ABSTRACT

A mobile robot has an ability to perform autonomous navigation in indoor environment when some information based on their current location was acquired. In order to perform navigation, the cricket indoor location system consists of transmitter and receiver was used in this project. This proposal describes how to integrate the cricket indoor location system with the mobile robot based on the current location from reference point. By using hardware/software design methodology, this project development was divided into two processes which are hardware design process and software design process. This project based on the embedded microcontroller, PIC located on the mobile robot process a signal from cricket indoor location system to perform the autonomous navigation. An event driven programming was used to ensure the correct event was executed based on input from sensor. Cricket indoor location system is a system that consists of several beacons and listeners to operate. As a conclusion, this proposal will demonstrate that integrated PIC and mobile robot, Stingray communicate with the cricket system to perform autonomous navigation.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious, the Most Merciful. Praise to Him the Almighty that in his will and given strength, had I managed to complete my final year project.

First and foremost, I would like to express my appreciation to the parents a lot to contribute and help in finance and advice throughout the training. Not forgetting the many family members who also give advice either directly or indirectly.

Not forgetting, I would like to express my appreciation to the project supervisor, Mr Abu Bakar Sayuti B. Hj Mohd Saman, who had support, guide and encourage me to successfully complete this project. He always expects for high quality works and this project is no exception. He continuously challenges me to learn new things and come out with new ideas in order to produce a high quality project.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Application of robotic covers many areas such as design, construction, operation, structural disposition, manufacture and integrating of digital system for control, sensor, and information gathering. During the 20th century, the research in robotics fields have run into advance level which discover the variety of functionality and potential uses of robots.

Currently, the focus on mobile robot was a great deal in the current research as many major universities provided specific lab for mobile robot development. Mobile robots that perform autonomous navigation in indoor environment required some information about its current location and how to perform various operations along the way. Localization technique deal with the information identifying the robot's position is calculated by one or more means, using indoor location system [1].

Cricket indoor location system provides a platform to perform navigation at indoor environment. The location system was calculated using distance measurement techniques by measuring the distances from a current location to a given reference point [2].

1.2 Problems Statement

Applications based on indoor localization system can provide many benefits for human life. Such system can be applied in mobilizing such as tracking of people and objects inside building or similar enclosed environment. One specific example is an application that can be used to evacuate immobile patients in hospital during emergency such as fire, earthquake or other disasters. Often, when fire breaks out, power is cut, the main lights are off and the building is filled with smoke, making visibility very poor. In this case, for safe quick evacuation, a navigation system that does not rely on visual will be very useful.

For mobile robots to perform autonomous navigation in indoor environment, a system should be developing to provide a path for robot to navigate from starting point until end point. The cricket indoor location system can be implementing for a mobile robot to perform such autonomous navigation.

1.3 Objective

Objective of this project is to demonstrate indoor navigation based on cricket indoor location system. A mobile robot will be used to perform the navigation using suitable algorithm to be developed later.

1.4 Scope of Study

The study of this project will cover a mobile robot navigate using cricket indoor location system and the algorithm to be developed later. The cricket indoor location system will provide a communication between a listener on mobile robot with the beacons at different point. The information from listener will be used for calculation using algorithm that developed using C programming.

CHAPTER 2
LITERATURE REVIEW

2.1 Cricket Indoor Location System

Cricket indoor location system was developed by MIT in order to be used in indoor environment. The hardware that used contain of a Radio Frequency (RF) transceiver, a microcontroller and other hardware used for transmit and receiving ultrasonic signals and interfacing with a host device [7].

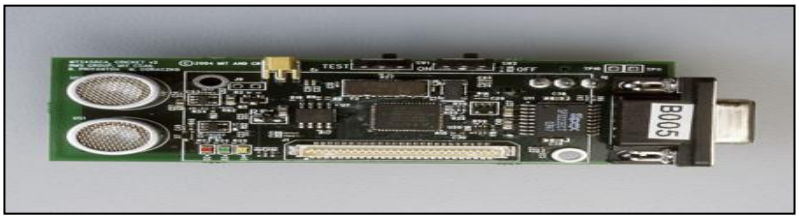

Figure 1 Cricket Hardware Unit

The cricket indoor location system consists of two parts which are listener and transmitter. The transmitter which is beacon was periodically transmitting RF message that contain current location information. Along with the RF signal, the beacons also transmit an ultrasonic pulse. On the other side, the listener will receive the message and used it to calculate the distances to nearby beacons and their own locations. However, the algorithm that was developed to manage the beacon scheduling algorithms and listener filtering algorithms [2].

Besides that, one of the Distance Measurement Techniques called Time-Difference-of-Arrival (TDOA) was widely usee to calculate the location. The two different signals with different speed which are Va and Vb, was transmitted from one point to one point. Assume Va>Vb, the formula that used to calculate the distance as below:

There are three simple algorithms for listener that can be used to calculate the beacon's position which is majority, minmean and minmode. Among these algorithms, the minmode is very reliable for listener to calculate distance among the beacons and determine the closest one. Using the minmode algorithm, the listener will have some value based on the mode of the distribution for each beacons, then the beacons that have the lowest value between all the modes will be defines as the closest one. For the majority algorithm, listener will evaluate the signal that has higher frequency was send by nearest beacon [3].

Based on the experiment that was conducted by MIT Laboratory for Computer Science, this method was not give accurate location of beacon and the listener will have wrong decision for the nearest beacon [3]. Besides that, using the minmean algorithm, set of data location from each beacon will be recorded in the data set and this data set will be used to calculate the mean for each beacons. The beacon that have minimum mean will be choose as the closest one but these algorithms will be interfered by multipath effect thus the mean that was choosen may not give the actual nearest beacon. Below is the statistical graph that shows the listeners performance for each algorithm [3].

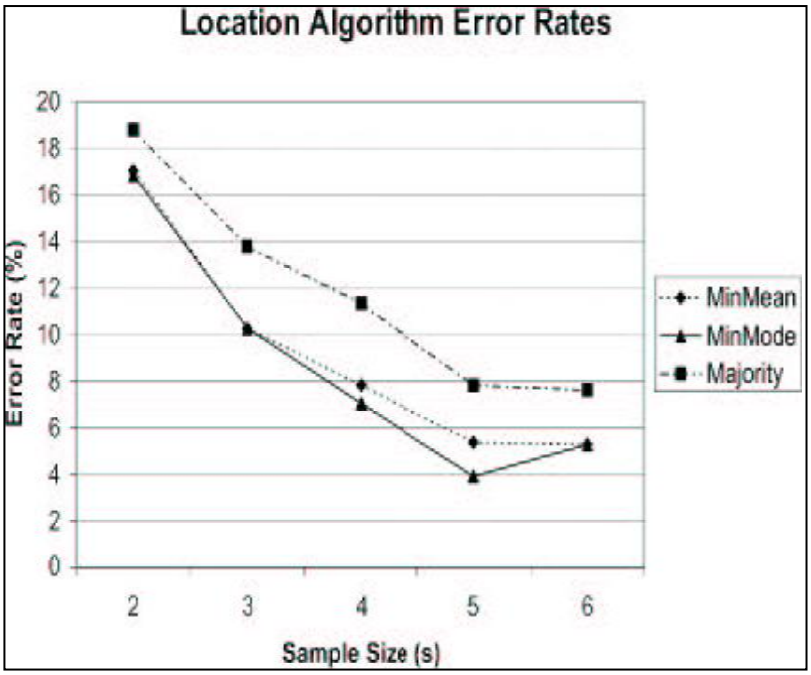

Figure 2 Error Rate for Different Algorithm

Furthermore, beacon positioning and configuration must be considered as important matter. This because the wrong beacon positioning and configuration will give a listener false space identifier. To overcome this problem, the researcher has found the easy and effective solution which is two beacons or more must be place at fixed distance from the virtual or physical boundary location. The diagram below can give a clear explanation how to make a proper beacon positioning and configuration.

