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December 12th, 2012

Dr. Andrew Rawicz
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Re: ENSC 440/305W Post Mortem for a Mobile Medication Alert System (MMAS)

Dear Dr. Rawicz:

Enclosed is the post-mortem report, outlines our Engineering Science 440 Capstone Project. Our project is a medical alert system which will physically keep track of a user's pills and alert them and their designated loved one/caregiver through a smart phone application when they have forgotten or improperly taken their pills.

This document details the current state of the device in the end of this term, deviations from our original plans, and our future plans for the MMAS (Mobile Medication Alert System).

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,

A handwritten signature in black ink, appearing to read 'Fan Yang', is written over a light grey horizontal line.

Fan Yang
Chief Executive Officer
SmartMed Incorporated
Enclosed: *Mobile Medical Alert System Design Specification*



Mobile medication Alert System

Post-Mortem

Project Team: Steven Verner
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Submitted to: Dr. Andrew Rawicz – ENSC440
Steve Whitmore – ENSC305
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1. Introduction

For the past four weeks, the idea of a Medication Mobile Alert System (MMAS) has drawn together 5 engineering students – Steven Verner, Freda Feng, Kevin Wang, Fan Yang and Li Xiang – who have worked tirelessly towards the realization of MMAS. The document re-checks the progress that makes this idea from only a concept to reality. It is also details the inter-personal and technical experiences.

2. Current State of the Device

As described in the project proposal, the basic functionality of the MMAS alert user to take medicine and send message if they forgot or mistook the medicine. The sensors in the pill dispenser will communicate to the microprocessor which pill cells are filled with pills. Details were shown in Figure 1.

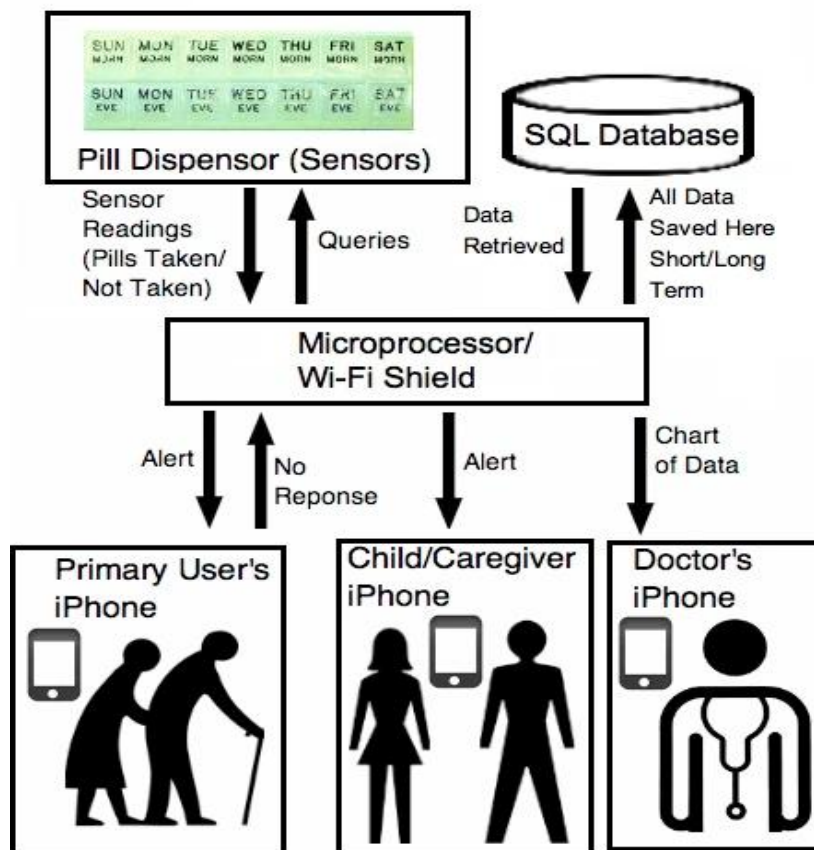


Figure 1: System Function Block Diagram

The pill dispenser has 14 cells which containing 7 days a week and 2 times per day. When the designated time, such as Monday morning, occurs, if there is medicine in that cell, an alert will send to user's iPhone. If the user forgot or mistake the medicine, he or she will receive another alert on iPhone. If they don't response, the MMAS will contact the designated secondary recipient. Moreover, the MMAS will record the times of medicine been taken, so that the user's doctor will be able to keep a track on patient.

