December 19th, 2003

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
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Re: ENSC 340 Project *Post-Mortem for a Dynamic Directional System*

Dear Dr. Rawicz:

The attached document, *Post-Mortem for Dynamic Directional System*, outlines the current and future states of the product, the problems we hope to fix, time and budget constraints and our personal experiences.

Our team at Sound Directions is comprised of six enthusiastic and hard-working fourth-year students. Group members include: Farhan Ali, Ted Liu, Chris Chun, Nima Jahedi, Daniel Kim, and Gelareh Parandian. If you have any enquiries or questions feel free to contact us at sd-ensc@sfu.ca. Thank you very much.

Sincerely,

Farhan Ali

Farhan Ali
President and CEO
Sound Directions

Enclosure: *Post-Mortem for a Dynamic Directional System*

Post-Mortem for Dynamic Directional System

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1 Introduction

For the past sixteen weeks the team at Sound Directions has been hard at work at designing our *Dynamic Directional System*. We have documented all the trials and tribulations of the design process, and the current and future issues of the design in this report.

The purpose of the *Dynamic Directional System* is to provide accurate directions to a visually impaired person to nearby locations of interest. After thorough research we discovered an acute need for this kind of product in the market. We concluded that our project would offer the following benefits over existing solutions:

- Wireless connectivity
- No line of sight communication required
- Discreet
- Easy to use, no training required
- Scalable

2 Present State of the System

The block diagram of the system that we delivered to our sponsors is shown in Figure 2.0.

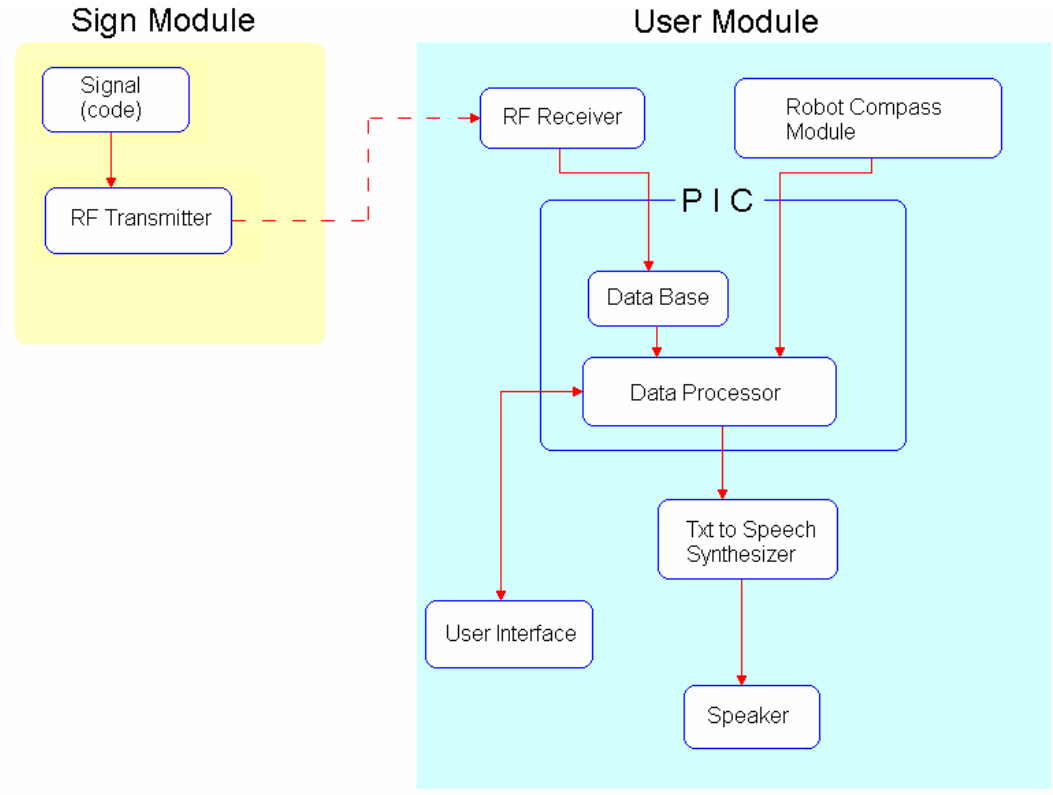


Figure 2.0 – System block diagram for ENSC 340 deliverable

Our deliverable had the basic functionality that was laid out in the design specifications.

