May 15, 2009

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

Re: ENSC 440 – Post Mortem for Home Heart Monitor

Dear Mr. Leung,

Heart disease is a growing concern for Canadians. We at VHeart are committed to help Canadians to reduce the occurrences of Cardiovascular diseases by building a portable home heart monitor that will estimates a person's 10-year risk for developing CVD and educates them on how to reduce their risk.

Our design, which consists of a hardware collection system and a software analysis program, will help individuals and health officials to detect, treat and therefore reduce the occurrences of CVD. The attached document, *Post Mortem for Home Heart Monitor,* contains the current state of the device and details the modifications made to the design specification document.

VHeart consists of four innovative and ambitious engineering students: Michelle Cua, Xiao Han, Louise Linggadaja, and Lilly Pan. If you have any questions or concerns regarding our project, please do not hesitate to contact me by phone at (604) 619-0862 or by email at emc2@sfu.ca. Our team can also be contacted at ensc440.vheart@gmail.com.

Sincerely,

Michelle Cua
CEO, VHeart

Enclosure: Post Mortem *for the Home Heart Monitor*

Post Mortem for the Home Heart Monitor

ENSC 440 – Capstone Engineering Science Project

Issued Date: May 15, 2009

Revision 1.0

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Submitted To:
Patrick Leung – ENSC 440
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Glossary

Term	Definition
BP	**Blood Pressure** Blood pressure is the pressure blood exerts against the arteries, and falls under systolic and diastolic. Systolic blood pressure is the blood pressure when the heart is pumping, and diastolic blood pressure is the pressure at rest.
BPM	**Beats Per minute** The number of times the heart beats per minute.
CVD	**Cardiovascular Disease** Diseases that involve the heart and blood vessels (1) which includes heart attack, stroke, high blood pressure, etc.
ECG	**Electrocardiogram** The electrocardiogram is a non-invasive measurement of the electrical activity of the heart.
FDA	**Food and Drug Administration** US Food and Drug Administration, and agency in the Department of Health and Human Services responsible for regulating safety of medical devices in US, among other things .
GUI	**Graphical User Interface** Software Interface which used graphics as opposed to command lines
ISO	**International Organization for Standardization** ISO is an international standard setting organization composed of various national standards organizations.
MI	**Myocardial Ischemia** Myocardial ischemia is the term given when there is reduced blood flow to the heart due to partially blocked arteries.

1. Introduction

Since the beginning of January 2009, we at VHeart have been developing a prototype for the Home Heart Monitor, a device which will enable individuals to track their health and calculate their chances of acquiring cardiovascular disease (CVD) for the next 10 years.

This document will outline the prototype which was completed by May 15, 2009. This document will show the overview of the finished prototype, modification to the details outlined in our design specification, project budget and timeline as well as suggestion for future development. Lastly, each member of VHeart will also share their individual experiences on the Home Heart Monitor project.

2. Current State of the System

Our system currently consists of a hardware data collection system and a software analysis system. This system is shown in the system overview and the system block diagram in Figures 1 and Figures 2 below.

