January 19, 2008

Mr. Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 305/440 Project Proposal

Dear Mr. Leung:

The attached document below presents the proposal for the Heart Rate and Motion Monitoring System (HRMMS), which will be implemented through ENSC 440, The Capstone Project course. The objective for this device is to monitor and analyze the stability of the heart through the use of heart rate and body position. The target consumer can be for all ages.

The proposal describes the project through the following categories: System overview, proposed design, competitors, market potential, source of information, budget, funding, project timeline, team organization, and company profile. This document also mentions some of the importance of heart disease prevention and early stage of medical testing in today's society.

Corazon Engineering Inc. is composed of four dedicated 5th year engineering students: Michael Mao, Benny Hung, Phillip Lin, and Thomas Cho. If there are any questions or comments about our proposal, feel free to contact Michael Mao by phone at (604) 782-5636 or by e-mail at mmao@sfu.ca.

Sincerely,

Michael Mao

CFO Corazon Engineering Inc.

Corazon Engineering Inc.

Proposal for a

Heart Rate and Motion Monitoring System

Project Team Members:	Benny Hung Philip Lin Thomas Cho Michael Mao
Project Leader:	Benny Hung, CEO bennyh@sfu.ca
Submitted To:	Patrick Leung – ENSC 440 Steve Whitmore – ENSC 305
Date Issued:	January 21 2008
Revision:	1.0

Executive Summary

Heart related diseases are the number 1 killer in North America [1]. Developed nations face an increasing number of heart disease cases each year. A large histological study (PDAY) showed cardiovascular injury accumulates from adolescence, making primary prevention efforts necessary starting from an early age. [Wiki say so] Studies show that adolescents are more concerned about risks such and HIV, accidents, and cancer than cardiovascular disease. Primary prevention starts with education and awareness. Cardiovascular disease poses a great threat and measures to prevent or reverse this disease should be taken.

Heart rate, one of the four vital signs is an important piece of information when evaluating the health condition of the heart. But heart rate alone without information on what a person is doing is meaningless. An athlete undergoing intense exercise can have a relatively high heart rate and be considered normal. On the other hand, an elderly person lying in bed with a slight decrease or increase of heart rate might be a serious issue. We can clearly see that a device with heart rate and physical activity recording together can provide more meaningful information than heart rate alone.

This document introduces a new device that will help to prevent various types of heart diseases. The proposed device records subjects' heart rate with respect to the physical activity level, and sends the information to healthcare professionals via cellular phone, for diagnostic and health maintenance purposes. The combination of the two functionalities above can assess the user's state of health. Other potential uses of this device can be: Monitoring user's activity outdoors, automatic distress calls for emergency situations such as a heart attack or stroke, and improving the performance of athletes.

This device is suitable for all ages. Not only seniors with known heart problems will benefit from this monitoring system, but young healthy athletes can also monitor their heart performance through various state of activities ranging from passive (such as sleeping) to intense (such as sprinting).

Corazon Engineering Inc. consists of four 5th year engineering science students from Simon Fraser University. Composed of team members with a wide range of skills and expertise in circuit design, software development, biomedical working experience, and wireless communication, a 12-week period of project development is sufficient to complete a working prototype. The entire project is budgeted at approximately $400, and equipments provided by Computational and Integrative Bio-Engineering Research (CIBER) lab.

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1. Introduction

Routine health check is currently the most acceptable indication for the general public's health condition and performance. The health of the heart can be determined by the electrocardiogram (ECG), where patients are monitored with electrodes wired to the body. However, due to lack of medical resources, the waiting time for performing ECG examination can be lengthy. As a result, this inconvenience deters people from performing regular health checks, resulting in many heart problems go unnoticed until serious complications arise.

