September 17, 2012

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

Re: ENSC 440/305W Project Proposal for a Mobile Medication Alert System (MMAS)

Dear Dr. Rawicz:

Enclosed is the proposal for our device, the *Mobile Medication Alert System (MMAS)*, which outlines our Engineering Science 440, Capstone. We plan to build, test and present a medical alert system which will physically keep track of a user's pills and alert them through a smartphone application when they have forgotten to take their pills or accidentally taken the wrong pills. Additionally our product will alert the user's designated loved one or caregiver if they do not respond to an alert, and present data on user's pill taking conveniently for their doctor.

The main objective of this proposal is to provide an overview of our proposed Mobile Medication Alert System, an outline of the design considerations, our sources of information, projected budget, sources of funding, and information on project scheduling, team organization and company profiles.

SmartMed Incorporated, consists of five motivated, innovative, and talented 5th-year engineering students: Li Xiang, Kevin Wang, Steven Verner, Fan Yang and Freda Feng. If you have any questions or concerns about our proposal, please feel free to contact us by phone at 778-882-9418 or by e-mail at fya3@sfu.ca.

Sincerely,

Fan Yang
Chief Executive Officer
SmartMed Incorporated
Enclosed: *Mobile Medical Alert System Project Proposal*

Mobile Medication Alert System

Project Team: Steven Verner
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Submitted to: Dr.Andrew Rawicz – ENSC440
Steve Whitmore – ENSC305
School of Engineering Science
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Issued date: September 17, 2012

Executive Summary

Picture your elderly mother in the first stages of Alzheimer's but still insisting on living on her own, as do one in seven Alzheimer's patients[1]. However she is taking a regimen of 4-6 heavy-duty prescription pills per day! How often would you drive out to check that she is taking her pills correctly? How much risk do you think forgotten and improperly taken pills pose to her health? How much stress and worry do you think these concerns will cause her and you?

With the Mobile Medication Alert System (MMAS), we at SmartMed Inc. have alleviated all these concerns with a simple, easy-to-use, inexpensive device that connects to both your mother's and your smartphones! Unlike expensive pill dispensers currently on the market, the MMAS physically checks that the user has taken the correct pills for the current day and time and in the case of forgotten pills first the MMAS user will be alerted, and if they don't respond then the user's designated loved one or caregiver will be alerted, all automatically through their smart phones! Moreover both the user and their loved one will be immediately notified if the wrong pills are taken out of the MMAS dispenser, often in time to prevent the user from actually swallowing them. Think of the peace of mind this will provide you and your mother as you both worry about her complicated pill regimen. Furthermore the MMAS takes advantage of the users' smartphones which more and more people already own, which greatly reduces its cost even compared to its non-mobile competition.

This document outlines the MMAS system which will include a small box for the morning and evening of each day of the week, only requiring refill once per week. Each box will have a sensor which will detect the pills' presence for that day and time, and communicative this information to the microprocessor of the MMAS system. The processor will communicate the sensor readings to the associated smart phone application which will then alert the user as required. If the user doesn't respond to an alert the user's app will pass this message back to the microprocessor then on to the designated loved one/caregiver's app, allowing them to follow up with the user.

SmartMed Inc is made up of five highly motivated fifth year engineering students with experience with sensors, microprocessors, mobile applications and project management. Our product design, budget, schedule and team structure are all clearly laid out in this document, providing a versatile plan to build the Mobile Medication Alert System. Over the next eleven weeks, with a budget of $606 obtained from several sources, we plan to complete and extensively test a presentable, working prototype of the Mobile Medication Alert System, to be ready for presentation by December 3rd, 2012.

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1. Introduction

According to a survey by the American Society of Healthy System Pharmacists, as many as one third of American seniors take eight or more different medications per day. Billions of dollars are being spent annually on such medications[2]; however, these medications are only proven to be effective if they are taken according to the doctors instructions. A recent survey found that half of seniors are forgetting to take medications, which can delay recovery and pose a serious danger to one's health[3]. Furthermore, just the stress of worrying about missed pills weighs on many seniors and their loved ones around the world.

We at SmartMed Incorporated propose a simple but far reaching solution to this massive problem, the Mobile Medication Alert System (MMAS). The objective of this system is to physically check that seniors have taken their pills, on time, each and every day, and alert them if they have not, through the MMAS iPhone App which will function whether they are in the house or not. Further, if a pill hasn't been taken and the user isn't responding to the mobile alert, a second alert will be sent to a designated child, or other caregiver, who can then remind the pill taker that they have missed a dose.

