September 18, 2010

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

Re: ENSC 440 Capstone Project Proposal for a Remote Diagnostic System

Dear Dr. Rawicz

Our team, MediCare Solutions, is proposing to build a Remote Diagnostics System for ENSC 440/305 project. We are aiming to improve the communication efficiency between the ambulance and the emergency room nurses in the hospital. As well, we hope to improve the efficiency of resource allocation inside the hospital with our product. All together, our goal is to reduce the patient's wait time and length of stay in the emergency room.

The attached proposal further explains the reasons and goals behind this project choice. It also shows more details on our design approach for the proposed solution, as well as discussion on any possible or existing solution. Lastly, it contains budget breakdown of components and expected timeline for this project.

MediCare Solutions consist of five members of senior engineering students with different engineering concentration: Da Zhou, Danny Chieh-Yao Cheng, Eric Chow, Jeffrey Tam, and Sean Yu-Hsiang Fang. If you have any questions or concerns about our proposal, please feel free to contact me by e-mail at cca16@sfu.ca.

Sincerely,

Danny Chieh-Yao Cheng
President and CEO
MediCare Solutions

Enclosure: *Proposal for a Remote Diagnostic System*

MediCare Solutions

Proposal for a

Remote Diagnostic System

Project Team: Danny Cheng
Jeffery Tam
Da Zhou
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Submitted to: Dr. Andrew Rawicz - ENSC 440
Michael Sjoerdsma - ENSC 305
School of Engineering Science
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Executive Summary

We have all heard of stories where a relative or a friend, who accidently cut themselves or burned their arm while pouring hot water, are asked to wait hours on end in the emergency room (ER). This situation is all too common and is often the case for any patient entering the ER whom are not in need of immediate assistance.

There have been many different solutions proposed to solve the issue of congested ER and lack of communication between paramedics and the hospital. Verbal communication through radio is used to communicate only the most important information to the nurses at the hospital, but there are major limitations with paramedics' ability to describe the situation orally. There is also a system using touch screen laptops to input details electronically. However, the information must all be manually inserted by the paramedic in addition to all the other tasks that they must complete. Furthermore, none of these solutions provide adequate information to the hospital ahead of time to actually reduce waiting time for patients arriving at the ER.

In this proposal, we will go over a system which will interface with existing ambulance equipment as well as being able to transmit a detailed incident report prior to arrival to hospital to reduce patient wait time. The handheld tablet device in the ambulance sends a file containing images and details of the patient and injury to the hospital allowing triage nurses to begin their injury assessment earlier. Using this device, the emergency department can allocate their resources well ahead and therefore reduce wait time for all patients at and arriving at the ER.

MediCare Solutions is composed of five fifth-year Engineering Science students with varying backgrounds and expertise that will help with the successful completion of our project. We have experience with software testing and the design cycle, network communication, and server setup & maintenance. In addition, we have dealt with real-time embedded systems and microcontroller assembly programming.

This project will span for 13 weeks with expected completion date as Dec 12, 2010. At which time, through research and development, we will have a functional prototype to demonstrate how the system works. Through the Engineering Science department, Engineering Science Student Endowment Fund, and Wighton Engineering Product Development Fund, we intend to generate slightly less than $700 to cover the budgeted cost of this project.

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1. Introduction

The Canadian health care system is a publically funded service for all residents in Canada. While most medical services are covered by the plan, there are few others along with drug prescriptions that are billed at the patient's expense. In general, Canadians are in support of the current health care system provided by the government. However, inefficiency in the current health care system poses a major problem.

Over the past two decades, the average spending on health care in Canada has been consistently increasing [1]. The health care system, however, have done a poor job in keeping up with the hiked demand. In British Columbia (B.C.), hospitals only have 1.8 acute/rehab beds per 1,000 population. The B.C. Royal Commission recommends 2.75 beds per 1,000 population, which puts B.C. 35% below what's recommended [2]. In Quebec, the average wait time in emergency room is 11.2 hours for complex patients, and 4.4 hours for minor conditioned patients [3].

