ENSC 305W/440W Grading Rubric for Post-Mortem

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project. Includes clear background and motivation for the project.	**/05%**
Body of the Document	Provides a high-level description of main functions and project modules. Outlines materials, costs, and schedule (both estimated and actual).	**/15%**
Problems/Challenges	Outlines major technical challenges encountered. Explains how these were resolved. Details any major changes in scope and design.	**/05%**
Group Dynamics	Includes a discussion of how the team was organized, any problems that arose, and how they were resolved	**/05%**
Individual Learning/Work-load Distribution Chart	Includes a one-page, individually written reflection upon what was learned from the project, both technically and interpersonally (each team member writes a page about their learning experience). **The workload distribution chart outlines major technical, administrative, and support tasks and indicates who participated significantly in those tasks.**	**/25%**
Conclusion/References	Summarizes outcome and evaluates the project. Includes discussion of future plans, if any (or explains why project will be abandoned).	**/10%**
Meeting Agendas/Minutes	Includes an appendix that provides all the meeting agendas and minutes produced by the team over the course of the semester. (NB. Neatness does not count here.)	**/20%**
Presentation/Organization	Document looks like the work of a professional. Ideas follow in a logical manner. Layout and design is attractive.	**/05%**
Format Issues	Includes title page, table of contents, list of figures and tables, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted.	**/05%**
Correctness/Style	Correct spelling, grammar, and punctuation. Style is clear, concise, and coherent.	**/05%**
Comments		

NBS^2 Solution

Post-Mortem: Smart Walker System

Project Team:

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Submitted to:

Lakshman One – ENSC 440

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School of Engineering Science

Simon Fraser University

Issued Date:

December 2nd, 2013

December 2nd, 2013

Prof. Lakshman One
School of Engineering Science
Simon Fraser University
8888 University Drive,
Burnaby, BC, Canada V5A 1S6

RE: ENSC440 project Post-Mortem for Smart Walker System

Dear Prof. One,

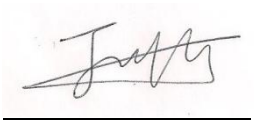
Enclosed is a Post-Mortem for our ENSC 440/305 Capstone Project Smart Walker System. The project aims to design a walker with safety features, which are able to assist the visually challenged elders to walk. The main system features of our product are the auto-brake mechanism, the obstacle detection sensors, the Android application and the user recognition system.

The Post-Mortem outlines a summary of our project. The document briefly describes the process of the project and the current state of our prototype; it then summarizes the project budget and time constraints that we went through. Also, it includes individual reflections of all our company members.

Our company is founded by one systems engineer and three electronic engineers: Junfeng Xian, Hongkyu Ahn, Andy Back, and Seung Yeong Nick Park. We believe that our dynamic team is able to accomplish the project within the intensive schedule.

If you have any questions regarding the design specification, please feel free to contact us via email at *jxian@sfu.ca* or phone at *778-862-7238*.

Sincerely,



Junfeng Xian
Chief Executive Officer
NBS^2 Solution

Enclosure: *POST-MORTEMFOR SMART WALKER SYSTEM*

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Glossary

GPIO	General Purpose Input/Output
USB	Universal Serial Bus
GND	Ground
OpenCV	Open Source Computer Vision Library

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1. INTRODUCTION

For the past 4 months, the motivated members of NBS^2 have been working hard to create a Smart Walker that is designed to protect elders from losing their balance or encountering any potential dangers while using a walker. The Smart Walker is capable of detecting obstacles at the front, applying auto-brake to the wheels, and notifying the user any hazards through a tablet. It also features a personalized email service with the simplified user login process through the face recognition.

This post mortem will provide a full overview of the project including how we have deviated from the initial plans to the current ones and to the future ones. Also, the time and budgetary constraints will be discussed in this document. In addition, each member of NBS^2 will provide the personal learning experience and contributions acquired while working on this project.

FIGURE 1 PICTURE OF THE SMART WALKER

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2. CURRENT STATE OF THE PROJECT

2.1 OVERALL SYSTEM

Currently, the prototype of Smart Walker is designed and developed on an existing walker as shown in Figure 1. Our prototype is divided into four major functional modules: obstacle detection, auto-brake system, tablet application and user interface simplification system as you can see the following Figure 2.

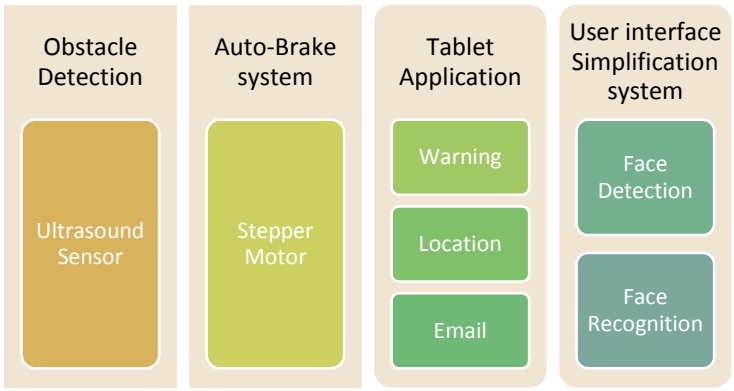

FIGURE 2 MAIN FUNCTIONAL MODULES

Each module consists of related hardware and software algorithm. The obstacle detection module consists of two ultrasound sensors for vertical and horizontal detections. The auto-brake system consists of two stepper motors. The tablet application is built on Android platform and it provides audible, visual and physical warnings with vibration as well as personalized services like email and location indicator. In order to simplify the user login process, we integrated face recognition system to Smart Walker. The obstacle detection features can be disabled when the user is not in need of them and it is implemented with face detection algorithm. Figure 3 shows how those four modules are interfaced with Raspberry Pi.

