BLUETOOTH-TRIGGERED ALARM SECURITY SYSTEM

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Dedicated, in thankful appreciation

for support encouragement and understanding to my beloved parents

Noriah Aripin and Abdul Malek Bilal Sidek. Special greet to all friends

who continuously support me.

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ABSTRACT

Security system nowadays become a need for houses or commercial premises and available with many modern features. This Bluetooth-triggered alarm security system comes with extra secure access and intelligent alarming. The system only can be accessed and configured by owner using Bluetooth communication via mobile phone to turn it on or off. In this project, when the alarm is triggered, an intruder alert message will be sent to the neighbor's phone through Bluetooth communication. After the certain time, the alarm system will be triggered and by that time the neighbors have already surrounded the compound and the probability of the intruder to be caught is higher. IR sensor of the system will continuously monitor movement or present of human in the building. The Bluetooth module will sent intruder alert message as microprocessor (PIC) receive signal from IR sensor. The PIC is programmed to wait approximately seven minute before activated the siren. The alarm system status is indicated using LED's to avoid owner accidently turned it off.

ABSTRAK

Sistem keselamatan hari ini menjadi sebuah keperluan bagi sesebuah kediaman mahupun premis komersil dan ianya dilengkapi dengan pelbagai keupayaan serba canggih. Sistem keselamatan pacuan Bluetooth ini didatangkan dengan akses lebih selamat dan mempunyai penanda kecemasan pintar. Sistem ini hanya boleh diakses dan diaktifkan oleh pemilik menerusi Bluetooth dengan menggunakan telefon bimbit untuk menghidupkan atau memadamkan sistem. Di dalam projek ini, apabila pECeroboh dikesan, isyarat kecemasan akan dihantar kepada telefon bimbit jiran-jiran menerusi komunikasi Bluetooth. Selepas beberapa ketika masa yang ditetapkan sistem, penanda kecemasan berupa siren akan diaktifkan dan pada masa itu jiran tetangga sudah pun mengepung kawasan yang diceroboh itu yang mana membolehkan penjenayah tertangkap. Penggunaan sensor IR pada system ini akan berterusan mengawasi jika terdapat sebarang kehadiran manusia di dalam bangunan. Modul Bluetooth pula bertindak sebagai perantara menghantar isyarat kecemasan setelah mikropemproses (PIC) menerima isyarat dari sensor IR. PIC ini diprogramkan supaya menunggu lebih kurang tujuh minit sebelum siren diaktifkan. Status system sekuriti ini dipaparkan menggunakan LED bagi mengelakkan pemilik memadamkannya secara tidak sedar.

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LIST OF ABBREVIATIONS

LED	-	Light Emitting Diode
GUI	-	Graphical User Interface
USART	-	Universal Synchronous Asynchronous Receive Transmit
SFR	-	Special function registers
ASCII	-	American Standard Codes for Information Interchange
PIR	-	Passive Infra Red
RFCOMM	-	Radio Frequency Communication
SPP	-	Serial Port Profile
USB	-	Universal Serial Bus
TX/RX	-	Transmint/Receive
PC	-	Personal Computer
GSM	-	Global System for Mobile Communications
PIC	-	Programmable Integrated Circuit
IC	-	Integrated Circuit
ISM	-	Iindustrial Scientific Medical
CPU	-	Central Processing Unit
I/O	-	Input/Output
EEPROM	-	Electrically Erasable Programmable Read Only Memory
ADC	-	Analogue to Digital Converter
TTL	-	Transistor–Transistor Logic
RAM	-	Random Access Memory
ROM	-	Read-Only Memory
DTE	-	Data Terminal Equipments
DCE	-	Data Communication Equipments
PBP	-	PicBasicPro

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CHAPTER 1

INTRODUCTION

1.1 Bluetooth Triggered Alarm Security System

Security system nowadays become a need for houses or commercial premises and available with many modern features. Robbery tends break in premises while the owners are away. Many security systems available in market are not really stable and smart enough to deal with the intruders. As for many security system, loss from robbery and if the criminal got away, it invites unconfident of security reputation. Furthermore, it is crucial to has advanced alarm system which could not only secure the premises, but also increase the chance to capture the criminal.

Additionally, it is significant to have an alarm system which could hardly to hack and conveniently operating in wireless environment. Thus, motion sensor, Bluetooth communication and smart alarming were the features opted into security system. The system only can be accessed and configured by owner using Bluetooth communication via mobile phone to turn it on or off. Meanwhile, if intruder detected, the alarm is triggered and an intruder alert message will be sent to the neighbor’s phone through Bluetooth communication. Then, only after certain delayed time, the siren will activated.

1.2 Problem Statement

False alarms, easy to hacks and costly design were the weakness of most security system. Normal motion detectors are capable to distinguish presence of human or animal hence avoid false alarm. More security systems implement this approach to overcome false alarm problem without involving high costs.

Bluetooth communication known to be secure and not require line of sight (LOS) making it invulnerable to hacking tactics. This Bluetooth configuration can be made by certain user that predefined by the system. Unrecognized communication or foreign access will not accepted by the system hence deny any possibilities being hacked. With battery operated and small size, made the system discrete enough from being knocked physically.

Most people hesitate to install security system since it requires expensive equipment and sometimes it have subscription fee. Security system build based on Programmable Integrated Circuit (PIC) will reduce the starting costs. Additionally, Bluetooth module price become less expensive over the time and Bluetooth enabled mobile phone become common in market make the system more affordable. Therefore most residents are able to own the security systems in their premises and install it as fast as possible.

1.3 Objectives

This project aims to produce a security system that operates using PIC and configured using mobile phones via Bluetooth. However, several objectives must be accomplished before reach this goal.

The first objective is to communicate Bluetooth Module and Bluetooth-enabled mobile phones successfully established. It is two way communications, so both devices must able to send and receive data.

Secondly is the Bluetooth Module and motion detector will interface with PIC without any problem. Motion detector and Bluetooth Module are only device attached with PIC and communicates directly.

Finally, is to ensure there is no stability problem in term of hardware and software with all components working together as a system as desired.

1.4 Scope of Project

In order to realize this type of alarm system by considering time constraint and budget, there are several scopes that need to be outlined. This is to ensure the project is heading in the right direction to achieve its intended purpose. This project is proposed under certain defined scopes;

i. Build security system that can be configured using mobile phone through Bluetooth
ii. Only a single user mobile phone can setup the system via Bluetooth
iii. Using only one motion detector, ceiling mounted with detection range of 5m diameter at 2.4m high

Using 16F877 PIC to control system behavior, input and output

CHAPTER 2

LITERATURE REVIEW

2.1 Chapter Overview

This chapter discusses projects and paper works related to this project. These related works have been reviewed carefully in order to improve the quality and reliability of this project. By analyzing the projects did by other researchers, there is a possibility to know what features are lacking in their projects. They also will recommend some future works that could be done to improve the same project. Moreover, there are some useful ideas that can be implemented in this project from other similar projects. Therefore, literature review process extended right from the start until the end of the project.

In this literature review there were source of information for this alarm system with Bluetooth technology. Furthermore they contain information on the in-depth understanding of the Bluetooth technology and also explained how each of various peripherals communicates through Bluetooth communication with various levels of protocols. Since alarm security systems with Bluetooth features are least significant in Malaysia, locally, most of the sources come from foreign on-line journal.

2.2 Related Projects and Articles

2.2.1 Home Security with Bluetooth Technology by Hunseng Chua

This project is meant to prototyping Bluetooth communication into a system. The Bluetooth communication link will be done by using two laptops with Bluetooth stack resides on the Laptop connected with the Ericsson ROK 101007 Bluetooth module via the Universal Serial Bus (USB). The motion detector will be connected to one of the laptop via the serial link (serial cable between the motion detector and the laptop) [2]. Status of the system, connection and detection can be monitored directly in computer screen.

This project had more focus on PIR sensor where the distance of detection is configured and monitored in real time. Despite of having Bluetooth technology, the system drawbacks is not portable since it uses two (2) laptops. However it is good reference of concept and idea for adding Bluetooth enable features to system.

2.2.2 Integrated Networked Security System by Mohd Haaziq Mat Zin

This project was reviewed since it had nearly similar system and hardware to the project being developed. The main concept highlighted is the zone based detection. If the intruder is detected in outside house area the warning light will lit as a precaution. When the intruders enter the house compound which is the medium-risk zone, silent alarm will be sent informing the guard house or nearby neighbor about the situation, finally when the intruders reach inside the house the loud alarm will blare to scare off the intruders [8].