The Sign module consists of a PIC microcontroller and an RF Transmitter. The transmitter continuously sends out a location code which is specific to each location.

The User module consists of a PIC microcontroller, RF receiver, Digital Compass and a text to speech synthesizer. The User module works as follows:

- The receiver collects the location code sent by the sign module; this code is then checked for errors by the microcontroller.
- After the error checking the on-chip database is searched to find all locations corresponding to that particular location code.
- Next, the orientation of the user is determined and the resultant directions to all the locations are calculated
- The directions are then ‘spoken’ to the user via the text to speech synthesizer

During our design process we had constant input from a host of people. Our focus group at the Vancouver Community College always had the final word on any major design decisions. We also interacted with many professors and colleagues in order to further improve our design.

3 Remaining Issues

The device works as presented on the functional specification, but there are still several issues to be resolved.

3.1 Magnetic interference

The digital compass is susceptible to surrounding magnetic interference. Even a small amount of interference can alter the compass reading, rendering it useless in the areas with high magnetic interference. The magnetic interference cannot be blocked or removed, but can only be redirected. Since interference from metal objects typically alters the existing magnetic fields, the magnetic sensor can never find the actual direction of the source of the magnetic field. Strong magnetic interference, however, can be detected with additional magnetic sensor, allowing the device to alert the user that the direction may not be accurate. This detection device will later be integrated into the project in phase two.

3.2 Tilting the compass

Tilting the compass off the horizontal will introduce an error to the reading. Tilt compensated compass that compensates up to 50º do exist in the market, but are extremely expensive at the moment.

We can design a tilt compensated compass ourselves thereby saving a lot of money

3.3 Power consumption of the user module

The user module consumes too much power during operation. Each of the text-to-speech synthesizer, the compass module, the signal processing circuit and the microcontroller need to be powered up for proper operation. The power consumption of the combined devices is larger than as predicted in the beginning of the project. We have tried up to three 9V batteries in parallel to boost current supply and failed to get the user module operating properly. Currently, the user module must be powered from a power supply. This issue will be analyzed more thoroughly in second phase to find which device is actually causing the power drainage.

3.4 Range Vs Accuracy

During the testing, we found a trade-off between range of coverage and accuracy of RF signal. Reduction in the range of coverage reduced the accuracy of the RF signal. Due to the short-range nature of the project, the coverage must be set less than 5 meters. This also reduces the accuracy of the RF signal, degrading the performance of the entire system. By trial and error approach, we have determined the optimal range that achieves

acceptable range and accuracy. In future, we will look into different technologies that can provide better signal accuracy while keeping the short-range requirement.

3.5 Overall size of the device

Currently, the device size is too large for a person to carry around with. The device will later be implemented on PCB, which will compact the overall size and make it portable.

3.6 User interface

Visually impaired individuals require a different user interface as compared to normal person. The interface must be simple and easily understandable. Audio feedback instead of visual and Braille display instead of text should be used for visually impaired. Currently, our device consists of one button which is used for speaking the directions. In future, we are planning to insert few more buttons or 'hot keys' for speaking directions to the most important locations, such as washrooms and information center. The buttons will have Braille display to allow the visually impaired to distinguish between them.

4 Phase two

This section outlines the Phase II of the project.

4.1 Phase two overview

In Phase II, we will redesign the data storage and the user interface of the system in order to enhance the commercial value and potential of our project. Figure 4.1 illustrates the system block diagram of Phase II.