The Mobile Medication Alert System will include a pill dispensing box with a section for each day, Monday through Sunday, and two compartments in each section for morning and evening. Sensors built into the pill dispensing box will check that the appropriate pills have been removed on the appropriate day and time, and will alert the user through the associated iPhone App only if they haven't taken their pills on time, or if they haven't taken the correct pills, and the user's child/caregiver will only be alerted if the user doesn't respond to their reminder.

The Mobile Medication Alert System will avoid the pitfall of many pill reminder apps on the market of sending daily reminders that the user can get used to turning off or ignoring. By only sending a reminder on occasions when the pills are still in the dispenser and clearly haven't been taken, the user will be much more likely to pay attention to the reminder. Also, unlike existing in-home reminder systems, the MMAS can alert it's users even when they are out of the house, or halfway around the world, and a secondary warning can will be sent to their loved ones or caregiver if they still aren't responding.

Furthermore, many children and caregivers of seniors are constantly worried about their loved ones/patients however calling to check in on a daily or hourly basis to remind them to take pills isn't practical. By letting them know when the MMAS user hasn't taken their pills, and by default also letting them know when the user has taken their pills, our product provides both peace of mind to concerned children/caregivers and a real second line of defence in the case where pills are actually forgotten, as the user will receive a phone call or visit from concerned and informed children or caregivers.

This proposal provides an overview of our product, the Mobile Medication Alert System, it's design, background research, funding, project schedule, and team structure. Different solutions to this issue are discussed and compared to our product. The project's financial plan is given as well as a description of team organization, a Gantt chart and a milestone chart. This proposal demonstrates why this product will be both useful and needed in todays market and outlines exactly how we will bring our project to fruition.

2. System Overview

Figure 2.1 outlines the basic functionality of the Mobile Medication Alert System (MMAS). The sensors in the pill dispenser will communicate to the microprocessor which pill sections (i.e. Monday Morning, Tuesday Evening, etc) are filled with pills. When the designated time, such as Monday morning, occurs, if there are pills in that section and the user fails to remove them, they will receive an alert on their iPhone. If they don't respond within an hour (a time period which can be adjusted from their app), the MMAS will alert their child/caregiver or other designated secondary recipient.

Finally a chart of the times pills are taken will be recorded by the app, and the user's doctor will be able to access this chart (with their permission) to insure that medication is being taken as instructed.