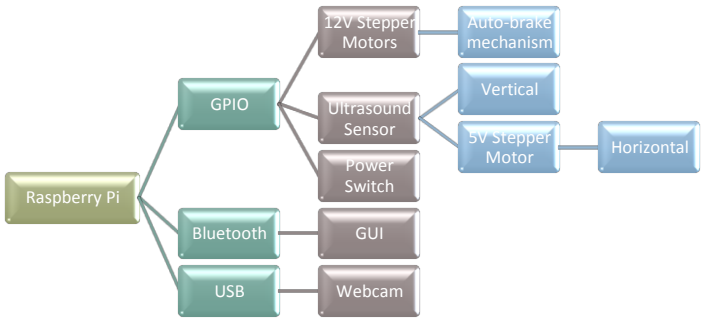

FIGURE 3 INTERFACES OF MODULES

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2.2OBSTACLE DETECTION

To detect objects higher than the ground, one ultrasonic sensor is placed horizontally as you can see in figure 4 in order to sense distance horizontally. We attached this ultrasonic sensor to a stepper motor; thus, the ultrasonic sensor can scan the wider range in front of the walker when motor is rotating.

To sense down-stairs or curbs, another ultrasonic sensor is utilized to measure the vertical distance between the sensor and the ground. This sensor is attached near the right front wheel as shown in Figure 4.

FIGURE 4 ULTRASOUND SENSOR LOCATION

2.3 AUTO-BRAKE SYSTEM

As soon after the ultrasound sensors detect any obstacles, the auto-brake will be applied to reduce the speed and give physical warnings to the user. We created our own dedicated brake mechanism while keeping the manual brake available in the existing walker. Figure 5 shows the actual design of the brake mechanism. Two stepper motors on each side mainly control the auto-brake mechanism. We designed this brake to be applied gradually in order to protect the user from a sudden brake. At the contacting surface under the brake, we used rubber to increase the frictions.

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FIGURE 5 AUTO-BRAKE MECHANISM

2.4 TABLET APPLICATION

Any Android tablets can be placed on the transparent shelf of the walker shown in Figure 1. We created an Android application that enables different types of warnings such as audible, visual and physical warnings when any obstacles are detected. Figure 6 shows the visual warning screenshot.

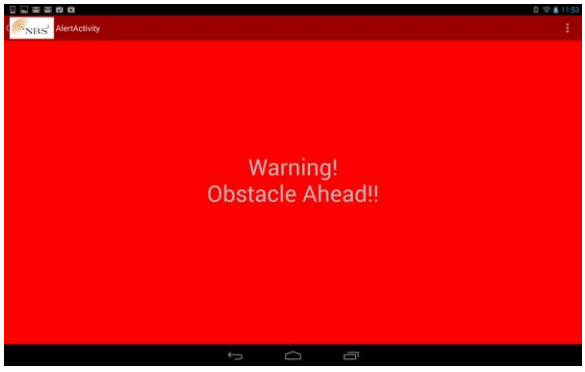

FIGURE 6 VISUAL WARNING ON TABLET

By generating beefing sound, the tablet will provides the audible warning. Also, the vibration of the tablet will provide the physical warning.

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As shown in Figure 7, the application provides the user location on Google Map, weather information, personal scheduler and email auto-generation features.

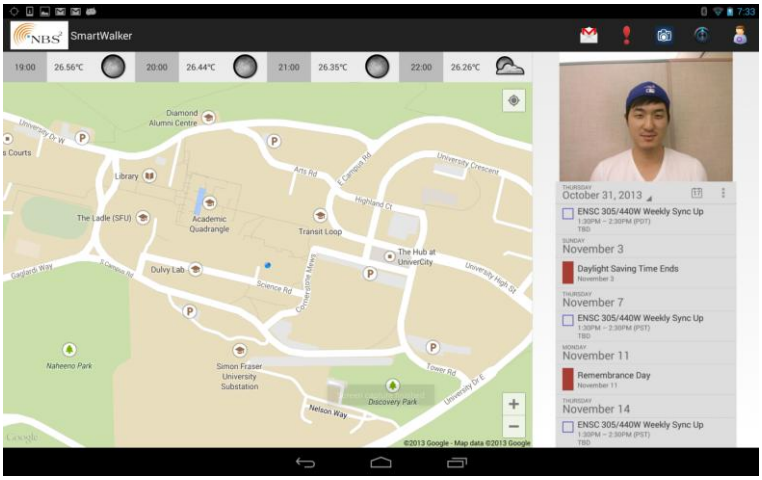

FIGURE 7 SCREENSHOT OF MAIN GUI OF APPLICATION

2.5 USER INTERFACE SIMPLIFICATION SYSTEM

While designing the application, we focused on the minimal user interaction while in use. In order to simplify the login process for the personalized services available on the application, we included the face recognition system. By capturing screenshot with the webcam attached on top, it will detect the facial photo on the ID card and recognize who the user is as long as the user picture is pre-stored in the Raspberry Pi.

In some places, users might not want to enable the obstacle detection features. We simplified the way to disable this feature by including the face detection feature. When the user ID card is not present, the obstacle detection will be turned off and the brightness of the tablet will be dimmed. Once the user ID card is present again, all the features will be enabled again.

3. DEVIATIONS FROM THE PROPOSAL

3.1 OVERALL SYSTEM

In our actual design, the major deviation from the proposal is in the systems of obstacle detection, auto-brake system. Moreover, we added a new feature to simplify the overall user interfaces.

