Auto Tech

December 10, 2012

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

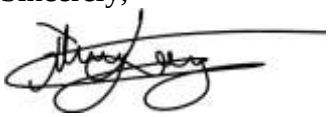
Re: ENSC 440W Post Mortem: Human Chasing Robot by Auto Tech

Dear Dr. Rawicz,

Please find the attached post mortem document for our project Human Chasing Robot by our company Auto Tech. It is a tracking robot that follows and monitors patients. Our product can be widely used in hospitals, mental institutions and nursing homes to track patients.

The document describes the current status of the devices, deviation from the initial plans and provides possible future implements for the model as well as some details about the budgets and time management. It also includes reflections from our five brilliant engineers about this project. For further inquires about our company and proposal please feel free to contact via our team email: ensc440-groupn@sfu.ca, or by phone at 778-855-2480.

Sincerely,



Johnny LEUNG
Chief Executive Officer
Auto Tech

Enclosure: Post Mortem for Human Chasing Robot

POST MORTEM FOR HUMAN CHASING ROBOT

Project Team

Johnny (Ho Cheung) LEUNG
Michael (Ko Yung) LEUNG
Eric (Zhuopei) ZHAO
Alex (Xu) JIANG
Ken (Kyoungwoo) NAM

Team Contact

ensc440-groupn@sfu.ca

Submitted to

Dr. Andrew Rawicz
Steve Whitemore
School of Engineering Science
Simon Fraser University

Issued Date

December 10, 2012

Table of Contents

Introduction

Our device is a tracking robot that uses ultrasonic sensors to determine the distance between the robot and the tracking beacon and the microcontroller will control the movement of the robot based on the received information from the sensors. Members of Auto Tech have been working closely on developing the device for the past four months. This document will provide the most current state and the deviation from the proposal. Also some issues that we encountered during the developing process and the possible future implementations will be discussed.

Current State of the Device

The device consists of three main parts, a robot unit, a tracking system which determines the distance and direction, and also a video-capturing system.

The robot unit we used is the one we bought from store. All we need to do is to program the microcontroller to control the movement of the robot. In this stage of the project, we have successfully control the movement.

The wireless communication circuit involves one ultrasonic transmitter, and three receivers which would be placed on the left, center, and the right on the robot. Right now we are able to determine the direction of the patient movement by comparing the pulse width of the signal from the three receivers.

The video streaming unit works perfectly with the portable battery. A webcam is connected to the Raspberry Pi which would perform video streaming. Right now we are able to stream our video to a webpage.

Deviation from Proposal

Robot Unit

Instead of using a RC car and a microcontroller kit for the robot unit, we chose to the BOE-BOT Kit from Parallex Inc. The final result of the robot is smaller than our initial design, but it met all the functional requirements we need. The robot's movement is controlled by the BASIC Stamp microcontroller. The two continuous rotation servos allow the robot to achieve all the required movements. The frame of robot is built using 2-3mm thick plastic boards, which are light weight and durable. Overall, the only notable deviation from our proposed design is the size of the robot unit.

Wireless Communication Circuit

The wireless communication unit is functional as we expected. The robot can move forward, backward, turn left and right based on the received signal from the three receivers. However, we are using three receivers instead of using two in our proposal.

Future Plans

Overall System

There are several possible developments that can make the tracking robot more competitive in the market. Specific upgrades will be listed in their own sections.

The first improvement that could be done is to increase the size of the robot. As mentioned in the deviation section, one of the possible functions of this robot is to follow the patients and carry the medical tools and supplies around. Since the robot unit we are using right now is directly purchased from the store with its pre-built frame, the size of the robot is limited. In the future, we can build a bigger frame on our own which would be big enough to match our initial proposal.

Wireless Communication Circuit

Since we build our circuit on breadboard, the size of them is much larger than it should be. The first improvement is to reduce the size of the circuit. Building the circuits on PCBs could be a solution. Secondly, we need to modulate the signal in our transducer before sending it out so that each signal will have its own identification. In other words, we would be able to keep track of multiple targets. Third, we need to reduce the power consumption of our circuit because right now while our transducer is sending signal continuously, the three receivers have to be ‘on’ all the time in order to receive the signal. Therefore, we are using four separate 9V batteries for the wireless communication system. This may bring a lot of heat to the device. In future, we plan to have alternative way to power up our ultrasonic communication system.