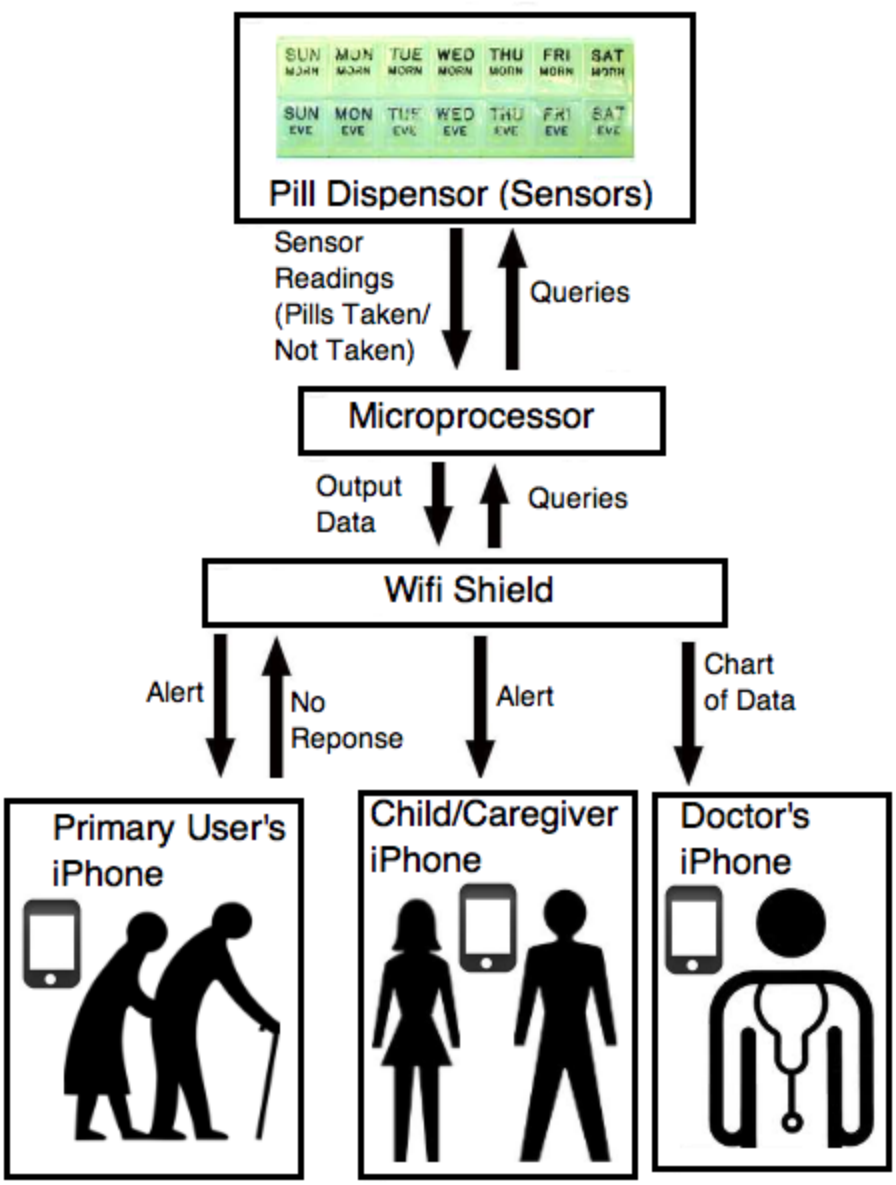

Figure 2.1

2.1 Mobile Application

The associated iPhone application will allow users to very simply and quickly sign up with their name, attached MMAS pin number, and whether they are the primary user, caregiver or doctor. From then on the application`s only screen will show an all clear, alert message for forgotten pills, alert message for incorrectly taken pills, alert message if the MMAS is unplugged or without internet access, or in the case of the doctor a clear chart outlining the user`s recent pill taking history. Finally the primary user will receive an alert if a secondary caregiver enters the

pin for their MMAS device and they will have to allow that person access to their MMAS data. The mobile application will focus on simplicity and ease of use to appeal to the broadest range of potential users.

3. Possible Design Solutions

In the current market, there are several ways to remind the patient to take their medicine on schedule. Although to some extent, they are able to push the patient to avoid forgetting, disadvantages still exist. The biggest problem in preventing misuse of medicine is a need for a system which can intelligently determine not only whether the patient takes pills on time, but also whether they have taken the correct amount of pills as doctors suggested each time and remind only when misuse of medicine happens. Some of the devices currently used are listed below.

3.1 Alarm Medication Reminder Watch

One of the problems with this device is that people might be able to take pills on time while wearing this watch, however when people have to take various kinds of pills each time, they might tend to forget what the amount of each kind should be taken. Also, the worst case is even after the alarm sounds, people still don't take the pill (Imagine what happened to some people after the bed alarm sounds every morning when they are still sleeping, they usually turn off the alarm and continue sleeping). Another problem is that to remind multiple people, they have to purchase the pricy watch for each, which is not a good thing economically. If the patient gets recovered, these watches are no longer useful. Environmentally, they are nothing but e-waste.

3.2 Pill Reminder Mobile Application

On some mobile platforms, there are medication reminder applications which can be downloaded. Although besides reminding, these apps can present to people the amount of each pill to be taken, they are basically a fancy alarm. It rings anyway, no matter if the patient remembers to take pills and correct amount of pills, or not. It could be annoying for users. Another problem is that for certain group of patients, such as seniors and kids, those smartphones are not straightforward to play with.

4. Proposed Design Solution

Our proposed solution is to build a module application which sends a medication alert to the patients' or caregivers' smart phones through the WiFi shield in order to remind patients take pills on time. This device would be beneficial to the senior patients and caregivers. First, this device can help patients to take pills on time. Second, this device is a mobile alert system, so users are able to receive medication alerts anywhere.

There are lots of medication alert modules on the market. Most modules can only make a loud beep to remind users. If users are out of their house or far away from the device, then they are unable to hear the alert and will miss the reminder to take their medication. A few of these modules have a mobile receiver which can receive the medication alert within a limit range, but these kinds of medication alert modules are quite expensive; and the receiving range is not large. However, our design takes all of the advantages from the existing products, and makes some improvements. Our design is a mobile medicine alert system. It can send the alert to the users' smart phone through WiFi shield; as a result, there is no limitation to receive the medicine alert.

