May 16th, 2008

Prof. Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia.
V5A 1S6

Re: ENSC 440 Post-Mortem for the Wireless Item Label Locator (WILL)

Dear Prof. Leung:

The attached document from The Third Eye (TTE) outlines the implementation of our ENSC 440 project, Wireless Item Label Locator (WILL). WILL is an assistive device to guide the vision-impaired user to locate items. A remote will senses and audibly indicate the range and distance of the radio-frequency identification (RFID) tag attached to an item.

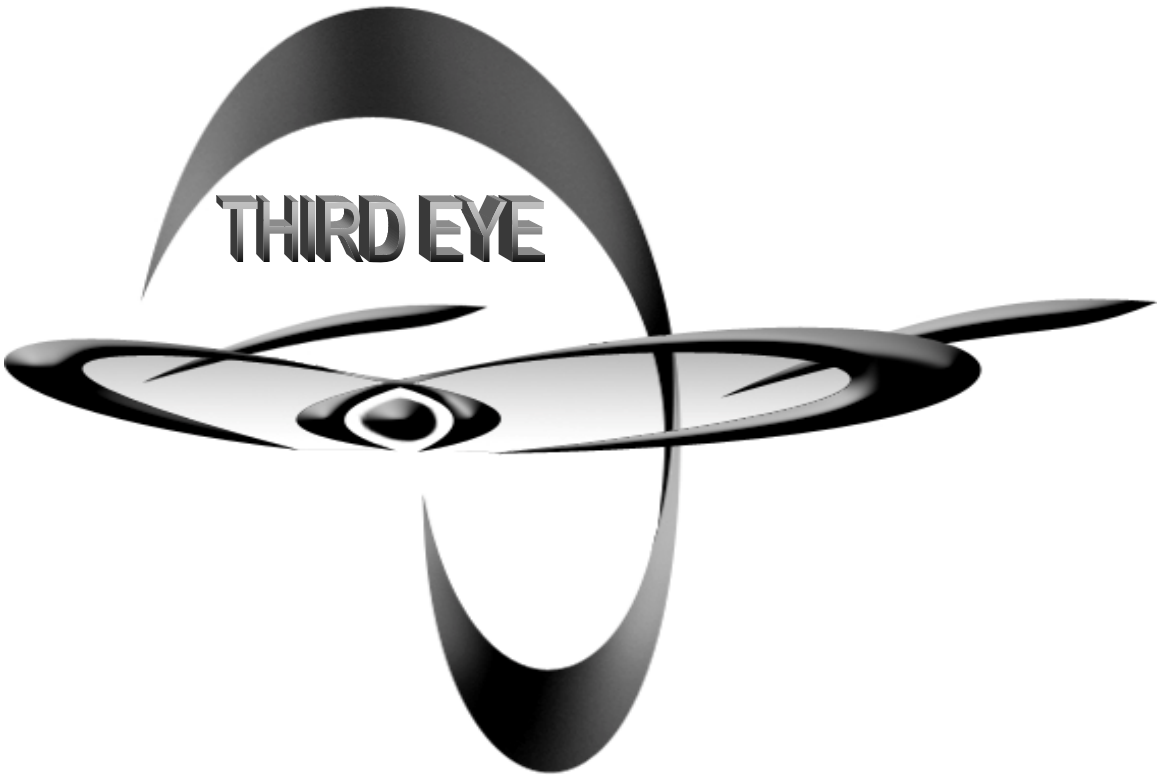
This document describes the current state of the device and deviation from our original design and plans. It also contains possible modifications in the future to make the product more market-ready. The project's timeline and budget are discussed, and we conclude the document with some thoughts and reflections on our experience working on this project as a team.

If you have any questions or comments, please feel free to contact us by email at ensc440-spring08-tte@sfu.ca or by phone at (778) 855-0457.

Sincerely,

Sieun Lee & Jieun Choi
The Third Eye Ltd.