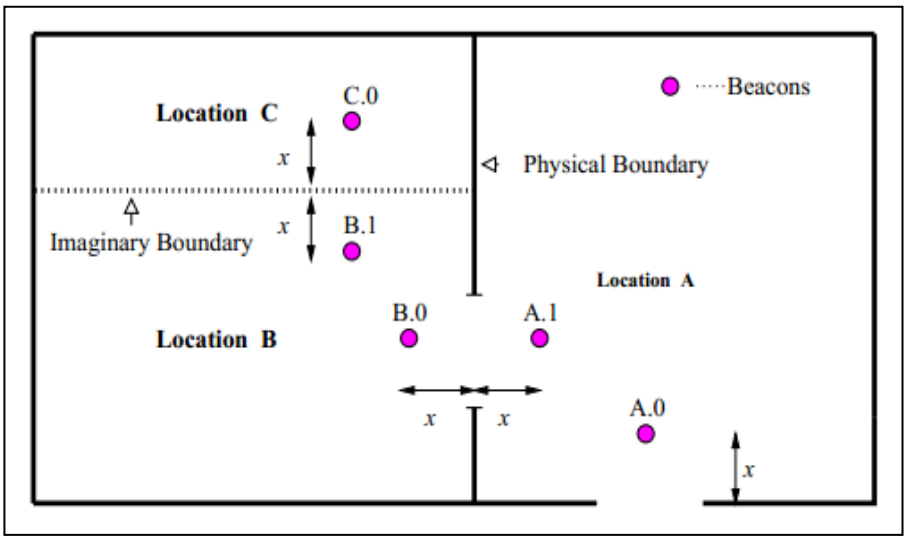

Figure 3 Correct Beacon Position

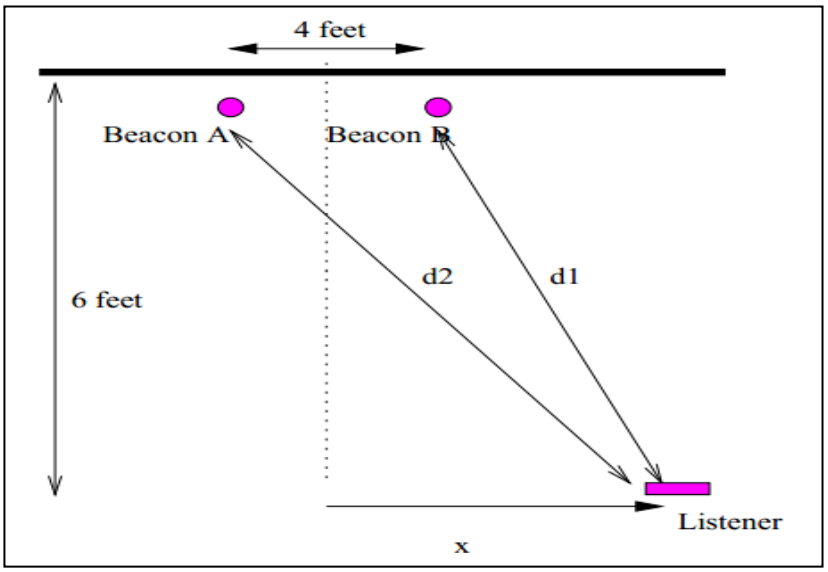

Figure 4 Boundary Performance

2.2 PIC 16F877 MCU

PIC was stand for Peripheral Interface Controller. It was a group of RISC microcontrollers that made by Microchip Technology. Basically it contains three main elements which are input and output devices, a processor and memory. The PIC 16F877 has three memory blocks and the Data Memory have a separate bus with the Program Memory in order to ensure the memory block can be access. Besides that, this PIC has a 13-bit program counter which is capable of addressing 8k x14 words of Flash program memory. PIC 16F877 also have several configuration need to be setting before main program download such as clock options, watchdog, power-up, brown-out timers, low-voltage programming, code protection and in-circuit debug mode. [4]

2.4 MPLAB Integrated Development Environment (IDE)

MPLAB IDE is a application that runs on the operating system to develop an applications for Microchip microcontrollers and digital signal controller. The IDE was provides a complete set of integrated environment that need by developer doing code development for embedded microcontroller. Basically, MPLAB IDE was consisting of several built-in components which are project manager, editor, language tools, debugger and execution engines. Besides that, MPLAB IDE also supported third party tools such as CCS Language Tools, Hi-TECH Language Tools, IAR Language Tools, and microEngineering Labs Language Tools. [5]

CHAPTER 3
METHODOLOGY

3.1 Flow Chart

During initial project, two flow charts which are final year project and project activities flow chart. These flow charts have been prepared to ensure the project can be done on time.

3.1.1 Final Year Project Flow Chart

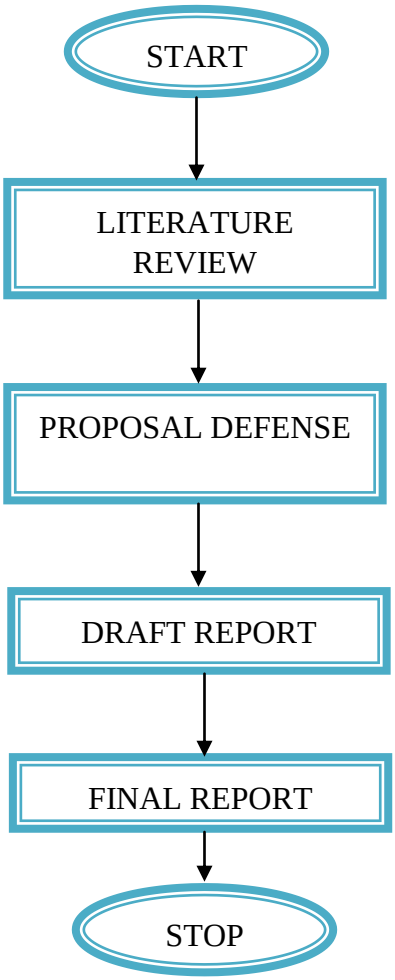

Figure 5: Final Year Project Flow Chart

3.1.2 Project Activities Flow Chart

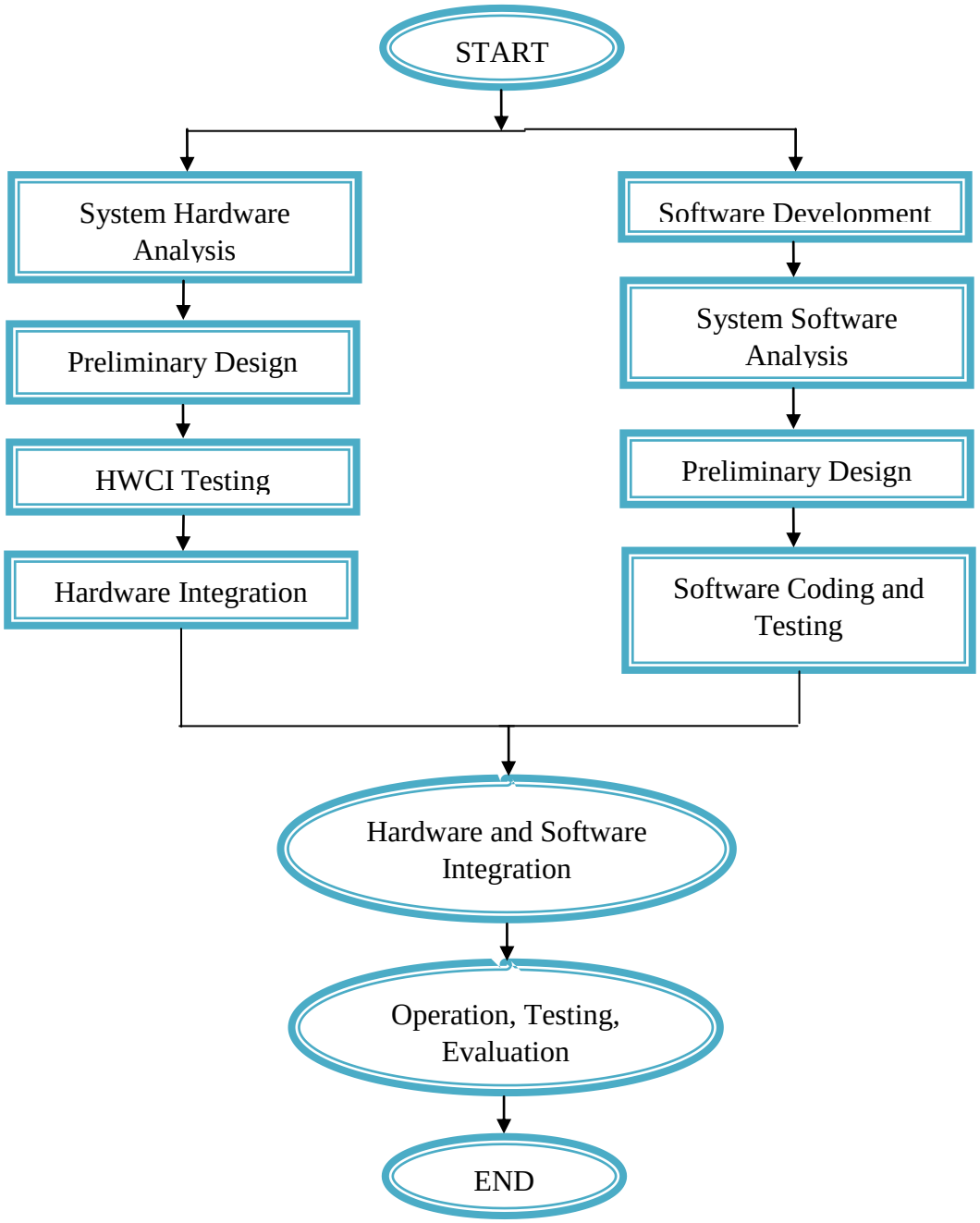

Figure 6: Project Activities Flow Chart

3.2 Project Methodology

Methodology for my project was based on a current model for hardware/software design process. Based on this model, my project task will be divided into separate group which are hardware design process and software design process. This is important because to ensure this co design process can improve my project quality, reduce cost and also reduce design cycle time.

System Hardware Analysis: In this part, the hardware that need for build my project must be taking into consideration. The analysis of system must be done accurately to ensure there are no hardware compatible issues. My project will be used hardware such as stingray mobile robot, cricket indoor location system, PIC 16F877, sk40c development board and USB to UART converter.

Preliminary Design: In preliminary design, the design that will be used to implement the system requirement was created. In this part, the function of each hardware will be map out to ensure hardware can perform function based on the requirement. For example, the stingray robot was able to make movement when the power supply. Besides that, the PIC 16F877 was able to fetch 8-bit instruction from memory [9].

HWCI Testing: In hardware development process, the HWCI must be conducted after system hardware analysis and preliminary design was done. In this process, the hardware will be testing to ensure they are in good condition thus able to function in the system. For example, the LED code will be download into PIC 16F877 to control the LED blinking using sk40c development board.

Hardware Integration: In this phase, the testing between two or more hardware will be conducted. A mobile robot called stingray will be integrated with the cricket indoor location system to perform autonomous navigation. A receiver will be installed with the mobile robot to communicate with the beacons at several locations [8].

System Software Analysis: In the system software analysis, the software that required for this project will be defined and analyzed. This software will be used to control the function of electronic part in this project. For example, MPLAB IDE software from Microchip technology will be used for writing, compiling, debugging, and programming the coding for hardware.

Preliminary Design: For this phase, the functionality of software will be testing to ensure the coding can be programmed into the hardware. At this time, the MPLAB IDE has been tested run on computer and doing compilation and simulation.