The main constraints in completing this project are the limited timeline. We have only thirteen weeks to complete the project, so we have to do lots of research about WiFi protocol and some functionality of sensors at the same time, as well as some work on the operation details about each sensor in the whole system.

For our ENSC 440 project, we have decided to design the Mobile Medicine Alert System to make senior patients' and caregivers' lives easier.

5. Sources of Information

After analyzing the ideal, we obtained information of senior pill taking report from Senior Journal, Institute for Safe Medication Practices (a non-profit organization) and the pill dispenser industry from internet retailers, such as the App Store (researching apps for pill reminder function).

In addition, our group members have strong industry working experience in analog and digital electrical field and software programming ability as developer. We will be able to gain a variety of information from industrial relationship we established during the Co-op terms.

At last, our group members have previously worked in related project in SFU engineering research department, such as robotic living assistance system, and have comprehensive experiences on developing mobile phone applications on various platforms. We have valuable knowledge of sensors and controlling ability and our Engineering science professor Kamal Gupta also would like to give advice in development process.

6. Budget and Funding

6.1 Budget

Table 6.1 shows the details of the provisional budget for the Mobile Medication Alert System (MMAS).

Table 6.1 Mobile Medication Alert System (MMAS) Budget

Equipment	Brand & Model	Price	Quantity	Budgeted Cost
WiFi Shield	Arduino Uno Rev3	$ 35.00	1	$ 35.00
Microcontroller	Arduino WiFi Shield (Integrated Antenna)	$ 100.00	1	$ 100.00
Force Sensor	Phidgets Force Sensor	$ 11.50	14	$ 161.00
Color Sensor	Parallax ColorPAL-Color and Light Sensor	$ 15.00	14	$ 210.00
Cable	N/A	$ 50.00	1	$ 50.00

Kits	N/A	$ 50.00	1	$ 50.00
Total				**$ 606.00**

The budget table lists the details of the equipment needed for the MMAS. Unit prices as well as the quantity required are also included in this table. Please be advised that the budgeted quantity for Force Sensors and Color Sensors are relatively large due to the nature of this project. The total funding requested in the amount of $606 is based on this budget and is overestimated by 5% over the market price. Please note that prices listed above are for budget purposes only and are subjected to market price changes.

6.2 Funding

Funding is critical in the engineering products development processes. The main sources of funding will be the Engineering Science Student Endowment Fund (ESEF) and Wighton Development Fund. Our team members are agreed to share the proportion of the cost which exceeds funding received from these sources. We will keep track of the cost incurred during the development of the MMAS project.

7. Schedule

Table 7.1 shows the Gantt chart of the expected time to be spent on the various tasks involved with our design. Figure 7.2 shows some important dates of our project.

Table7.1 Gantt chart of our project

	Date	Sept				Oct					Nov				Dec
ID#	Task name	4	10	17	24	1	8	15	22	29	5	12	19	26	3
1	Hardware Requirements and System Concept														
2	Order all required hardware/parts														
3	Functional Specification														
4	Iphone app														
5	Microprocessor/sensor integration														
6	Design Specification														
7	Microprocessor/wifi shield integration														
8	Iphone app integration														
9	Overall system integration														
10	Integrated System Testing and Debugging														
11	Documentation														

Figure 7.2 Important Dates of our Project

8. Team Organization

SmartMed Incorporated consists of five talented engineers: Steve Verner, Kevin Wang, Freda Feng, Fan Yang and Li Xiang. All team members are 5th year engineering students with different specializations. Our common interest is to develop an innovative product to make people's lives easier by utilizing each member's diversity of experiences and skills. The specific skills of each member will be mentioned in the Company Profile.

In SmartMed Incorporated**,** each member will be assigned tasks individually and the schedule in Section 7 will be followed as closely as possible. However in some cases, work will be shared between members if the workload is heavy. Fan will lead the whole team and ensure that all the required documents are completed efficiently. Also he will assist Li on his job of Chief Operations Officer. Steven Verner is in charge of the technical design and integration of the mobile application. Kevin is responsible for taking care of any parts/components needed for the project, including seeking, ordering and testing parts from various sources. Also he will take care of the hardware design of the project. Li will be responsible for the microprocessor development, with assistance from Fan. Freda is taking care of the financial budget and will assist Kevin if needed.