Enclosure: ***Function Specification for a Wireless Item Labelled Locator***



THIRD EYE

POST-MORTEM FOR WIRELESS ITEM LABEL LOCATOR (WILL)

Project Team: Jieun Choi
Sieun Lee
Tongxin Feng
Contact Person: Sieun Lee
ensc440-spring08-tte@sfu.ca
Submitted to: Patrick Leung – ENSC 440
Steve Whitmore – ENSC 305
Brad Oldham
Jason Lee
Issued date: May 16th, 2008
Revision: 1.0

Table of Contents

1. Introduction

The idea of Wireless Item Label Locator, or WILL, was conceived from an everyday inconvenience – often having to search for keys, cell phones, and other easily misplaced items. We then realized this would be a far more difficult problem for those with vision loss. The need is particularly relevant considering our society with increasing life-expectancy and aging as the leading cause of vision

A simple and intuitive solution is to attach tags on these items which can be tracked with a wireless device like a remote controller. Market research revealed that existing products all employed active tags, which have short battery life. Our goal in this project was to design and build a system with the visually-impaired in mind, employing passive tags without the unnecessary LCD screen which also would require a more complicated processor.

2. How System Works

The user interface of WILL is simple: it consists of a power button, item buttons, and a buzzer. The user turns on the system and presses an item button. The remote searches in the direction it points to for the tag corresponding to the button. When the tag is located, the remote beeps, and as the user moves closer to the tag, the beeping frequency increases. In such a way, the user can tell the direction and approximate relative range of the tag.

Inside the remote is a micro-controller, RFID reader, and an antenna. When a button's pressed, the micro-controller identifies it, and commands the RFID reader to search for the tag. When the search signal from the antenna (connected to the reader) reaches a tag, the tag is powered up and sends back its own protocol back. The reader receives it, and the micro-controller compares it to the pressed button. When it is the correct tag, the micro-controller will activate the buzzer. When it is not the correct tag, the reader will continue searching. The reader is configured such that it would continue to receive the pulse of protocol from the correct. This causes 'beeping', and the closer the tag is, higher the frequency the reader receives the tag's signal.

Figure 1 illustrates above description.