Due to the inconvenience of performing ECG at hospitals, many portable heart monitoring devices are available in the market today. Many devices such as heart rate watches allow users to examine their heart rate at anytime, anywhere. However, these devices only provide instantaneous heart rate readings, which is not sufficient in determining heart problems. An improved method of monitoring heart related problems can be observing the heart rate over a period with respect to the physical activities. For example, the heart rate should increase over a period of intense exercise. In failing to do so, this might be an indication to heart problem. In addition, another problem with existing heart rate monitoring devices in the market is that users cannot interpret the heart rate's information from their heart rate alone.

The project objective is to implement a wearable device that can monitor users' heart rate over a time period, based on various physical activities. Along with the stand-alone heart monitoring system, our product also incorporates Bluetooth wireless connectivity and customized software. Bluetooth's convenient communication method and its widely acceptability in cellular phones allow our device to send data to medical professionals for regular check-up or during emergency situations. Since the heart rate depends on many factors such as age, weight, athletic levels, etc.., customized software allows different parameters to be entered in order to better reflect each individual's health condition.

This document proposal of the monitoring device includes the following sections: system overview, design sketches, design solution, proposed design, market demand, budget and funding, project timeline, team organization, and finishing off with company profile.

2. System Overview

Figure 1 below shows the basic operation of our proposed Heart Rate and Motion Monitoring System (HRMMS). The user will be required to have two sensors attached to their body. One will be attached in the chest area, while the other one will be attached onto the thigh. These sensors will monitor the heart rate and position of the user and send the data back to a processing unit carried by the user. The processing unit will send the data via Bluetooth to a cellular phone. A customized software application on the phone sends data to location according to user's preference. For example a senior might want the software to contact his or her doctor when their heart rate is above 200 beat per minute while sleeping. Another example will be if the heart rate decreases below a certain threshold while the person is lying down, then emergency services will be contacted.