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3.2 OBSTACLE DETECTION

In our functional specification, Smart Walker is proposed to utilize camera and distance sensors to detect obstacles [1]. We noticed that the camera response and related image processing algorithm take longer processing time than we expected. Due to the limitation of the transfer speed between the camera and the tablet, we could not give real-time detection information to the user. We overcame this issue by using ultrasonic sensors instead of camera in our actual implementation. Also, we attached the horizontal sensor onto the additional stepper motor in order

3.3 AUTO-BRAKE SYSTEM

The major deviation on the auto-brake system is the specification of the stepper motors and its power source. Initially, we proposed to user 4-6 AA batteries in order to draw 5 – 7.2V inputs for the motors [1]. After the careful re-calculation of the required torque as explained in the design specification, we replaced the stepper motors with the ones with a higher torque value [2]. In our current design, we utilized 8 AA batteries for the power source of these stepper motors.

3.4 USER INTERFACE SIMPLIFICATION SYSTEM

We newly added the face detection and recognition functions in our actual implementation in order to simplify the user interaction with other major systems such as the tablet application and obstacle detection. Also, we proposed a wireless charging solution to enhance the usability.

4. BUDGETARY AND TIME CONSTRAINTS

4.1 ACTUAL COST AND ESTIMATED BUDGET

Our proposed cost for the first topic prototype was CAD $400, but we extra cost of CAD $297 incurred due to the change in our project topic in early October. Because we were able to re-use most of the parts we had ordered in the first topic, so the CAD $400 proposed cost could be counted into the actual cost of our Smart Walker system project. Also, we obtained our initial fund $250 from the Engineering Science Student Endowment Fund (ESSEF), and we may have further funding from other professors at SFU. Thus, the fund would mostly compensate the actual cost of our project.

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Table 1 presents the differences between actual cost and proposed budget of our project.

TABLE 1 PROPOSED BUDGET AND ACTUAL COST

Income				
Grant from ESSS	$250			
		Income Total		**$250**
Expense				
Estimated Budget		**Actual Cost**		**Deviation**
Raspberry Pi	$65	Raspberry Pi (x2)	$130	($65)
Bluetooth Module	$35	Bluetooth Dongle (x2)	$40	($5)
NFC Module	$55	NOT INCLUDED	$0	$55
SD card	$25	SD card	$25	$0
Hard drive	$50	NOT INCLUDED	$0	$50
Power Supply and circuit components	$50	Rechargeable Batteries (x12) and Battery Pack	$95	($45)
Wireless charger and circuit components	$80	Wireless charger/circuit components	$80	$0
Wireless charger transmitter	$40	Wireless charger transmitter	$55	($15)
Android App and development kits	$0	Android App and development kits	$0	$0
NOT INCLUDED	$0	Used walker	$50	($50)
NOT INCLUDED	$0	Stepper motors	$30	($30)
NOT INCLUDED	$0	Web cam	$12	($12)
NOT INCLUDED	$0	Acryl	$50	($50)
NOT INCLUDED	$0	Parts (screws, wood, etc)	$40	($40)
NOT INCLUDED	$0	Sensors (x2)	$30	($30)
Budget Total	**$400**	**Cost Total**	**$637**	**($237)**

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4.2 ACTUAL TIMELINE AND ESTIMATED PROJECT SCHEDULE

As we mentioned before, we had a topic change in the early October. Thus, comparing to other teams, we had less days to complete our project. To finish our project and prepare a product prototype before the demo day, we should have a more precise and intense project schedule. Moreover, there were some incidents that cause delays on the schedule. For instance, several pieces of ordered parts arrived later than expectation, and some parts did not function suddenly and so we postponed the integration date. However, because each member put much effort into the new project topic, we eventually met all the deadlines for the documentations as well as the presentation and demo. The following Figure 8 shows the Gantt chart.

Smart Walker
NBS2 Solution

Project Lead: Junfeng Xian
Start Date: September 3, 2013 Tuesday

WBS	Tasks	Task Lead	Start	End	Duration (Days)	Actual Start	Actual End	Duration (Days)
1	**Topic selection and project proposal**	Junfeng Xian	9/3/13	9/26/13	24	9/3/13	9/26/13	24
1.1	Topic selection		9/3/13	9/16/13	14	9/3/13	9/16/13	14
1.2	project proposal		9/17/13	9/26/13	10	9/17/13	9/26/13	10
2	**Research and functional Specification**	Junfeng Xian	9/3/13	9/30/13	28	9/3/13	9/30/13	28
2.1	NFC, BT concepts and modules selection		9/3/13	9/30/13	28	9/3/13	9/30/13	28
2.2	Android app programming		9/3/13	9/30/13	28	9/3/13	9/30/13	28
2.3	Power supply and wireless charger circuit		9/3/13	9/30/13	28	9/3/13	9/30/13	28
3	**Project funding and parts ordering**	Junfeng Xian	9/16/13	10/5/13	20	9/16/13	10/5/13	20
4	**Project design**	Seung Yeong Park	9/27/13	10/10/13	14	9/27/13	10/10/13	14
4.1	BT and NFC firmware combiation	Junfeng Xian	9/27/13	10/10/13	14	9/27/13	10/10/13	14
4.2	Hard drive selection	Hongkyu Ahn	10/7/13	10/10/13	4	NULL	NULL	0
4.3	Power supply and wireless charger design	Seung Yeong Park	9/27/13	10/10/13	14	9/27/13	10/10/13	14
4.4	Android app design	Andy Back	9/27/13	10/10/13	14	9/27/13	10/10/13	14
5	**Project Topic Shfiting - Smart Walker**	Junfeng Xian	10/10/13	10/31/13	22	10/10/13	11/13/13	35
5.1	Quick research on Smart Walker	Junfeng Xian	10/10/13	10/11/13	2	10/10/13	10/11/13	2
5.2	System overview and functionalities specifications	Seung Yeong Park	10/12/13	10/13/13	2	10/12/13	10/13/13	2
5.3	Order new parts and components and tasks assignment	Junfeng Xian	10/14/13	10/14/13	1	10/14/13	10/14/13	1
5.4	Ultrasoninc sensor design and communication with Raspberry Pi	Junfeng Xian	10/15/13	10/31/13	17	10/15/13	11/5/13	22
5.5	Auto brake system design and communication with Raspberry Pi	Hongkyu Ahn	10/15/13	10/31/13	17	10/25/13	11/13/13	20
5.6	Motor, camera and Raspberry Pi connection codings	Seung Yeong Park	10/15/13	10/19/13	5	11/6/13	11/13/13	8
5.7	Wireless charging circuit design	Seung Yeong Park	10/20/13	10/31/13	12	11/6/13	11/10/13	5
5.8	user interface design	Andy Back	10/15/13	10/31/13	17	10/25/13	11/13/13	20
6	**Project integration**	Seung Yeong Park	11/1/13	11/17/13	17	11/14/13	11/24/13	11
6.1	integration with brake system and walker attachment solutions	Hongkyu Ahn	11/1/13	11/17/13	17	11/14/13	11/18/13	5
6.2	integration with sensors, camera and switches	Junfeng Xian	11/1/13	11/17/13	17	11/16/13	11/20/13	5
6.3	Wireless charging circuit design and camera usage designs	Seung Yeong Park	11/1/13	11/17/13	17	11/16/13	11/17/13	2
6.4	User requirement survey and Android user interface design	Andy Back	11/1/13	11/17/13	17	11/17/13	11/24/13	8
7	**Project testing and verification**	Hongkyu Ahn	11/18/13	11/27/13	10	11/25/13	11/27/13	3
8	**Project documentation**	Andy Back	9/3/13	12/2/13	91	9/3/13	12/2/13	91
8.1	Lab journal, meeting minutes, Canvus discussion	Andy Back	9/3/13	12/2/13	91	9/3/13	11/28/13	87
8.2	Functional specification	Andy Back	10/1/13	10/17/13	17	10/1/13	10/17/13	17
8.3	Oral progress report	Andy Back	10/25/13	10/31/13	7	10/30/13	10/31/13	2
8.4	Design specification	Andy Back	10/18/13	11/7/13	21	11/1/13	11/17/13	17
8.5	Progress report	Andy Back	11/8/13	12/2/13	25	NULL	NULL	0
8.6	Post-mortem	Andy Back	11/29/13	12/2/13	4	11/29/13	12/3/13	5
9	**Project demo, presentation and final report**	Junfeng Xian	11/28/13	12/2/13	5	11/28/13	11/28/13	1