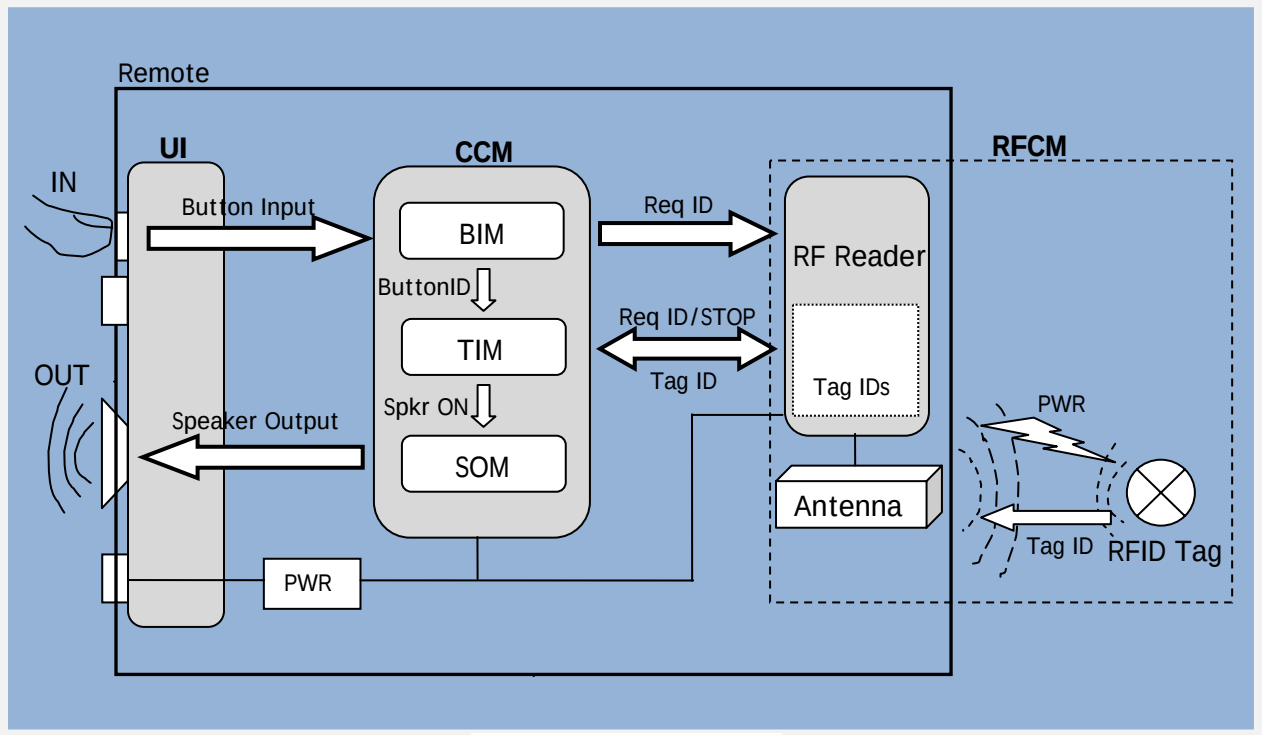


Figure 1. System Overview

3. Problems

3.1 Unavailability (or non-existence) of parts

We had many problems trying to find the right RFID modules which can detect long range (at least 1 meter) and portable size. Before we wrote the project proposal we did not had enough research about the actual product we can use and access. We based on academic researches and other people's research and assumed that we were able to find it. However, for most of the UHF RFID products are for commercial uses. We have contacted all the companies we found. Most of them asked us to contact their RFID licensed consultant and they mentioned their consultant will provide advice for the business usage of RFID especially inventory management.

3.2 Responses from manufactures

Skyetek, the company which manufactured our RFID reader and tags, did not provide us with all the information. First of all, there was the antenna with which there was no radiation pattern diagram. The diagram is the bare minimum to understand the behaviour of the antenna, especially when it is encased in a black box. Skyetek refused to give us neither the radiation pattern nor any schematic for the PCB antenna. For a while, I had to only guess what type of antenna it was, until an expert was able to look at it tell us it was a monopole antenna.

Same happened with the RFID reader interface board, which did not come with any schematic and left us guessing which line led to which.

At least Skyetek answered our emails. Many companies did not reply to our emails or phone messages seeking for more information regarding their products.

3.3 Time and human resource shortage

Our team had three people. We started as a team on January 15th. Two of us were taking more than two or more courses outside of ENSC 440.

3.4 The one month of many, many wrong paths

Another problem is connecting RFID reader module and the user interface. Our original plan to use reader module's I/O pin was not possible because we could not find any document or tool about how to program Skyetek reader module. We contacted the Skyetek and they said we cannot program it. We started brainstorming and decided to use microcontroller to connect user interface by sending the protocol. However one of the member said it was impossible but the other member thought it should be possible and ask for help to professors and confirmed it can be done by using UART signals. And we have to start studying UART signal and implementing it. And the current program still has a critical bug for one tag type 18000-B. however it works with other tag types.

4. Comparison of the estimated and actual

4.1 Budget

For RFID extra modules, we are trying to return the last one which we only used it for few hours, so our actual cost might reduce to around $ 2000. We are 4 times over the estimated cost due to RFID development kit. Our plan was to buy RFID module only however, after searching for parts, we realize that RFID modules are very expensive and Skyeteck M9 module is the only one that meets our requirement. The module itself was only $303 dollars however; we bought development kit because we wanted to speed up our project progress. Development kit gives us all the tools which allow us to

understand the RFID more deeply in short time. However, development kit is not essential hardware for our project and we could just use RFID module only but it was going to delay our project progress. We chose to spend more money than our plan and speed up our project.

Table 1: Budget

Component		Actual Cost	Estimated Cost
RFID	**RFID Development Kit**	**1706.69**	**150**
	RFID extra modules	**606**	0
Microcontroller	**AVR Starter Kit and chips**	**180**	**200**
Electronics	**Switch**	**10**	**100**
	Cables and others	**60**	**0**
Miscellaneous	**Phone calls and etc**	**5**	**200**
Total		**2577.69**	**650**

Table 2: Funding

Funding	Amount
Departmental Funding	**50**
Engineering Science Student Endowment Fund	**335**
Total	**385**