Software Coding and Testing: There are many available languages that can be used for coding. In this project, C language programming was selected for coding because it's one of famous language that was used to program software. Besides that, C also supported by embedded system and memory size of microcontroller was increased. Furthermore, the understanding on finite state machine must be taken into consideration in order to develop algorithm based on event-driven programming. For the testing, the coding was compiled first and download into PIC 16F877. This coding contain instruction for PIC 16F877 to doing specific operation. [6]

Hardware and Software Integration: At this phase, the hardware development and software development will be combined into one. The hardware will be integrated with the software to produce the final result. As example, during this phase, the C coding contain bunch of instruction will be downloaded into PIC 16F877 and will be use by mobile robot for autonomous navigation.

Operation, Testing and Evaluation: The final development was operation, testing and evaluation. In this part, the mobile robot will do autonomous navigation in indoor environment. The mobile robot will be test to perform autonomous navigation based on the signal that transmitted by beacons at referenced point. The mobile robot will be evaluated whether it can perform autonomous navigation or not. If not, some troubleshoot will be conducted to ensure that mobile robot can function as required.

3.3 Project Activities Progress

3.3.1 What have been done

Based on my project gantt chart, there are several experiments during semester. Below are the details about my project activities progress:

- **Testing output using LED**. At this stage, the PIC 16F877 was loaded with the C programming language to give an output using several LED.
- **Testing the function of SK40C board using PIC kit2**. At this stage, the experiment was done to store the code into the PIC 16F877 using PIC Kit2 hardware and MPLab IDE. The correct pin output of SK40C must be identifying to ensure the correct assignment of pin during the experiment. The correct voltage for SK40C board also be identified which is around 7-12V.
- **C Programming Language for PIC 16F877.** At this stage, the example C programming language that was developed by other party to be program into PIC 16F877 was been study to understand how it work from top until bottom.
- **Learn using MPLab IDE**. At this stage, all the function of the compiler, debugger, programmer, stop watch, and other tools have been study and testing. The entire tool was bundled with the MPLab IDE to provide the suitable environment for developing PIC coding.
- **Display output on LCD**. At this stage, the LCD needs to be attached to the SK40C board by soldering the LCD pin on the SK40C board. After that, the C programming language for given LCD output display will be compile and run onto PIC 16F877.
- **Data display using HyperTerminal**

  At this stage, the data from the cricket unit/listener will be display using hyper terminal program in Window XP. The HyperTerminal was set bit per seconds to 115200, data bits to 8, the parity to none, the stop bits to 1, the flow control to Xon/Xoff. From this terminal, the data which are contain about the beacons information such as distance to beacon (DB), duration (DR), the uncorrected time of flight (TM), system time (TS) and others based on the configuration of the listener.

- **Data display using cricketd**

  At this stage, the data from the cricket unit/listener will be display using cricketd in Cygwin environment. This is the alternative way besides using hyper terminal to display data from listener. The cricketd is the software that available from website under MIT. [7] All the configuration can be setting using commands that available in the cricket v2 user manual.[7] The cricketd was enable using command ‘./cricketd.exe’ in Cygwin environment. After that, the telnet program was used to establish connection with cricketd program. The address was used to connect is localhost at port 2947. The ‘r’ key was press for enable/disable data flow from cricket unit to command prompt.

- **Distance measurement using Cricket**

  At this stage, the direct and triangle distance measurement was conducted. The direct distance measurement was conducted using one beacon and one listener. The sensor of the beacon was facing directly with the sensor of the listener at certain distances. For the triangle distance measurement, two separated beacons were mounted on the floor at certain distance. The distance between listener and beacon was calculated at three different points and the result was display at the HyperTerminal.