For communication with the security module, two Bluetooth modules are required where one of it from Sparkfun which is called BlueSmirf Gold and another one is Ezurio Bluetooth Intelligent Serial Module II (BISM II). To communicate with personal computer (PC) via Bluetooth link, Bluetooth dongle from Ezurio is used.

This project intended to have multiple connections with the device which may have an issue in connecting device from different manufacturers. Despite on having large detection area it may cause false detection for alarm. Moreover, the absences of remote controlling device degrade its mobility.

2.2.3 SOREX Wireless Solution GesmbH

SOREX Wireless Solution GmbH had commercialized their Bluetooth based alarm security system. Their product was very similar to the project being developed but different in approach. SOREX uses Bluetooth as a key where mobile phone Bluetooth used to open auto gate and magnetic locked doors.

Taking SOREX Wireless Key Basic for example, it uses mobile phone Bluetooth's as access key and registered device can be up to ten (10) phones. As user approach to a door, the mobile communicates automatically with the SOREX module. It is up to user if the door shall open automatically when they approach or push a button as alternative.

Security system developed by SOREX seamlessly advanced as they involves in electronic industries for almost six years. Their Bluetooth technology known to be provides by Bluegiga Technologies using WT11 Bluetooth Module. The product seems to be more passive since it is physical key replacement. There also will be issue on locking function during electricity blackout. SOREX approach style can greatly improve feature for project being developed.

2.2.4 Remote Control from Your Mobile Phone by Richard Hoptroff

Richard Hoptroff, as a development engineer for FlexiPanel Ltd writes this article in Elektor Electronics magazine. He even reviewed several project involving Bluetooth as remote control especially using FlexiPanel products.

Picking one of the projects, Access Controller project is selected. Each user has a separate password, and a log is kept of time and person accordingly. No custom transmitter is needed but any suitable mobile phone or handhelds would do [11]. Relay is used to provide an isolated switch for opening the electric lock. Relay and electric lock usually require high voltage to operate which make the system require supply from main or socket outlet. During electrical blackouts, the system easily vulnerable or in either way user will trap until the supply back on. The other project stated in the article which are Temperature Logger and Robot Controller with Route Tracking strengthen that the two ways communication is possible between Bluetooth Module and Bluetooth enabled mobile phone.

The only barrier is whether other Bluetooth Modules are capable performed same as manufactured by FlexiPanel. This article greatly provides brilliant idea on adding Bluetooth features in application. Several electronic industries start referring concept introduce by Richard Hoptroff in progress for product evolution.

CHAPTER 3

METHODOLOGY

3.1 Chapter Overview

This chapter will discuss the methods and alternatives that have been used from the beginning until the end of this project. Project flow and system overview will be discussed briefly to give more understanding of the design and development concept of this project.

This project involves more in software than hardware in overall. However, hardware part need not to taken lightly as it involves equipment that quite sensitive, expensive and moreover hardly to acquire in Malaysia. Bluetooth Module and Bluetooth enabled mobile phone were the significant examples. To avoid spending too much costs, most hardware were lent from laboratory and lecturers.

Software part hence mostly takes role around Bluetooth communication both at PIC16F877 and mobile phone sides. Mainly, PICBASIC, AT-Commands and IVT BlueSoleil used to develop the software part. Software or programming task had been conveniently done using PC.

3.2 Project Flow

This project starts with hardware development. Hardware provides this project with strong and reliable framework. Hardware involves are not complex in connection and configuration and it was better to determine functionality first to avoid software alteration due to different hardware model. Software was developed accordingly with hardware involves because certain hardware require their own typical programming method.

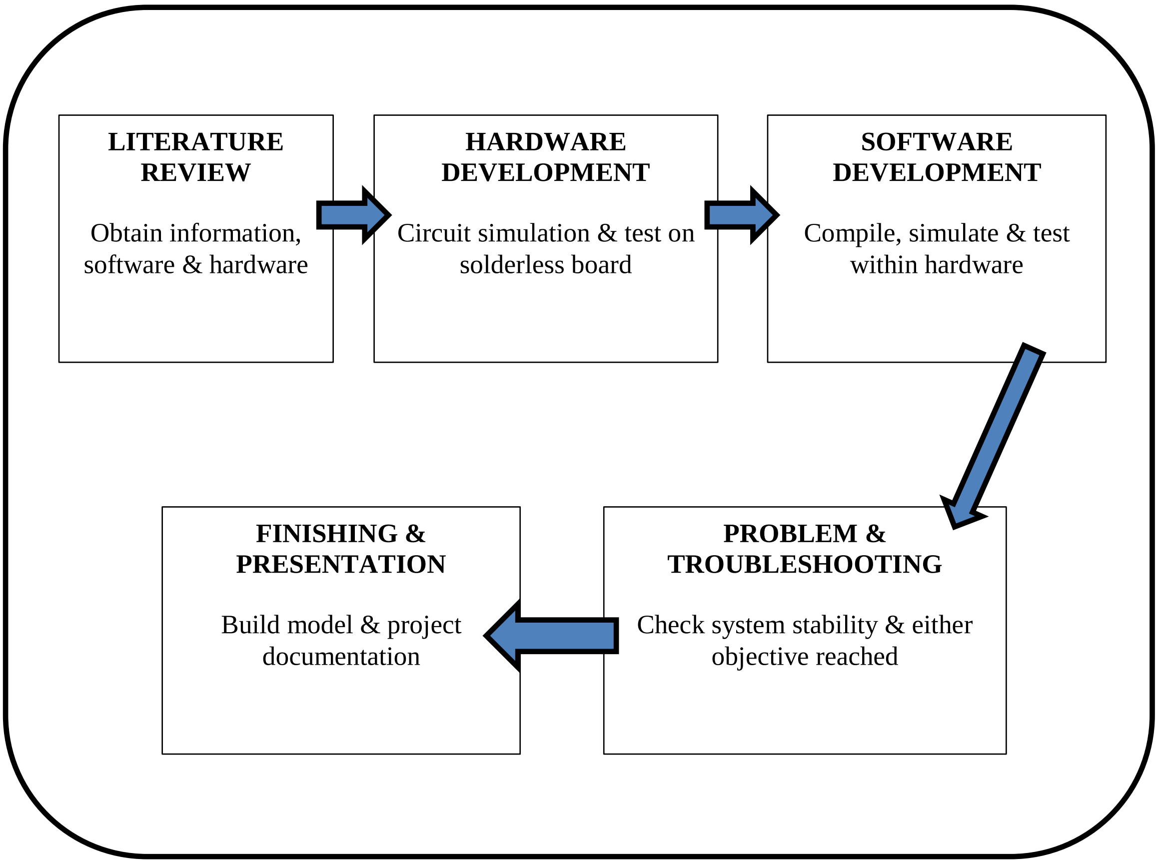

Figure 3.1: Project flow information

3.3 Tools Used

There are several main software and hardware used to develop this project. This is provided to give clear view on how the software and hardware being developed. Each of software and hardware used will be explained briefly in next chapter onward.

- Hardware
  - PIC16F877 microcontroller
  - L4128D PIC Programmer
  - WRL-08332 (BlueSmirf Silver) Bluetooth Module from Sparkfun for Bluetooth communication
  - Parallax PIR Sensor for human presence detection
  - RS-232 Shifter for level/voltage translator
  - Bluetooth enabled mobile phone
  - Bluetooth Dongle for testing and configuration

- Software
  - MicroCode Studio for PICBASIC compiling
  - Melabs Programmer for PIC microcontroller programmer interface
  - Proteus 7 for circuit functionality and PIC simulation
  - IVT Bluesoleil for Bluetooth setup
  - Microsoft Hyper Terminal for AT-Commands interface via Bluetooth
  - Btterm for mobile phone GUI

3.4 Assumptions

Some assumptions were made in this project to avoid issue related to be concerned. It also clearly gives picture how the alarm system will work. Below are stated several assumptions regarding this project:

- Users are outside detection range while configuring the alarm system
- Security system and user mobile phone is already identified each other
- Mobile phones are reachable via Bluetooth

3.5 The Alarm System

The alarm system design construction is very simple. The microcontroller acts as a brain managing input, output and how the system reacts upon event occurred. Bluetooth module functioned as communication medium between mobile phone (user and neighbor) and alarm system. Therefore, all the communication of Bluetooth module with mobile phone and PIC microcontroller are two-way or bidirectional.

Regarding on PIC microcontroller side, the communication responds are depending on software programmed inside. Any unrecognized codes or command sent will be ignored by PIC microcontroller. Additionally, the siren and motion detector physically had direct interface with microcontroller as they are in one system functioning as input and output. Following diagram in Figure 3.2 will give the picture how the system works while Figure 3.3 describes the hardware interface.