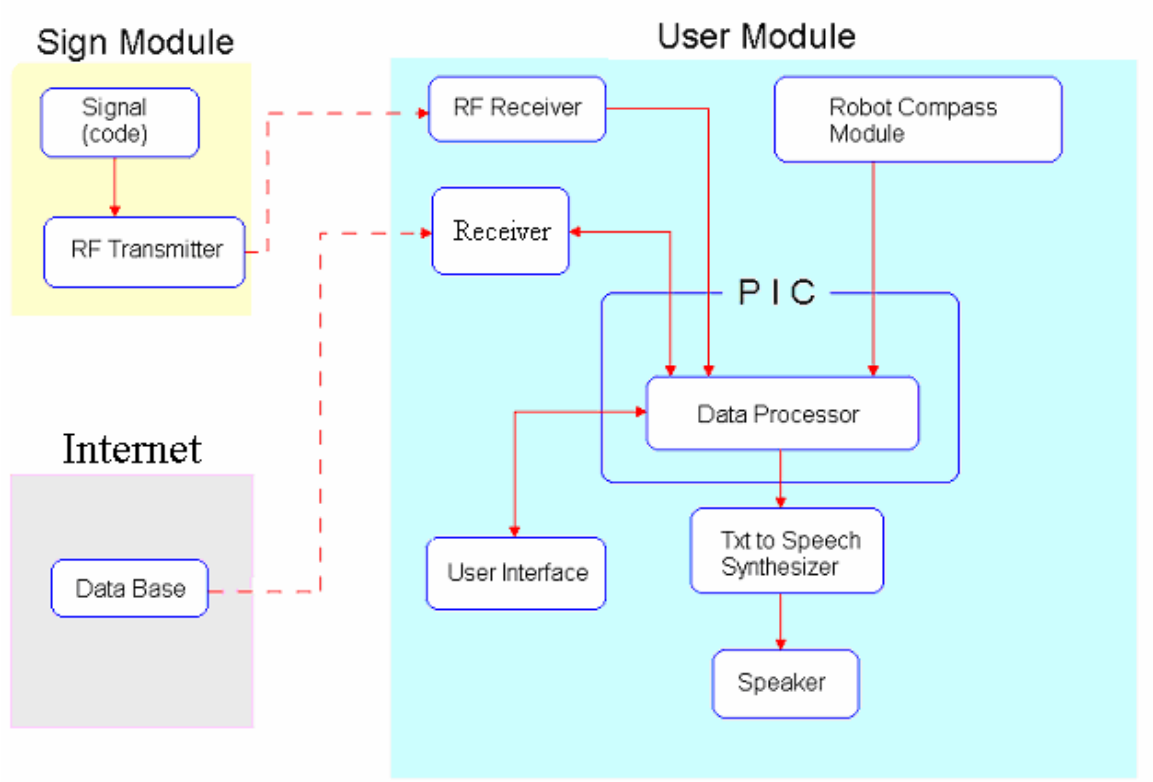


Figure 4.1 – System block diagram of Phase Two

The main difference of the system in phase two is the use of Internet. Nowadays, with Internet access widely available in major urban centers we believe that this technology will allow us to provide a complete guidance solution to the visually impaired using pre-existing infrastructure. Also the use of the Internet for data transfer would considerably simplify the design of the sign modules. Simplifying and reducing the cost of sign modules are key issue for our project since we would be able to reduce cost for building sign modules (infrastructure) accordingly.

There are few options for Internet integration. We can integrate with PDA with WLAN card since it is easy to program and minimize the hardware design. Unfortunately, PDA is

not designed for visually impaired people and they have no other uses for the PDA device as it can be difficult to use even for non-visually impaired people.

We can also integrate using the cell phone since it allows Internet access. Cell phones are one of the most widely used handheld devices and visually impaired people also use them. However, its data transfer rate is too slow. Also it costs a lot of money to establish phone signal coverage if there is no coverage for a specific area.