3.3.2 Result

1. Testing output using LED

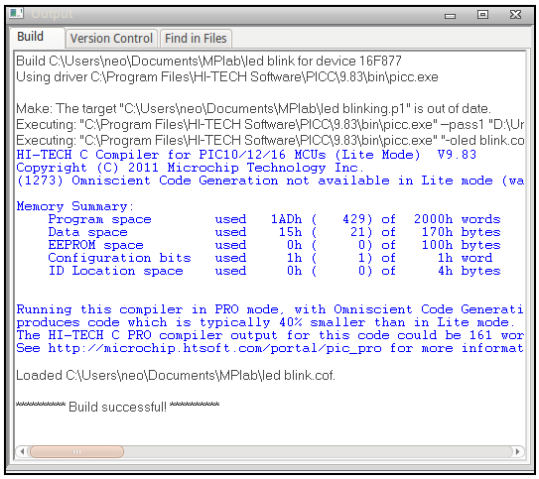

Figure 7: Compilation of LED Blinking Coding

2. Testing the function of SK40C board using PICkit2

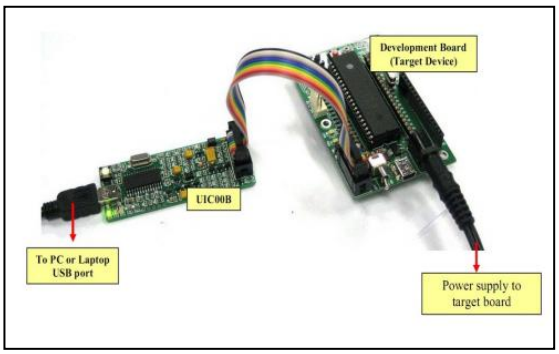

Figure 8: SK40C and PICkit2 Connection

3. C Programming Language for PIC 16F877

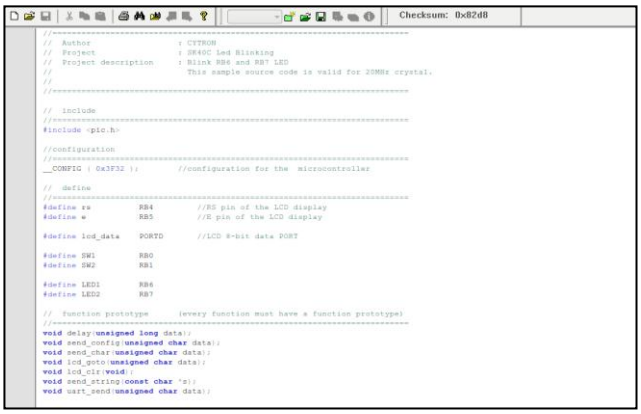

Figure 9: Part of C Programming Coding

4. Learn using MPLab IDE

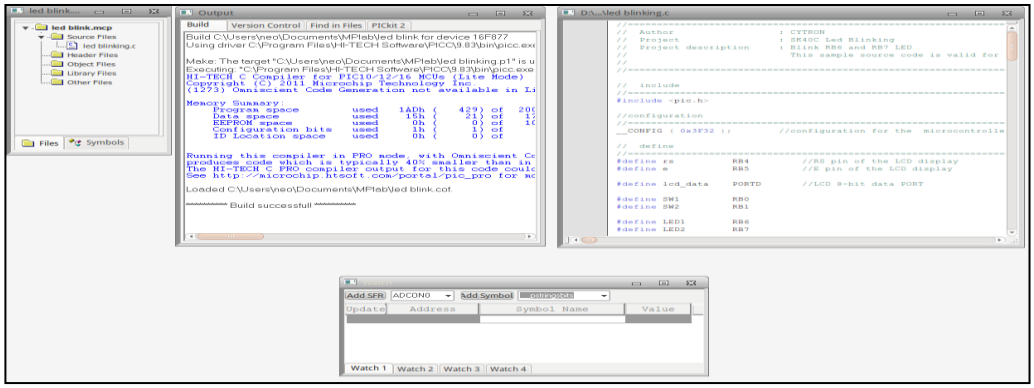

Figure 10: MPLab IDE Tools

5. Display output on LCD

Figure 11: LCD Display

6. Data display using HyperTerminal

Figure 12: Connect Using Port COM1

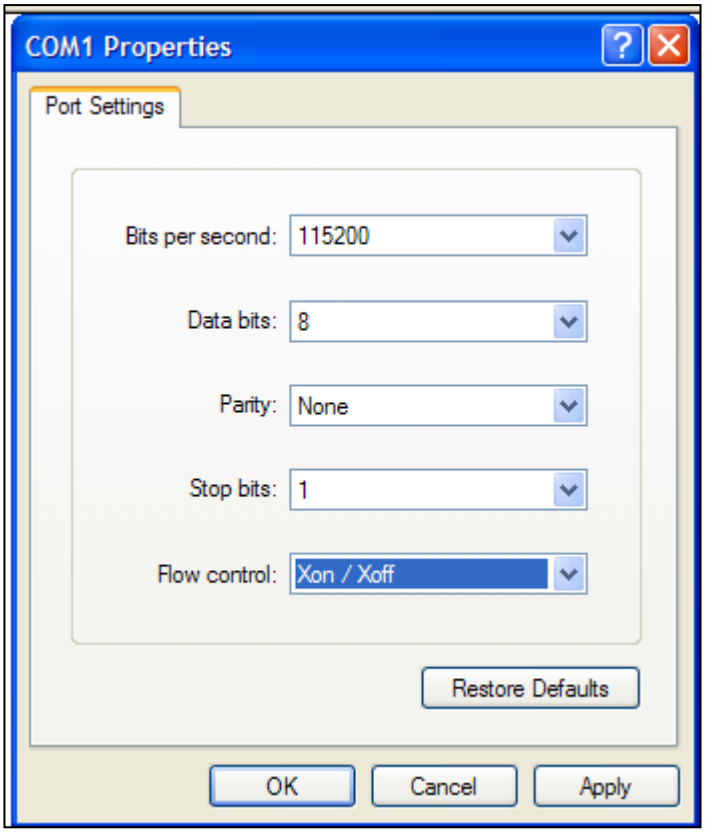

Figure 13: COM1 Setting

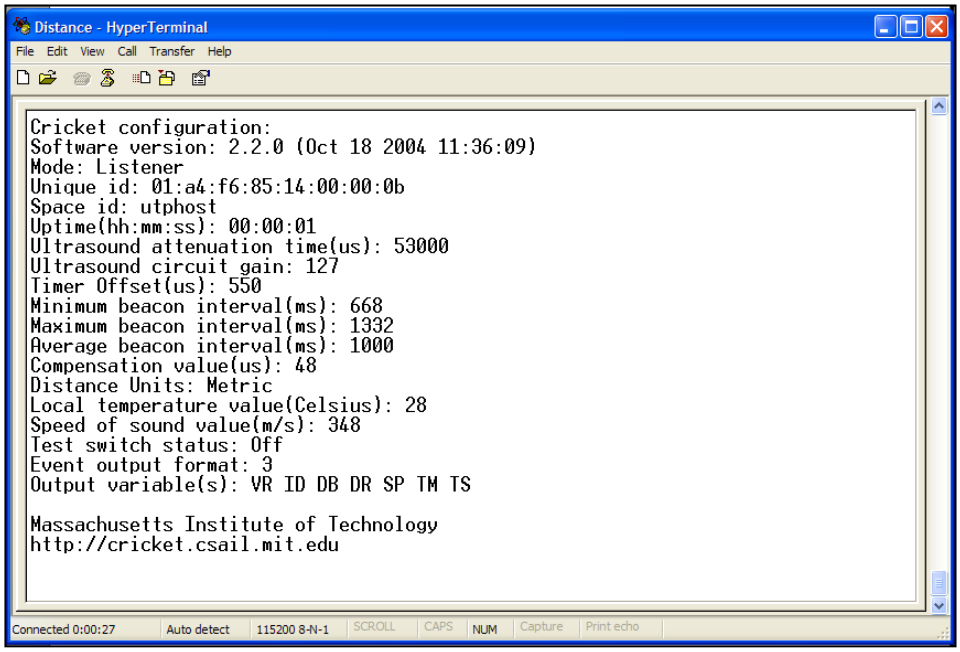

Figure 14: Cricket Configuration

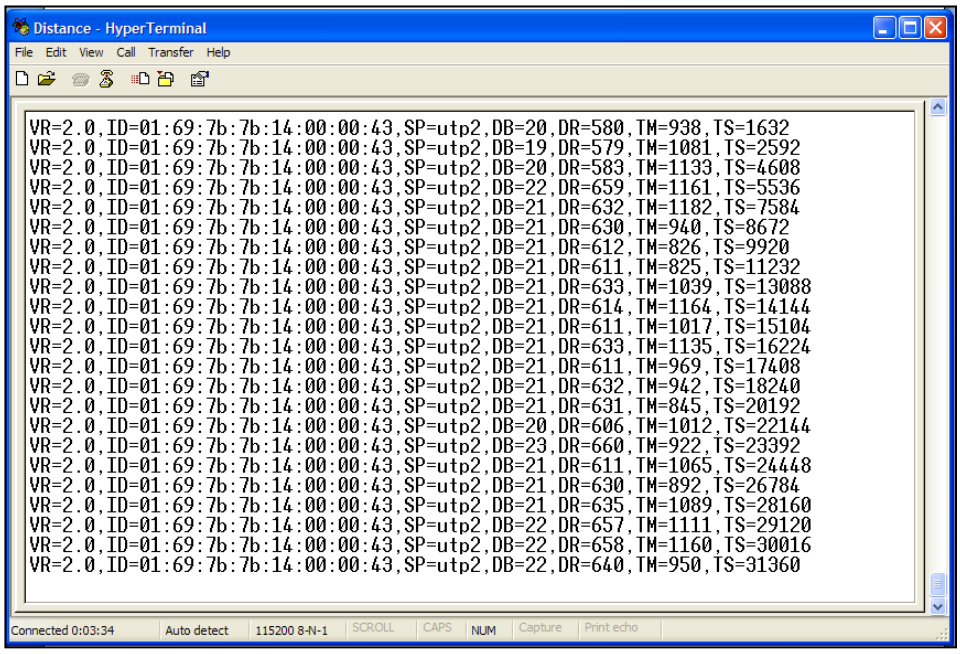

Figure 15: Cricket Data Display using HyperTerminal

7. Data Display using CricketD

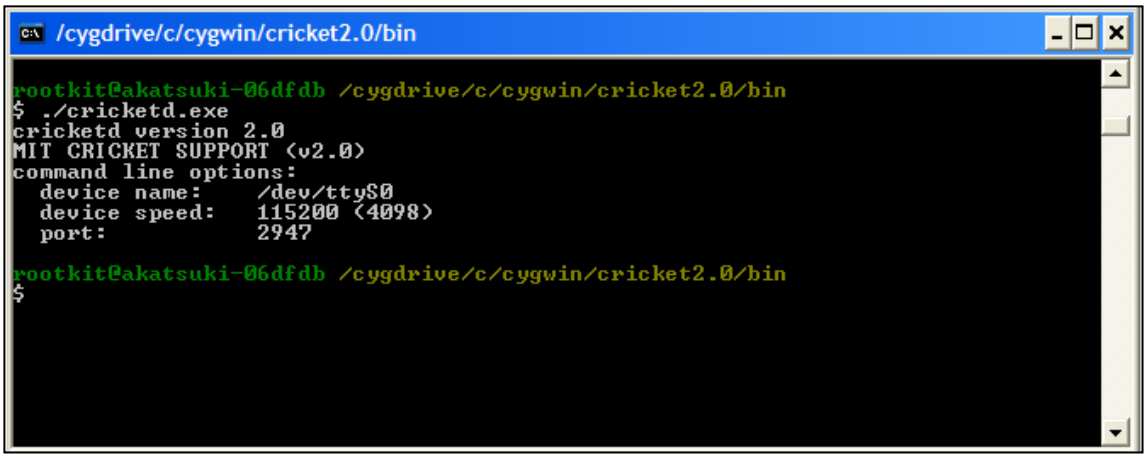

Figure 16: Cricketd In Cygwin Environment

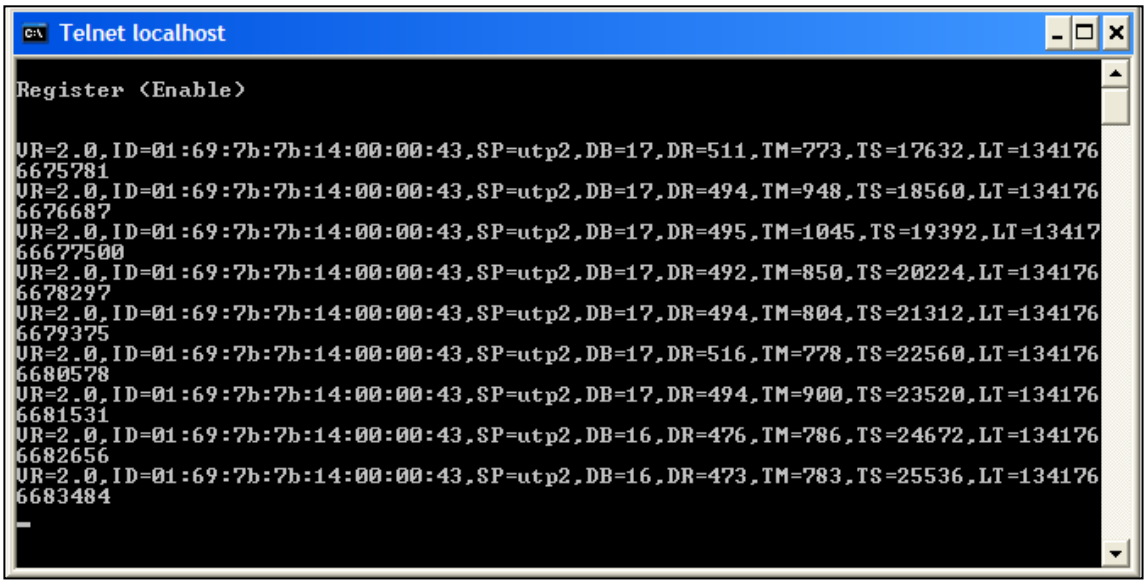

Figure 17: Data Display using Command Prompt

8. Distance Measurement Using Cricket

i. Direct Measurement

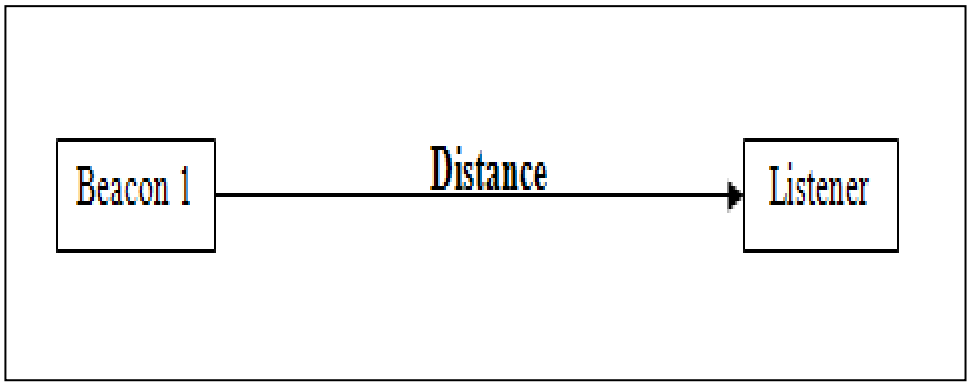

Figure 18: Layout for Direct Measurement

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Figure 19: 1 Meter

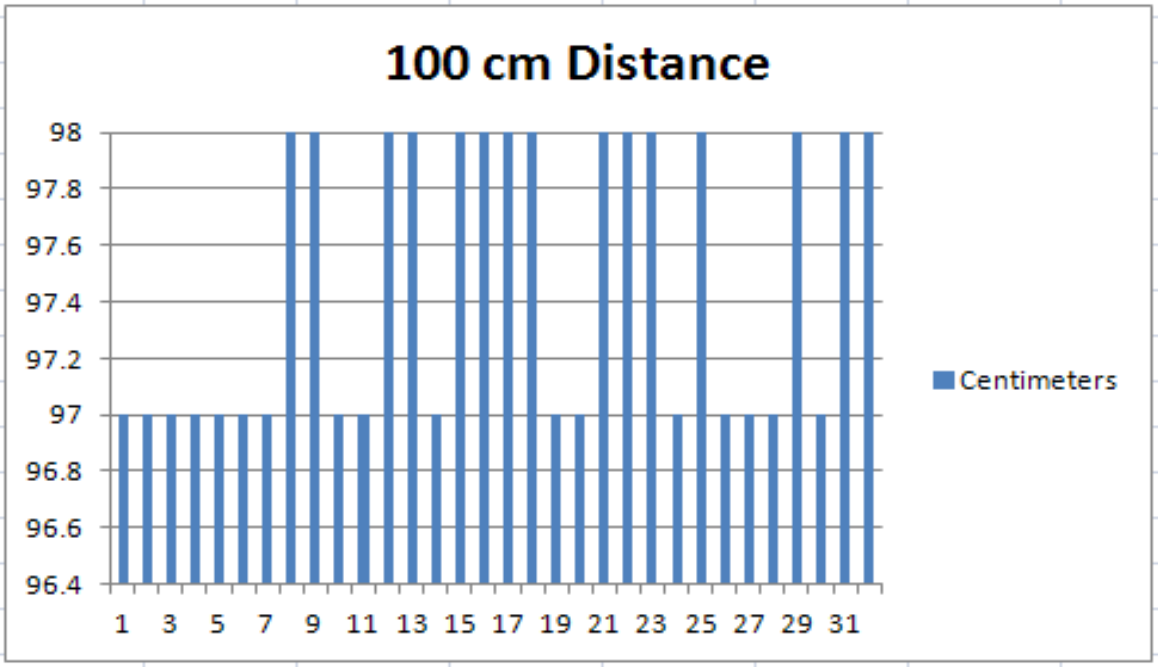

Figure 20: 1 Meter Graph Bar

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VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5489,TM=5991,TS=10560
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5499,TM=5713,TS=11648
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5503,TM=5957,TS=12480
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5500,TM=5714,TS=15232
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5501,TM=6003,TS=16448
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5507,TM=5865,TS=17760
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5504,TM=5958,TS=18528
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5507,TM=6009,TS=19680
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5506,TM=5720,TS=20576
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5507,TM=5913,TS=21472
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5508,TM=6058,TS=22784
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5505,TM=5815,TS=23680
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5500,TM=5810,TS=24992
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5505,TM=5863,TS=25728
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5503,TM=6053,TS=26816
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5502,TM=5812,TS=27904