The lack of available resources often lead to ambulance diversions (AD) which delays possible life saving treatments. As well, prolonged wait time and delayed treatments in the ER can result in life threatening situations. Such incident was witnessed in 2002 when a woman died of heart attack because of waiting in the ER for more than an hour at Royal Jubilee Hospital [4].

Our proposed solution to the inefficiency in the ER is to engage remote diagnosis before the patient arrives at the hospital. In conjunction, timely and easily accessible patient data will aim to decrease the patient's length of stay, and to reduce the wait time for other patients in the ER. The solution consists of three components: remote diagnosis tool, central server, and a data display client. The combination of components create what we call the Remote Diagnostic System. Paramedics will be able to assess the patient's condition and digitally transfer the assessment data to the hospital. ER doctors will review the data on a data display client, and can contact the paramedics for additional assessment if needed. Otherwise, they can simply prepare treatments and wait for the patient's arrival so it can be done immediately, depending on the severity of the injury.

In this proposal, we will discuss our product system overview, design considerations, funding, the projected schedule, and the team composition in MediCare Solutions.

2. System Overview

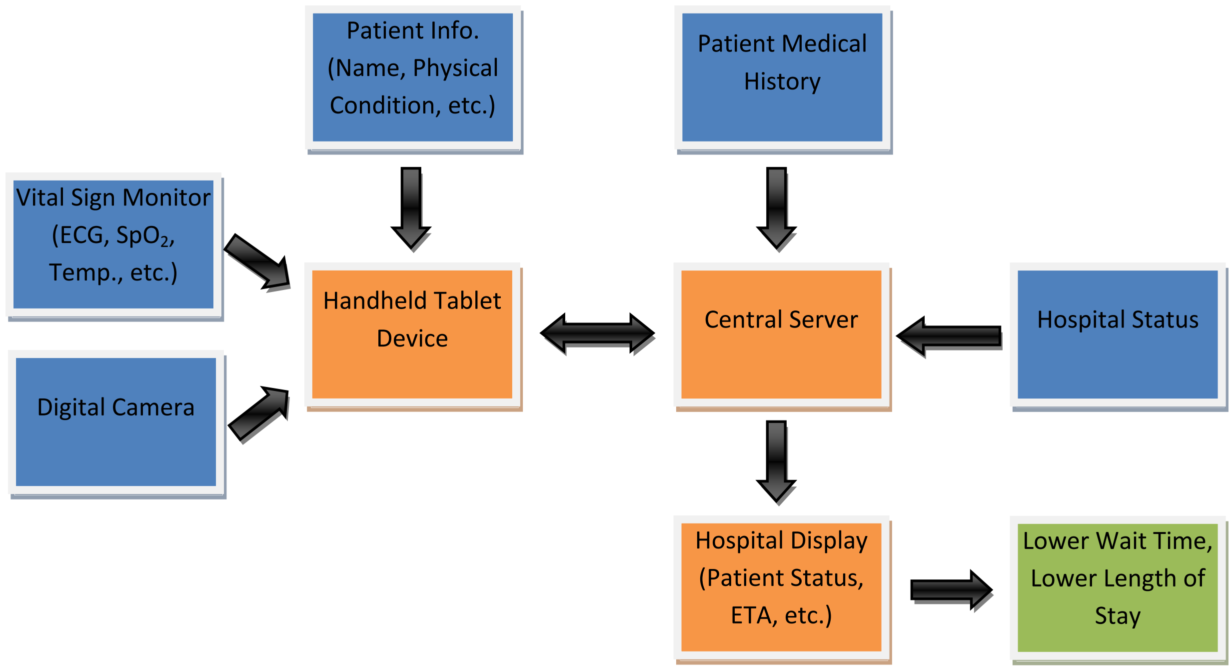

Figure 1 - System Flow Diagram

Figure 1 is the overall view of how the Remote Diagnostic System will work. Each ambulance will be equipped with a handheld tablet with customized graphical user interface (GUI). The GUI will be designed to allow intuitive patient data entry for the paramedics as they assess the scene, and some of the data could be patient's name, location of injury, and vital signs. Additionally, paramedics may take photos of the injury and send them to a hospital for further assessment. Before transporting the patient to a hospital, the tablet can be used to search the nearest hospital with sufficient resources to treat the patient without suffering from diversion. During the trip, vital sign monitors inside the ambulance will be connected to the tablet to transmit real-time patient status to the hospital. Therefore, in the case of an unexpected change in patient's health, the hospital can react accordingly prior to arrival.

At the hospital, ER staffs will see the conditions of the incoming patient and be able to research the patient medical history from the medical database. In return, an efficient and accurate treatment without unnecessary diagnosis can be performed. Overall, a large display screen in the ER will notify the department of everything that's happening in real-time. Included in the large display screen are the real-time status of the patients that are currently waiting in ER. Each patient will be categorized in terms of injury severity and waiting time so they can be treated in the proper order. The waiting time will be important to know so uncomplicated patients don't become complicated to threaten life.

3. Existing and Possible Design Solution