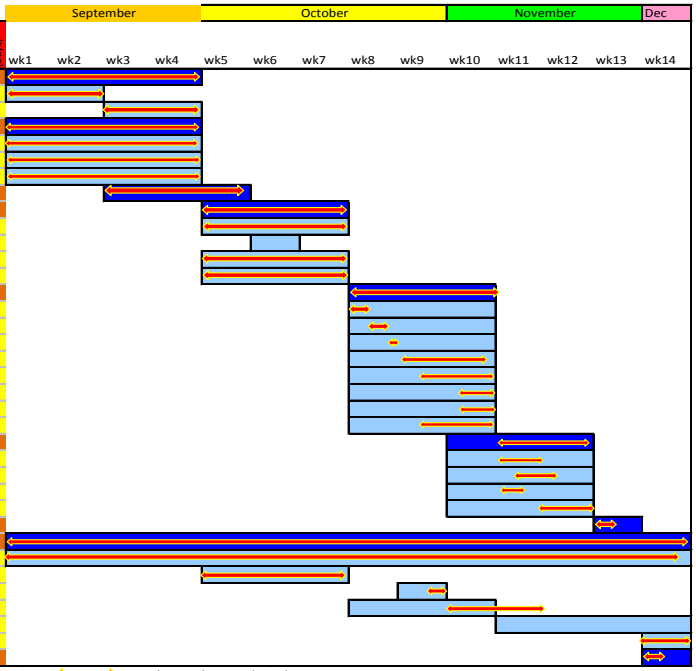

FIGURE 8 GANTT CHART

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5. FUTURE IMPROVEMENT ON THE PROJECT

Smart Walker is to provide users great comfort and safety. In our prototype, the functions are working as expected but it still has great potential for further research and improvement. As we reexamine the development of the product, we came up with the following potential improvements.

5.1 MECHANICAL

Currently, we are using stepper motor to generate force for the brake. The stepper motor was not perfect to put brake on the wheel. However, we could consider translational actuator. This could give a vertical force to push down the pad against the wheel. This will give stable and reliable force so that a user of Smart Walker faces a pleasing stop.

5.2 SENSOR

Sensor measures the distance between the walker and an object in front of it. The sensor's measurement is not perfect and sometimes not stable. We are using a stepper motor the turn the sensor to detect the wide range. To make an improvement, we could place more powerful sensor or implement a filter to obtain more stable measurements.

5.3 POWER SUPPLY AND WIRELESS CHARGING

The Smart Walker is operated by many rechargeable batteries. It saves the user money in the long term and it is good for the environment. We may implement a power indicator so that the user knows if the battery is fully charged or not. He/she may want to know how much battery is left because they do not want to see the battery run out in the middle of the trip. We may also implement a wireless charging system. This will be fond to elders with physical difficulties because they do not have to perform extra activities to charge the battery. They could simply place the walker to the charger.

5.4 USER INTERFACE AND COMMUNICATION

Since walkers are mostly used by elders who are not familiar with tablets, we want to minimize interactions between them. For example, a user should not look for icons in the tablet to start the

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application. Also, we noticed there is some delay between detecting obstacles from sensor and notification on tablet. The system is run in real time and it requires faster data processing time. We may use better microprocessor to process data quicker. Also, wired communication such as USB port can be used instead of Bluetooth.