Video Streaming Unit

The video streaming unit is working as we planned. The video captured from the webcam is streamed over the Wi-Fi network and the client can view the streaming using a web browser. The requirements are met and the performance is good enough. It is not necessary, but there are some improvements that can be made to the unit. Firstly, the camera can be replaced with a smaller and lighter one with higher performance. It will increase the frame rate, resolution and save space. Secondly, the battery can be replaced with a smaller and a lighter one. It will save the space and make our robot lighter. These are some changes that can be made to improve the performance of the video streaming unit. However, making these changes will also increase the price of the system.

BUDGET AND TIME CONSTRAINTS

Budget

Table #1 below shows the initial estimated budget in our project proposal. Table #2 lists the components we purchase throughout our project development.

Table 1- Estimated Budget

Equipment List	Estimated Cost
RC Car with Camera	$200
Proximity Sensor	$50
Chips and other basic circuit components	$50
Small LCD Display	$50
Microcontroller Kit	$150
Total Cost	$500

Table 2 – Actual Budget

Robot	Cost	Note
BOE-BOT	$174	replaces cost of RC car and microcontroller
Plastic boards	$14	
Screws/nuts	$9	
Tools+Labour	Free	
Sensors		
Electronic components	$67	
Breadboards	$15	
Battery	$36	unexpected cost
Maxsonar-EZ1	$35	Not used
Sensors from Ebay	$80	Not used
Video		
Raspberry Pi	$25	
Webcam	$10	
USB Battery	$15	
Micro SD card	$5	
WiFi Dongle	$11	
Total	$496	

Note that due to changes in our design, some units in our estimated budget were never purchase. Our initial estimate of the budget was over simplified. Many details we left out in our initial design. For example, the cost of batteries was a significant portion of the cost that we failed to account for in the proposal.

We reduced our cost in the robot unit by purchasing the BOE-BOT kit instead of the RC car but we overspent in the Sensors unit. In the end, the two even out and we were able to meet our initial $500 budget.

Funding

Due to a misunderstanding, we lost our main source of funding from the Engineering Science Student Endowment Funding (ESSEF). We cannot collect the $500 that was approved. Funding for the project comes from each team member in the group.

Schedule

The team basically followed the timeline suggested in the proposed Gantt chart. However, since each member was busy dueling with midterms in October and November, things started go off the schedule. Also it took much longer time for us to build a workable wireless communication circuit, which made everything so packed up in the last week of semester. The following figure demonstrates the proposed timeline and the actual schedule we had.