As our last option, we can build our own WLAN module. We can build the system cheaper and we would be able to customize the system in specific for visually impaired people. The downside is that it requires extensive and challenging hardware design.

Figure 4.2 shows the overview of phase two systems.

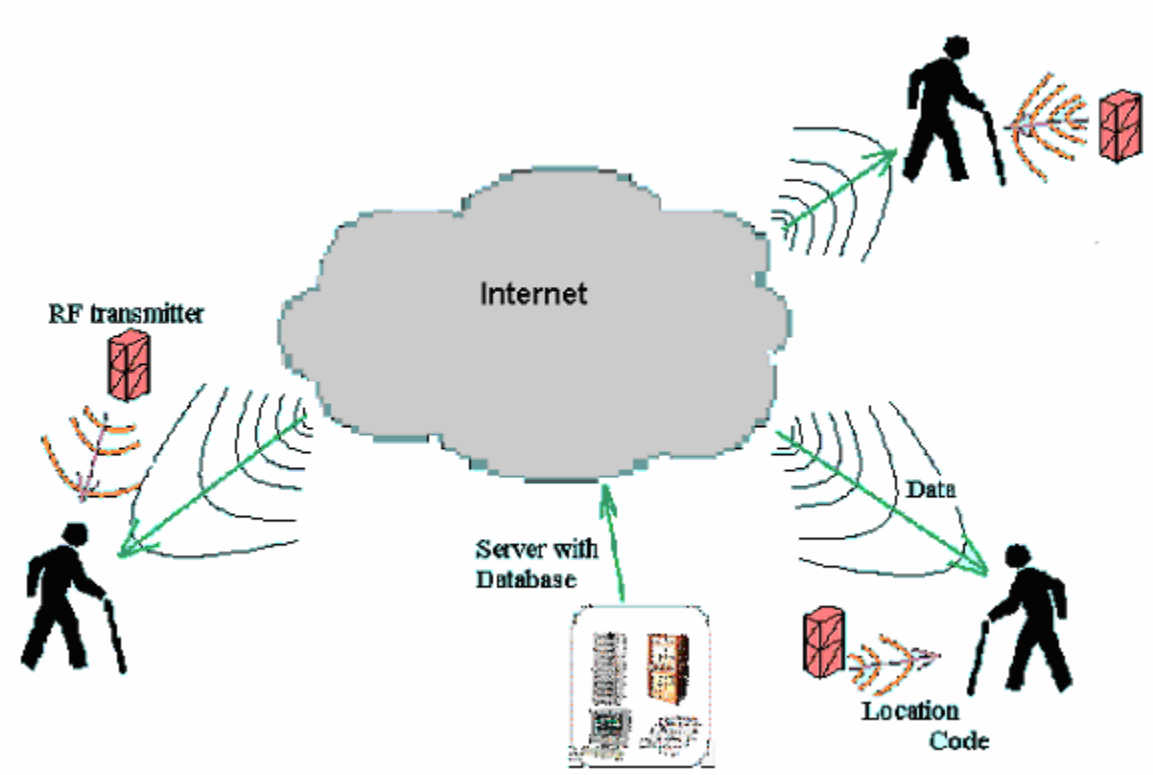


Figure 4.2 – Overview of Phase Two system

As a user approaches to a sign module, it receives the location code. The user module then connects to an online database over the internet and retrieves the directions specific to that code. The user module then determines the user orientation and calculates resultant the directions. These directions are again 'spoken' through a speaker/headphone.

4.2 User interface

In addition to the modification of the data storage technique, the user interface of the user module will be improved. Our research on the visually impaired people strongly suggested the need of hot keys for important locations such as washroom, information center and bus stops. A user can simply press a hot key and the user module would 'speak' the place of user's interest. Headphones and Braille subtitles will also be implemented in phase two.