Figure 2 provides the entire system including hardware, software and the server.

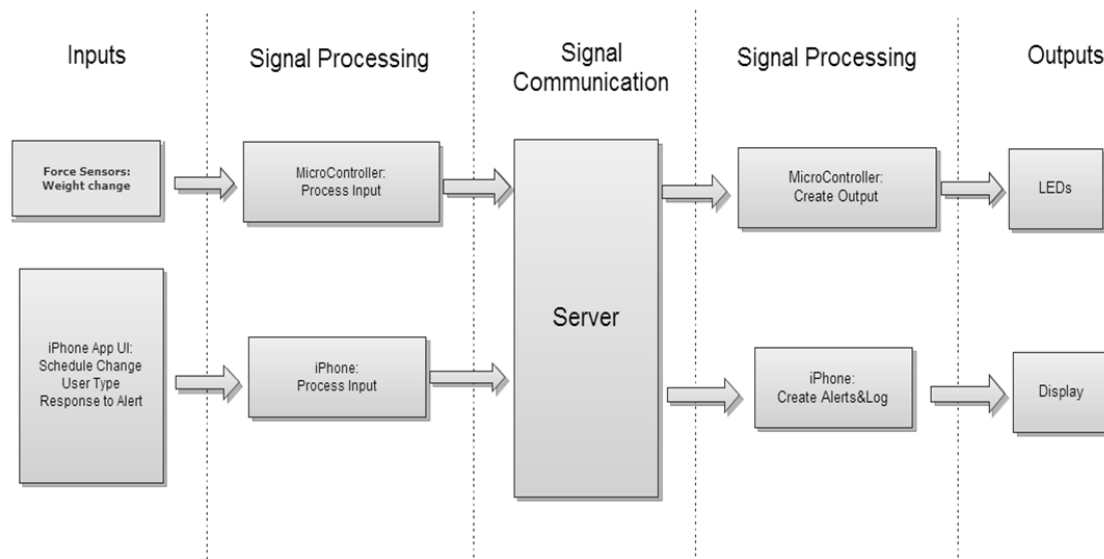


Figure 2: System Mechanism Diagram

The system inputs include force sensors, which mounted on the bottom surface of medicine cells and the user interface of iPhone app. The analog signal of force sensors will be transmitted to microcontroller to state the status of the medicine cell. In signal processing stage, the microcontroller sends specific data strings to the server through WiFi Shield. The iPhone app also sends user schedule to the server. In signal communication stage, the server analyses request and categorises data sent from Microcontroller or iPhone and saves them into database. Moreover, the server responds Microcontroller or iPhone with data saved in database.

3. Deviation of the Device

3.1 Overall System

In terms of functionality, we achieved what we planned. Currently, our prototype consists of four separate parts, the iPhone app and server, microcontroller, electric circuit and pill dispenser with force sensors and LEDs.

There has a small problem that there is about one minute communication delay from the force sensor detecting the signal to the iPhone app receiving the signal.

3.2 iPhone App and Server

The iPhone app and server part has not deviated very much from our original plan. In our original plan, we wanted the log-in screen would show up in the beginning of user open the iPhone app. However, we skip this part because we do not have enough time to add it in the end.

3.3 Pill Dispenser with LEDs and Force Sensors

There is huge difference between our original plan and final plan about sensors. We used to decide to have both color sensor and force sensor to detect whether the medicine cell is empty or not. After more research, we found out that it is enough to use only force sensor to check the status of the medicine cell instead of using both two kind of sensors. This decision can also cut off about one third of the original cost to make our product cheaper.

4. Future Plans

MMAS has great potential for the further research and development. As we reconsider the development of the device, we have the following suggestions and comments for the future work.

4.1 Overall System

4.1.1 Size of the device

As a prototype to prove the concept, the device in current state is large, and hard to carry it. For the future work, the developer can make a portable MMAS or a smaller version.