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5501,TM=5811,TS=28864
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5501,TM=5715,TS=29952
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5500,TM=5762,TS=30784
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5501,TM=5859,TS=31584
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5501,TM=6051,TS=32896
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=190,DR=5498,TM=5760,TS=33824
```

Figure 21: 2 Meter

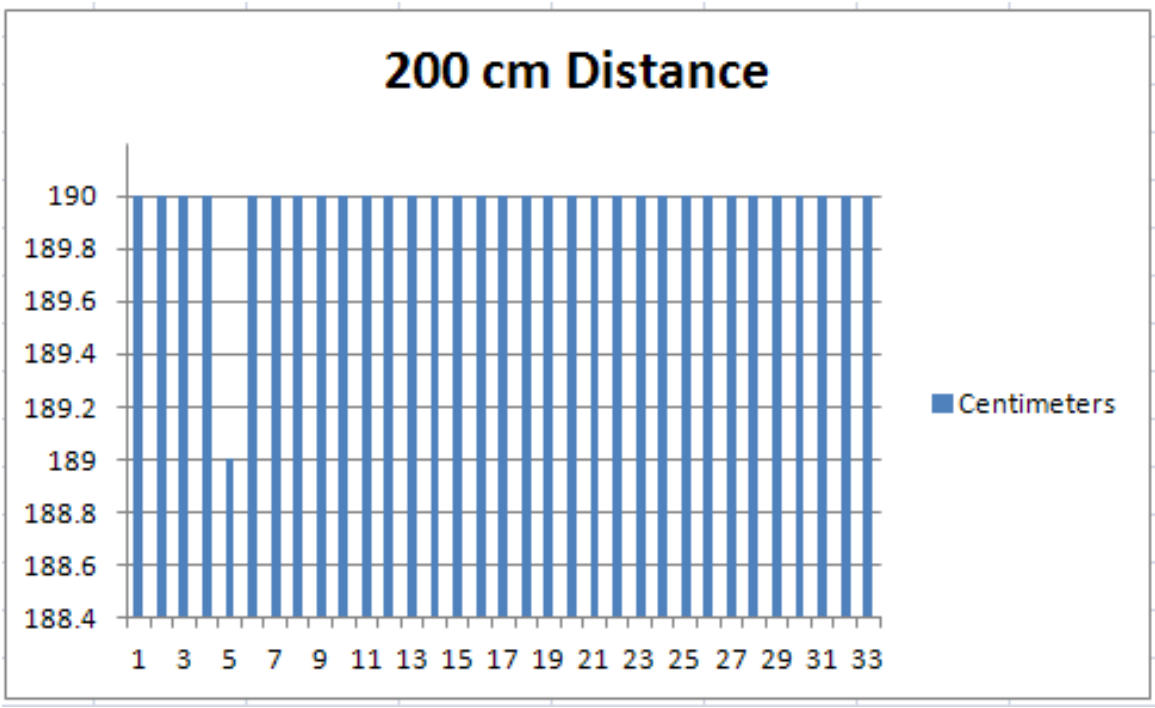

Figure 22: 2 Meter Graph Bar

```
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8164,TM=8618,TS=312192
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8164,TM=8570,TS=312960
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8166,TM=8572,TS=313888
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8165,TM=8667,TS=314720
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8164,TM=8522,TS=315552
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8162,TM=8376,TS=316640
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8170,TM=8672,TS=317888
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8187,TM=8401,TS=318848
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8166,TM=8620,TS=320000
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8169,TM=8623,TS=320864
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8166,TM=8572,TS=321792
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8169,TM=8527,TS=322560
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8188,TM=8450,TS=323840
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8166,TM=8716,TS=324928
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8189,TM=8451,TS=326176
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8166,TM=8668,TS=327488
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8165,TM=8523,TS=330400
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=285,DR=8213,TM=8475,TS=331360
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8163,TM=8521,TS=332480
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8162,TM=8376,TS=333664
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=283,DR=8159,TM=8373,TS=334496
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8165,TM=8475,TS=335648
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8163,TM=8377,TS=336448
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=beacon1,DB=284,DR=8160,TM=8422,TS=337632
```

Figure 23: 3 Meter

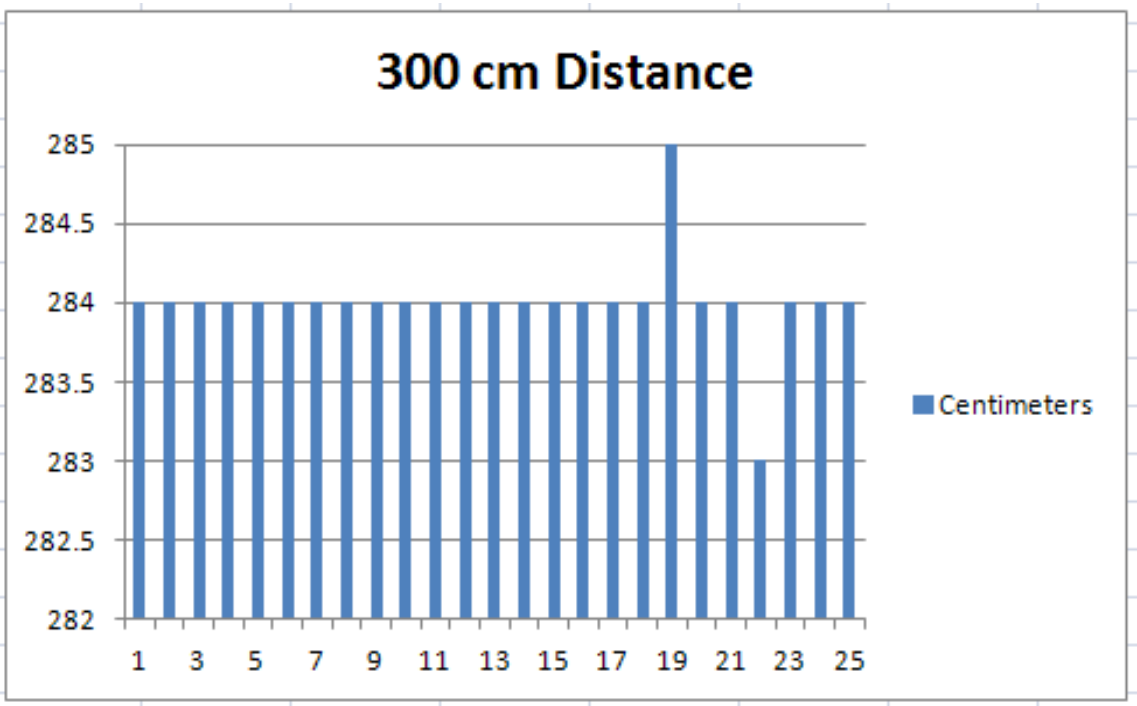

Figure 24: 3 Meter Graph Bar

ii. Triangle Measurement

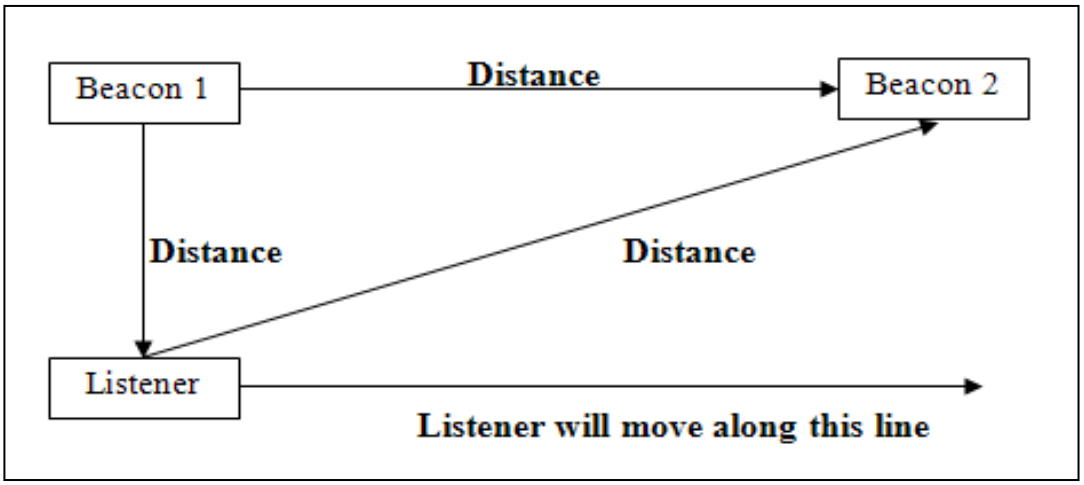

Figure 25: Layout for Triangle Measurement