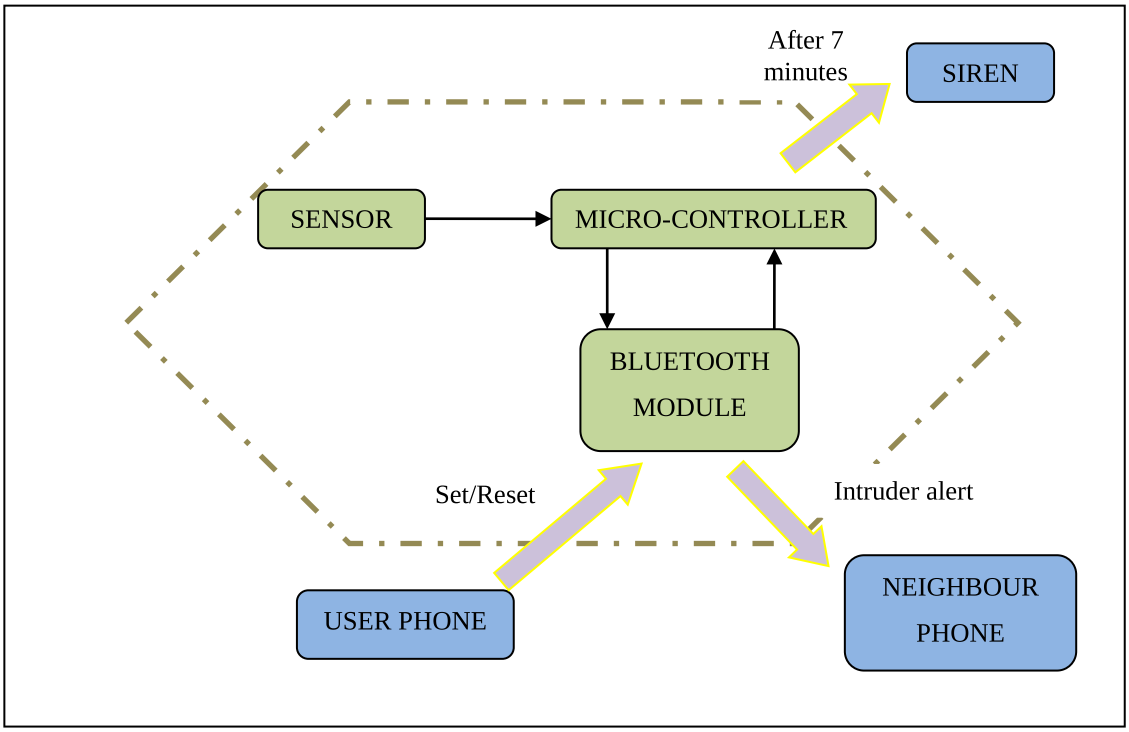

Figure 3.2: Block diagram of the system

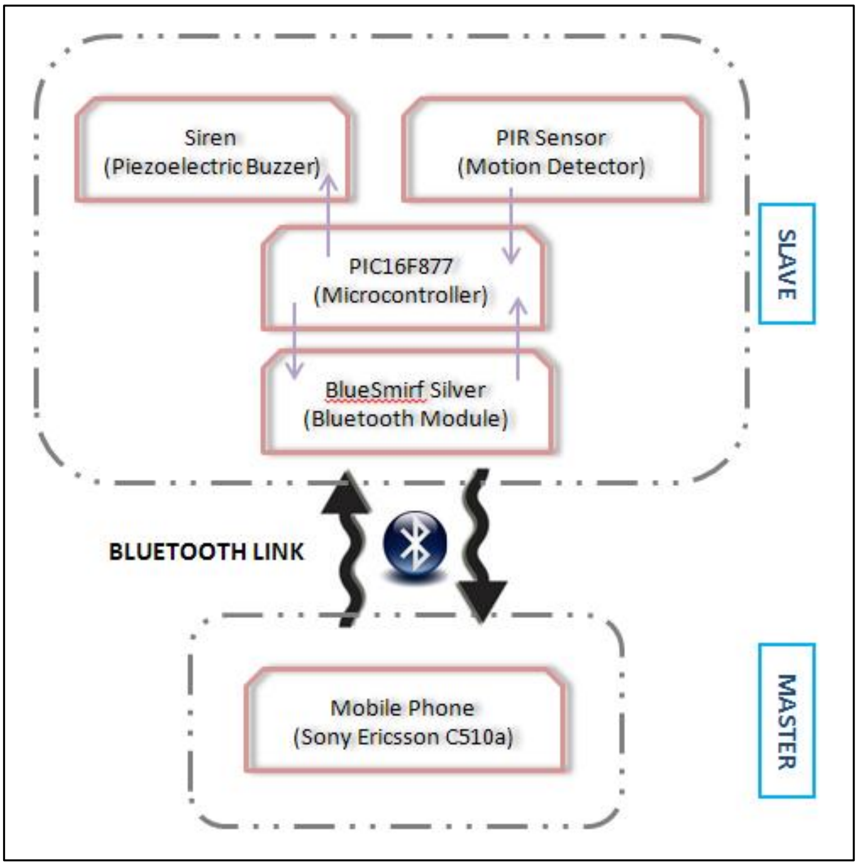

Figure 3.3: Hardware interface method

3.6 Introduction to Bluetooth

In recent years, wireless applications have been rapidly evolving in personal computing and communications devices. By using Radio Frequency (RF), it resulted in new way for people to communicate and gain access to data without the means of cables. The Bluetooth wireless technology was created to solve a simple problem or as an alternative replacing the cables used on mobile devices with radio frequency waves. Bluetooth is an open specification and the technology encompasses a simple low-cost, low power solution for integration into devices. Bluetooth operate at the globally unlicensed 2.4 GHz Industrial Scientific Medical (ISM) band that is available worldwide. This chapter will discuss only part of Bluetooth aspect that closely related to project being developed.

3.6.1 Security in Bluetooth

Bluetooth uses a technique called spread-spectrum frequency hopping that makes it rare for more than one device to be transmitting on the same frequency at the same time. In this technique, a device will use 79 individual, randomly chosen frequencies within a designated range, changing from one to another on a regular basis. In the case of Bluetooth, the transmitters change frequencies 1,600 times every second and it’s unlikely that two transmitters will be on the same frequency at the same time. This same technique minimizes the risk another Bluetooth devices disrupt another Bluetooth network since any interference on a particular frequency will last only a tiny fraction of a second.

According to Bluetooth specialists in written articles by Greg Halls, in order to hack into a Bluetooth device, the hacker must achieve all these three hacking approach;

- Force two paired devices to break their connection.
- Steal the packets that are used to resend the pin.
- Decode the pin.

Of course, the hacker must also be within range of the device, and using very expensive developer type equipment. The "pairing process" is one of the most basic levels of security for Bluetooth devices [15]. Pairing, is two or more Bluetooth devices that recognize each other by the profiles they share, in most cases they both must enter the same pin. The core specifications for Bluetooth use an encryption algorithm, which is completely and entirely secure. Once the devices pair with each other, they too become entirely secure.

Until they have successfully paired, the Bluetooth devices won't communicate with each other. Due to this pairing process and the fact that it is short range Bluetooth technology is considered to be secure. As indicated, experienced hackers have developed ways to get around this level of basic security first.

3.6.2 Bluetooth Protocol Layers

Bluetooth Protocol Layers also is part of the introduction for Bluetooth. It plays important role to determine what services the Bluetooth device offered, type of data involved and connection method. Beforehand, we need to know what are protocols mentioned here. Protocols are agreed-upon way that devices exchange information. The Bluetooth specification is made up of seven main Protocol Stacks. A brief description of each of their function is shown in Figure 3.4 below.