6. GROUP DYNAMICS

Our company is formed by one systems engineer and three electronic engineers: Junfeng Xian, Hongkyu Ahn, Andy Back, and Seung Yeong Park. We all have similar knowledge backgrounds. Junfeng Xian, the Chief Executive Officer and Chief Financial Officer of NBS^2, has been in charge of task assignments and organized all team activities and regular team meetings. We divided the entire project into three stages: individual development, system integration, and system testing. Under individual development, each member took an ownership and led of tasks shown in Figure 9. Even though we changed our topic in early October, we were able to adapt to the new schedule, and eventually caught up the milestones within a month.

For any technical issues, we usually set up a quick meeting led by the task lead, then came out with at least two solutions. For example, during the design of auto-brake system, we did our first brake design with 5V stepper motor and a lever mechanism on the brake handles. However, the motor only supplied small amount of torque which was not enough to pull the lever down. Therefore, we set up a quick meeting, and after an extensive discussion, Hongkyu, the task lead for mechanical system design, decided to develop a new brake mechanism.

The strongest part of our team dynamics was that every team member was willing to contribute and spend as much time as possible. Moreover, when one person lagged behind or had too much tasks on his plate, other team members didn't hesitate to fill in their shoe, helping out as much as they can.

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7. INTER-PERSONAL AND TECHNICAL EXPERIENCES

The following figure shows the workload distribution for the project.

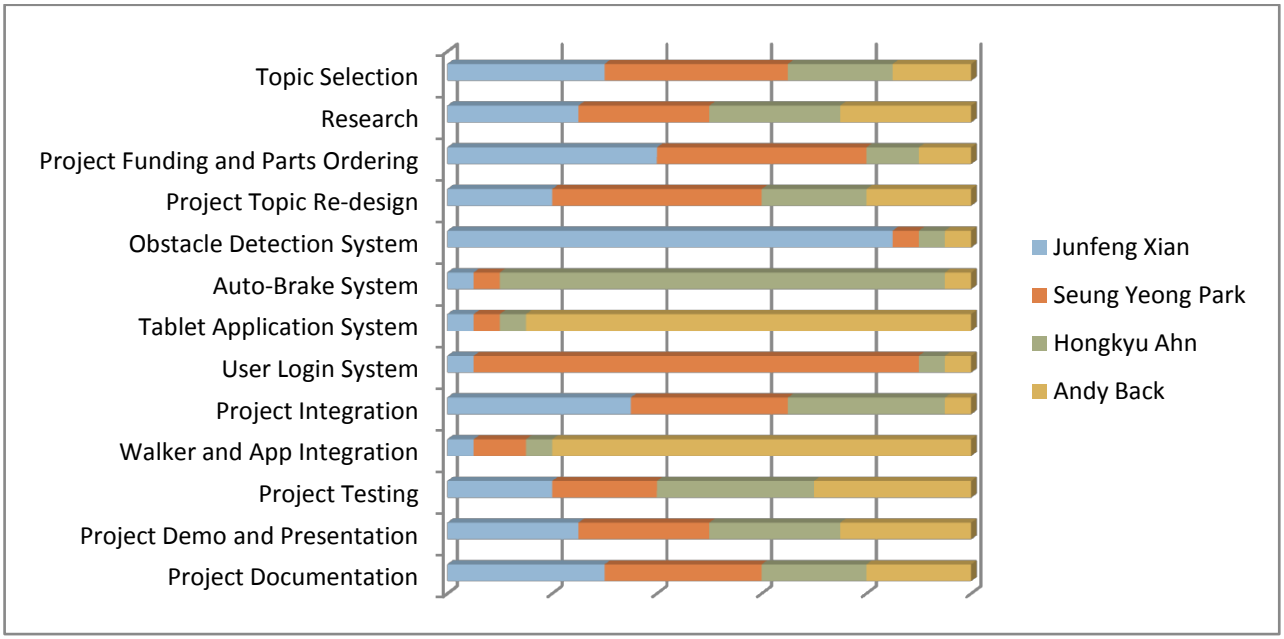

FIGURE 9 WORKLOAD DISTRIBUTION CHART FOR THE CAPSTONE PROJECT

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Junfeng Xian: Chief Executive Officer (CEO)/Chief Financial Officer (CFO)

SFU Engineering Sciences Capstone Project is my largest school project. The project took about three months and I had done a great deal of research and put much effort into the project. In my opinion, Capstone project is the final project of my undergraduate degree and it did test me on every aspect that I had learned during my university life. After this project, I improved my programming skill, communication skill, and team management skill. Also, I think I will be more confident and self-motivated now even I am facing a new challenge.

I was the Chief Executive Officer and Chief Financial Officer of our company NBS2. In terms of group dynamics, my responsibilities were making decision for the team, assigning tasks to team members and organizing regular team meetings and events. Moreover, I had my individual tasks which was developing obstacle detection system and implementing main code on Raspberry Pi. Our team encountered many different types of issues. The biggest challenge I had met during the project was to change topic from wireless hard drive to Smart Walker. After we got our proposal feedback, I noticed that the wireless hard drive was already an existing product in the market. It was most likely we would obtain a low grade on the project if we continued the old topic. I wanted to change the topic, but we might run out of time because that was already in the early October. Fortunately, other team members also knew the situation, and they all consented to change topic very soon. Thanks to all members' cooperation and quick response, we consolidated the new topic to Smart Walker. As a CEO, I knew the next step was to revise the group schedule and motivate the members to catch up the new schedule. From late October to the second week of November, I felt stressful and I knew the team members also had the same feelings; but we had a strong teamwork spirit, we encouraged each other and solved issues together during the meetings. After the second week of November, we finished all individual components and were ready for integration. Also, during this project, I had developed strong software and hardware skills. For example, I applied ENSC 351 multi-thread knowledge on main code programming, and I analyzed ultrasonic sensor quality using ENSC 387 techniques.

My experience in Capstone Project allowed me to gain valuable hand-on experience with many hardware and software development technologies as well as leadership skills. This project had definitely made a significant impact on my university studies and my future career development.