```
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1455,TM=1909,TS=0
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3244,TM=3746,TS=160
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1457,TM=1863,TS=544
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=113,DR=3266,TM=3816,TS=1024
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1456,TM=1862,TS=1280
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1457,TM=1767,TS=2080
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=113,DR=3264,TM=3766,TS=2240
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1456,TM=1814,TS=2848
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3241,TM=3455,TS=3328
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1458,TM=1912,TS=3840
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3246,TM=3556,TS=4064
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1452,TM=1666,TS=5184
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3241,TM=3455,TS=5344
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1456,TM=1958,TS=5952
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3242,TM=3504,TS=6464
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1456,TM=1766,TS=6912
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3244,TM=3698,TS=7808
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1454,TM=1860,TS=8160
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3241,TM=3695,TS=9184
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1456,TM=1814,TS=9312
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1451,TM=1761,TS=10208
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3240,TM=3550,TS=10368
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1455,TM=1909,TS=11200
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=112,DR=3243,TM=3601,TS=11296
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1453,TM=1763,TS=12128
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=113,DR=3262,TM=3812,TS=12416
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1452,TM=1714,TS=13152
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=113,DR=3261,TM=3667,TS=13408
```

Figure 26: 1 Meter (Listener at Beacon 1)

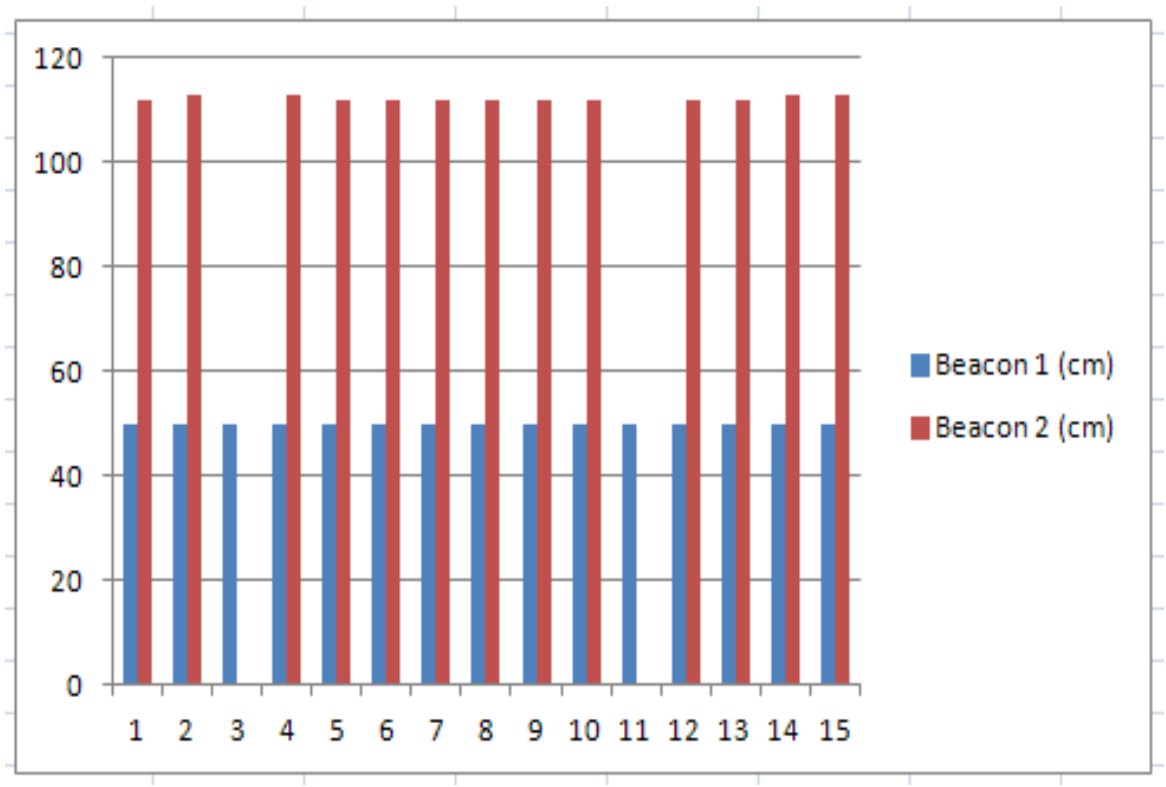

Figure 27: 1 Meter Graph Bar (Listener at Beacon 1)

```
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3447,TM=3997,TS=0
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1770,TS=160
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3450,TM=3808,TS=544
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1458,TM=1912,TS=1056
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3448,TM=3662,TS=1728
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=1723,TS=2368
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3447,TM=3901,TS=2880
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1866,TS=3552
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=118,DR=3444,TM=3754,TS=3840
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=1963,TS=4576
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3450,TM=3952,TS=4704
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1459,TM=1817,TS=5632
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3449,TM=3807,TS=5888
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=1771,TS=6496
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=118,DR=3449,TM=3807,TS=6944
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1674,TS=7712
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=118,DR=3449,TM=3855,TS=8032
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1674,TS=8640
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3453,TM=4003,TS=9312
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=1819,TS=9984
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3451,TM=3713,TS=10592
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1462,TM=1772,TS=10976
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3450,TM=3952,TS=11552
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=2010,TS=12192
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3446,TM=3660,TS=12800
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1459,TM=1769,TS=13504
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3448,TM=3758,TS=13792
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=1915,TS=14528
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=119,DR=3449,TM=3999,TS=14816
```

Figure 28: 1 Meter (Listener at Beacon 2)

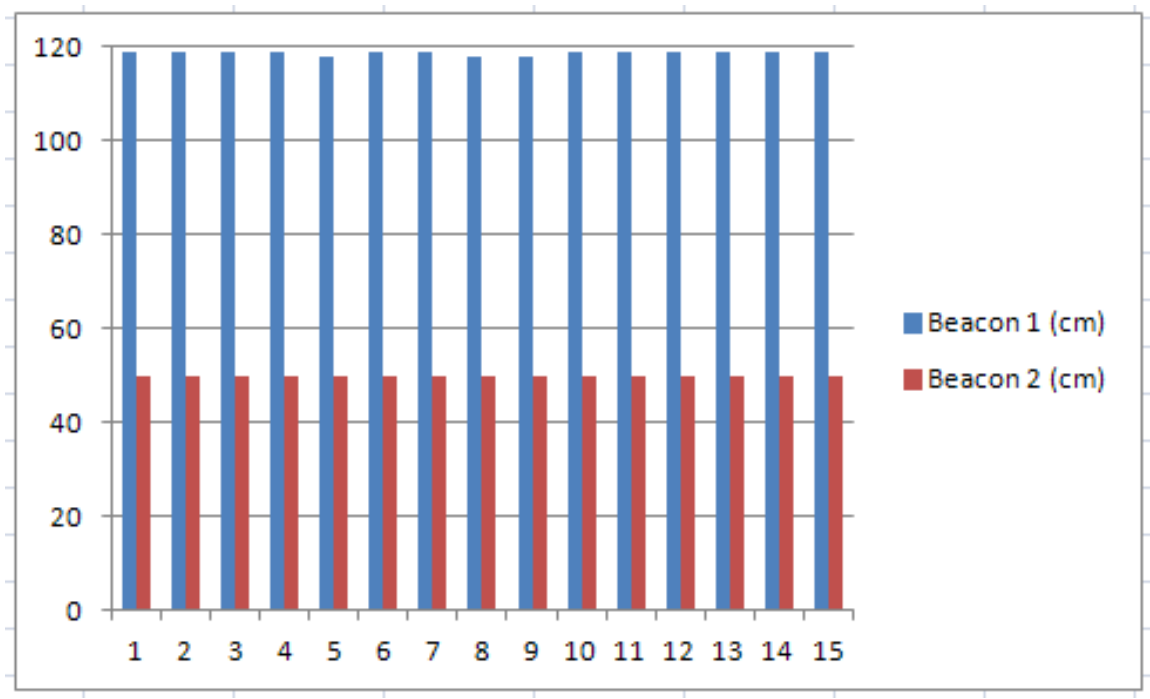

Figure 29: 1 Meter Graph Bar (Listener at Beacon 2)