5 Budget and Time Constraints

5.1 Budget

Table 5.1 shows the comparison between the proposed cost and actual spending:

Table 5.1 – Estimated versus actual cost

Required Materials	Estimated Costs	Actual Costs
Linx Technologies ES-series Evaluation Kit	$280	$260.30
Devantech CMPS03 Magnetic Compass	$100	$97.64
Devantech SP03 Text To Speech Synthesizer	$100	$97.64
PIC Microcontroller(s)	$120	$0.00
Discrete components	$50	$18.54
Prototype board(s)	$40	$20.00
Cables and wiring	$40	$0.00
Miscellaneous	$86.5	$101.12
Total	**$816.50**	**$595.24**

The actual costs above are tentative since we will be going to the WECC competition in Winnipeg, Manitoba. Additional costs will incur that may include transportation and extra discrete components that we need to integrate overall system onto the PCB.

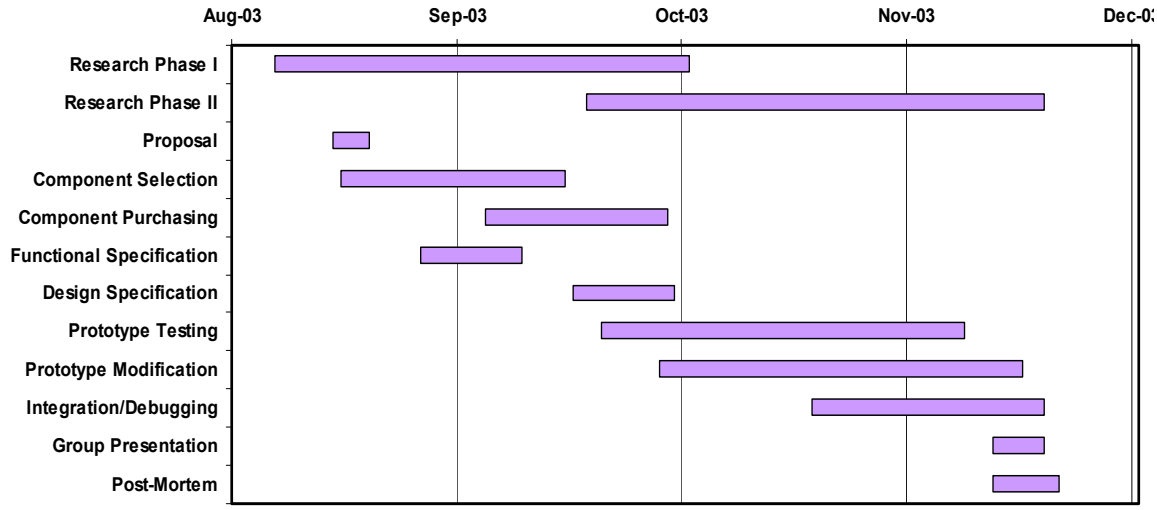
During the course of this project we were able to reduce costs on the microcontrollers, discrete components, prototyping boards, and cables and wirings. We were able to obtain free microcontroller samples from Microchip, prototype boards and discrete components from the generous donation of group members. The wiring and cables were obtained from the Engineering Science Lab.

In the future we plan to reduce additional costs by manufacturing our own RF or any wireless communications system without using the current evaluation kit. The costs on the digital compass and speech synthesizer can further be reduced if we manufacture them ourselves with discrete components.

5.2 Time

The final Gantt chart for the course of this project is shown below:

Table 5.2 – Gantt chart (in month)



The component selection and purchasing took more time than expected since certain modules required a careful consideration in terms of interface and overall functionality, especially the microcontroller, RF system, digital compass, and text-to-speech module.

The actual prototype design and implementation stages requires about twice as much time as we anticipated. This delay was mainly caused by underestimating the complexity of certain stages of the project, such as the RF system, overall integration.