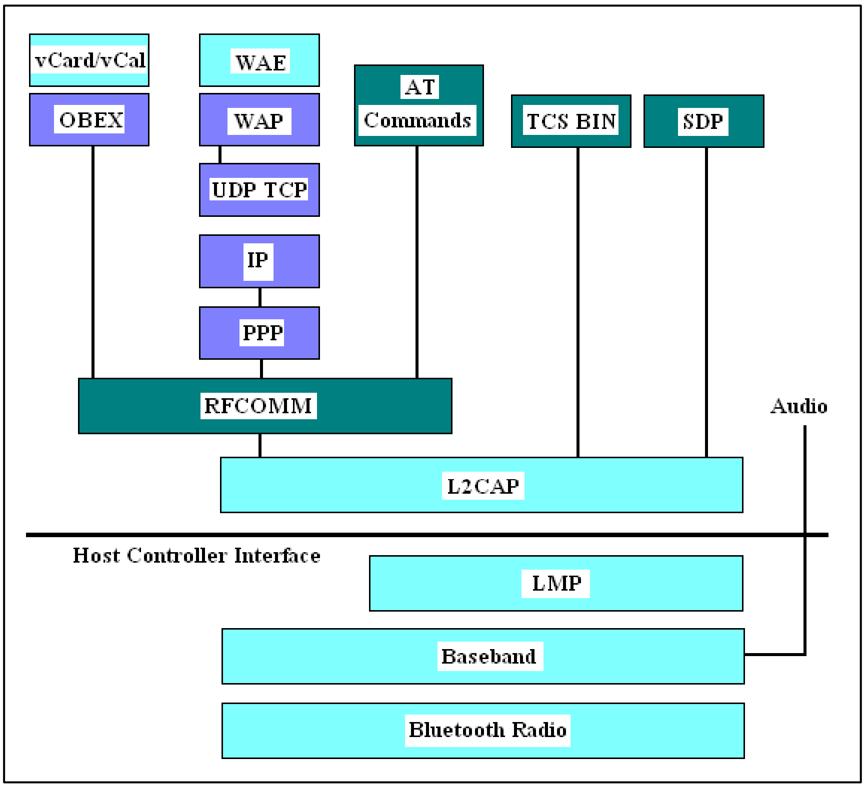

Figure 3.4: Bluetooth Protocol Layers

It is important to understand what protocol will be used in this project. For this project, IVT BlueSoleil software with Bluetooth dongle is essentially used to determine what services offered by mobile phone and Bluetooth module.

3.6.3 RFCOMM

As stated before, this thesis will only discuss related part of Bluetooth fields. Radio frequency communications (RFCOMM) is used for this project for several reasons like hardware limitations, requirements, availability and simplicity. RFCOMM is the most common and basic protocol layer and many Bluetooth applications use RFCOMM because of its widespread support and publicly available application programming interface (API) on most operating systems.

RFCOMM is a cable replacement protocol used to create a virtual serial data stream or implementing profile called as Serial Port Profile (SPP). RFCOMM provides for binary data transport and emulates EIA-232 (also known as RS-232) control signals over the Bluetooth baseband layer. Additionally, applications that used a serial port to communicate can be quickly ported to use RFCOMM.

SPP is limitation of BlueSmirf Silver Bluetooth module hence mobile phone offer almost all service for Bluetooth. SPP provides a simple reliable data stream to the target, clock independent and seemly fast. As shown in Figure 3.3 before, AT-Commands and virtual cards are covered in RFCOMM. As this project involves sending AT-Commands in form of ASCII codes, RFCOMM protocol is decided as the most suitable to use.

CHAPTER 4

HARDWARE IMPLEMENTATION

4.1 Chapter Overview

This chapter will explain the project design and hardware implementation. This will provide brief explanation on how and why they implemented in the design. The whole system acts as Master and Slave network where Bluetooth Module is the communication medium device. Master or Server part is the mobile phone while the Slave or Client part is the security system itself. Main focus in hardware development is on the Slave part which involving PIC microcontroller, Bluetooth Module and motion detector.

This section also discuss about serial communication between device and PC which influence the success rate of project development. However, only Bluetooth Module to PC communication being focused since that is the only way the Bluetooth Module can be configured.

4.2 PIC16F877 Microcontroller

This PIC microcontroller from Microchip is selected after considering several factors and criterions. Features comparison within PIC in 16F87X range is summarized in Table 4.1. Programming language used also one of the reason that make us tends to choose this PIC microcontroller. 16F877 PIC also had been used in most projects with no problems with availability in Malaysia.

Table 4.1: PIC16F87X family features comparison

Key Features	PIC16F873	PIC16F874	PIC16F876	PIC16F877
Operating Frequency	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
Interrupts	13	14	13	14
I/O Ports	Ports A, B, C	Ports A, B, C, D, E	Ports A, B, C	Ports A, B, C, D, E
Serial Comm.	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART

The most focused features in PIC16F877 were memory and I/O ports which make it more reliable to expand the system design thus reduce the design complexity like parallel system or using external memory. Pin diagram, involved pin connections and descriptions were shown in following Figure and Table.

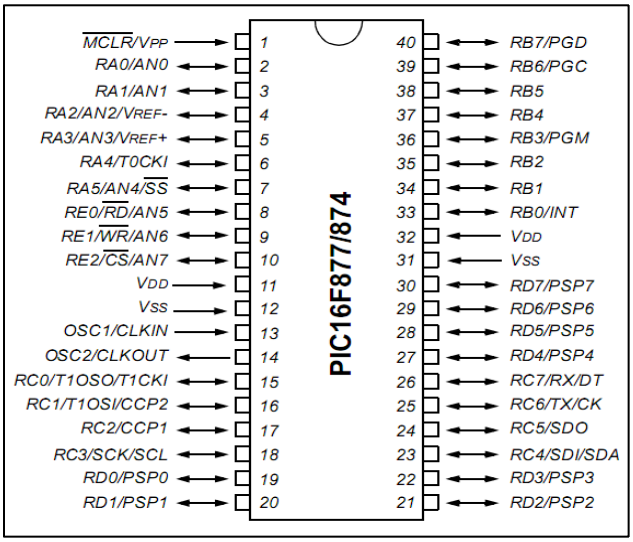

Figure 4.1: PIC16F877 pin diagram

Table 4.2: Pin connection of PIC16F877

Pin No.	Pin Name	Description	Application
(1)	MCLR*/VPP	Master clear to reset PIC program to initial	Tied to High with push button to Ground
(11) (32)	VDD	Positive supply	Connect to +5V supply
(12) (31)	VSS	Ground reference	Connect to Ground reference pin
(13)	OSC1/CLKIN	Oscillator crystal input	Connect to 20Mhz crystal through RC circuit
(14)	OSC2/CLKOUT	Oscillator crystal output	
(19)	RD0/PSP	Bi-directional I/O or parallel slave port	Read motion detector signals
(20)	RD1/PSP		Push button for event triggered program
(25)	RC6/TX/CK	Asynchronous Transmit or Synchronous Clock	Connect to Bluetooth module for serial communication
(26)	RC7/RX/DT	Asynchronous Receive or Synchronous Data	
(33)	RB0/INT	Bi-directional I/O or external interrupt	Connect to LED for status indicator
(34)	RB1	Bi-directional I/O	
(35)	RB2		

4.2.1 External oscillator

PIC16F877 microcontroller has no internal oscillator, so external oscillator is required to make it operates. Figure 4.2 shows a diagram of an oscillator circuit. The value of crystal/resonator and capacitor could be critically selected because USART application depends on it to generate baud rate. Table 4.3 shows capacitor values and baud rate for two crystal value in asynchronous mode. We can observe the error occurred for different value crystal especially in high speed. Crystal/resonator used is only up to 4 MHz since microcontroller used is rated for 4 MHz.

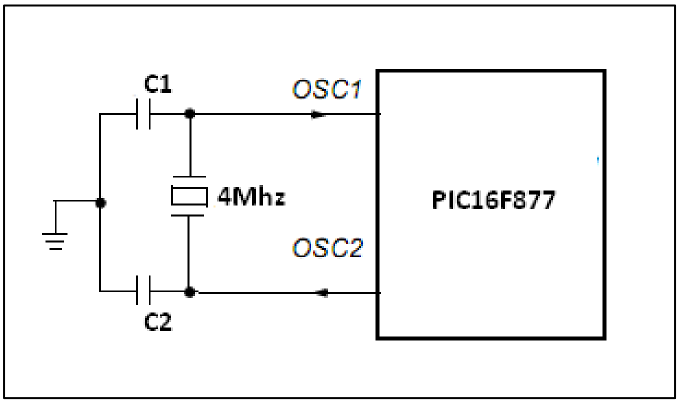

Figure 4.2: Oscillator circuit

Table 4.3: Capacitor and crystal comparison (SPBRG = 1)

Baud Rate (k)	FOSC = 4 MHZ			FOSC = 10 MHz		
	Kbaud	% Error	SPBRG Value (decimal)	Kbaud	% Error	SPBRG Value (decimal)
1.2	1.202	0.17	207	-	-	-
2.4	2.404	0.17	103	2.4	1.71	255
9.6	9.615	0.16	25	9.6	0.16	64
19.2	19.231	0.16	12	19.2	1.72	31
28.8	27.798	3.55	8	28.8	1.36	21
33.6	35.714	6.29	6	32.9	2.10	18
57.6	62.500	8.51	3	57.6	1.36	10
C1 & C2	15-68pF					

4.2.2 Reset

Reset is used to put the microcontroller into a known state. Normally when a PIC microcontroller is reset, the execution starts from address zero (0) of the program memory where the first executable user program resides. The reset action also initializes various SFR registers inside the microcontroller.