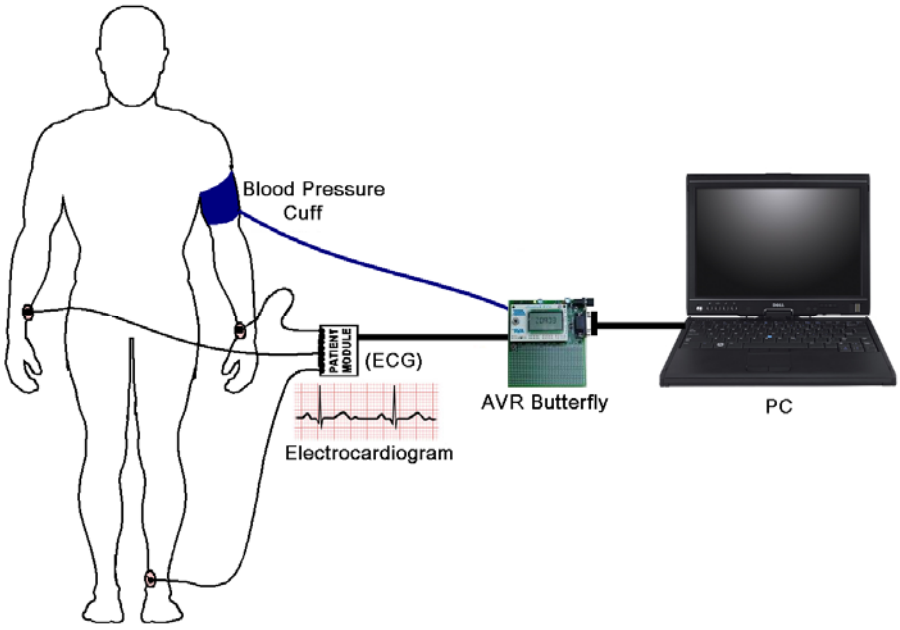

Figure 1: System Overview

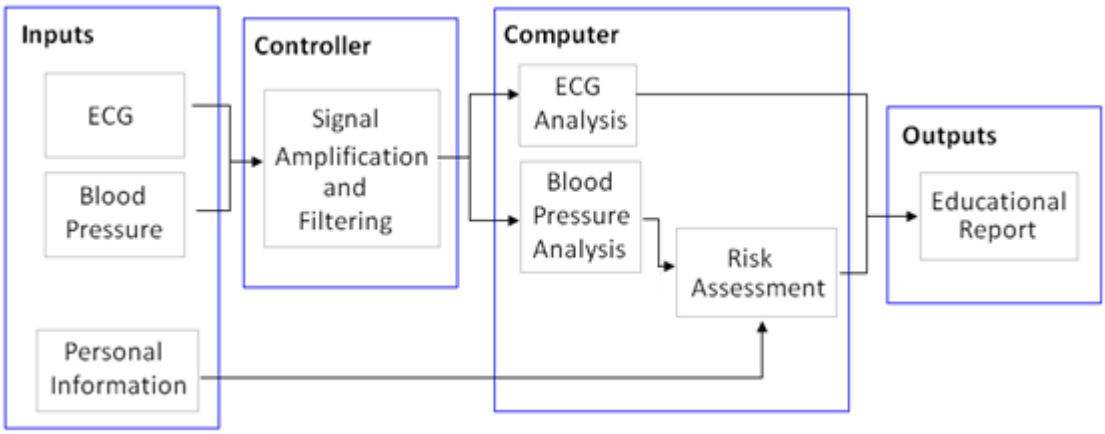

Figure 2: The Home Heart Monitor System Block Diagram

The hardware component of the system is responsible for sampling and data collection system while our software program will analyze the data gathered and give a detailed and educational report of the individual health.

2.1 Hardware Data Collection System

Our hardware data collection system consists of BP and ECG data acquisition. Both types of data acquisition system are built using an instrumentation amplifier and a few active filters. The data in then run though an ADC before it goes into the computer for further analysis. BP data will be roughly filtered to get a systolic and diastolic reading.

2.2 Software Analysis System

Our software analysis system consists of a user-friendly GUI, data analysis algorithms, and a data management system. The GUI takes in personal information and the results from the data analysis, and generates a user-friendly educational report.

The data management system was built using Microsoft Access, for easy viewing and modification.

Finally, the data analysis portion analyzes the ECG and BP data from the hardware data collection system.

3. Deviation from Design Specification

3.1. Blood Pressure Motor VS Manual Hand Pump

In our design specification, we proposed to use a motor to inflate the blood pressure cuff. However, due to our inexperience in choosing motors, the type of motor acquired was inappropriate for our application. After making this error, due to budget constraints, the group decided to inflate the blood pressure cuff using a manual hand pump.

3.2. Data Analysis section VS Integration to the program

In our data analysis section, MATLAB is used because it is easy to test and modify code in Matlab, and it has very user friendly plotting and calculation functions. We were unable to finish converting the analysis code into C++, so that it could be integrated into our GUI program, due to time constraints.

4. Assessment of Project Management

4.1. Budget

Table 1 and Table 2 bellow contains the cost of the project up to May 15th, 2009.