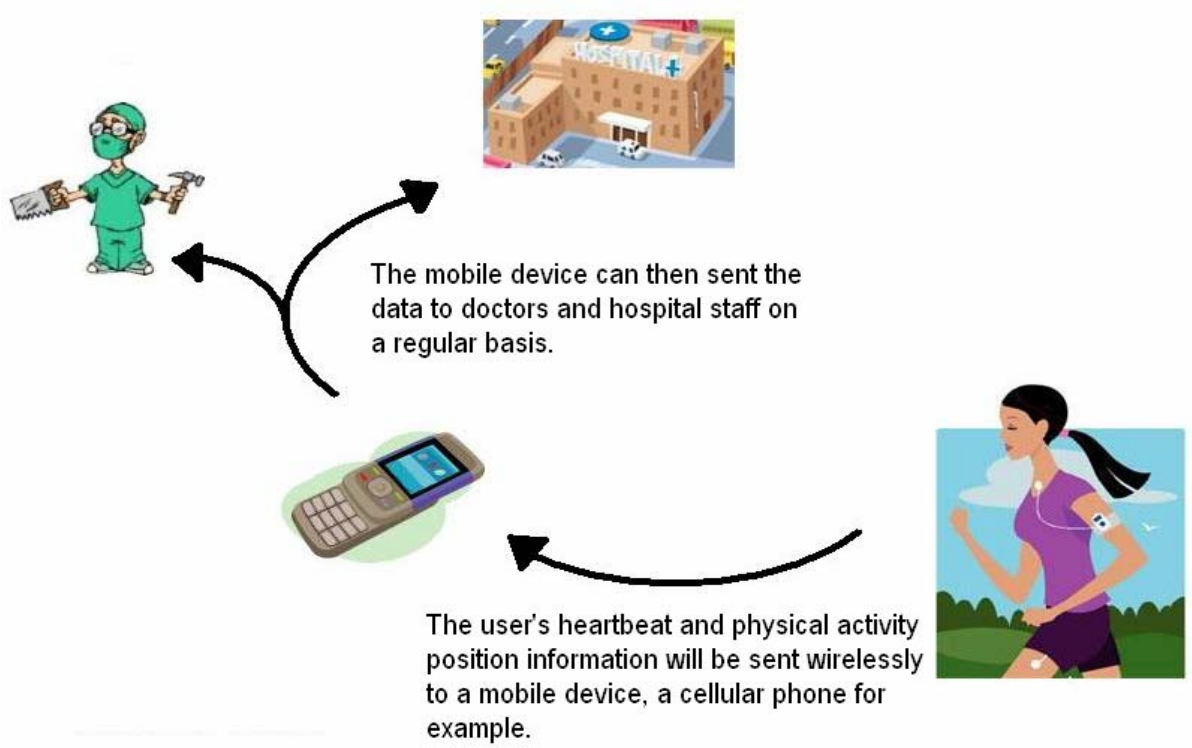


Figure 1 Basic System Operation

3. Propose System Design

Figure 2 is our product's system block diagram. Our design is composed of three main components: The sensor unit, processing unit, and the cellular phone application:

The sensor unit contains a pair of accelerometers and an ECG sensor. The accelerometers will be responsible for detecting body part movements while the ECG sensor outputs the electrocardiogram waveform. The output of the sensor unit is then fed into the processor unit. The microcontroller will contain an algorithm which will translate body orientation and movement into user's physical activity. The heart rate will also be calculated from the ECG waveform within the microcontroller. These data will then be transferred to the user's cellular phone wirelessly via Bluetooth.

A Nokia® cellular phone which runs on the Symbian Operating System will receive the data with its own Bluetooth module. A customized application written on the Symbian OS will then act as the user interface of our product.

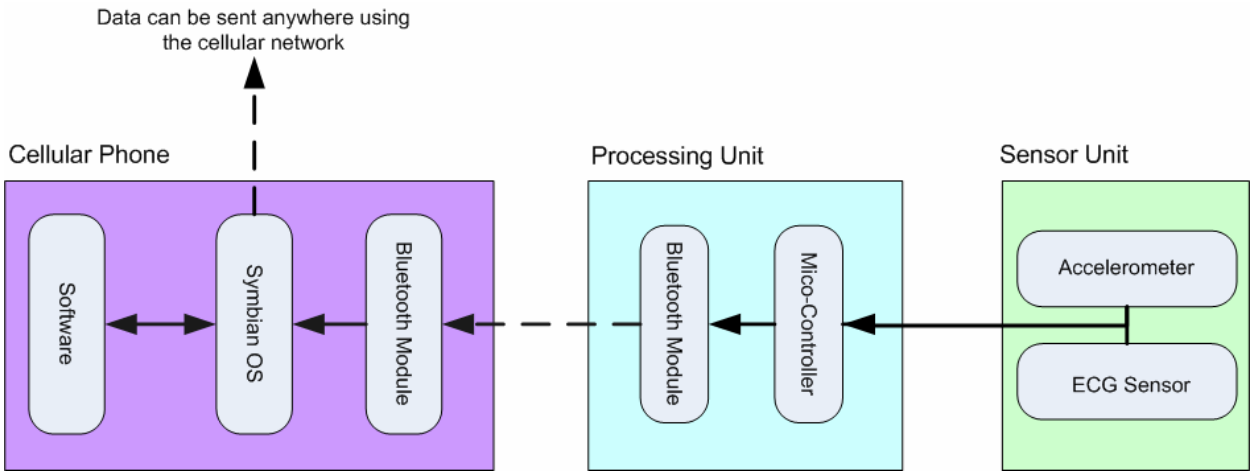


Figure 2 System Block Diagram

3.1 Future Development and Consideration

For the future developments, other biomedical sensors such as blood sugar level sensor or heart sound can be incorporated into our device for obtaining additional health information.

Another future design is a data logging system to keep a history of heart rate activity for long-term monitoring use.

The third option can be to develop more generic software to work not only on Symbian OS but for all Bluetooth cellular phones.