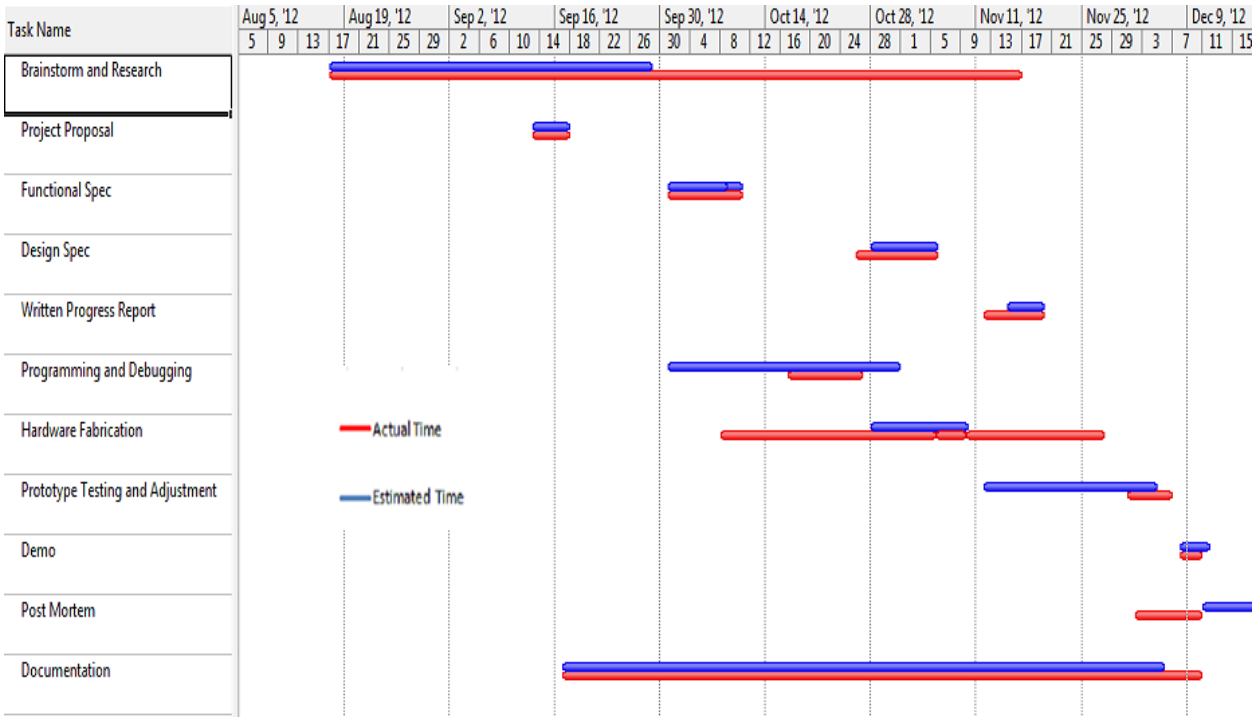


Figure 1 – Updated Gantt Chart

As we can see from the figure, the blue timeline is the estimated schedule we suggested in our proposal and the red timeline is the actual schedule that we worked on our project. Note that we have spent a lot of time on hardware fabrication which also include design and testing on wireless communication circuits. But still, we can still finish our project on time.

Individual Reflections

Johnny (Ho Cheung) LEUNG – Chief Executive Officer

Well, despite the fact that it requires a lot of time and efforts, ENSC 440 has been a great experience to take this course since it is not just about creating a new device, but also sharing of ideas between team members and working together to get things done are delighting and priceless.

Most of the time spent on this project was to do researches on the internet. It was frustrating when similar posts appear again and again and you are not getting any useful materials that you are looking for. We spent about three months on researching since our circuit of the sensors was not working as we thought, so we kept looking for new circuit designs and methods to improve the performance. This researching part was painful, but also makes this project unforgettable to me.

In this course, I have developed a strong team management skill by holding team meeting and assigning work to team members. This was done for the good of the team by making sure that no one is fooling around and we are on schedule. Although we were stuck on the wireless communication circuits for two months, we are still right on track since we were able to get the other parts done before integrating the device. I would not say that is my own achievement on leadership but it is the whole team effort to get things going. Also I have spent lots of time on documenting and soldering, those are good review of what I have done in my coop semester.

The past four months has been a great experience for me to work with such talented and brilliant teammates. Getting stuck on building the circuit for two months made me to lose hope to finish on time. I am delighted that we can finish it. Thanks guys!

Michael (Ko Yung) LEUNG – Chief Financial Officer

ENSC 440 can be very enjoyable, but it can also be incredibly frustrating at the same time. I loved the freedom given to us to develop our projects. However, this also means the course lack the rigid structure like other university courses. After taking this course, I truly appreciate the importance of research. All decisions made during the development progress need to be carefully considered and thoroughly researched. The consequence of a bad decision can be costly in both time and money.

Along the way, we encountered many issues and obstacles. There were many decisions needed to be made before solving a problem. Finding a feasible solution can be very difficult. Time, money, and technical knowledge are all important factors in the decision-making process. We made the mistake of purchasing components without doing sufficient research and ended up wasting time and money. We were lucky enough to recover from such mistake.

Time management skills and self-discipline are necessary to surviving ENSC 440. Many times during the development of this project, I found myself drifted away or distracted by other school work. Luckily, I have a group of dedicated teammates to keep me on track. Tremendous amount of teamwork and communication are needed in order for group to function efficiently. I am fortunate to have a group of diligent and devoted teammates to carry me along the way. I am astounded by the professionalism my teammates. Everyone in the group deconstructed leadership and initiatives throughout the development of our project. Teamwork is what made it possible for our project successfully complete on time.