Table 1: Estimated Cost

Required Materials	Estimated Cost (CAD)
AVR Butterfly	60
Pressure sensor	20
Instrumentation amplifiers	40
Electrodes and connector	20
Electrode Gel	10
Diaphragm Pump	48
9V Butteries	5
3V Butteries	5
Total:	**208**

Table 2: Actual Cost

Required Materials	Actual Cost (CAD)
AVR Butterfly	68.44
Butterfly Import Tax Charge	16.01
MPX2050 Pressure Sensor	21.75
4:1 digital multiplexers dip	9.36
Instrumentation amplifiers	41.19
Shipping fee	10.93

Electrodes and connector	27.00
Electrode Gel	Granted
Capacitors & Resistors	Granted
Diaphragm Pump	78.03
Import charge	45.36
9V Butteries	7.81
3V Butteries	3.90
Total:	**329.78**

The costs listed above indicate the total cost of the project by May 15th 2009. As one can see, our estimated cost was less than the actual cost of the project as of now. One of the major reasons is that we did expect import charges when we estimated cost. Second, shipping charges were not including in the estimated cost. However, we are able to borrow certain items, such as electrode gel, capacitors, and resistors; therefore, the cost of the project is reduced a bit.

4.2. Time Line

A Gantt chart shows in figure below is the timeline at the beginning of the semester, and figure 4 is the actual timeline for the project.

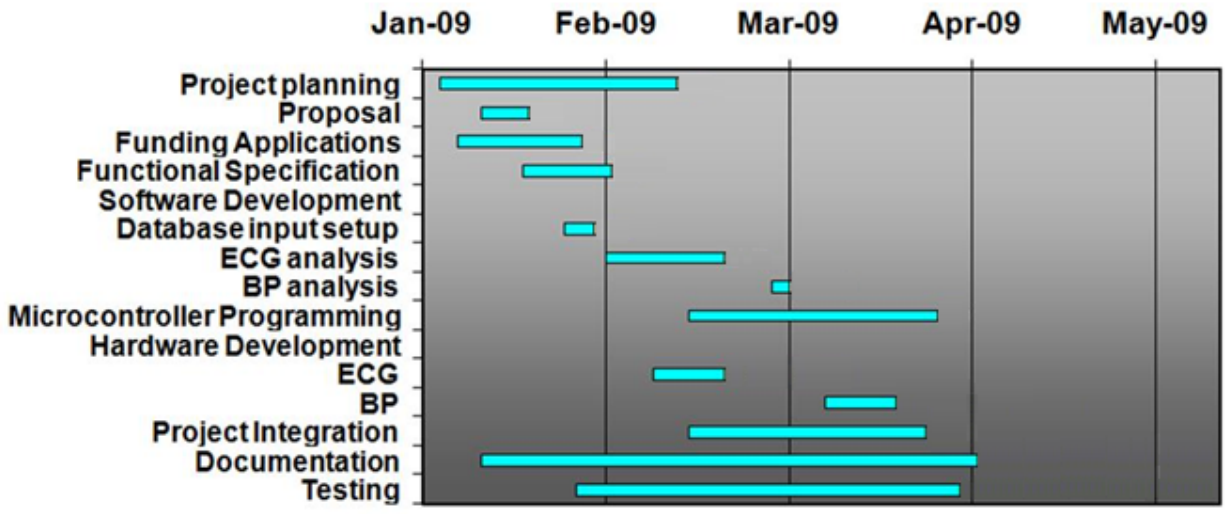

Figure 3 Gantt chart of the project (planed)