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Seung Yeong Park

Through this Capstone project, I had a great chance to experience the entire project development and management process in a limited time. At the beginning of the project, we have struggled to come up with an interesting project idea and we decided to create a portable storage device. After we noticed that the proposed idea is not really marketable, we ended up changing our project topic at the middle of October. It was because we did not perform a market research thoroughly in order to initiate the development process as soon as possible. Although we had to spend a huge amount of time to finish our project on time, I acquired a valuable lesson that having a careful research and studying about the existing markets and products is as important as the actual development process.

On the technical point of view, I was firstly in charge of power supply and charging solutions. At the beginning of the course, I started this project by looking for a powering and charging solution by picking up step up regulator and charging IC. This was a good experience for me to learn since I had to make right choices choosing components and solutions among all other alternatives by reading numerous datasheets. After changing our project topic, I utilized this charging IC and a related circuit with a wireless charging solution to provide an easier charging method for a Smart Walker. At the same time, I implemented a stepper motor control code enabling a thread on the main code and tested it on Raspberry Pi.

From the mid-October, I focused on developing face detection/recognition features. By starting with in-depth research about OpenCV library including Eigenface and Haar Cascade Classifier, I implemented prototype versions of face detection and recognition sub-functions in Python. This initial algorithm did not produce the expected results since the accuracy and performance dropped significantly in low light conditions. Thus, I researched and implemented several image filters and tested all of them by comparing their algorithm complexity and accuracy. As we progressed further, I heavily involved in debugging and testing during the integration process.

Throughout the past 4 months while working as a member of NBS^2, we improved our team productivity by communicating each other more frequently with all other members. Although we sometimes experienced miscommunication and misunderstanding, but we helped each other whenever someone was in need of help as a team. I learned how important to have a good teamwork for a successful completion of the project.

Overall, I improved my software skills on Linux environment and refreshed hardware-related knowledge. Additionally, I had great learning experience by spending long hours to deal with various problems throughout the entire project process in a limited time. Most importantly, I learned how important to have in-depth research in order to avoid making wrong decisions.

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Hongkyu Ahn

ENSC 305/440 course has been an excellent learning experience. I learned valuable skills that are not taught in school. I find that this experience is much more realistic and much more challenging than other projects. The interpersonal skill that I have improved includes reading, writing, management and team work skills. By doing an extensive research regarding the project, I became more proficient reading and writing. The process of developing a project from scratch to finish is certainly helpful for professional development. I realized that teamwork, team dynamic, and communication may be more important than individual technical skills.

My task covered brake mechanism, a bit of software, amplifying circuit and overall structural (frame) design and implementation. The toughest part of this project for me would be the brake mechanical design with the stepper motors. It required very precise measurements and testing. It was very disappointing when I had to discard couple of the mechanisms I have built, because they failed when tested. Testing the motor with brake mechanism is challenging because they have to be completely harmonized. I learned that mechanical system requires extensive iterative testing. Design of the overall structure was fun to work with. My previous Co-op experience helped me on the hands-on implementation of the structure. Selecting the best location for each component and mounting them on the walker consumed a lot of time since it required quite a bit of carpentry, but I enjoyed the work.

As a team, we faced some challenge during the term due to the change of the topic of the project. Also, we had to change some of the features as we work through, however, we managed to quickly adapt to a change and was able to meet internal and external deadlines. Although not everybody was perfect on each other, we were able to understand each other and created strong bonds.

Throughout the project, I had chance to devote myself to this developmental experience and it was one of the most important parts of my degree.

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Andy Back

It has been privilege for me have a chance to work with a group of engineers who have strong passion towards various areas of technology. Over the past 4 months, I've gained an unforgettable learning experience working with amazing and talented team members, which, without a doubt, will help me to transition from being an undergrad to a professional.

My responsibility in this team was to develop an Android application, as well as maintaining meeting minutes and revising all the documents before submission. Android development was considered as one of the most important part of our project as it was the only way the end-user would be able to interact with our whole system. I wanted to work on this software part from the very beginning, because I knew that after graduation, I will be looking to pursue my career in software development area, and being able to develop an Android app would be a huge asset for me.

Throughout this project, however, my team and I had encountered a lot of challenged and barriers. First and foremost, we simply wasted almost half of the semester, due to the change in our topic. We had scrap all the work we had done up to that point, go back to the top of our development cycle, and meet all the deadlines, which all seemed impossible to achieve. Fortunately, we were able to meet the deadlines, and complete all the newly-proposed functionality of our prototype, but looking back at a time when we made such a decision, every single one of us were in a panic due to a limited time constraint.

Other than the topic change, I also faced some challenges working with an Android environment. Before I started this project, I had some experience working on an iOS application, so I thought developing an Android application would be a piece of cake. However, it turned out that because I've never used Java before, and because Android, being an open source, provides various (and mostly inefficient) ways to solve a problem, I had really difficult time adjusting to the new environment.

Lastly, I've realized that the life doesn't go in a way that we've planned. We had incidents where we blew up our one and only Raspberry Pi, only few days before our final demo, malfunctioning Bluetooth USB dongle, which was the only way to communicate between an Android device and the Raspberry Pi, and some of the parts not arriving even after 6 weeks. From those incidents, I learned that even if we think that the planning was done properly, there are some unexpected events that block us to meet the deadlines, which I didn't really agree before we started our project.

This project, without a doubt, will be one of the most memorable experiences I've ever had in my time at SFU. I'm really grateful that I had such an amazing team, as we encouraged each other in tough times, and had no problem what so ever throughout the term. I have learned what it is to be a professional engineer, and I'd like to thank all our team members, TAs, Lucky and Mike, who helped our way throughout the course.