Despite a few delays, we began integration of the entire system right on time and had the first successful prototype trial on December 2nd, 2003, one week ahead of our scheduled deadline. For the last week of the project, additional modifications have been taking place to increase the robustness of the device.

Due to exam conflicts, we were not able to continue for few days during the week of December 8th. But since we have already done a major part of our integration, we were able to finish it as scheduled and been able to demo on time at Wednesday, December 17, 2003.

6 Inter-personal and Technical Experiences

Farhan Ali

ENSC 340 gave me an opportunity to test out my leadership and organizational skills, as a result I have gained invaluable experience in team and resource management. Being the most experienced person in the group and the team leader, I had to divide the project up into several mini projects and distribute them to the team members according to each of their skill levels. Since the technology we used was new to all of them, there was a great deal of training and motivation involved in order to get people comfortable with what they were doing.

In managing this project I learned how to achieve a balance between accomplishments and learning. If I maximized learning then we probably would not have finished, and if accomplishments were maximized then only a few members of the team would learn anything.

For my own benefit and the good of my fellow team members, I approached the project management in a very industrial manner, setting different goals and standards for different members. I did this so that I could give my colleagues a taste of how things actually are when you work in an engineering firm.

Since I assigned projects of varying difficulty to the different team members, this obviously led to some group dynamic issues which I had to resolve in order to keep the group running at full strength.

On the technical side, I had my fingers in all the slices of the proverbial project 'pie'. After assigning a task to a team member, I would check the end result and then approve or disapprove the deliverable. Thus I was involved in some capacity in the design of basically all the circuits and firmware for the project

Last but not least, my interaction with the Visually Impaired community has given me an idea of how a bunch of seemingly useless technical things we learned at SFU could have such a profound effect on a large segment of our population.

Chris Chun

Even before this semester, I was looking forward to work on ENSC 340/305 with the team members since I worked many projects with most of the members and knew what to expect from them. We were able to save time from the beginning since we knew each other's strength, interest, and characteristics and assigned appropriate tasks to each member. For this project, we had to use knowledge gained from previous courses. I was little surprised since I thought some of those courses were totally irrelevant to other

courses. This project has helped me to tie many fields of engineering studies for the better understanding of engineering work.

In Phase One project, I contributed on RSSI, Schmitt Trigger, and other hardware design to establish stable signal reception. I also worked on writing codes for UART and parity error check although Nima did most of the work on this section and was responsible for the overall design of the sections. I also interviewed visually impaired people in VCC so that we can have better understanding of their needs and the real value of our project.

From this project, I have increased my knowledge of various RF technologies. Also I have learned and gained hand-on-experience with UART, I^2C, and RF module. I believe such knowledge will become useful for my thesis work and other future researches. At the end of phase I project, I was satisfied since I realized that my study in SFU has helped me to become a skillful engineer whose knowledge can be contributed to the society.

From my experience in ENSC 340/305 project, I felt group dynamics problems can be prevented if everyone knows how far the project is progressed and where the project is heading. Every member should be responsible for getting updated on the status of overall project so that they would not left alone in the middle of the project. To do so, members need to communicate regularly, be honest about what they think, and should not be afraid of asking what they do not know.

There was one incident when I had trouble with one of our team member. However, we were able to solve the conflict fast since both sides were trying to listen to each other and understood the importance of the project and team work.

Nima Jahedi

ENSC 340 was one of the most memorable and useful course that I have ever taken. I learned more than any other conventional “daily” classes. Researching about new technologies and the features of each gave me a good insight about wireless technologies, especially on Bluetooth, RF, ultrasound.

During the course of this project I was able to apply what I learned in school to both the design and implementation of an industrial equivalent project. I learned about different interface methods, such as I^2C, and UART. In addition, I also improved on my assembly programming skills. Now I have more confidence that I can finish a complex engineering project and be able to walk through difficulties and problems. I used the stuff I learned from in ENSC 425 in designing the Schmitt trigger and RRSI circuit. I was always very good at handling group work, and it is not until this project that I had to deal with new group dynamic problems. This course taught me how to peacefully coexist with other members of a project group.