In an emergency, when it is a matter of life and death, timing definitely plays a significant role. Delayed treatment can lead to life threatening situations, therefore it is important to shorten the wait time for patients to receive their treatment. To address this issue, we evaluated a few existing and possible solutions.

3.1 Communication over Radio

Currently, most ambulances use radio to communicate with hospital before the patient arrives at the ER. The advantages of using radio includes low cost and quick training process for the medical crew. However, information exchanged over the radio are limited. Doctors in the ER can only understand so much about the patient's condition based on the oral report transmitted, which may be insufficient for deciding upon the most effective treatment. In addition, the accuracy of information exchanged over the radio channel is in question, due to human error, since both ends of communication channel are operated by people.

3.2 Cellular/Smart Phone Devices

Nowadays, mobile phone services are mature and convenient. Paramedics can also use cellular/smart phone to report the situation to the hospital. Communication over phones requires little cost and training. However, it faces similar problems as communication over radio where information delivered are limited to the effective use of words. Even with the ability of some smart phones, to transfer data in text-based or image-based form, it would still be inefficient to key in all the patient information on such a small size screen (~5 inches), not to mention the difficulty of designing an user-friendly UI on them.

3.3 Laptop installed with Software

Using laptop computers can be a possible solution to the problem. The laptop is installed with software which allows paramedics to electronically fill out all required paper work. In addition, the touch screen/stylus system allows paramedics to click on an image of a human body, representing the location of the wound, and describe the injury. Disadvantages of using a notebook on an ambulance are its size, weight and stability. Paramedics will have a difficult time operating a notebook in an emergency situation when they are simultaneously examining the patient, operating monitoring devices, and jotting down the information. In addition, current systems do not have the ability to transmit these electronic forms ahead of time and therefore, only saves the time of the paramedics while filing out reports.

4. Proposed Design Solution

Our proposed solution is to build a specialized touch screen tablet for the paramedics to record the patients' information and injury assessment before they arrive at the hospital. Upon completion, the tablet will transmit those electronic forms immediately to hospital. Such a device would ensure that all critical information is handed over from the paramedics to the hospital, and shorten the waiting time before doctors begin to treat patients. In a typical emergency service routine, both paramedics and nurses at hospital will need to perform the injury assessment, and often time they do not communicate effectively together. This device will assist the communication channel. Nurses will have first-hand information even before the patient's arrival, so the hospital will be better able to anticipate the demand of resources and allocate accordingly. The precious minutes wasted could mean the difference between life or death.