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8. CONCLUSION

The NBS^2 planned to design and present Smart Walker to make elderly people's life much more pleasing and convenient. Despite the difficulties encountered on the way, we were able to present the final prototype of the Smart Walker. We worked well as a group and met all major deadlines as described in the previous documents. There are some future plans as described earlier in this report. Every components of our product may be improved, but they are not critically required except for the brake system. Overall, we may consider the project to be a success.

The NBS^2's Smart Walker is to be marketed towards the elderly with visual problems. The team was presented with challenges throughout the entire three months, but the professionalism shown by each member gave positive contribution towards the product. The NBS^2 team is very proud of what they produced and would readily work together again.

9. REFERENCE

[1] NBS^2 Solutions Inc., "Functional Specification for Smart Walker System", Simon Fraser University, Burnaby, BC, Canada, Oct 13 2013.

[2] NBS^2 Solutions Inc., "Design Specification for Smart Walker System", Simon Fraser University, Burnaby, BC, Canada, Nov 17 2013.

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10. APPENDIX

---------- ENSC 305/440 Meeting Minutes ----------
Date: Friday, September 6th, 2013
Time: 16:00:00-17:00:00
Location: Tim Hortons @ West Mall
Attendees: Jun, Hongkyu, Andy, Seung Yeong Nick (via Skype)
---

1. Our initial idea was rated 1 out of 3, which means it's too easy for 4 of us.
1.1 Lucky suggested that we look for an alternative idea(s). If we're not able to come up with a new (and good) one, then we could build up on our original idea and make it more complex
2. Should we stick with using NFC? Raspberry Pi?
3. Possible Ideas:
3.1 Expanding our Bluetooth idea
3.1.1 Can be used to connect to old computers (without any Bluetooth or NFC) wirelessly - like Bluetooth dongle
3.1.2 Old smartphones? TVs?
3.1.3 Could act like a cloud computing as long as the devices are close to one another (external hard drive with NFC and Bluetooth)
3.1.4 We are providing a solution not a product
3.1.5 Lets say we have a tablet
3.2 Fall detection
3.2.1 Target: Old people, people with disability
3.2.2 Whenever they fall for some reason, then this device notifies the supervisor
3.3 Advanced Black Box
3.3.1 Bluetooth connection to our phone?
3.3.2 Finger prints?
3.4 Motion detector
3.4.1 Detects finger
3.4.2 Could be used on Tablets
3.4.3 Flicking finger from one device to another initiates data transfer between two devices?
4. From now on, we'll try to have a discussion on canvas since Lucky will look at it and provide us with some feedback

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Friday, September 20th, 2013
Time: 15:30:00-16:48:00
Location: Lab 4
Attendees: Jun, Hongkyu, Andy, Nick
---

1. We're going back to our original idea to have portal external hard drive. Instead of buying modules, we're buying individual chips (NFC, Bluetooth) and design a PCB board.
2. Due to change in our project, we should modify contents of our proposal

---

ACTION ITEMS Complete the action items by Sunday afternoon
(ACTION-Andy) Intro/Background
(ACTION-Andy) Prototype Design
(ACTION-Andy&Hongkyu) Come up with milestones on software side (Android App)
(ACTION-Hongkyu) Scope/Risks/Benefits
(ACTION-Hongkyu) Logo
(ACTION-Hongkyu) Individual responsibilities (CEO, CFO, etc)
(ACTION-Nick&Jun) Make a list of components (parts) and see if the project is doable
(ACTION-Nick) Research on the existing market
(ACTION-Jun) Gantt Chart for the team
(ACTION-Everybody) Gantt Chart for each individual

Next meeting: Sunday, September 22nd, 2013 @ 3PM

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Sunday, September 22th, 2013
Time: 15:00:00
Location: Lab 4
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Nick: During last meeting I mentioned that we might need SATA to USB converter; he got an external hard drive and it seems like it's already embedded - we don't need a converter circuit, so we need to add something more. Adding wireless charging as another feature since whole theme of our project is building something portable?
- power supply circuit
- charging circuit
- power receiver circuit
2. This would mean Jun will be responsible for NFC/Bluetooth - Andy and Hongkyu will help him out whenever he needs help.
3. Nick and Jun to work on integration once their works are done
4. Hongkyu and Andy to design a storyboard (or flowchart) for SW app

---

ACTION ITEMS Complete the action items by Sunday afternoon
(ACTION-Andy) Intro/Background
(ACTION-Andy) Prototype Design
(ACTION-Andy&Hong) Come up with milestones on software side (Android App)
(ACTION-Hong) Scope/Risks/Benefits
(ACTION-Hong) Logo
(ACTION-Hong) Individual responsibilities (CEO, CFO, etc)
(ACTION-Nick&Jun) Make a list of components (parts) and see if the project is doable
(ACTION-Nick) Research on the existing market
(ACTION-Jun) Gantt Chart for the team
(ACTION-Everybody) Gantt Chart for each individual

Next meeting: Sunday, September 22nd, 2013 @ 3PM

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Thursday, September 26th, 2013
Time: 13:30:00
Location: Lab 4
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Status Update
1.1 Andy and Hongkyu: Android environment setup all done. Finished hello world tutorial and now will move on to implementing nfc and Bluetooth
1.2 Nick: Power circuit:
- charging circuit: looking for inductive capacitor for receiver
- power circuit: battery selections
- hard drive: looking for cheap ones (small capacity of around 100GB)
1.3 Jun: NFC development platform setup done
---

2. Issues
2.1 Battery selections:
- 3.7V cell phone + boost circuit
- 1.5V AA battery x 3 -> not good charges
- 9V mobile device battery -> unstable
---

3. Action Items
3.1 New items for this week:
3.1.1 (ACTION - Everyone) Editing final version of the proposal
3.1.2 (ACTION - Nick) Fix issue 2.1
3.1.3 (ACTION - Everyone) Move on to the next item on each one's schedule
---