4.1.2 Material of the medicine kit

The kit of MMAS current state is made by wood, but wood is not stable with acid or base. We still select wood to be the material of prototype, because it is easy to machine. The cell box is made by paper, because of the same reason of kit. For the real product, we

highly recommend that the kit and cell boxes are made by PVC, due to the chemical and physical stability.

4.1.3 Backup Battery

MMAS does not have a backup battery. If the power supply is down, MMAS is unable to give a reminder to user on time. Therefore, the next generated MMAS is better to provide a Back Battery.

4.2 Force Sensor

The sensitivity range of the sensor we are using is 0.2N to 20N which is 20g to 2kg; therefore, the sensors may lose some valuable signals right now. In the future, the developers should use high resolution force sensors. Based on our research, there are 500mg resolution sensors in the market, but we did not use them on this MMAS unit due to the project's schedule and budget.

4.3 Setup and Speed of Communication

The communication setup of MMAS is hardcoded by programmers, so users are unable to change or setup by their own. In the next version of MMAS, the developer should integrate an input device into MMAS in order to let user setup the wireless communication. The developers switch the Wi-Fi shield to Ethernet Shield which is plugging and go without any coding; however, Ethernet shield limits the MMAS mobility.

Current MMAS has a little bit of communication delay which is up to 30 seconds. In the future, if the developer chooses a better CUP and Wi-Fi shield, then the communication delay may be overcome.

5. Budget and Timeline

5.1 Actual and Estimated Project Timeline

The Gantt chart below shows the expected time for completion in dark green and the actual time for completion in light blue.

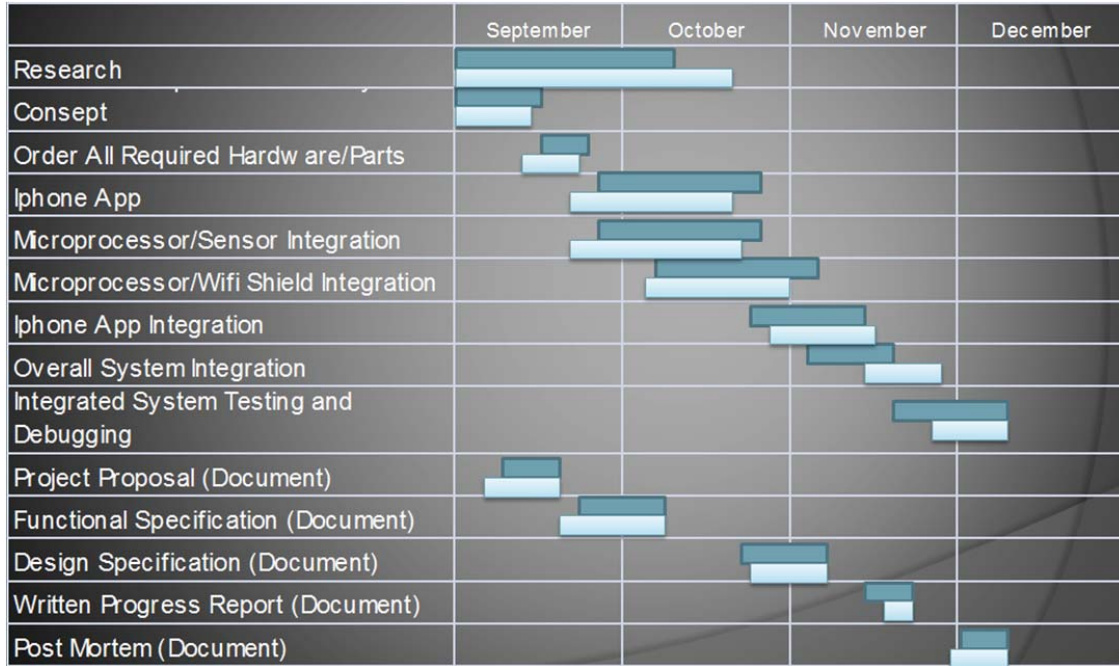


Figure 3: Actual and Estimated Timeline

As we can see from the chart, ordering parts took more time than we expected because the force sensors we ordered first were not sensitive enough, so that we changed another one which is more expensive.

Notice that we spent a little bit more time on integration because it was more complex than we expected. The overall system integration, testing and debugging have been delayed for about 10 days because they had to start after the previous task finished.