There exists multiple solutions to this problem as listed in the previous section. The most commonly used method of radio frequency and cellular devices have proven to be inefficient. Compared to a computer with specialized software, our design will have the addition ability of connecting to other vital sign monitoring devices inside of the ambulance. This information will be transmitted in real-time to the hospital to allow early stage diagnosis. The digital camera module is also available for paramedics to take pictures of the injury, therefore allowing nurses to begin their injury assessment immediately. The construction of such a dedicated device will also be less expensive than purchasing a computer with the software. The device stability is also improved because we will limit the functionality to only serve one purpose.

The main constraints in completing the project are the limited time and resources. We have been given only thirteen weeks to complete the prototype of the device. In order to connect our device to the vital sign monitoring devices, we need access to the equipment available inside the ambulance. There could potentially be many possible unforeseen obstacles in getting access to ambulance equipment during the limited time frame. We will build a prototype device that allow digital forms to be filled out and transmitted to a central server. The prototype will also have a digital camera and connectivity to some simple life monitor module, such as pulse oximeter in the Biomedical lab.

With more funding and time, a more robust system that will allow live video transmission and compatibilities with ambulance equipment could be constructed. The graphical user interface would be refined based on the paramedics' requirements and preferences. The central sever would be well constructed to handle multiple devices at the same time. An overall database of critical patient information could be constructed and added to the central server for the hospital.

5. Sources of Information

In order to analyze and improve the usability and practicality of our product, we tried to obtain information from different sources: professors, Vancouver General Hospital (VGH), SFU ENSC laboratories, academic journals, survey studies, and other sources on internet.

In order to understand the possible areas of improvement to our emergency health care system, we looked into survey studies and papers regarding the efficiency of the emergency medical care department. We also contacted VGH emergency physicians and St. John's paramedic organization for more detailed information on how paramedics respond to each emergency service request and what type of standard tasks do they have to go through. We will continue to contact VGH and other physician representatives later on to verify our design approach, ensuring its practicality.

The internet is a good source of information to look for component parts or solutions to any possible technical issues. For example, functional specifications and component pricings of the programmable board we will be using for our product, and the suitable server operating system for data communication. We will also have meetings with Dr. Rawicz and our teaching assistance, Ali Ostadfar for further consultation and techniques on problem solving.

Lastly, we are fortunate to have a diversified group with members in different concentrations of the ENSC program. We will have access to different ENSC laboratories equipment and have people who are familiar with different devices; for example, the vital sign monitor in biomedical lab.

6. Budget and Funding

6.1 Cost Analysis

Having looked through various suppliers, we have broken down the estimated cost for our Remote Diagnostic System in table 1. Our primary purpose will be an evaluation board with 7" to 10" LCD display with additional hardware modules to enhance user-friendliness of the system. In order to provide for contingencies, costs have been overestimated by approximately 15%.

Equipment	Estimated Cost (CDN)
Evaluation Board	$350
Hardware Add-Ons	
VGA Module	$35
USB WiFi Module	$50
3G Module	$105
USB Digital Camera Module	$105
Total Cost	**$645**

Table 1 – Cost of Material Breakdown

Note: Shipping and tax are not included in estimated costs

6.2 Funding

Due to the fact that our project will be embedded software oriented, the total cost for equipment will be relatively inexpensive. We have also generated funding from Engineering Science department and are currently in the process of generating funding from the Engineering Science Student Endowment Fund (ESSEF) provided by the Engineering Science Undergraduate Student Society.

MediCare Solutions will attempt to seek further funding from the Wighton Engineering Product Development Fund and possible research funding from VGH if necessary.

In the event where MediCare Solutions failed to generate enough capital to be at par with our costs, our team members have agreed to cover all outstanding costs evenly until a working prototype has been produced.