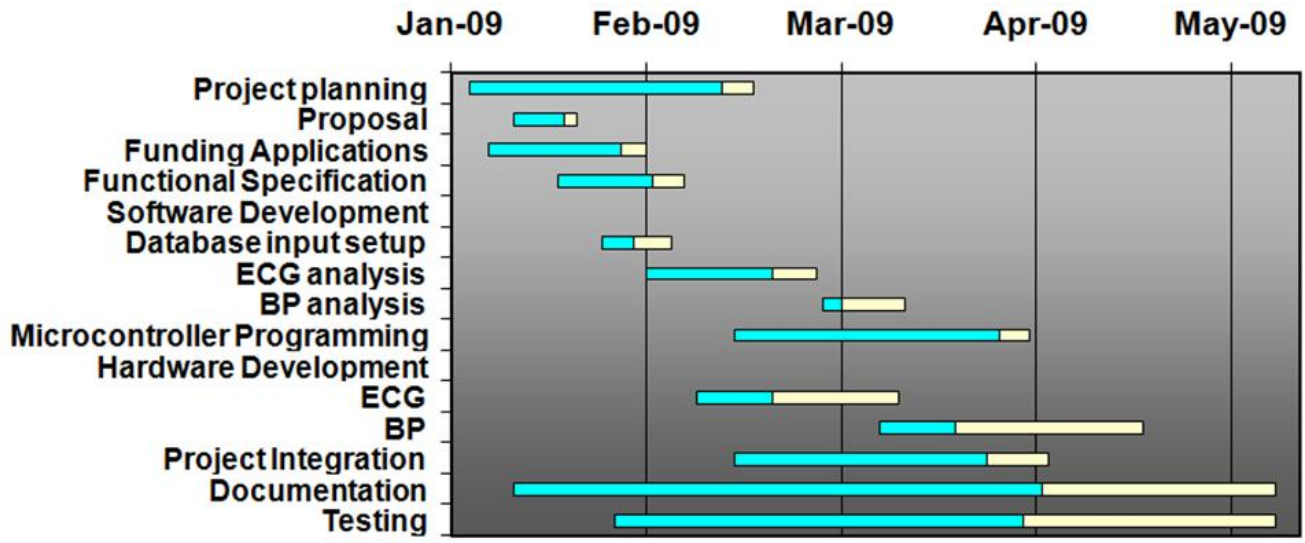

Figure 4 Gantt chart of project (actual timelines)

As one can see, the actual implementation of most stages requires longer time as we anticipated. One reason is that we had underestimated the complexity of certain stages, such as the ECG analysis part. Also, later orders of hardware, such as AVR butterfly, caused the prototype development timeline varying differences between the planned and actual timelines.

We all felt that it was very important that we tried our best to follow project schedule and complete our project as planned. The most time-consuming task was combination, which affected other milestones such as system testing and debugging.

5. Project Future Development

The Home Heart Monitor has more future potentials for development. The following items are suggestions for future development which can increase the functionality of the Home Heart Monitor:

5.1. Nutritional Log Analysis and Daily Physical Activity Log Analysis

Nutritional and daily physical activity analysis will provide the Home Heart Monitor users with guide on how to live a healthy lifestyle. Using the logs provided by users, the program will be able to recommend its users of the different food groups to be consumed or avoid as well as the different physical activity needed to be done to improve their health. In the long run, this additional analysis feature will hopefully regulate its user BP and lower their chances of acquiring obesity related health problems.

5.2. Body fat measurement

As proposed in the functional specification, the Home Heart Monitor ability to measure its user's body fat will increase the accuracy of the individual's physical health. By measuring, instead of asking the user of his/her height and weight, we are able to eliminate user input errors.

5.3. Improve Error Handling for BP and ECG analysis

Our current project only does a small amount of error handling. Furthermore, noise reduction and error handling mechanism will need to be implemented before the product can be mass produced and introduced to the market.

5.4. Improve processing and data handling to enable system to exist as an independent unit

Currently, the Home Heart Monitor consist of a hand held hardware and a software program to be installed in the user personal computer. While the current configuration works properly, we at VHeart believe that improving processing and data handling to enable us to create an independent unit will increase the ease of use of the product as well as its user friendliness.

6. Group Dynamics and Individual Experiences

6.1. Michelle Cua

During the past few months, VHeart was working towards building a portable home heart monitor that could assess and educate the user on their heart risk and how to improve it through practical lifestyle modifications. While we did not fully achieve this goal in the end, there was still a lot that I learnt from the process.

I was mainly working on project design and team management. Early on, Louise and I had split the project up so that she would oversee the hardware portion, while I would oversee the software portion. In terms of the technical aspects, while I did learn a lot of the various methods out there for ECG and BP analysis, I was unable to implement them in code due to the complexity. I also touched briefly on the design of the data management system.