PIC microcontrollers can be reset when one of the following conditions occur:

- Reset during power on (POR – Power On Reset)
- Reset by lowering MCLR input to logic 0
- Reset when the watchdog overflows.

Figure 4.3 shows how PIC microcontroller reset circuit is normally designed. The pull-up resistor is functioned to pull up the state of the pin to almost Ground levels to make hard reset without shorting to Ground VDD.MCLR pin is active low and when thereset button is pressed this pin goes to logic 0 and the microcontroller is reset. When the reset button is released the microcontroller starts executing from address 0 of the program memory.

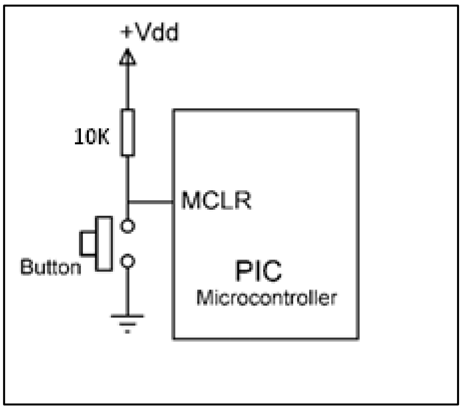

Figure 4.3: Reset circuit

4.2.3 USART

The Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART) is a highly flexible serial communication device. USARTs are commonly used in conjunction with other communication standards. A USART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. USARTs are now commonly included in microcontrollers. Many modern ICs now come with a USART that can also communicate synchronously or synchronously.

The USART usually does not directly generate or receive the external signals used between different items of equipment. Typically, separate interface devices are used to convert the logic level signals of the USART to and from the external signaling levels. Communication may be "full duplex" (both send and receive at the same time) or "half duplex" (devices take turns transmitting and receiving). USARTs are commonly used with RS-232 for embedded systems communications. It is useful to communicate between microcontrollers, peripherals and also with PCs. Many chips provide USART functionality in silicon, and low-cost chips exist to convert logic level signals (such as TTL voltages) to RS-232 level signals (for example, Maxim's MAX232).

In order to use the USART, it must be initialized and configured first. The configuration mostly involves programming which will be discussed later in software development part. This thesis will only discuss only part of USART where communication between Bluetooth Module and PIC microcontroller involved.

For this project, pin 25 (RC6/TX) and pin 27 (RC7/RX) is used for serial communication purpose. These two pins are especially dedicated for USART and do not require pin definition in programming. In this project, those pins are connected to Bluetooth Module to enable data transferred serially.

4.3 SparkFun BlueSmirf Silver Bluetooth Module [WRL-08332]

The BlueSmirf is the latest Bluetooth wireless serial cable replacement from SparkFun Electronics. As a modem, this BlueSmirf Silver works as a serial (TX/RX) pipe. Any serial stream from 9600 to 115200bps can be passed seamlessly to the target [21]. The Bluetooth Module signal pins of TX and RX are 3V to 6V tolerant, so there will be no level shifter or level translator for connection to microcontroller. However, to preserve device stability and prolonged usability, voltage divider circuit is included at the microcontroller signal pin out. Figure 4.4 shows how the voltage divider implemented for this project.

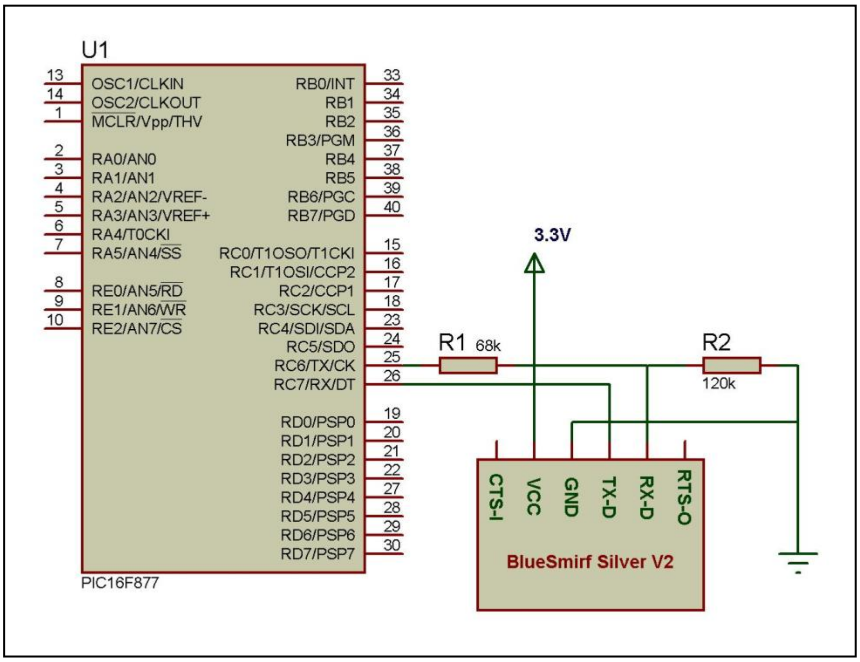

Figure 4.4: Bluetooth Module with voltage divider diagram

Eventually, BlueSmirf Silver is not as it advertised and specification or datasheet is not provided. Configuring the device on air (via Bluetooth communication) is also not possible. Therefore, the solution is connecting the Bluetooth Module using wired method to computer. For connection of the Bluetooth Module to computer, RS-232 shifter circuit is required. More about RS-232 shifter and serial communication on this will be discussed later within this chapter. Using Philips BGB203 as reference datasheet will be useful in AT-Commands and default configurations guidelines.

BlueSmirf Silver has two modes; command mode and data mode. While in command mode, all incoming data were commands (AT-Command). Hence in data mode, BlueSmirf Silver will transfer all data from source to target. Mostly, all data mentioned here were texts or ASCII codes where they were commonly used. Related AT-Commands will be discussed later in software development.

BlueSmirf Silver powered by 3.3V which is used by many modern peripherals to meet low power specification. It has two indicator LEDs to indicate power and connection status. Figure 4.5 below shows the structural of the actual device. Pin outsspecifications were described in Table 4.3.

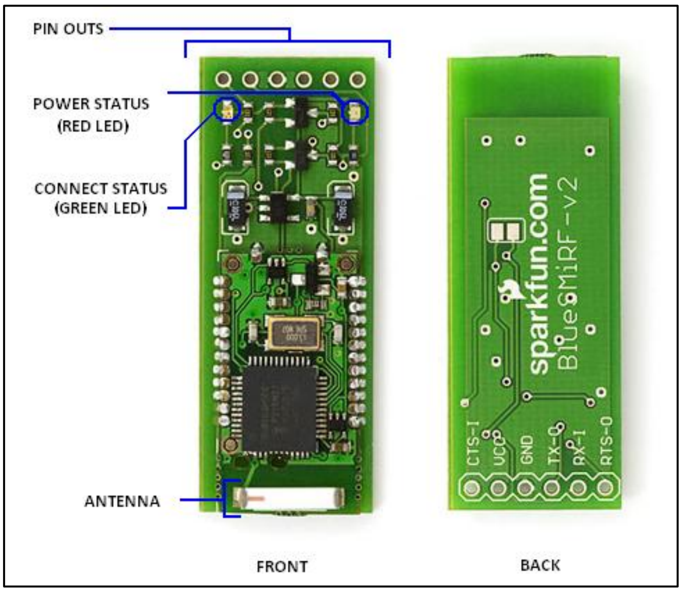

Figure 4.5: BlueSmirf Silver [WRL-08332]

Table 4.4: Pin description

Pin Name	Description	Application
CTS-I	Clear to send, active low for hardware control	Not used
VCC	Positive supply	Connect to +3.3V supply
GND	Ground reference	Connect to Ground reference pin
TX-O	Transmit data link	Connect to PIC RX
RX-I	Receive data link	Connect to PIC TX
RTS-O	Ready to send, active high for hardware control	Not used

4.3.1 Configuring BlueSmirf Silver Bluetooth Module

As mentioned in previous, this Bluetooth Module was unable to configure wirelessly via Bluetooth communication because by entering Command Mode, all active Bluetooth link will be disconnected. Overcoming the obstacle, wired solution to configure the device is chosen. However, as stated in SparkFun website, the Bluetooth Module should not directly connected to RS232 communication port. A RS-232 shifter is required to translate voltage bi-directionally from and to PC.

SparkFun sell this RS-232 shifter is a part of their marketing strategy. Considering the costs, shipping period and circuit complexity, it is not worth to buy. With a little effort and research, RS-232 shifter can be easily built with very low cost as it only needed for one time configuration. Figure 4.6 shows circuit diagram on how the RS-232 shifter is constructed.