4. Potential Competitors

Currently in the market, there are many heart rate monitoring related devices and undergoing researches. They are primarily based on incorporating biosensors into ECG monitoring system.

Aerotel Medical System [2]

One of the commercialized heart rate monitoring system available from Aerotel Medical incorporates ECG, blood pressure and blood glucose sensor into one package. The only downside to their device is lack of a cellular component. Data connected on the device cannot be sent to a medical professional for analysis. The user will need to educate themselves on blood pressure and glucose measure for them to use the Aerotel device properly. The steep learning curve to use the device might pose a problem for seniors.

University of Technology Sydney [3]

The University of Technology Sydney has research into smart phones that work with biosensors to detect blood sugar levels, blood pressure, and heart rate. This device is also connected to the hospital via cellular communication service during emergency situations. However, the downside to this device is that it is designed strictly on smart phone devices working on Windows Mobile, while our device future design goal is to have our software working on all mobile devices with Bluetooth connectivity. Their device is also design to work only with Wi-Fi which requires the using to configure network properties every time when they switch networks.

The above two devices can both compete with our heart monitoring device. However, our device is superior in terms of mobility and customizability which can better suit the needs of different user groups.

5. Market Potential

Biomedical engineering, although, is closely associated with assuring general public's health care and security, it is by far just a slowly emerging industry; there are yet many new ideas to be implemented and tested for reliability. As the modern society becomes more prosperous and advanced with media communications, it has been much easier for the general public to access information on health issues, which arouse awareness for self health care. In our case, HRMMS has provided a perfect mobile platform to perform routine self check on the users' heart condition based on their daily activity done at anytime and anywhere. An alarm is designed to

sound when any subtle symptom is detected, so any heart related disease such as atrial fibrillation can be discovered and fixed at its early stage.

According to strength, weakness, opportunity, and threat (SWOT) market analysis, the HRMMS's strength is that currently in the market, there is no portable mobile heart monitoring devices that have attempted to incorporate motion sensing into analyzing heart condition along with the ECG capability. This exclusive strength has provided us with the competitive advantage in this market. On the other hand, the weakness of this system is that because it is a new idea, there exists the uncertainty on how willing a person will have this device attached to their body and monitor their heart condition. Further market research such as surveying a random population might be needed to confirm the market demand.

As mentioned above, HRMMS combines the heart rate, motion sensor, and mobility together which has opened a brand new market opportunity for us. Along with the effort that the Canadian government put into health care, this device can help facilitate and reallocate the use of the medical resources. However, the downside of this device is that, in order to monitor the heart beat, a small amount of electric current is required to flow through the body. This might bring criticism on safety issues which will become the major threat to the device.

To conclude, this HRMMS currently has the absolute competitive advantage and a great market opportunity. The acceptability should increase over time as the device is proven beneficial. Overall, HRMMS's advantages have outweighed its disadvantages, and Corazon Engineering Inc. is looking forward for the increasing demand in this emerging market.

6. Source of information

The HRMMS consists of four major components: Bluetooth module, sensors module, and microcontrollers, and the Nokia® cellular phone's Symbian OS. The component specifications can be obtained on the internet. All the knowledge required to integrate these component can be found on the internet, source book and journals. All the Symbian programming system development kit (SDK) and Bluetooth programming example can be found on the Symbian developer website.

This project is partly supported by Dr. Bozena Kaminska and Dr. William New, who are both experts in biomedical engineering and are also members of the CIBER lab, the biomedical research centre at SFU. Many of the graduate students in the lab are not only experts in biomedical engineering, but also very knowledgeable in telecommunication and in electronics designs. These graduate students can also provide helpful advice and assistance throughout our project.

7. Budget and Funding

7.1 Budget

The approximated cost for individual components for our project is listed in Table 1 below. These costs are all over estimated by 10 – 20 % margin. In order to reduce cost, we will be borrowing some of the component from our sponsor CIBER lab. All of the SDKs need for software development can be downloaded for free over the internet.

