September 21, 2009

Dr. John Bird
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for an Ecological Monitoring System

Dear Dr. Bird:

The attached document, *Proposal for an Ecological Monitoring System*, outlines our project for ENSC 440 (Capstone Engineering Science Project). The project entails the monitoring of environmental conditions (CO_2 levels, temperature etc.) in remote areas using a wireless data 'hopping' technology.

This document provides an overview of our proposed project, some possible design solutions including our proposed design solution, sources of information, a tentative budget including our sources of funds and a proposed schedule for the completion of project milestones. Also, a section discussing our team's organizational structure, members' roles and background information has been included. The purpose of this document is to identify the need for our project, discuss the feasibility and some possible limitations, and illustrate our ability to successfully complete this project.

The ECOmonitoring Technologies Inc. team consists of five innovative and passionate engineers: Ryan Cimoszko, Amandeep Grewal, Brian Lee, Kianoush Nesvaderani and myself, Harvir Mann. If you have any questions or concerns about our proposal, please feel free to contact me by e-mail at hmann@sfu.ca.

Sincerely,

Harvir Mann
President and CEO
ECOmonitoring Technologies Inc.

Enclosure: *Proposal for an Ecological Monitoring System*

ECO Monitoring Technologies Inc.

PROPOSAL FOR

ECOLOGICAL MONITORING SYSTEM

Project Team: Ryan Cimoszko
Amandeep Grewal
Brian Lee
Harvir Mann
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Submitted to: Dr. John Bird – ENSC 440
Steve Whitmore – ENSC 305
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EXECUTIVE SUMMARY

With issues surrounding global warming and climate change, monitoring of ecological conditions is increasingly important for those concerned with safety, security and research within environmental systems. For example, the increase in wildfires and glacier retreat has been attributed to global warming and climate change [1, 2]. Being able to monitor and collect data from our environment helps society to better understand how our actions are affecting environmental behavior.

Our design solution, the ECOmonitor, entails the construction of a sensor network that gathers data on certain environmental characteristics and communicates with a base station via a signal 'hopping' scheme. The data will first be collected at each monitoring station and then it will be wirelessly relayed to the next monitoring station, which is closer to the base station. Finally, the data will be sent back to the base station where it will be analyzed and available online.

Current technology for monitoring or detecting environmental conditions are expensive or difficult to implement .The ECOmonitor will be able to wirelessly monitor ecological conditions without an excessive initial investment. Our wireless 'hopping' network will enable our system to monitor a large area without the use of long range communication. Finally, the website component will allow real-time monitoring for detection of abnormal behavior.

ECOmonitoring Technologies Inc. is comprised of five fifth year engineering students with a wide range of expertise and experience. Team members have hardware experience dealing with circuit design, real-time embedded systems and signal processing, as well as software experience in areas such as website development and various programming languages.

The proposed project has a budget of $940 which will be funded by external sources. A 13 week schedule has been implemented and the proposed date for the project completion is December 1, 2009.

TABLE OF CONTENTS

1.0 INTRODUCTION

Monitoring of ecological conditions is of importance for those concerned with safety, security and research within environmental systems. With issues surrounding global warming and climate change, the need for monitoring ecological conditions is increasing. For example, many scientists believe that global warming has had an effect on the increase in the number of wildfires and by monitoring humidity and abnormal traces of CO_2 in vulnerable areas, prevention of wildfires can be increased [1]. Additionally, the increase in climate has affected glacier retreat which ultimately causes landslides and flooding. By monitoring glacier temperatures, preventive measures can be taken prior to a landslide [2]. Being able to monitor and collect data from our environment helps society to better understand how our actions are affecting environmental behavior.

Monitoring ecological conditions can be done in a number of ways. Some methods currently used for data collection or abnormal behavior detection include Data Loggers, IR Satellite Imaging, and Telemetry Systems. These methods however are not always sufficient and can be expensive or difficult to implement.

The core idea of the ECOmonitor involves monitoring environmental conditions for multiple areas of concern. Our goal is to provide flexibility for monitoring a range of environmental conditions. By using various sensors, measurements can be collected for conditions such as traces of gases, temperature levels, acoustics, motion, pressure, humidity, etc. With this data, abnormal behavior can be detected or analysis can be formed.