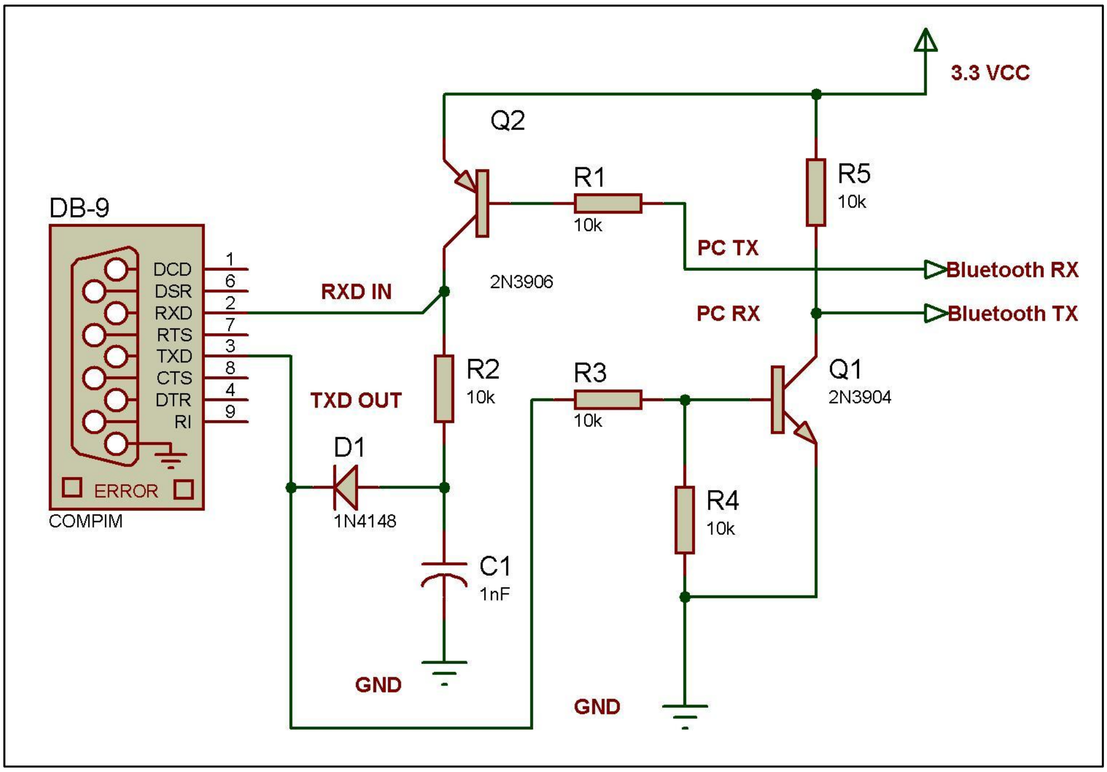

Figure 4.6: RS-232 shifter circuit

This RS-232 shifter can operates in various voltage rating. For this project, the shifter circuit is powered from 3.3V supply to have it communicate conveniently with the Bluetooth Module. For other device such as microcontroller, the shifter circuit must powered from 5V supply to employ stable operation. Baud rate will not become problem because this shifter can operate up to 115,200 bps.

4.3.2 RS-232 Serial Communication

RS-232 is the most old serial communication standard that exists since 1962 which its purposes are for connecting two computer, data modem, and also desktop peripherals. Originally RS-232 connector was developed to use DB25 connector pin out which capable of two serial communications occur in a time. Smaller version of connector called DB9 was designed later to equip with consumer level PC. Refer on Figure 4.7 for pin connection of DB25 and DB9.

Referring to this project, the Bluetooth Module is appointed as serial cable replacement. Instead of Bluetooth protocol, serial communication also had its own standard or protocol to distinguish it from other communication protocol. In RS-232 specification, the voltage swings are quite large and can damage connected device if it cannot withstand indefinite short circuit.

Introduced before was RS-232 shifter to translate voltage levels between PC and Bluetooth Module. Voltage swing and related voltage of device is presented in Table 4.4. It shows that TTL voltage levels and RS-232 levels for logic ‘1’ and ‘0’ are greatly differs.

Table 4.5: Logic levels difference

	RS-232		Bluetooth Module
High	+3V to +15V	↔ Shifter ↔	3.3V
Low	-3V to -15V	↔ Shifter ↔	0V

In RS-232 speak the modems or connected devices are called Data Communications Equipment (DCE) while computers or connecting terminals are called Data Terminal Equipment (DTE). Depends on devices labeling, usually making DTE talk to DCE does not require TX/RX swapping. Figure 4.8 will gives picture how DTE and DCE connected. In this project, PIC16F877 microcontroller and PC act as DTE while BlueSmirf Silver acts as DCE.

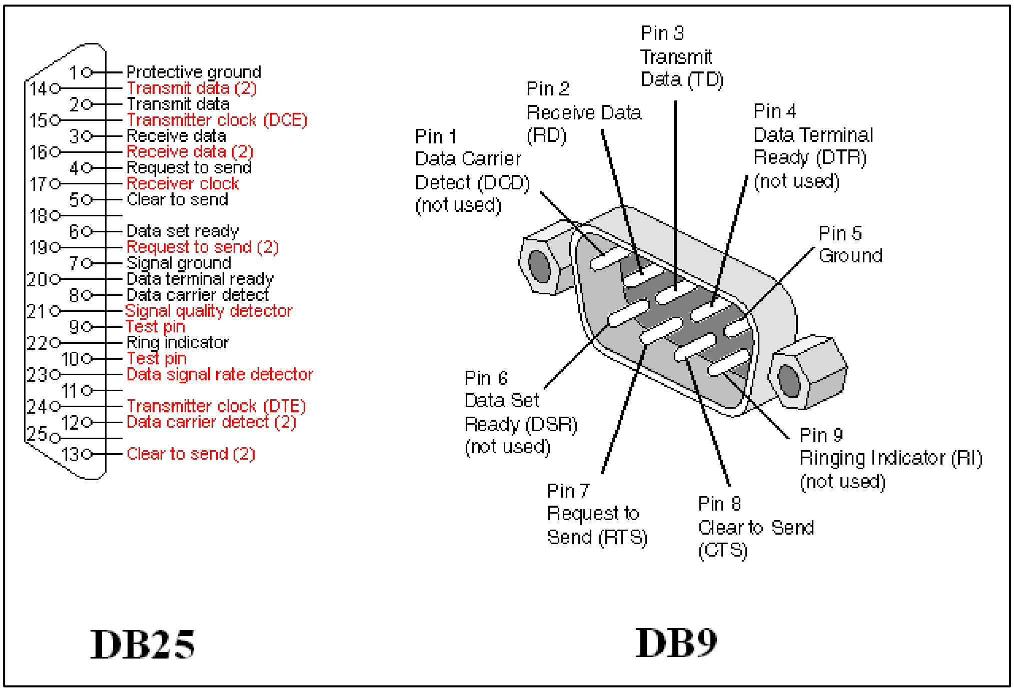

Figure 4.7: DB25 and DB9 connector pin diagram

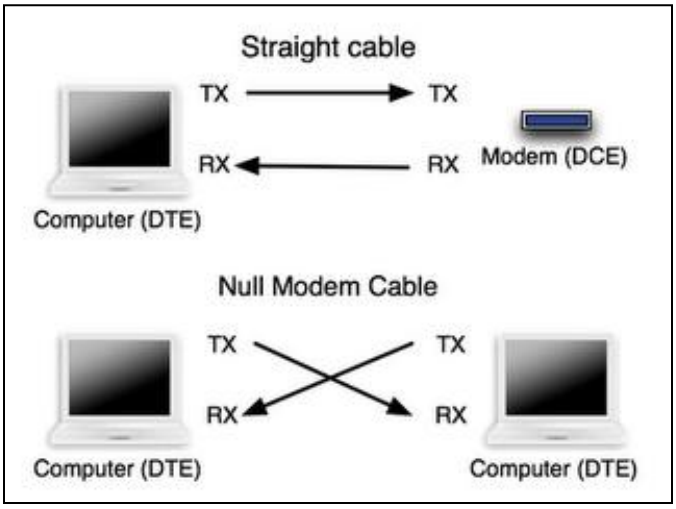

Figure 4.8: DTE and DCE connection

4.4 Parallax PIR Motion Detector

The purpose of motion detector in this project was to detect any presence of human within the range of the sensor. Regarding to its name, passive infra red (PIR), infrared was the measuring parameter of the sensor. Infrared is the portion of the electromagnetic spectrum that falls between microwaves and visible light. Infrared has wavelengths longer than visible light but shorter than microwaves. Humans, at normal body temperature, radiate most strongly in the infrared, at an approximate wavelength 10. With this fact, PIR sensor or motion detector is most adequate device with having least false detection.