Components	Price
Accelerometer	$10.00
ADC	$20.00
Battery Power System	$20.00
Bluetooth Module	$50.00
Cables	$20.00
Case	$20.00
Electrode	$20.00
Heart Rate Monitor Module	$80.00
Microcontroller	$100.00
PCB	$10.00
Miscellaneous	$50.00
Total Cost	$400.00

Table 1 Cost Break Down

7.2 Funding

The budget approximation for one prototype costs $400. This pricey budget can be reduced through various methods: First, we will try to ask for funding from CIBER. Since we are developing biomedical devices involving the heart, another sponsor for us can be the American Hearts Association. We will also apply to the Heart and Stroke Foundation of Canada and the Engineering Science Student Society endowment fund for further support. Lastly, each of our team members will contribute equally to the remaining funds needed to develop this project.

8. Project Timeline

Table 2 below is the Gantt chart that shows the propose timeline and milestone for our project. We expect to finish our project by March 28th 2008. This gives us approximately 78 days for the entire project development process.

ID	Project Name	13-Jan	20-Jan	27-Jan	3-Feb	10-Feb	17-Feb	24-Feb	2-Mar	9-Mar	16-Mar	23-Mar	30-Mar	6-Apr
1.0	Project Development													
1.1	Scope Definition													
1.1.1	Define Project Objectives													
1.1.2	Overall Design													
1.1.3	Functional Specification													
1.1.4	Design Specification													
1.2	Components Selection													
1.2.1	Components Search													
1.2.2	Components Selection													
1.2.3	Components Idle Time													
1.3	Module Developments													
1.3.1	Motion Detection													
1.3.2	Heart Rate Monitor													
1.3.3	Wireless Communication													
1.4	Project integration													
1.3.1	Integration													
1.3.2	Debugging and Modification													
1.3.3	Final Testing													
1.5	Documentation													
1.5.1	Project Proposal													
1.5.2	Writing Progress Report													
1.5.3	Funcitonal Specification													
1.5.4	Design Specification													
1.5.5	Oral Progress Report													
1.5.6	Group Presentation													
1.5.7	Post Moderm													

Table 2 Project Timeline

This schedule is based on five project development phases: Scope definition, components selection, module developments, project integration, and documentation stage. Some of the categories can be worked on in parallel for efficient time management.

9. Organization

Corazon Engineering Inc. is found by four innovative, talented, and determined engineers: Benny Hung, Mike Mao, Thomas Cho and Phil Lin. All of our members are about to graduate within a year. With different industrial experiences gained through various co-op work terms and technical courses, we are confident to achieve the same goal of completion of our project within the time frame.
Corazon Engineering Inc. structure is organized as in Table 3 below:

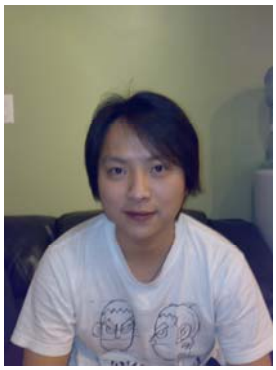
Members	Benny Hung	Mike Mao	Thomas Cho	Philip Lin
Position	CEO	CFO	CTO	VP of Engineering
Roles in the Company	Company Direction Financial Analysis	Market Analysis Material Sourcing	Technical Consulting Software Development	Product Design
Project Roles	Project Leader	Biomedical Specialist	Software Specialist	Hardware Specialist

Table 3 Corporation Structure

All members of our team will take part in both corporation management and engineering research and development (R&D). This arrangement is based on the strength and area of expertise of individual member.