Multiple monitoring stations will be used to periodically collect readings of ecological conditions. These readings will be analyzed by a microcontroller and relayed wirelessly across each monitoring station, ending at the base station where the data will be broadcasted on a website. These monitoring stations can be strategically placed in order to maximize the area where the data is collected.

This proposal contains a system overview of the ECOmonitor, various design solutions and a final proposed recommendation. Sources of information and funding will also be presented in order to address the feasibility of the ECOmonitor. A proposed schedule and budget will be presented to assure that the project is completed on time and within the budget. Lastly, a team organization and company profile will be presented to demonstrate team members' expertise and ability to successfully complete the project.

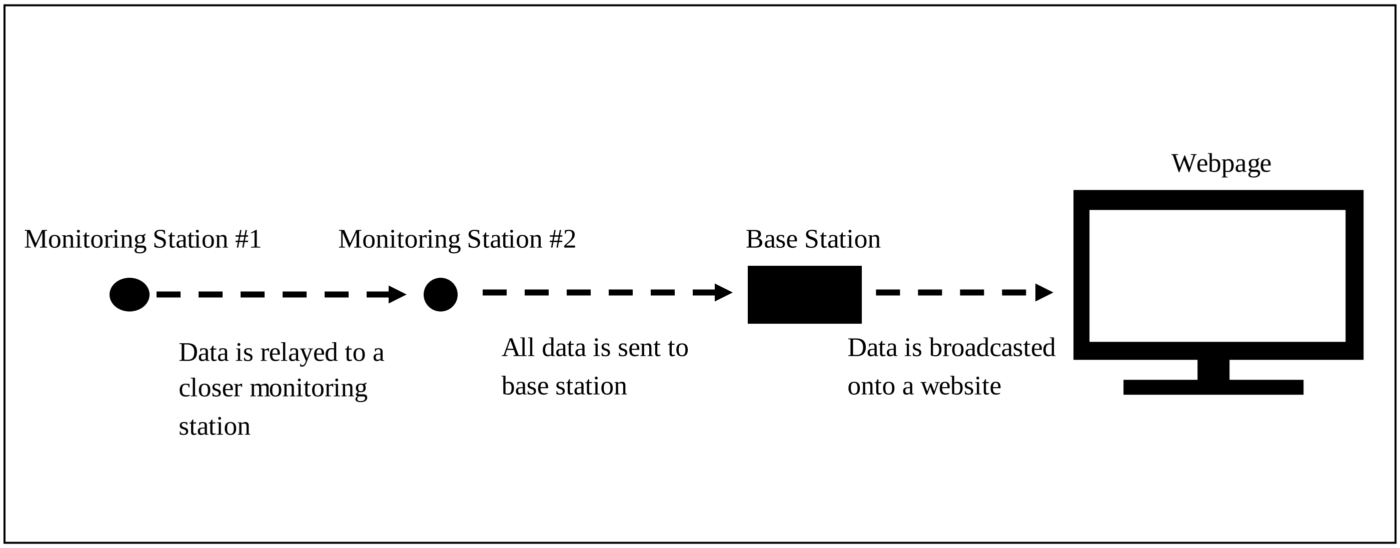
2.0 SYSTEM OVERVIEW

To demonstrate a proof of concept of the ECOmonitor, the following components will be used:

- Two monitoring stations that periodically collect temperature, CO_2 and humidity measurements
- One base station to collect all data to be broadcasted
- A website to view the data

The data collected at Monitoring Station #1 will be wirelessly relayed to Monitoring Station #2. Monitoring Station #2 will wirelessly send all the data back to the Base Station which will then be broadcasted on a webpage to be viewed. The system operation of the ECOmonitor is shown in **Figure 1**.

Figure 1: System Operation



3.0 POSSIBLE DESIGN SOLUTIONS

The following section discusses some of the ways current technology monitors environmental conditions. Two ways of data collection or monitoring of environmental conditions are Telemetry Systems and Data Loggers. Seeing that fire detection is one of the applications for the ECOmonitor, we included some possible alternatives in the discussion.