```
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2113,TM=2615,TS=0
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2094,TM=2452,TS=0
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2113,TM=2423,TS=544
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=73,DR=2110,TM=2468,TS=1024
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2115,TM=2425,TS=1440
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2093,TM=2643,TS=2176
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2118,TM=2620,TS=2400
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2089,TM=2495,TS=3040
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2117,TM=2379,TS=3264
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2112,TM=2422,TS=4224
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2095,TM=2453,TS=4416
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2090,TM=2400,TS=5312
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2115,TM=2521,TS=5472
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2103,TM=2317,TS=6080
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2110,TM=2324,TS=6560
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2089,TM=2495,TS=6816
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2115,TM=2377,TS=7744
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2090,TM=2352,TS=8064
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2115,TM=2521,TS=8736
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2091,TM=2353,TS=8960
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2093,TM=2547,TS=9696
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2112,TM=2326,TS=9920
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2113,TM=2423,TS=10624
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2091,TM=2497,TS=10752
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2115,TM=2521,TS=11584
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=73,DR=2106,TM=2416,TS=11808
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2113,TM=2327,TS=12384
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2092,TM=2498,TS=12736
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2112,TM=2518,TS=13184
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=72,DR=2090,TM=2352,TS=13632
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=73,DR=2116,TM=2618,TS=14240
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=73,DR=2102,TM=2316,TS=14464
```

Figure 30: 1 Meter (Listener in the middle)

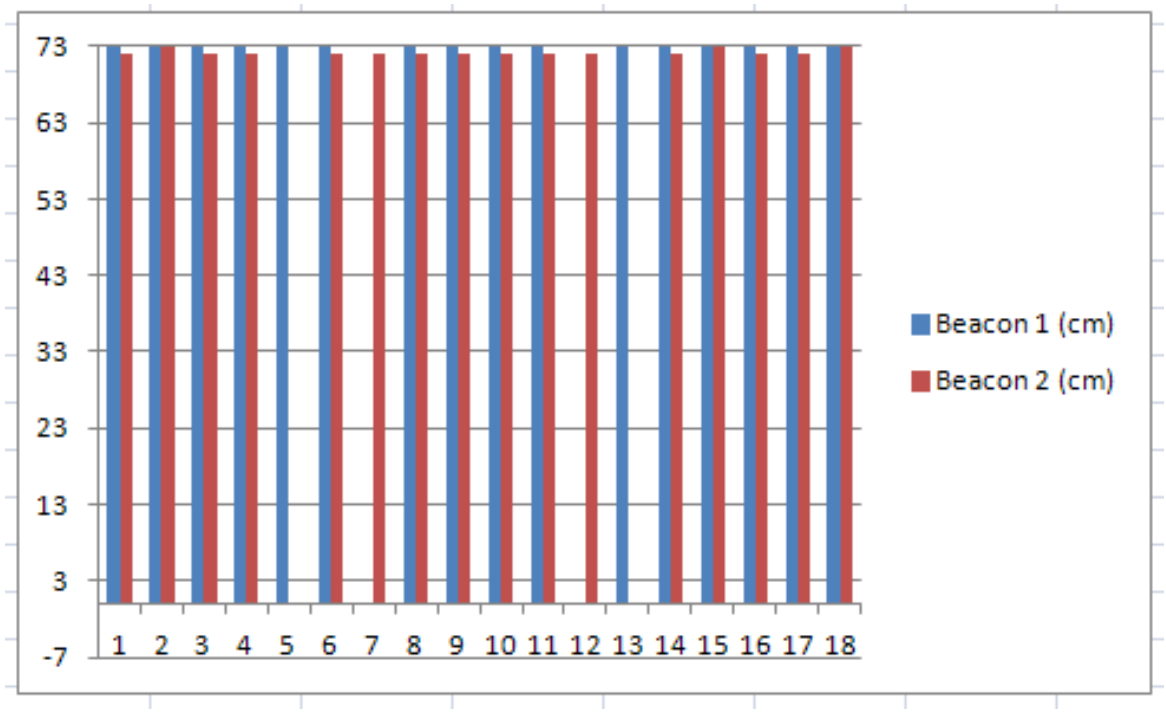

Figure 31: 1 Meter Graph Bar (Listener in the middle)

```
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=206,DR=5940,TM=6442,TS=0
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1460,TM=1866,TS=160
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=203,DR=5889,TM=6199,TS=288
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1463,TM=1821,TS=1376
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5918,TM=6276,TS=1536
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1460,TM=1722,TS=2208
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5913,TM=6223,TS=2432
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5897,TM=6447,TS=3296
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1461,TM=1675,TS=3520
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5917,TM=6419,TS=4128
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1464,TM=1774,TS=4416
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5892,TM=6154,TS=5408
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1463,TM=1821,TS=5760
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,TS=6304
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1464,TM=1870,TS=6848
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=207,DR=5983,TM=6197,TS=7328
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1462,TM=1868,TS=8032
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=206,DR=5942,TM=6444,TS=8640
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5896,TM=6302,TS=9408
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1465,TM=1727,TS=10080
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=203,DR=5870,TM=6084,TS=10656
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1461,TM=1963,TS=10848
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1464,TM=1966,TS=11712
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5890,TM=6200,TS=11968
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1461,TM=1723,TS=12832
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=206,DR=5965,TM=6467,TS=13248
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=50,DR=1463,TM=1917,TS=13792
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=204,DR=5873,TM=6375,TS=14368
```

Figure 32: 2 Meter (Listener at Beacon 1)

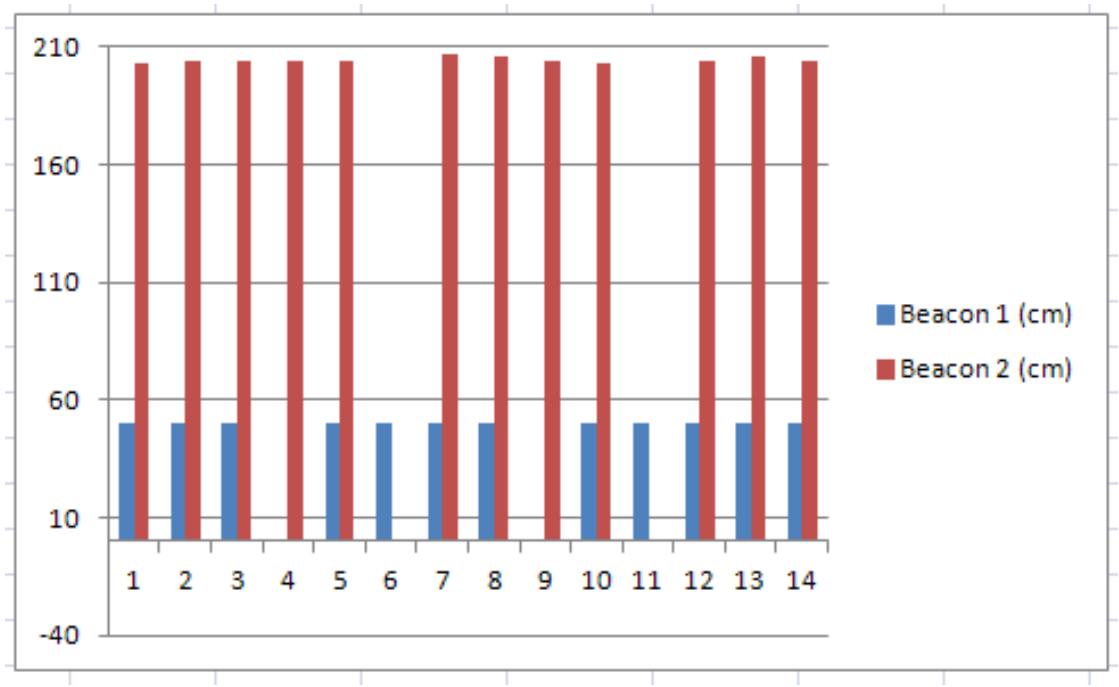

Figure 33: 2 Meter Graph Bar (Listener at Beacon 1)