After presenting our design to the professional audiences of ENSC 340 I was surprised at the enthusiastic responses from the audience. The encouragement and inputs from the audience allowed us to strive forward to the Phase II, and make the project better and more reliable. We hope by taking the idea and prototype to WECC competition we will obtain some positive feedbacks for additional future improvements.

Daniel Kim

Past sixteen weeks have been perhaps one of the most valuable periods of my life. I met great friends and had wonderful time with them. I learned many new technologies such as RF, Bluetooth and WLAN, and improved my programming and hardware skills.

I was mainly responsible for I^2C interface and data processing portion of the project. I set up I^2C interface for compass and text-to-speech synthesizer in partnership with Ted Liu. As for the data processing, Ted and I developed an algorithm for determining user's orientation and resultant direction. I was heavily involved in programming the PIC microcontroller.

In January 2004, Nima and I are presenting our project for Entrepreneurial design in West Engineering Conference and Competition (WECC). I believe this will be an excellent opportunity to present and promote our design to public.

Ted Liu

In the past sixteen weeks I had special privilege to work with my team members. During the course of this project I gained sights into how the entire design stage takes place in a project-oriented environment from foundation to the actual prototyping of the product. Furthermore, I learned how to effectively interact with team members and resolve problems as a whole.

In the course of this project, I was mainly responsible for the wireless communication, I^2C interface, and data processing portion of the project. In terms of wireless communication, I was responsible for the careful selection of the communications medium that best satisfy our project requirements. As for the I^2C interface and data processing I worked in partnership with Daniel Kim where we resolved many problems while devising and implementing the binary search algorithm for determining orientation of the user. Now and then, I also helped debugging both the software and hardware part of the project. I was also an active member of the group where I participated in the development stage of the overall *Dynamic Directional System*.

With respect to technical skills, I have learned how to program and integrate with PIC microcontroller, how the I^2C, USART, FSK RF communication works as a whole, how the process of project team documentation works, how to effectively communicate with group members and resolve any group dynamic issues.

Gelareh Parandian

Working on ENSC 340 project was one of the most enjoyable but challenging experiences of my school life. I was faced with both technical and timing challenges. As a matter of fact, I was the only female in the group, but I cannot ask for better group member. In terms of technical, I had to learn a lot about everything in this project. On the other hand, I am now more confident to think about an idea and make it actually working as well.

In this phase of the project I was responsible more in writing codes for the comparator and analog to digital modules of the PIC processor. Therefore I have improved my assembly language coding and also got familiar with PIC processors. At the same time, I gained a large amount of knowledge about UART, I^2C, RF, and other wireless communication technologies. In addition, I learned how to apply my previous knowledge from other courses to a big project.

Furthermore, working on this project gave a fair amount of satisfaction about my goal as an engineer. I have always wished that I could be somehow helpful and supportive to the people how are either seriously ill or disabled. This project was my first step toward my lifetime goal. I am greatly interested in Biomedical applications of engineering and I certainly believe that our project could be an enormous benefit to my future plans.

Overall, I am very pleased that the great effort we have put through this project has lead us to an excellent results. However, this achievement wouldn't be possible without the full support of the school including instructors and the TAs. I am grateful to work with this group and I hope we continue work on the second phase and participate in the future competitions.

7 Conclusion

Over the course of this semester the team at Sound Directions has gelled together to form a powerful design group. Together we have improved many of our skills namely collaborative work and assembly language programming. We have further improved our understanding of customer relations and user centric design. Through our interaction with the visually impaired community we have gained a sense of responsibility and purpose.

The future looks bright for Sound Directions, with upcoming appearances at WECC and possibly Solutions. Together we will continue to evolve our final product into a complete guidance system for the visually impaired.