3.1 TELEMETRY SYSTEMS

Telemetry is the used for real-time monitoring of environmental conditions or equipment status at remote locations. These devices are equipped with a sensor to measure the condition which then can be transferred via radio, infrared or satellite technologies. Telemetry is commonly used in hospitals to monitor multiple patients simultaneously or in conjunction with Supervisory Control And Data Acquisition (SCADA) systems which are able to monitor and control equipment [3].

3.2 DATA LOGGERS

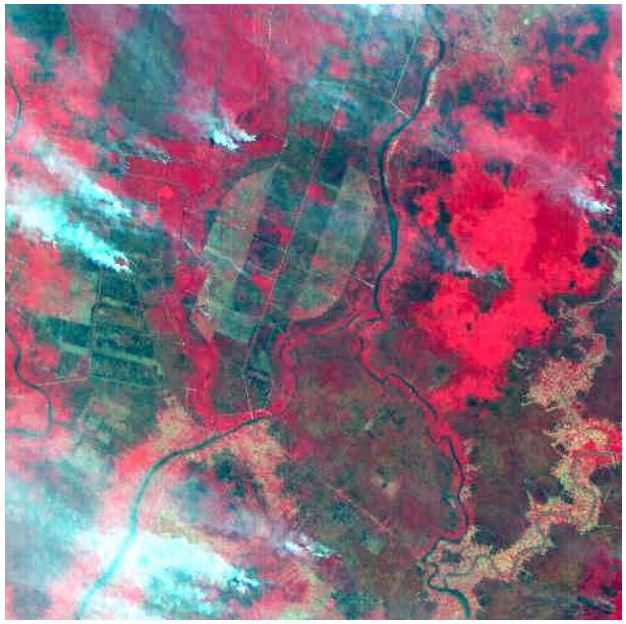
One method of collecting environmental measurements is the use of a data logger. These instruments are usually robust, battery-powered electronics equipped with a preferred sensor. The data can be recorded on the device's memory or a storage card. When the user wants to retrieve the data, the data logger or storage card can bet connected to a computer and viewed [4]. Some applications of data loggers include unattended weather station, hydrograph and gas pressure recording [5]. The main issue with data loggers is inability to monitor and detect abnormal environmental behavior since the device must first be retrieved prior to viewing the data.

3.3 METHODS FOR FIRE DETECTION

Using IR Satellite Imaging

A new technique to detect hot spots in remote areas involves using Infrared (IR) satellite imaging. This system uses a satellite equipped with an infrared imaging system, which sends back a live feed to a monitoring centre. The IR imaging system captures images using three bands which are then used to provide various types of information to the monitoring centre. This information includes the distribution of the smoke, aerosols characteristics and the location of hot spots. **Figure 2** shows an IR image for when a fire has been detected.

Figure 2: IR Image from Space [6]



However, this solution has some drawbacks. Since satellites cost millions of dollars each, one major drawback is the initial cost of the system. This system also tends to give false hot spot readings for areas which have high sun reflectivity, including some parts of land, clouds and sea water. This system can also only estimate the location of the fire to about 1 square kilometer, so it can be hard to pinpoint exactly where the fire is. Another drawback is that this system tends to underestimate the number of fires present in a given area [7].

FireALERT - DC Solution

The FireALERT-DC is a fire detecting system which uses an IR scanning sensor system along with Spectral Resonance Imaging (SRI) pattern recognition software to detect fires in remote areas. Once a fire has been detected, the system sends a message to the closest fire dispatcher using GPS. This message tells the location of the FireALERT-DC unit that detected the fire and the actual location of the fire. The systems software is able to distinguish between an actual fire and other heat producing events. The major drawback of this system is that the unit must have a clear vision of the fire to operate properly [8].