7. Schedule

ID	Task Name	Duration	Start	Finish
1	Research	4 days	Tue 10/9/7	Fri 10/9/10
2	Proposal Writeup	8 days	Tue 10/9/14	Thu 10/9/23
3	Functional Specification	14 days	Mon 10/9/20	Wed 10/10/6
4	Design Specification	26 days	Tue 10/10/5	Sun 10/11/7
5	Progress Report	47 days	Tue 10/9/7	Fri 10/11/5
6	Tablet GUI	33 days	Sat 10/9/25	Fri 10/11/5
7	Server GUI	28 days	Thu 10/10/7	Thu 10/11/11
8	Tablet Connectivity to Server	17 days	Wed 10/9/22	Tue 10/10/12
9	Tablet-Pulse Oximeter Module	16 days	Sat 10/9/25	Thu 10/10/14
10	Tablet-Thermometer Module	12 days	Tue 10/10/5	Tue 10/10/19
11	Tablet-Digital Camera Module	16 days	Mon 10/10/11	Sat 10/10/30
12	Tablet-Modules Integration	22 days	Fri 10/10/15	Fri 10/11/12
13	GUI Integration	23 days	Sat 10/10/30	Tue 10/11/30
14	Functionality Test of Tablet Modul	20 days	Sat 10/10/30	Thu 10/11/25
15	Tablet Data Transmission Test	39 days	Thu 10/9/30	Sat 10/11/20
16	Overall System Performance Test	23 days	Wed 10/11/10	Fri 10/12/10
17	Project Demo	75 days	Tue 10/9/7	Wed 10/12/15

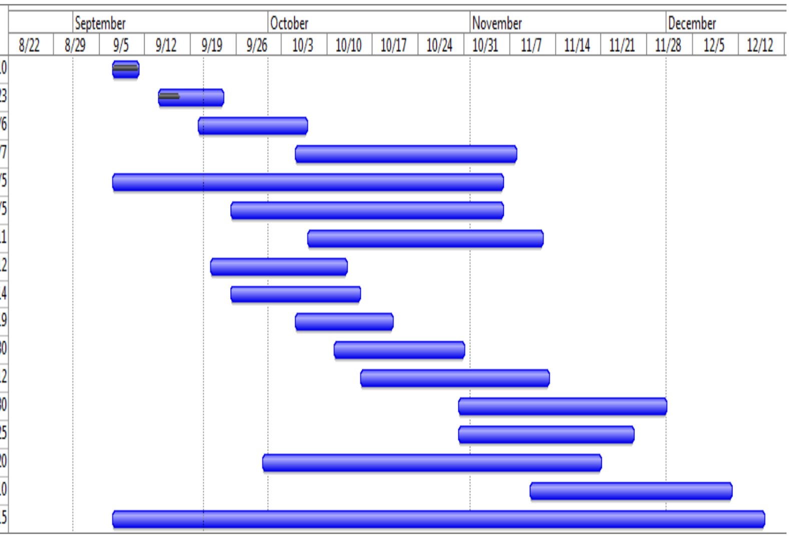

Figure 2 - Proposed Project Schedule

Figure 2 represents the ideal schedule of tasks we came up with. The proposed schedule will have the project finished well ahead of the demonstration period for the course. In doing so, it will allow us to make any last minute fixes or improve our product before demonstration.

8. Team Organization

The Medicare Solutions team consists of five innovative fifth-year engineering students: Danny Cheng, Eric Chow, Sean Fang, Jeffery Tam, and Da Zhou. We have members concentrating in the computer, electrical, biomedical, and systems option. Our diversity of interest and concentration will play a big role as each individual will have in depth knowledge in a specific part of our project. In addition, brief background information about each of our members will be highlighted in the Company Profile section.