4.2 Timeline

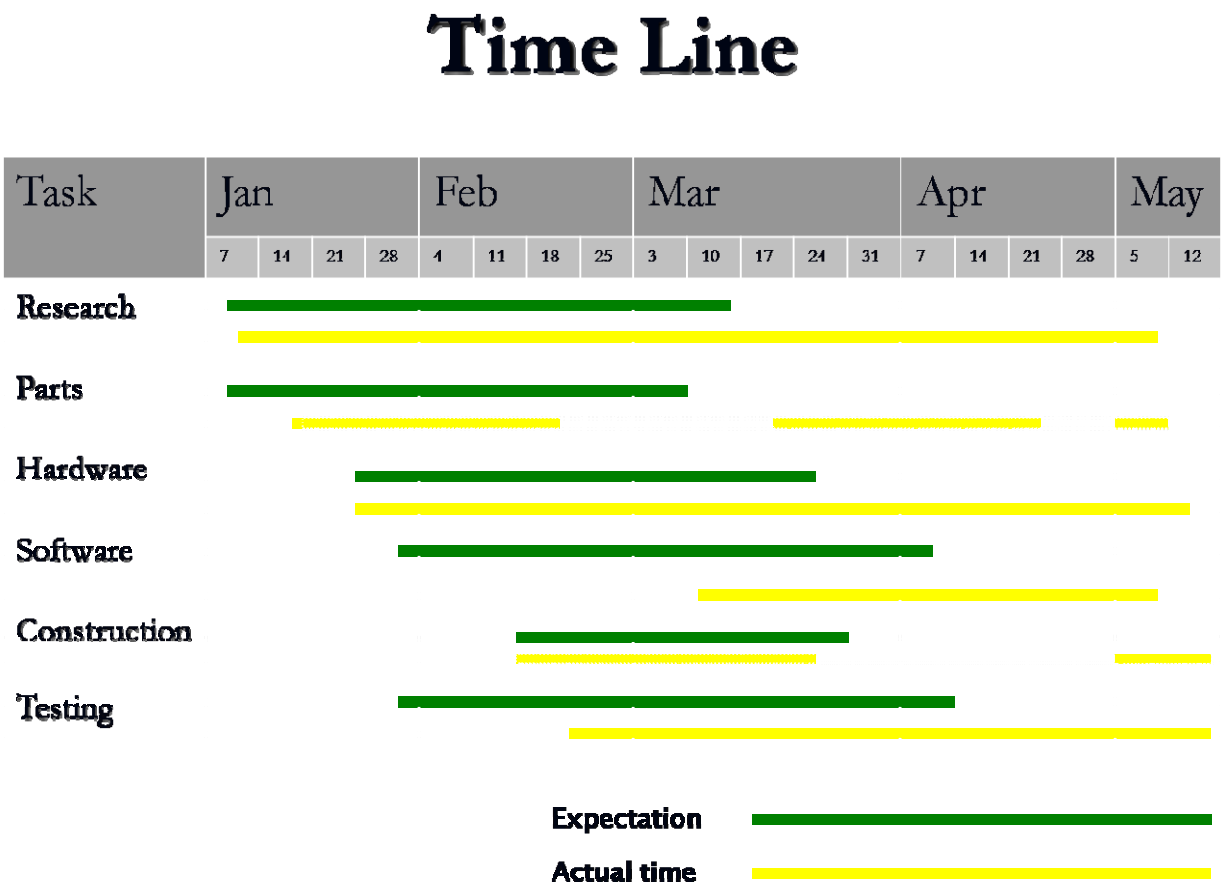


Figure 2: Time line

Our schedule was delayed because of two main reasons. First, we spent extra two weeks trying to find the right RFID product which meets our categories. When we wrote the project proposal we were based on academic research, so we were not aware that they are not many products that meet our requirements on the market. Second, we had problem connecting user interface module and RFID reader module. Our original plan was to program RFID module using its general I/O pins however, Skyeteck confirmed that we cannot program the reader module itself. And we start research again how to connect two modules and decided to use microcontroller to connect user interface and reader module. It caused two weeks delay. And having trouble to implement this method caused another three weeks delay in our schedule.

5. Group dynamics

Attached in the back

6. What we would do differently

I will try to find out the common approach to engineering project. We were very naïve thinking if we can find a solution by actually taking baby steps. However, understanding the level of technical skills we have and knowing what other people have accomplished in their projects and what problems they had, we could have chosen our project and also the methodology more careful, so we can make our project suitable for our prototype and also our level of skills.

For team dynamic, I would definitely talk to supervisors as soon as it is out of my hand. When the other two members did not want to talk to professors, I should have talk to them even if the other two did not want to because I already knew that I was not able to work with that member if we did not resolve this. And it was not something I could just ignore or can be solved by just being nice to that member. Not having a good team dynamic distracted us to work on the project and brought down our project accomplishment.