4.0 PROPOSED DESIGN SOLUTION

Our design solution entails the construction of a sensor network that gathers data on certain environmental characteristics and communicates them to a base station, via a signal 'hopping' scheme. The data is collected at each monitoring station and then wirelessly relayed to the next monitoring station, which is closer to the base station than itself. Finally the data is sent back to the base station at which point the data is analyzed and placed online. The sensor network would be dynamic in the sense that a station could be equipped with different sensors depending on which environmental characteristic a user would like to monitor. A system like this would be invaluable in the detection of ecological changes in remote areas that would otherwise be difficult to observe. Detection of ecological changes in remote areas is very important for a couple reasons. As we have seen over the last few months, forest fires present a huge challenge for government agencies in terms of containment and suppression. This system is properly equipped with a CO_2 sensor which will allow for early detection of such fires, and will result in much lower suppression costs. Likewise temperature and pressure sensors will give up to date weather conditions which will be readily available for prospective campers.

Ecological monitoring is not a new concept and has been around for many years in one form or another. The advantage of our system comes mainly in the low initial investment when compared to the financial burden of a satellite monitoring system. As such we propose a happy medium in a system that allows for large areas to be monitored by a minimal workforce without a huge initial investment.

Through initial investigations of the feasibility of this product a constraint that we may see as being difficult to overcome is the creation of a 'hopping' network which does not result in data being lost due to transmission failure. In order to minimize the likelihood of this, a confirmation signal and re-transmission protocol will have to be integrated into the design. In addition to this, an interface will need to be created that allows for different types of sensors to be integrated into the station without requiring a great deal of re-engineering. In order to overcome this issue the idea of PCB board mounted sensors that can be connected via universal inputs to the station has been conceived and several iterations of such a design will be tested in order to find the optimal solution. Time will be another constraint to the complexity of this project as we will be given 13 weeks to complete the project. Within these 13 weeks we will need to obtain all the necessary parts, build a wireless network and data transmission protocol as well as create a webpage that will display all of the data being collected by the field sensors.

Given a longer timeline the design could be modified to make it suitable for more widespread commercial and private uses. The adaptability of this system would make it ideally suited for use in the agricultural market for keeping track of humidity and air temperature in greenhouses. This system could be fitted with a water level sensor and used for early detection of abnormal changes in the water level on remote lakes, creeks or rivers. There is a wide range of applications for sensor network, but our project we will be creating a system suited for detection of ecological changes via temperature, humidity and CO_2 sensors.

5.0 SOURCES OF INFORMATION

In approaching design solutions for our problems, we will gather information from a variety of sources such as the Internet, online patents, books, electronic journals, textbooks, and even professors who have field experience on similar projects. Another source of vital information includes companies who are working on similar projects. By looking at their finished products, we can determine the types of components which are needed for various aspects of our project.

Moreover, our proposed design consists of communication network systems and we will be facing many conceptual challenges. There are great communication networks professors such as Jie Leung, Ivan Bajic and John Bird who are always eager to listen to our new challenging questions and give valuable suggestions.

In addition, our project has a website component that will interactively present data to the users, which would include the use of a proper database and effective server programming. Luckily, a colleague of one of our members is currently running a website company, and he will be a great source of information whenever we run into technical issues regarding database management.

6.0 Budget and Funding

6.1 Budget

The tentative budget is outlined in **Table 1**. Each component has been overestimated by 10 % for contingencies.

Table 1: Tentative Budget

Equipment List	Estimated Unit Cost
Solar Panel x 2	\$85 x 2 = \$ 170
Wireless Transmitters x 2	\$ 40 x 2 = \$ 80
Developmental Kit	\$ 200
Microcontroller x 2	\$ 150 x 2 = \$ 300
CO_2 Sensor x 2	\$ 20 x 2 = \$ 40
Temperature Sensor x 2	\$ 15 x 2 = \$ 30
Humidity Sensor x 2	\$40 x 2 = \$ 80
Miscellaneous	\$ 40
Total Cost:	**\$ 940**