The project proposal and functional specification started earlier than we expected because four of our members are not English speaker and they had to take more time. The design specification started late because our project is a little bit behind for the integration.

Due to exam conflict in first week of December which we couldn't spend much time on project, the actual time on testing and debugging was just about several days.

We all felt that it was very important for us to make a more reasonable timeline and tried our best to follow the schedule and complete our project on time.

5.2 Actual and Estimated Budget

Table 1 below shows the expected cost and actual cost of our project.

Component	Brand & Model	Unit	Proposed Price	Actual Price	Deviation
Micro-controller	Arduino Mega	1	\$ 35	\$ 38	-\$ 3
Wi-Fi Shield	Arduino WiFi Shied (Integrated Antenna)	1	\$ 100	\$ 93	\$ 7
Force Sensor	Interlink Electronics FSR 406	14	\$ 161	\$ 121	\$ 40
Color Sensor	Parallax ColorPAL-Color and Light Sensor	14/0	\$ 210	0	\$ 210
LEDs		0/15	0	\$ 6	-\$ 6
Cable & Kits	N/A	--	\$ 100	\$ 30	\$ 70
Total			\$ 606	\$ 288	\$ 318

Table 1: Actual and Estimated Budget

As we can see from the table above, we added some LEDs which were actually an essential part to indicate the status of each medicine holder but we forgot in the beginning by spending additional \$6. In order to reduce the cost, we decided to build the medicine dispenser manually using wood.

The major difference between the expected cost and actual cost is we did not have to purchase the color sensor because it is enough for us to know if the medicine holder is empty or not just using force sensor. It saves us \$210 from the budget.

6. Inter-personal and Technical Experiences

6.1 Fan Yang - CEO

The past 4 months designing experience is much more valuable than any other academic courses for me. I have learned lot of knowledge of hardware and software designing. In addition, I've gained much of debugging and troubleshooting experience not only from self-research, but also from my talented team members. My intuitive feeling of this period is: when study and design with people who has similar background as yourself, the work efficiency will keep high, and the positive attitude is highly motivated as well. The general meeting of each week brings us a lot design inspiration, and it also motivates me to finish the work strictly relying on the Timeline.

The experience of making our pill box makes me gain the new ability of using milling machine, laser cutting machine, and handy tools in machine shop. The experience of LED soldering, sensors soldering make me gain the ability of circuit building. Plus the experience of Arduino programming makes me gain the knowledge of microcontroller application in real product design.

By analyzing and researching the market value of our product from business prospective, I've learned how a technical idea becomes to a real product, and then how to become a company for mass production. And as CEO I've learned how to coordinate the work from each member and how to integrate them into whole team work.

6.2 Freda Feng - Chief Financial Officer

For the past four months, I felt that I have spent a meaningful time with my team members in SmartMed. I have learned a lot of experience not only for the technical field, but also the team work during these four months. This course is one of the most challenging courses so far and provides our students an opportunity to give a try for our ideas.

As a chief financial officer, I am response for controlling the budget and study the marketing of the product, as well as assisting for integration and testing. During this time, I have gained a lot of experiences with microcontroller, Iphone app, WiFi shield and server. I have also found that the budget controlling and research especially for the market are very important for a project. Even though our project is completed on time and within budget, it actually could be more efficiency. I have learned from this project that it is very important to make a reasonable and efficiency timeline ahead and also try the best to follow the schedule.

As a group, we kept working together, communicating to each other and helping each other to solve the problems. I have learned that team work determine the success of a group because every group member can learn from others' strong points and close the gap. I feel very proud of our product and having such a wonderful team.

6.3 Kevin Wang – CDO (Hardware)

Over the course of the semester, I have worked really hard with my team members and acquired a variety of new knowledge. As the CDO (Chief Development Office) in hardware of the team, I was in charge of the selection of the microcontroller, Wi-Fi shield, and force sensors. I promoted the design of the pill dispenser according to our hardware.

In terms of my contribution, I had two major tasks in this project. First, I have written some functions for our embedded software developer, due to my experience about Arduino Mega microcontroller. Second, I was responsible for the electrical system design. I have design the layout of I/O pins to connect the sensors and LEDs. I constructed circuits that deliver the signals to microcontroller, and receive the driving current from the microcontroller. In addition, I have done the assembly works of medicine kit.