Parallax had built many decent electronic devices with convenient specification. This motion detector is one of the examples. Being powered as low as 5V supply and TTL 5V output signal made it efficiently integrated with the design. The rated supply and output signal reduce the system design by not having any extra power line and signal converter. Figure 4.9 below shows actual internal part of motion detector. Motion detector is actually a module constructed from infrared sensor, filter circuit, converter and Fresnel lens.

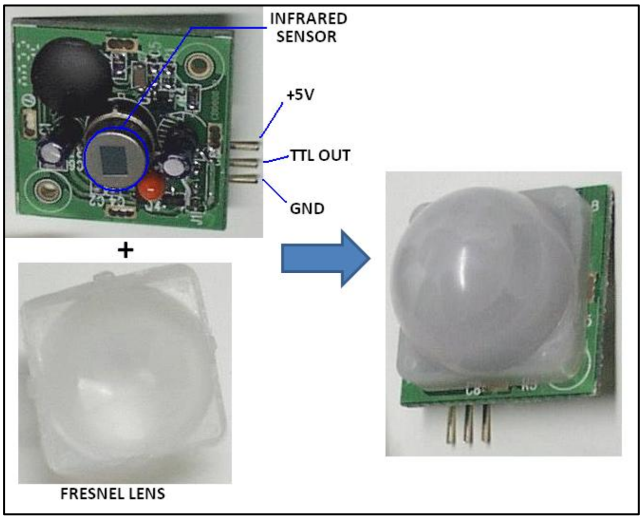

Figure 4.9: Parallax PIR motion detector

Since the output of motion detector is already TTL levels, the connection to microcontroller is straight forward. Figure 4.10 shows connection diagram for motion detector. Mostly all motion detectors including this Parallax PIR motion detector have their uptime delay from 15 to 60 seconds. During this uptime, any movements detected are not triggering the output.

Not to confuse, Parallax had include this motion detector detection timer which is put delay on how long detection occurred before triggering the output signal. This is one of notable features other than TTL output which makes it chosen.

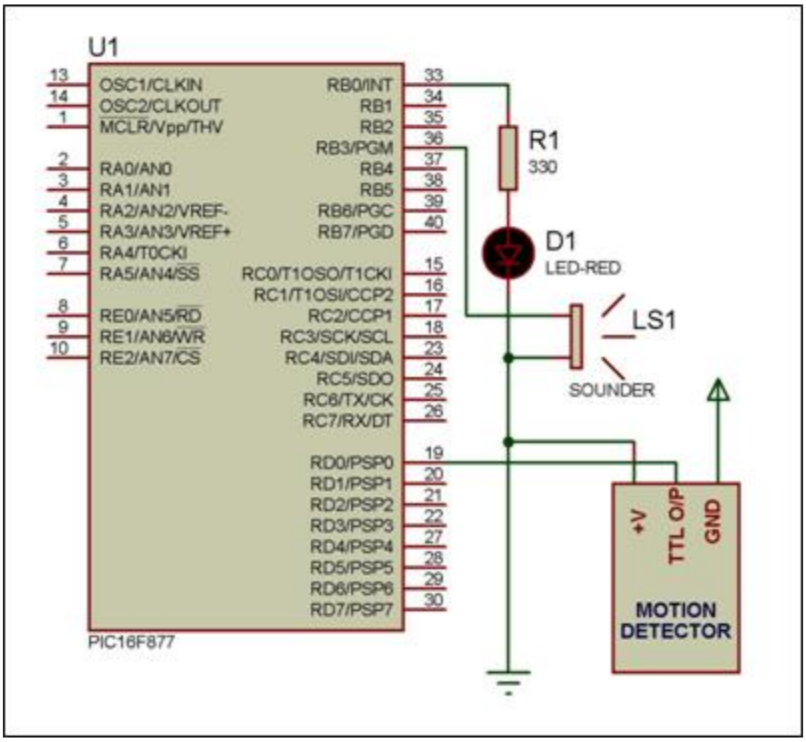

Figure 4.10: Motion detector connection diagram

4.4.1 Fresnel Lens

A Fresnel lens is a Plano Convex lens that has been collapsed on itself as in Figure 4.11 to form a flat lens that retains its optical characteristics but is much smaller in thickness and therefore has less absorption losses.

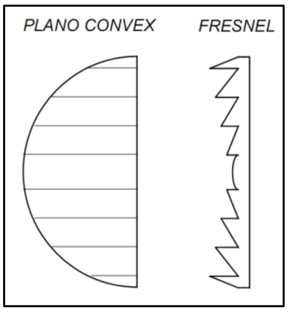

Figure 4.11: Fresnel lens construction

Parallax had equip its motion sensor with Fresnel lens that made of an infrared transmitting material that has an IR transmission range of 8 to 14 µm that is most sensitive to human body radiation. It is designed to have its grooves facing the IR sensing element so that a smooth dome surface is presented outward to the subject. Chart of IR wavelength is presented in Figure 4.12 below.

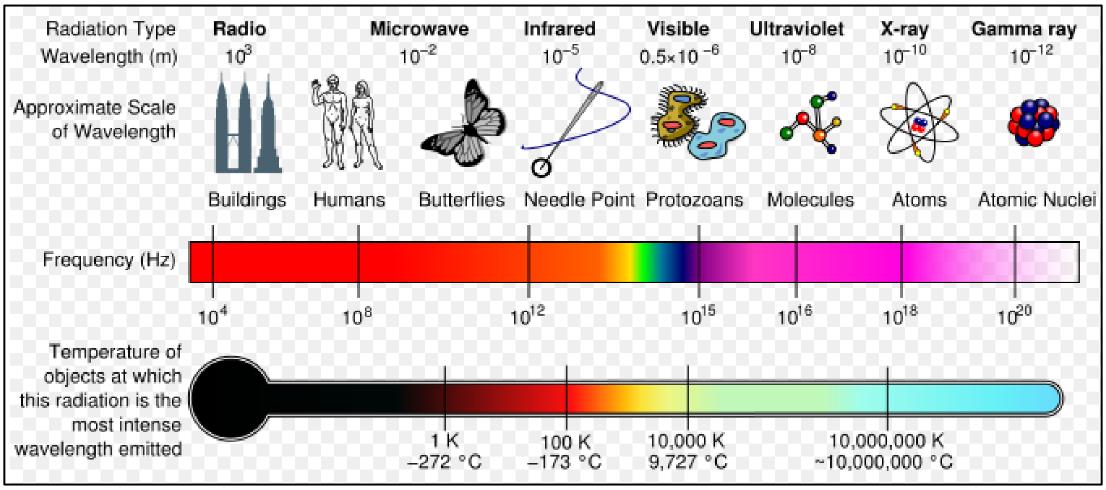

Figure 4.12: Infrared Wavelength chart

4.5 Piezoelectric Buzzer

A buzzer for this project is for alarming sound or siren. For prototype purpose, a low power piezoelectric buzzer in chosen. This device can operate excellently for 5V environment with acceptable level in decibels for alarming purpose. The connection diagram to microcontroller already showed previously in Figure 4.10 where the buzzer labeled as sounder.

Piezoelectric material used in many application such as sensor, acoustic pickup, sound device, print head and many more. There are two categories of the material; ceramic and crystal. In this case, sound from buzzer generated when electrical current applied to piezoelectric device. Mechanical stress occurred which is directly proportional to current applied will produce high frequency sound. Figure 4.13 and 4.14 shows the buzzer internal parts, construction and how it works.