More than the technical aspects of the project, what I take out of this the most is how to work with a team. While we all started out as friends, having been together for the past 3 or 4 years, our knowledge of what each member could contribute to the project was rocky. Not everyone contributed equally at first; however, this was not due to a lack of effort or time on their part, but due to a miscommunication, and a resulting confusion of people's roles and what was expected of them. In retrospect, it would have been better had we talked it out, and agreed on what was expected from each member from the

beginning. Due to the miscommunication, the group dynamics at the beginning was quite rocky, as certain people were contributing more than others to the overall project.

By the end, though, after the peer evaluation, we were better able to assess people's strength and weaknesses, and give them tasks that better suit them. While we only figured this out relatively late, our group did work out in the end.

6.2. Sherry Han

For the past 15 weeks, I was mainly working on the software part with Michelle. I felt that I have learned a lot more on C++ programming, Access database design, and connections between Access database and GUI. I also work with hardware circuitry part, and had deeper understanding of filter design now. I learnt SQL sentences while connecting database to GUI, and also leant how to design a user friendly GUI interface in this project.

Since this is a group project, we have been having weekly meetings, and each member reported the weekly progress to the whole group at the meeting. And we divided task as two people on hardware part and two people on software part. I enjoyed participating in this group, because people in this group are dedicated and thoughtful. Although we have some misunderstandings with each other at beginning; however, as time goes by, we are able to get along very well. Because everyone is different, and everyone has her own strengths and interests, understanding each other is a very important factor of success. For example, Michelle has her leadership abilities to direct our project along, and Louise is good at set goals, schedules and deadlines, while Lilly and I are more confidence working under instructions from them. This particular group dynamics gained the benefit of efficient contributes to our project.

6.3. Louise Linggadaja

During the course of the semester, I have worked on both the data acquisition hardware and the software (for PC) aspect of the project. On the data acquisition part of the project, I was responsible for the filter design needed to measure the Home Heart Monitor's user BP and ECG signal as well as the software that resides inside the Butterfly evaluation kit. I worked closely with Lilly on the ADC (Analog to Digital Converter) module and collaborate on the algorithm to measure and transfer BP measurement.

On the PC software, I was responsible for the Data transfer algorithm (for BP and ECG) and the Framingham 10 year prediction module for both stroke and CVD. I also worked closely with Michelle and Sherry to produce a user friendly GUI.

This project has enabled me to put into practice the skills that I've acquired during the 4 years of study in SFU. My social contributions to the team also includes completing the secretarial task that needed to be done by the team as well as providing extra time to help other team members.

In the beginning of the semester, our goal as a team is to create a prototype of a device that can help improve the health of the society. I believed that, as a group, we had work hard and achieved the goal that we set in the beginning of the semester. However, we acknowledge that there are many further improvements that can be made to our system.

6.4. Lilly Pan

For the past 8 months, as a group, we have accomplished our project goal to produce a prototype of the Home based heart monitor. Since October 2008, we started to discuss about our ENSC 440 goal and possible project ideas. At the beginning of this year, we decided to work on the heart monitor. During the length of the course, I have worked on both software and hardware parts. I walked away with a great project experience, seeing how a project is carried out and through. I think I have learned a great deal on the following sections.

Hardware skills: despite the elective course I took on the hardware design, this project gives me an opportunity to practice skills such as to select hardware to fit specific need and to program a hardware using C language. I think this course strength my ability using C language and more confident in hardware design.

Software skills: I have taught myself to build a window application in both C++ and C# language. Since I have not taken many software courses, I decided to challenge myself by taking the initiative in the GUI design. I have some rough time trying to debug and figure what I did wrong; but eventually, I was able to construct a rough bone structure for the GUI for the project.

Management and communication skills: during the course of the project, sherry and I worked closed as partners on testing, circuit board soldering and project integration. Throughout the partnership, I learned how to utilize tasks according to individual's weakness and strength. I felt this experience is value for team management and communication.

I believe as a group, we have achieved our initial goal. We worked hard and acknowledge each other's effort to this project. There are many possible improvements that can be made to our system. If we have more time, I believe we could be able to produce a marketable product

7. Conclusions

After countless hours of hard work, VHeart has created a prototype of a device which can help individuals to monitor their health. Our product has the potential to reduce the occurrence of

heath issues related to obesity and CVD at the convenience of its users. Although we cannot eliminate the needs for medical personals, we hope that the Home Heart Monitor will be able to assist medical personals in diagnosing as well as advising patients.