To increase our product's R&D efficiency, we will organize our team dynamically based on the problem that we need to resolve. There are three team structures that will be in use, Problem Solving structure, parallel working structure, and cross function structure. We will function as problem solving team structure for resolving common design problem, technical difficulty and emergency occurrence. Parallel working team structure involve separating workload from the project, this is typically apply to sub module development phrase of the project. To enhance the team orientation among members, we will also operate our team as cross function structures.

10. Company Profile



Benny Hung - Chief Executive Officer

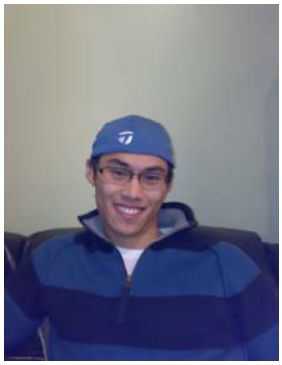
I am an fifth years engineering student, on my last academic term, at Simon Fraser University. In my previous coop terms, I have worked at VTech Engineering Canada as a Software/Hardware engineer. I was responsible for application development for quality assurance on VTech analog phone. I am currently working at CIBER Labs as a research students in the bio-engineering field. This leads me into great interests in engineering development on application that aid human races.

Michael Mao - Chief Financial Officer

I am a SFU fifth year electronic engineering student graduating in summer 2008. My previous co-ops were: At Powerex, working as a software developer using C# and Java. I have also participated a research co-op term working on biomedical sensors at CIBER, sponsored by NSERC. I am also currently working at Mapletec Ltd. as the marketing manager of the company's Vancouver branch. With working knowledge and real business experience, I am confident in managing the financial and marketing portion of Corazon Engineering Inc.

Thomas Cho - Chief Technology Officer

I am a fifth years engineering student at Simon Fraser University. I have work at Honeywell and Syspro Tech for my previous Co-op terms as a software developer. I was mainly responsible for software development and application testing. I am fluent in C++, C# and Visual Basic programming languages. I have also extensive experience programming on Windows using MFC and the .Net architecture. Because of my extensive programming experience I will be working as the main software developer on the project.



Philip Lin - Vice President of Engineering

I am a fifth year electronics engineering student at Simon Fraser University with two coop experiences at Synnex International Corp. in Taiwan and at TELUS Corp in Burnaby, BC. At Synnex International Corp., I was a software application engineer. I had experience with building OS images on embedded systems and with promoting the software package to the embedded manufacturers. At TELUS Corp., I worked as a RF engineer, responsible for analyzing the signal performance and quality of a radio system

11. Conclusion

As baby boomers are entering into the late ages in life, more medical attentions are needed, which will put a strain onto the healthcare system. Due to the lack of medical resources and prolonged waiting time, patients with minor sickness might not bother with entering the 'waiting period'. This trend can lead to major problems such as minor sickness turning into more serious diseases or even fatal. Deaths caused by a delay of treatment are often heard of in the news.

Corazon Engineering Inc. proposes a new heart monitoring device which incorporates heart rate with motion detection. This innovative solution can help in preventing heart related diseases by discovering abnormal heart conditions in the early stages. Not only can this reallocate valuable medical resources into other areas that need attention, the general population can also gain valuable knowledge and monitor their heart conditionings remotely with emergency triggering mechanisms such as heart attacks or strokes.

The final prototype of this heart monitoring device will be worked on by four talented 5th year SFU engineering students. The proposed deadline of mid-April can be met. Future developments of this device also look promising. With additional features such as detection of blood sugar level and heart sound, the heart monitoring device will be a huge lifesaver to the number one killer of developed nations, heart disease.

12. Reference

1. National Center for Chronic Disease Prevention and Health Promotion, "Chronic Disease Overview," [Online Document], 2005 Nov 16, http://www.cdc.gov/nccdphp/overview_text.htm, [last accessed 20th Jan,2008]

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4. iStockphoto , "Cartoon Hospital," http://www.istockphoto.com/file_closeup/health_and_beauty/medical_concepts/hospitals/1881064_cartoon_hospital.php?id=1881064