Eric (Zhuopei) ZHAO – Chief Hardware Officer

My work was mainly focused on building circuits. We were looking for lot of design on the internet and tried it one by one at the beginning. It wasted lot of time on looking for a suitable design. Even we designed our circuit and built it, we still faced lots of problem, such as: distance, noise, sensitivity and so on. We cannot make the circuit has both long distance range and lowest noise. We have to design and come up an idea to balance them for the convenience of programming. A lot of debug and adjustment are out of we expect.

After this project, I have developed a strong team working skill and problem solving skill. This project helped me have a better understanding of the importance of the applications of many hardware devices and techniques. I have also learned the importance of breaking a large circuit into several sub- circuit and testing to examine the satisfactory performance of a sub- system before combining them together. I have gained an extensive and valuable knowledge about the building transducer, receivers, and power circuitry. Throughout this project, I was very enjoying it because I can use what I learn in school. It is not only written on a piece of paper, we finally made it.

Alex (Xu) JIANG – Chief Communication Officer

Taking ENSC 305/440 was a wonderful experience for me. For the past four months, I have improved both of my technical and non-technical skills through working on this project. As working in a group, our group members have been working hard under the well-organized team dynamics. I would like to take a chance to thank everyone in the group. It was a unique experience working with everyone in the group.

At the beginning of this term, each team member gave the idea of our project's topic. After hearing professor's suggestion, we fixed on working on Human Chasing Robot. Meanwhile, we named our company as Auto Tech.

We divided our project to three parts: the imaging system, action control circuit and wireless communication circuits. I was involved in building wireless communication circuits (Hardware Department) and integration. From building up the communication circuits, I have learned a lot of technical knowledge and improved the skill of solving problem. The most important component for our communication circuits is sensor. I have been familiar with many different sensors during my research, such as Ultrasonic range finder sensor, Infrared sensor, laser sensor and so on. My partner and I built three receivers and one transmitter in total. From building up those circuits, I have improved my skill of solving problem. There were many problems during building circuits, such as our two different sensors operate at different frequencies, our circuits only works at a very short range, the receiver receives too many noises and so forth. By solving those problems I am more familiar with circuit building and testing.

I also learned that teamwork is very important. As a group project, a good communication between different departments is required. It could save a lot of time if all members have a good communication. It's also important to design carefully before building it; otherwise it may take much more time to redesign.

Working on this project, I am not only learned much technical knowledge, improved my skill of solving problems and also communication skill. A good communication with group members can make our job easier. I would like to take this opportunity to thank everyone again, without you guys; the project could never be finished.

Ken (Kyoungwoo) NAM – Chief Software Officer

Although the robot that we built is not perfect, I am very pleased with the result we have now and the experience I gained from the project. As an engineering student at Simon Fraser University, I have learned so many topics such as programming, circuit design and so on. However, I honestly had no idea why I was learning all these. However, while I was working on this project, I finally realized the reason why I had to study everything and I felt like I am a real engineer. I solved a real life problem by building a robot! There are some other lessons I learned like teamwork, time management and real-time applications too and this project was the best project that I have done at SFU.

My work was mainly focused on the software side of the system. I worked on the PBASIC code that runs on the Boe-Bot, and the video streaming unit. Working on the PBASIC code was simple. Although it was first time using PBASIC, it was not that different from the programming languages that I am familiar with. The challenging part was the handling of the instability of the output values of the receivers. It was not easy to distinguish between the noise and the actual signal so it was very difficult to implement the moving functionality. For the video streaming unit, it was mostly a research work. I used Raspberry Pi, which can run a Linux. Since it can run Linux, it can run most applications that run on Linux. Therefore, I just needed to find out which applications provide the services that I need, and correctly configure the applications. It was still challenging because I had to try multiple software and configuring these software were not straightforward.

Overall, the past four months has been very enjoyable. I was lucky to have such a bright teammates and I am glad that we have finished the project. This semester was one of the best semesters I had at SFU.

Conclusion

At the beginning of this semester, our motivation is to solve the labor force problem by introducing a new type robot into the industries. After four months of researching and hardworking, the Human Chasing Robot prototype has been successfully completed. There may be some deviations from the proposal but the main goal of this project is achieved. The team has gained a lot of technical experiences like circuit implementation and soldering and non-technical skills like project management and communication skills throughout the past 13 weeks. There is much more work is required to create an ideal device for the market, but we are crawling slowly on the right track to achieve the success in the future.