```
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=309,DR=8904,TM=9214,TS=0
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1458,TM=1720,TS=192
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=306,DR=8837,TM=9147,TS=672
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1459,TM=1865,TS=1088
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=308,DR=8910,TM=9460,TS=1696
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1458,TM=1816,TS=2112
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8950,TM=9404,TS=2944
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1458,TM=1912,TS=3264
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8953,TM=9407,TS=4032
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1459,TM=1961,TS=4192
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1459,TM=1817,TS=4864
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8974,TM=9284,TS=5280
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1770,TS=5952
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8952,TM=9406,TS=6208
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=308,DR=8908,TM=9314,TS=7104
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1914,TS=7328
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8977,TM=9383,TS=8096
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=2011,TS=8544
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=313,DR=9048,TM=9598,TS=9088
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1722,TS=9600
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8955,TM=9265,TS=10080
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=49,DR=1431,TM=1981,TS=10944
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=312,DR=9002,TM=9408,TS=11232
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1461,TM=1915,TS=12096
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=310,DR=8935,TM=9437,TS=12352
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1457,TM=1719,TS=13024
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=309,DR=8927,TM=9237,TS=13696
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1459,TM=1769,TS=13824
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=311,DR=8954,TM=9360,TS=14688
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1460,TM=1962,TS=15072
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=50,DR=1458,TM=1720,TS=15808
```

Figure 34: 2 Meter (Listener at Beacon 2)

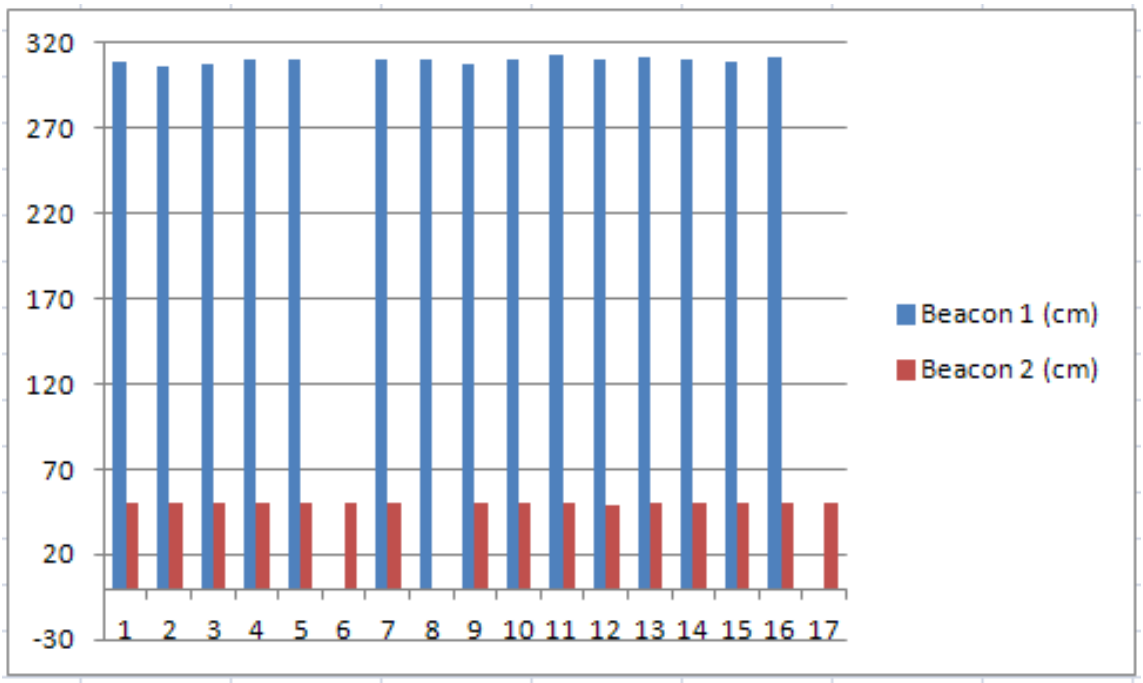

Figure 35: 2 Meter Graph Bar (Listener at Beacon 2)

```
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=113,DR=3276,TM=3538,TS=0
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3310,TM=3860,TS=0
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3253,TM=3707,TS=384
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3310,TM=3572,TS=896
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3254,TM=3516,TS=1440
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3310,TM=3716,TS=1824
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=113,DR=3277,TM=3779,TS=2592
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3309,TM=3619,TS=3168
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=113,DR=3275,TM=3681,TS=3520
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3311,TM=3717,TS=4096
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3311,TM=3765,TS=4896
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3314,TM=3672,TS=5696
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3255,TM=3757,TS=6144
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=115,DR=3337,TM=3839,TS=6976
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3254,TM=3564,TS=7296
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3314,TM=3528,TS=7872
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=113,DR=3278,TM=3540,TS=8352
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3316,TM=3866,TS=9152
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3253,TM=3563,TS=9344
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3314,TM=3720,TS=10528
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3253,TM=3707,TS=10688
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3254,TM=3468,TS=11520
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3316,TM=3674,TS=12224
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3250,TM=3464,TS=12448
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3254,TM=3516,TS=13312
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=114,DR=3316,TM=3722,TS=13472
VR=2.0,ID=01:69:7b:7b:14:00:00:43,SP=utp1,DB=112,DR=3242,TM=3456,TS=14368
VR=2.0,ID=01:23:7a:7a:14:00:00:d2,SP=utp2,DB=115,DR=3316,TM=3626,TS=14784
```

Figure 36: 2 Meter (Listener in the middle)

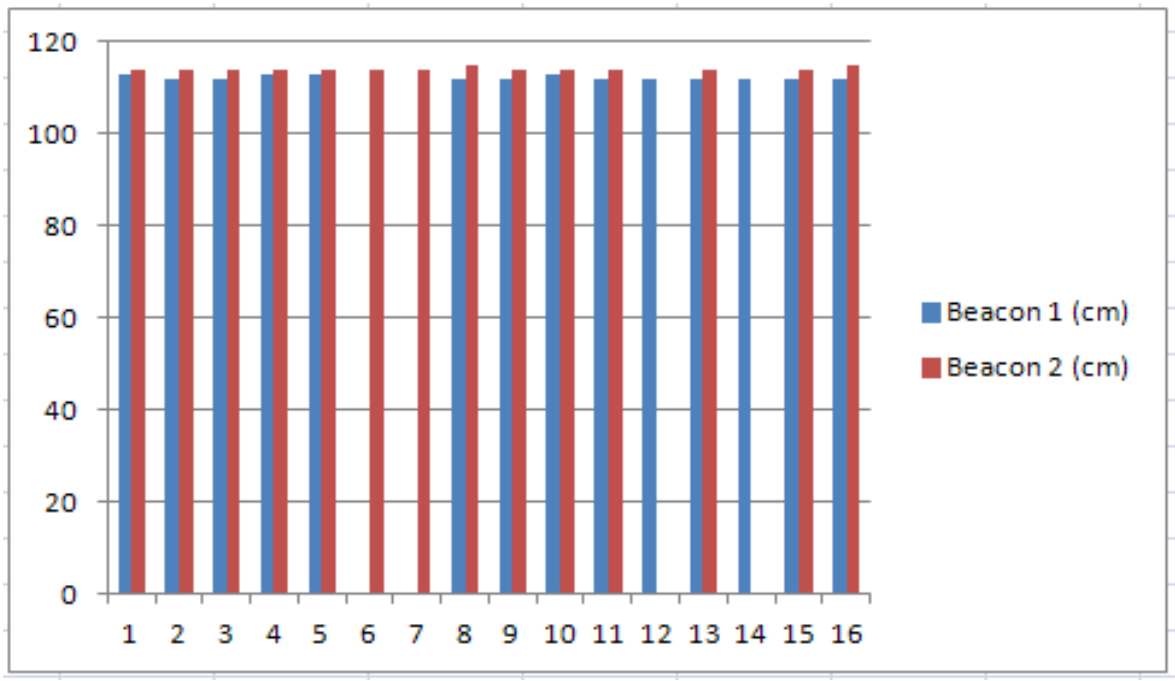

Figure 37: 2 Meter Graph Bar (Listener in the middle)

3.3.3 Discussion

1. The direct measurement shows the data that was collected using listener was quite accurate. The error becomes larger as long the distance increase.

2. The triangle measurement shows that the distance from the beacon quite accurate. When listener located at mid between two beacons, the distance from these two beacons was quite accurate as between 2 cm and 3 cm.

3. The error that occurs during the direct measurement may come from the interference of the signal itself during transmission signal.

4. The error that occurs during the triangle measurement comes from the position of listener. The sensors that transmit signal not directly facing each other and may cause some error. The interference of the signal also introduces some error in the result.

3.4 This is Gantt chart and milestone for my final year project

Task/Activities

		FYP1														FYP2													
NO	DETAIL/WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	PIC 16F877																													
2	Board SK40C																													
3	C Programming																													
4	MPLab IDE																													
5	Demo PIC Using Serial Terminal																													
6	Demo PIC Using LCD Display																													
7	Cricket Localisation System																													
8	Demo Cricket Listener																													
9	Finite State Machine																													
10	Demo PIC Listener																													
11	Measure Distance Using Cricket																													
12	Coding for serial transmission																													
12	Data Analysis																													

Milestone

NO	DETAIL/WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Preliminary Report																													
2	Proposal Defense																													
3	Submission of Interim Draft Report																													
4	Submission of Interim Report																													
5	Submission of Progress Report																													
6	Submission of Draft Report																													
7	Submission of Technical Paper																													
8	Submission of Final Report																													
9	Viva																													

3.5 Tools and Equipment Required

For completing this project, variety of hardware and software was used as below:

- PIC 16F877
- Stingray Robot
- MPLAB Integrated Development Environment
- Cytron SK40C microcontroller starter kit
- Cricket indoor location system
- Cytron UIC00B
- Cytron DS-LCD-162A
- USB-UART converter
- 2510-04 Connector
- DB9 Male Connector
- Cable 3-way ribbon cable
- LED
- DC Power Supply

CHAPTER 4
CONCLUSION AND RECOMMENDATIONS

The main task of this project is to equip a mobile robot with an indoor navigation based on the cricket indoor location system. The progress of the project show that this project will be achievable in the period of given time. In this project, the advantages of using cricket indoor location system such as scalability, privacy, low cost and accurate space detection will help the listener to calculate the correct decision based on the signal given by beacons before robot can make their movement [11].

The hardware in this project consists of two parts which are mobile robots and cricket indoor location system. This project covers various aspect of engineering such as programming, communication and robotics. At the end of this project, a mobile robot with the capability of doing autonomous navigation can be further developing to provide more benefits for human life.

4.1 Suggested Future Work for Expansion and Continuation

This project will be completed during remaining period. Further activities will be proceeding according to the gantt chart and methodology. The discussion with the supervisor will be regularly held to discuss about the project progress and also to solve the problem that will occur during the project development. At the end, the system of cricket indoor location system and mobile robot will be evaluated to ensure it can be operate successfully.

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