From the past four months working on the MMAS project, I have learned a lot of rewarding programming experience. I have written some function by using and changing the default libraries which are given by Arduino. During the hardware selection, I have seen lots of new products and known lots of new technologies. These experiences are really helpful when I enter the real industry.

In the end, I really enjoyed working with all of my teammate in the past 4 months. It is not just the completion of the project; I also gain the plenty of knowledge and skills about the technical and project management.

6.4 Steven Verner – CDO (Software)

During the course of developing the Mobile Medical Alert System (MMAS), I've learned a lot about completing an end-to-end engineering project both technically and organizationally. Technically, my main responsibilities as Chief Development Officer-Mobile Technology, were to develop the iPhone application and the server, but my learning experience went way beyond this. I learned what it takes to plan, organize and coordinate a large scale project, to interact and work positively with team members, and to insure that all the aspects of the project come together, on time, to meet each deadline.

Our group divided the project into three main areas, mobile development (including the app, server, and communications), Arduino microprocessor programming, and hardware (including the sensors, LEDs, circuit construction, and container). I was primarily involved in mobile development and I learned a great deal about creating mobile applications in Objective C, servers in PHP, and just as importantly, client-server communications. Before the project I had a firm grounding in mobile applications development, but I was surprised at what I learned about the importance of the back-end server and client-server communications to the development of a project. I have a much better understanding now of real world products which use mobile applications, which I think will be very useful in my future career in telecommunications development.

Organizationally the division of the MMAS project into three main areas, along with documentation, worked very well for our group. Initially, we were meeting one to two times per week to review progress, plan and work on the project, and assign tasks to be completed by the next meeting date. In this way we progressed well ahead of schedule, and the elements of the project remained extremely well coordinated. However, I think when we got ahead of schedule we became a bit overconfident and allowed our strict organizational practices to slide by having fewer and less detailed meetings. This caused our project to slip slightly behind schedule and more importantly reduced the coordination between our teams. In future projects, I have learned that it is extremely important to stick to the organizational guidelines you have set, no matter what, especially if those guidelines are working for your team.

Another thing I've learned, which didn't sink home until the question period of the final presentation is that it is easy to get caught up in where you want a project to go but it is extremely important to always keep the desires and needs of your customers and stakeholders, in our case the Ensc 440/305 professors and TAs in mind. We spent a lot of time and effort achieving the goals we set for our project; however, I think that spending a few extra minutes reviewing, as a team, the comments and feedback on our marked documents could have led to significant improvements in our project with relatively little effort.

Our team worked well together with very few interpersonal problems. I enjoyed taking on a leadership role, especially as we were integrating and testing our product and I think I've learned quite a bit about leading, organizing and bringing together a technical team to produce a product and maximize the value of everyone's effort. I learned exactly how important organization and communications about the different tasks are for successful integration.

Personally, I feel very satisfied and proud of the Mobile Medical Alert System, about our progress as a team and about my personal learning experience. I think this is a great course and an excellent capstone to an engineering degree.

6.5 Li Xiang - COO

For the past 4 months, I have worked together with my fellow team members on the MMAS system. We had meetings on weekly basis, the atmosphere is very relaxing and everybody could finish the assigned task on time. There was only a bit rush during the last week of the course, we spend couple of nights in the lab, intensive but lot of fun and knowledge had been learned.

In my personal perspective, I was in charge of the main development of the Arduino board. Initially I didn't have too many experiences on this kind of microcontroller, but by doing researching and learning from different sources, including online support forum, YouTube etc, I find it was not that tough to start the programming on it. Indeed, it can be programmed to bunch of interesting projects. From this past 4 months, technically my programming skill has been improved, as well as the debugging skill. Remember when we had difficulty parsing the data from the server, I spent couple of hours on debugging, tested each line of code one by one, examined the output.

Furthermore, I have been involved in the project management. I get some exposure on how to manage a team efficiently and assigned the task to each member based on their productivity. That's the most important point to get the whole team worked smoothly. Not to mention that I have got a good chance to work with different kind of people, this really helped me on my future career.

I really enjoyed working with my team members. If our prototype needs to be optimized in future, I will definitely choose to work with them again.