Danny Cheng, President and CEO, is responsible for the success of the overall project, dealing with conflicts, and transmission of real-time vital signs from the medical devices to our handheld device. Eric Chow, Vice President of Marketing, will market our product to a target audience, handle web page design, and develop a GUI that is user friendly and suit the needs of paramedics. Sean Fang, Chief Engineer, will be expected to come up with innovative solutions for any technical issue that may arise. Also, he is expected to handle the database requirements on the central server. Jeffrey Tam, Chief Financial Officer, will handle the team budget, acquire funds, resolve all financial issues, and deal with any issues revolving the setup and maintenance of the central server. Da Zhou, Vice President of Operations, will monitor the overall progress of each module. An example would be checking up on individual members to ensure that deadlines are not only met, but with a quality solution. Da will also be responsible for completing the wireless communications between handheld device and central server.

We will have meetings twice a week to ensure that operations are flowing smoothly and to resolve any technical or interpersonal issues that may arise. The meetings will begin with the overall progress of the project and the tasks that need to be completed to date followed by a round table so that each member can give a quick update as to their individual progress. Afterwards, any technical issues that arise or require discussion will be discussed and possible solutions will be presented.

In our break down of the required modules, each member is responsible for a specific portion in the overall design in addition to the work that is expected of them for their specific position. However, as this is a group project, we will be offering assistance to each other throughout the semester ensuring all milestones and deadlines are met.

ENSC 440 is not only a work intensive class, but one that requires large amount of team work and planning. This is why we intend to use our project management skills in addition to working well as a group to create a successful project.

9. Company Profile

Danny Cheng – Chief Executive Officer (CEO)

Danny Cheng is in the fifth year of his biomedical engineering degree. Due to his expertise in the medical field, his inputs will greatly lead the project to the right direction. Mr. Cheng also brings valuable research and programming experience to our team. His excellent knowledge in embedded system design as well as his connections to the medical sector will be invaluable to the development of our system.

Jeffrey Tam – Chief Financial Officer (CFO)

Jeffrey Tam is in the final year of his double major concentrating in electronics engineering and finance. He is also a Chartered Financial Analyst (CFA) candidate. He brings hardware testing as well as software programming experience in real-time embedded system. In addition, Mr. Tam possesses rich experience in research and documentations.

Da Zhou – Vice President of Operations (VP Operations)

Da Zhou is currently in his final year of his bachelor degree for system engineering. He has a strong background in laboratory research where he provided assistance to the hardware design of a microfluidic microscope. His experience in system designs and hardware integration will be of great value to the team. Mr. Zhou's organization skill as well as his natural leadership quality will assist the team to accomplish any important milestones and ultimately lead to the successful implementation of our system.

Eric Chow – Vice President of Marketing (VP Marketing)

Eric Chow is a fifth year systems engineering undergraduate. Having worked in a software testing and researching position for a year, he brings valuable experience in dealing with software testing and debugging. In addition, he is familiar with developing software solutions for courses such as real-time embedded systems and imagery processing. Furthermore, having completed a minor in business administration, he has a rich knowledge in fields varying from project management to marketing.

Sean Fang – Chief Engineer

Sean Fang is in his final year of his computer engineering undergraduate degree. He is also finishing his minor in computer science. From driver developments to programming, his experience and expertise in computer science will be heavily demonstrated throughout our system's development cycle. Mr. Fang is also familiar with database designs and maintenance, which will be a crucial component of our system.

10. Conclusion

Medicare Solutions is determined to use information technology, to the fullest extent, in order to help reduce critical patient waiting time in the emergency department and therefore saving lives. The resulting product is one that is not only both financially and technologically feasible, but effective and user friendly.

Our proposed solution allow paramedics to systemically input information about a patient into an electrical form, and transmitting this information to the hospital ahead of time which allows for better allocation of resources. Our approach is more in-depth and customized for the entire emergency department compared to similar existing systems; due to the ability to receive real-time data from equipment and a more sophisticated base station GUI.

Judging from the figures in our scheduling section, we can see that this project, although fairly broad in scope can, and will be completed before the end of the semester. We have gone over all of our research, existing designs, source of information, financial sources, and have a set timeline to implement our proposed design which will facilitate the achievement of our objectives.

11. Sources and Reference

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