Group dynamics play a key role. Normally, detailed tasks will be assigned to each person in the regular company meetings, usually on the first day of each time period, according to the time table. Furthermore, during the meeting, every member should present what has been achieved in

the past time period, so we will maintain a good communication between each members. However, informal meetings held by members to resolve issues on their own work will also be encouraged.

9. Company Profile

Fan Yang- Chief Executive Officer

Fan is a fifth year Electronics Engineering student with strong interests in the both software and hardware filed and keeps his eyes on the latest technological developments and consumer electronic products. He has experience working in the SFU Robotics LAB with other graduate students for professor Kamal Gupta, and also designing LED Therapy product for a small startup company. With this foundation in the area of sensors and analog circuitry he has confidence he will successfully build our our medical assistance dispenser system.

Freda Feng - Chief Financial Officer

Freda is an Electronics Engineering student in her fifth year. She has finished two co-op terms in Ballard as Failure Analyst on fuel cell and another co-op term in Photon Control R&D Ltd. She also completed one term with professor on campus for his research. Freda has strong passion for circuit design, programming using Jave, C++ or Python and also Matlab. She has experience working on fuel cell and using Scanning Electrons Microscope and Energy Dispersive Spectroscopy.

Steve Verner- Chief Mobile Development Officer

Steve is a Computer Engineering student in his final semester of studies. The computer engineer program, three software-based co-op terms and a personal passion for programming have made Steve an excellent programmer in many programming languages such as Java, C, PHP and Objective C. He has already created his own iPhone app and at his last co-op as a digital signal processing software developer Steve learned how programming projects are divided up, executed and integrated in a professional setting, complete with soft and hard deadlines and modularized software development. Steve's experience and passion for programming make him an ideal choice Chief Mobile Development Officer for the Mobile Medication Alert System.

Li Xiang - Chief Operating Officer

Li is a fifth year Engineering student with Electronic concentration. He has strong interest in embedded system development, and has completed several related projects with other students. He spent two co-op terms working for a mobile phone corporation, and has comprehensive knowledge of Java, JavaScript and C++, as well as application development on mobile platforms. His diversity of knowledge and experience will ensure the project development process will be proceed smoothly.

Kevin Wang - Chief Hardware Development Officer

Kevin is a fourth year electronics engineering student and has completed 3 co-op term experiences (Prof Siamak Arzanpour and Photon Control R&D Ltd.). Kevin has have a strong academic background in circuit design, and using Java and Python. He is doing his first hardware focused co-op term where he will be working with both microprocessors and a wireless devices. Moreover, he has done substantial research in the area of wireless communications, and is familiar with ZigBee, Wi-Fi, and ANT+. Kevin also has finished several projects with sensors, when he worked in Photon Control R&D.

10. Conclusion

The number of seniors taking a large numbers of prescription pills daily and even hourly has exploded in the past decade, and we are only beginning to understand the consequences of failing to take the correct pill at the correct time to this ever growing group. The demand for technology to help with pill taking has grown along with the problem and continues to grow to this day. We at SmartMed Inc plan to meet this ever growing demand with the next level of pill reminder, the Mobile Medication Alert System (MMAS)

The MMAS will physically monitor the user's pill case and will use its associated iPhone app to alert the user if they have forgotten to take their pills whether they are at home or on the other side of the planet. Furthermore, if the user doesn't respond to this alert then a secondary alert will then be sent to a designated loved one or caregiver. The convenience and versatility of the Mobile Medication Alert System, along with it's low cost to those who already have an

smartphone and the peace of mind provided to the loved ones of MMAS users set it above and beyond any pill dispenser system on the market. The MMAS addresses a current, growing problem and is both highly beneficial to public health and highly marketable to seniors and their families around the world.

We have carefully planned every aspect of the development of the MMAS from finances to time management and team organization. Our budget has been formulated to match our expected sources of funding with a cushion for cost overruns and more importantly we have verified and researched our design against the planned hardware to insure that costly hardware problems do not occur. Our schedule has been clearly laid out in both a gantt chart and project milestones to insure maximum resilience to unforeseen issues as well as organizational efficiency. Finally our company dynamics have been organized to complement all these other details, with a versatile, clear team structure that encourages both individual contribution and group collaboration on the various sections of our project.

We have clearly outlined our design for the Mobile Medication Alert System and our plan for bringing this product to fruition, and we will complete the MMAS by December 3rd, 2012, on time and on budget.

11. References

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