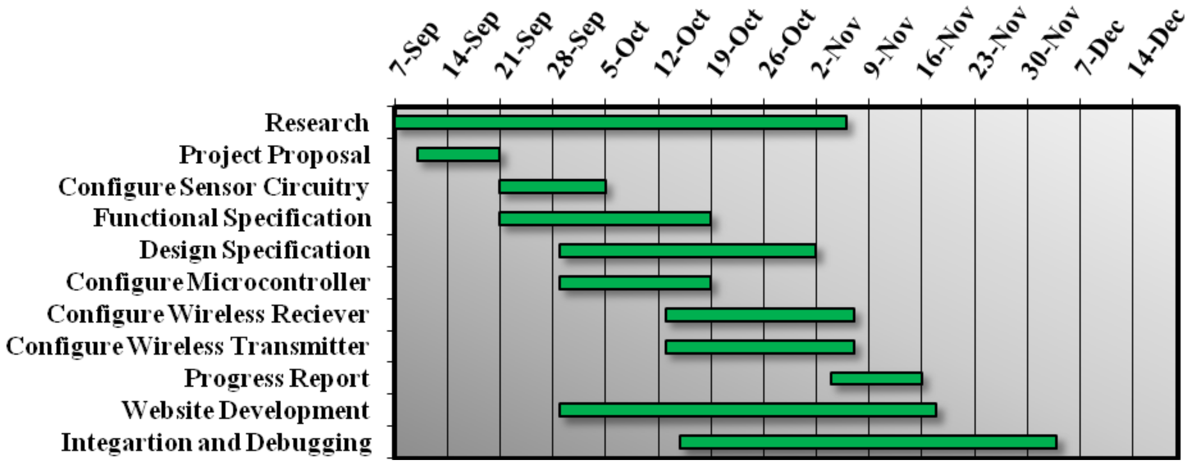
6.2 Funding

We have been approved for funding of up to $ 800 with Engineering Science Student Endowment Fund (ESSEF) and are currently in the process of applying for funding from the Wighton Fund. If for whatever reason, we are unable to fully fund our project with external sources, each team member has agreed to evenly divide the remaining costs amongst each other.

7.0 SCHEDULE

The proposed schedule for completion of various project tasks are shown in the Gantt Chart in **Table 2**.

Table 2: Gantt Chart



The proposed date of completion for specific tasks are shown in the **Table 3** below. The tasks italicized indicate written documents to be completed.

Table 3: Milestone Chart

Task	**Completion Date**
Project Proposal	September 20, 2009
Configure Sensor Circuitry	October 5, 2009
Functional Specification	October 19, 2009
Configure Microcontroller	October 19, 2009
Design Specification	November 2, 2009
Configure Wireless Networking	November 7, 2009
Progress Report	November 16, 2009
Website Development	November 19, 2009
Completed Project	December 1, 2009

8.0 TEAM ORGANIZATION

Our team is composed of five engineers: Ryan Cimoszko, Amandeep Grewal, Brian Lee, Harvir Mann and Kianoush Nesvaderani. All team members are fifth year engineering students. However, each member brings forth a different aspect of engineering expertise and experience collectively producing a very unique team dynamic. The following section, Company Profile, outlines each member's specific role within the organization as well as their areas of expertise and experience.

For a small organization, it is imperative to define roles for each member in the team. Harvir Mann (CEO) is responsible for making final decisions. Amandeep Grewal (CFO) is in charge of acquiring funding and adhering to the company budget. Ryan Cimoszko (COO) will oversee day-to-day operations in order to remain on schedule. Brian Lee (CTO) is in charge of the technical operations for the project and will be consulted with prior to any technical decisions. Finally, Kianoush Nesvaderani (CMO) is responsible for conducting market research and website development and maintenance.

Communication within the team will consist of email, telephone and group meetings. In order to ensure proper time-management, meetings have been designated on an as needed basis. The ability for each member to meet at flexible times is of significance because meetings are only scheduled when necessary. An agenda is initially set prior to each meeting as well as time allotted to each task, however open forum discussions are encouraged to increase creative thinking. Detailed meeting minutes are taken to ensure communication is understood across all levels.

The project's tasks have been divided into four divisions: sensor circuitry, microcontroller configuration, wireless networking and website development. **Table 4** below illustrates who will be working on each project task.

Table 4: Project Task Distribution

Project Tasks	Amandeep	Brian	Harvir	Kianoush	Ryan
Sensor Circuitry	✓		✓	✓	
Microcontroller Configuration	✓	✓	✓		✓
Wireless Networking	✓	✓	✓	✓	✓
Website Development		✓		✓	✓

With the many obligations and demands of other classes, having each project task to be worked on by a minimum of three individuals allows for unexpected conflicts. Overall, we believe that our team's dynamic expertise and organizational structure will provide the necessary foundation to successfully complete this project.