Next meeting: Thursday, October 3rd, 2013 @ 1:30PM

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Thursday, October 3rd, 2013
Time: 13:30:00
Location: Lab 4
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Status Update
1.1 Andy and Hongkyu:
1.1.1 Working on integrating NFC
1.2 Nick
1.2.1 Got 2 chips from linear tech for charging and discharging
1.2.2 Also 1 chip from TI for wireless charging
1.3 Jun: Trying to access NFC chip using Raspberry Pi
---

2. Issues
2.1 Cost - Total cost for all the parts ordered by Nick will be around $200 and it's expected to increase by $50 when we get an external hard drive
2.2 Device compatibility - Find out if all android devices with NFC are compatible with PN352
2.3 Extra device - There is an extra Galaxy S3 device with broken LCD so research on how we can make the use out of it (i.e. find a way to control UI on PC by connecting USB?)
---

3. Action Items
3.1 From last week:
3.1.1 (ACTION - Everyone) Editing final version of the proposal
3.1.2 (ACTION - Nick) Fix issue 2.1
3.1.3 (ACTION - Everyone) Move on to the next item on each one's schedule
3.2 New items for this week:
3.2.1 (ACTION - Everyone) Start working on Functional specs, which is due Thursday, October 17th
3.2.2 (ACTION - Nick) Build and test circuit once all the parts arrive
3.2.3 (ACTION - Andy) Complete NFC and Bluetooth connection
3.2.4 (ACTION - Andy) Issue 2.2
3.2.5 (ACTION - Hongkyu) Complete NFC and Bluetooth connection
3.2.6 (ACTION - Hongkyu) Issue 2.3
3.2.7 (ACTION - Jun) Finish NFC part and start on Bluetooth as soon as the module arrives
---

Next meeting: Thursday, October 10th, 2013 @ 1:30PM

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Thursday, October 10th, 2013
Time: 13:00:00
Location: Lab 1
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Status Update
1.1 Got 81/100 for our proposal but for the Benefit/Risk/Background part we got 8/25
1.2 After a talk with Lukas, we've decided to change our topic slightly to a roller walker
---

2. Issues
2.1 Mechanical
2.1.2 Brake System
2.1.3 Camera Direction Control Motor
2.1.4 Switch (Power)
2.1.5 Tablet Holder
2.2 Electrical
2.2.1 IR Distance Sensor
2.2.2 Camera for Pic/Vid
2.2.3 Battery Pack
2.2.4 Bluetooth (Optional; to be done if permitted under time constraint)
2.3 App
2.3.1 Map (Navigation)
2.3.2 Warning System
2.3.3 Weather
2.3.4 Bluetooth (Optional; to be done if permitted under time constraint)
---

3. Action Items
3.1 From last week: Not applicable
3.2 New items for this week:
3.2.1 (ACTION - Everyone) Start working on Functional specs, which is due Thursday, October 17th
3.2.2 (ACTION - Andy, Hongkyu) Research how to connect Android devices with ourprototype
3.2.3 (ACTION - Jun) Research on Brake System 3.2.4 (ACTION - Nick) Buy a cheap walker from Walmart
---

Next meeting: Thursday, October 17th, 2013 @ 1:30PM

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Thursday, October 24th, 2013
Time: 13:30:00
Location: Lab 1
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Status Update
1.1 Nick
1.1.1 Finished integrating camera to raspberry Pi.
1.2 Jun
1.2.1 Distance sensor integration done with minimal testing. Will try to attachit to the walker and do the real testing
1.3 Hongkyu
1.3.1 Automatic brake almost done, but might change the design (where to put the brake) since the motor we have is pretty weak
1.4 Andy
1.4.1 Weather part done. Now working on the map/navigation part
---

2. Issues
2.1 Motor too weak. Should we order a 10V one instead?? (but 10V will require 2x the batteries)

Next meeting: Thursday, October 31st, 2013 @ 1:30PM to get ready for oral progress report

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Thursday, November 7th, 2013
Time: 13:30:00
Location: Lab 1
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Status Update
1.1 Nick
1.1.1 Finished integrating face recognition using a webcam, which is connected to a Raspberry Pi.
1.1.2 Bluetooth module on Raspberry Pi not working properly due to broken circuit. Ordered new component and will start testing when it arrives (estimated ~1-2 weeks)
1.2 Jun
1.2.1 Finished integrating the motor that will turn one of the distance sensor.
Also will start doing the assembly for all the modules that are connected to the Raspberry Pi
1.3 Hongkyu
1.3.1 Finished attaching acrylic glass on the walker. It will be used to attach a webcam (for face recognition), and a tablet for user interaction
1.4 Andy
1.4.1 Finished integrating map and navigation. Now the map zooms and follows the current location of the user.
---

2. Issues
2.1 Ordered new Bluetooth module (see 1.1.2)

Next meeting: Thursday, November 14th, 2013 @ 1:30PM

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---------- ENSC 305/440 Meeting Minutes ----------
Date: Thursday, November 14th, 2013
Time: 13:30:00
Location: Lab 1
Attendees: Jun, Hongkyu, Andy, Nick
---

1. Status Update
1.1 Nick
1.1.1 Still waiting for Bluetooth module that's being shipped
1.1.2 Finished all the parts for design specs
1.2 Jun
1.2.1 Almost finished design specs. Working on appendix right now
1.3 Hongkyu
1.3.1 Ordered another motor since the 5V motor that we've ordered doesn'tproduce enough power to apply the brakes 1.3.2 Design specs should be done by tomorrow (since I have an interviewtoday, I can't work on it today)
1.4 Andy
1.4.1 Working on the Google Calendar and account integration
1.4.2 Design specs almost done. Should be finished by the EOD tomorrow (Sat, Nov 15th)
---

2. Issues
2.1 Ordered another motor (see 1.3.1)

Next meeting: Tuesday, November 19th, 2013 @ 1:30PM at Andy's house for integration

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