and tested medical scope prototypes, and evaluated and verified design improvements. I was also working as an accountant at Amacon Group for two years through which I developed strong communication skills in business environments.

Conclusion

FlexiSys fixes the limitation that water sprinklers have. Our system allows water to flow only to an area where the fire exists. As a result, furniture or electronics equipments that are not affected by the fire or water damage will retain their value. The result of our system helps owners with financial savings and peace of mind.

Our goal of this project is to develop a working model from our proposed design specifications within schedule and budget as proposed. We had proved that this system will do much less damage than the current fire sprinkler system. If successful, this system can replace current fire sprinkler systems. Future expansion that we are considering after this project is to provide even more functionality with our system. One example can be integrating our intelligent fire fighting system into a moving system (robot) to assist in the dangerous jobs that fire fighters encounter everyday. However, that will be a separate project and we will focus on what we've proposed in this document.

References

[1] A. S. Sedra, K. C. Smith, *Microelectronic Circuits.* New York: Oxford University Press, 2004.

[2] N. S. Nise, *Control Systems Engineer*. Massachusetts: Lehigh Press, 2004.

[3] Transworld Business. "Austrian Tram Tunnel Claims 170 lives", January 14, 2010, http://business.transworld.net/uncategorized/austrian-tram-tunnel-claims-170-lives

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[5] Wikipedia – The Free Encyclopedia. "Fire sprinkler system", January 12, 2010, http://en.wikipedia.org/wiki/Fire_sprinkler_system

[6] W. L. Brogan, *Modern Control Theory*. New Jersey: Prentice Hall, 1991.