9.0 COMPANY PROFILE

Harvir Singh Mann – Chief Executive Officer (CEO)
I am a fifth year Electronics Engineering student at Simon Fraser University with extensive experiences working with communication equipment on the Military Command systems at my previous co-op at General Dynamics. Through this co-op I have gained experience in the design and implementation of object oriented programming solutions (C/C++). I have taken courses in analog circuit design, digital communications and communication protocols, and real-time embedded systems. These courses have allowed me to complete projects entailing the use of a sensor actuator pair that wireless could detect the insertion of a metal object between them, and a system designed to select and detect different types of blocks through the use of a robot arm and optical sensors.

Amandeep Grewal – Chief Financial Officer (CFO)
I am a fifth year student at Simon Fraser University who is majoring in Electronics Engineering and pursuing a minor in Business Administration. Through my coop experience at FDM Software, I have learned SQL 2000 and SQL2005 programming skills and became knowledgeable about database management. In addition, I have taken many courses related to analog and digital circuits which have allowed me to be comfortable working and designing circuits. I have also become familiar with different communication protocols and systems, from courses I've taken in networking and communication systems.

Brian Lee – Chief Technical Officer (CTO)
I am a fifth year student majoring in Electronics Engineering Science. To point out the type of electronics and science applications experience, I have worked at TRIUMF (national sub-atomic particle physics laboratory) where I have worked on electronics designs/testing/protocol programming/embedded solutions. I have also worked at CPS (Cyber-Physical Systems Laboratory) on my international exchange to KAIST in Korea where I have worked with the professor to design energy-efficient unmanned cars and highway systems (a lot of work related to power and motor efficiency analysis). In addition to the above experiences, I have worked with Professor Ash at SFU on the nano-robot soccer competition program to design nano-robots and fabricate them. In terms of non-technical skills, I have worked at Verecom (Web design company) and many food restaurants as a chef where I have learned how to work with colleagues efficiently and manage my time. Examples of skills I possess include SMC, Cadence, C/C++, QNX neutrino, Linux, UNIX, and documentations using all Microsoft products. All, but not only those mentioned above, would be effectively used in developing a good product in this project.

Ryan Cimoszko – Chief Operating Officer (COO)

I am a fifth year student pursuing a Major in Business Administration and a Minor in Computer and Electronics Design. I have worked two years at GeoAdvice Engineering Inc., where I've written numerous requests for proposals and technical reports, as well as conducted data analysis for water and wastewater systems. Through my education at Simon Fraser University, I have developed hardware and software skills which includes programming in languages such as C++, C and QNX, as well as circuit design, communication systems and real-time embedded systems. Lastly, I have strong communication abilities and work well in a team.

Kianoush Nesvaderani – Chief Marketing Officer (CMO)

I am a fifth year Systems Engineering student at Simon Fraser University with previous co-op term working experience on banking databases, database spreadsheets, and online database websites. During the course of my work term, I gained experience in creating, programming, and updating EXCEL based spreadsheets and databases. I also gained more experience working on websites and making online databases on a website. I have taken courses in Digital Signal Processing, Feedback Control System, Manufacturing Aided Design, Actuators and Sensors, and Robotics. These courses have allowed me to complete projects designing robotic simulations in Open-GL and testing them using Haptic technology. They have also allowed me gain experience designing robotic systems using Solid Works.

10.0 CONCLUSION

Monitoring of ecological conditions is not a new concept, however with the effects of global warming on environmental behavior it is becoming more important. At ECOmonitoring Technologies Inc. we are dedicated to provide a product that is flexible, cost efficient and easy to implement.

The ECOmonitor will be able to wirelessly monitor ecological conditions without an excessive initial investment. Our wireless 'hopping' network will enable our system to monitor a large area without the use of long range communication. Finally, the website component will allow for real-time monitoring for detection of abnormal behavior.

We are more than confident that our team can complete the project according to the Gantt chart and milestone table presented. Our budget, sources of funds and information, organizational structure and company profile has been presented to demonstrate our team members' expertise and ability to successfully complete the project on time and within budget.

11.0 SOURCES AND REFERENCES

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