7. Contributions & What was learned

Jieun Choi

I was responsible for finding RFID modules and study it. I searched all the products on few electronics online shops and read their manual and selected the candidates for our project and record them in our data sheet. I also looked for buttons and speakers and did the same procedure as finding RFID modules. After we chose our product, I read their manuals and documents and contacted Skyetek company for resources. I studied their protocol and tag type to find which function and their protocol is suitable for our project.

Another contribution I made is to connect reader module and user interface module. I ran into so many problems how to do it. I used resources such as avrfreaks site and building robots tutorial sites. It was very useful because these people are doing their own project and explain what kind of problem they had and how they solved it or suggested alternate ways. I got very motivated after I read their projects and found it very interesting. After I studied their posted tutorials, I was able to find and choose the proper technical method for our project. And I implemented the code on the microcontroller to send and receive the protocols from the reader.

I also worked on user interface module. I programmed the microcontroller to accept user input and respond with LED and buzzer. I built the circuit for buttons, LED, and buzzer. My circuit is only for

temporary testing and actual circuit design has not been done yet. I did not have chance to review my electronic circuit knowledge but I learned it is very important to review the basics to make simple project.

Sieun Lee

My main contribution to the team was the antenna - research, modification, design and implementation of the performance test, and analysis and presentation of the test result.
Since an antenna is a graduate-level topic, I initially knew very little about it. I researched and studied, and met with my old professors to ask for advice. I attended an event held by IEEE to get the antenna characterized.
With the original antenna our product would have been not very useful because of its short range (less than a meter) when the antenna and the tag were not aligned. My modification doubled the reading range, the maximum being from 3 meters to more than 6 meters. Now even when the antenna and tag are completely out of phase with each other, the reading range would still be greater than 2 meters, exceeding our initial goal. I think this improvement was an essential step for the completeness of our project.

The second major contribution I made to the team is market and user research which determined the direction and goal of this project. I collected data of existing products and analyzed them, justifying our project and providing strong motivations. Researching user responses to these products made me realized that the tag battery life was the biggest source of complaint, and that passive tags should be the main feature of our product.
I researched on vision-disability in North America, and learned : I) the majority of people with vision-impairment has some sense of sight – only 10% are completely blind. For the rest, bright lights, strong color contrast, or even very large letters can be very helpful. ii) The leading cause of vision-loss in Canada is age-related Macular Degeneration, and aging often accompanies loss of memory and hearing. The first further justifies our motivation. I have used these as the basis of our user interface design – portable but not overly small remote, large color-coded buttons with space for large labelling, addition of backlight to the buttons, and a buzzer that has clear and loud sound

Thirdly, I managed the documentations of the team. I planed the document and handed out outlines. I wrote the cover letters, executive summaries, introductions, and conclusions, in addition to my portion in the content of the documents. I revised and edited other members' writing and organized the material for better logical flow.

For the final prototype, I constructed the power supply unit and power delay unit. I also assisted Jieun while she was trying to solve her problem for a month. I measured signals in and out from the reader and microcontroller and worked with wire and cable connections. In my wrong path, I designed and built a non-inverting summer-amplifier to add an offset and amplify the microcontroller signal. I also helped

Jieun in research for writing her code. I also did parts research with my team members in the beginning stage of the project. I compiled a list of many international vendors and contacted them all.

This was the biggest engineering project that I had a significant role in, and I learned a lot. I learned to deal with people in my team, and also how things never happen as you expect. I learned to make back-up plans and to know when to stop dragging on what clearly will not work. I learned to do my homework thoroughly before jumping into anything. I learned a lot about antennas and wave propagation, people with vision-loss, and simple programming using AVR. I could hone my skills in hardware while building the power unit, and review my circuit courses.

8. Future Plans & Recommendation

Current software has to be fixed for one type of tag, 18000-B. Currently it detects all the 18000-B tag regarding its tag ID. However, other tag type, it is able to detect only one tag ID.

Very detailed version of full testing is required to find more bugs

More sophisticated error handling is required and some extra function can be added to let user know when power is on and off using speaker or buzzer sound.

- More polished hardware

The buzzer sound is not big enough and therefore need to use different buzzer and different programming for the different frequency.

LED is not bright enough for vision impaired people.

User interface circuit design is not fully done.

Our casing is not done.

We would design and build our own, better and smaller antenna to suit our application.