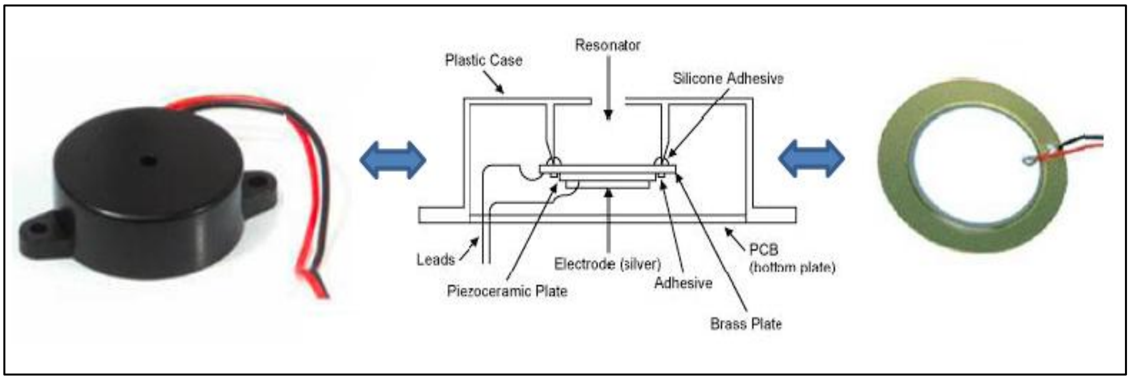

Figure 4.13: Piezoelectric buzzer details

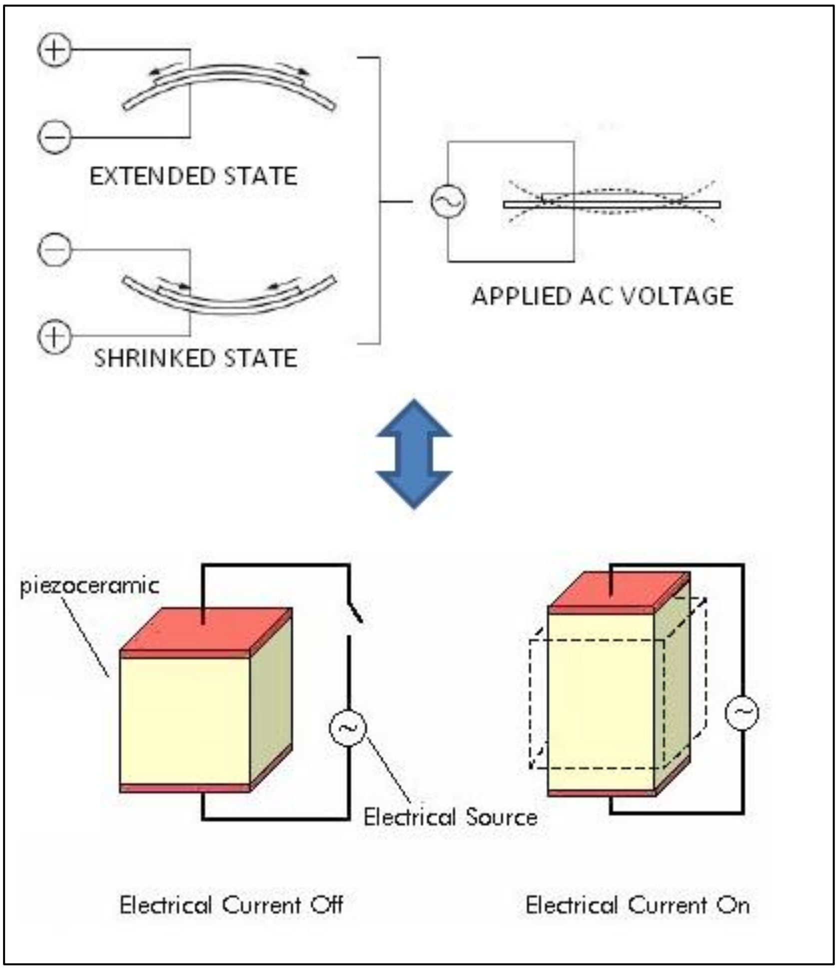

Figure 4.14: Concept use in producing sound

CHAPTER 5

SOFTWARE IMPLEMENTATION

5.1 Chapter Overview

This chapter will explain thoroughly of software used. This software part will include the simulation, compiler, programming and GUI. Most of the software used are closely related to hardware and depend with each other. Preferable softwares somehow were guided by supervisor and through seminar.

This chapter also however concentrated on programming, especially for serial communication. Part of this thesis also will discussed about involved AT-Commands that used by BlueSmirf Silver Bluetooth Module.

Simulation is quite useful before we build the actual circuit on the board. However, unfortunately for this project, the simulation could not provide desired output and not very helpful. This is because of the absence of Bluetooth Module and motion detector similar device. Since then, we could only able to simulate that the data successfully sent serially.

For GUI part, there will only brief explanation since we use open source software that hosted in website. Coding and programming language are the main elements and will explained in detail.

5.2 MicroCode Studio

This software had many features other than compiling the written codes and it has easy to use GUI. Microcode Studio also can handle many variant of PIC microcontroller. However, we just using the compile function since we need the HEX file in order to burn into PIC microcontroller. Microcode Studio also can be used with PIC burner, however suitable burner for it unfortunately unavailable.

Program for PIC microcontroller is written in PicBasicPro (PBP) which is seem to be easier than other Programming Language for PIC microcontroller. Screenshot of the software is shown in Figure 5.1.Full programming codes can obtain in Appendix B.

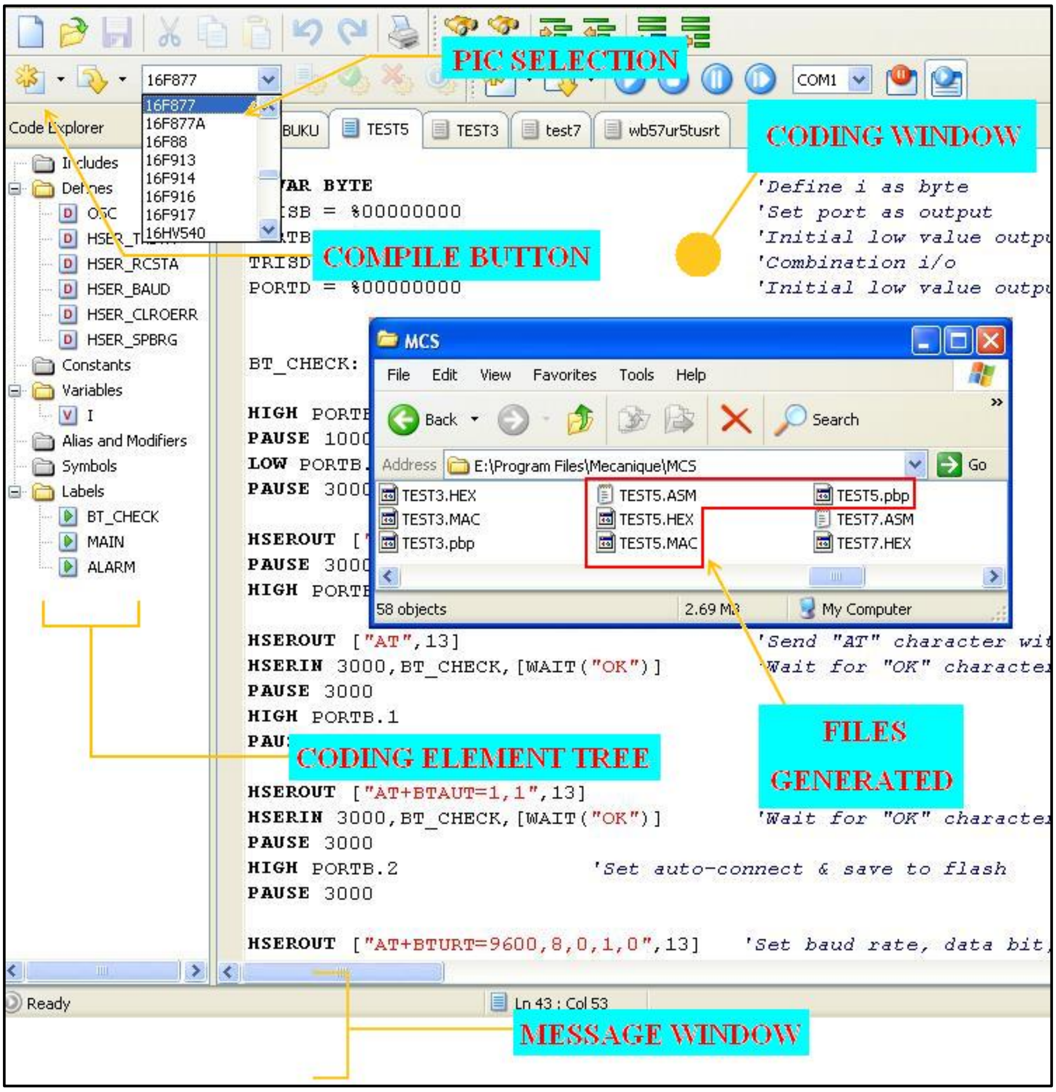

Figure 5.1: Microcode Studio GUI screenshot

5.2.1 PICBASIC PRO (PBP)

Choosing programming language for PIC microcontroller also is a critical task in this project development. Available in many types, several criterions should be taken in consideration. Since this project is leading to prototyping Bluetooth device in security system, PBP is chosen to ease the project development.Table 5.1 shows comparison of programming languages where several feature and criteria used as comparison points.

Table 5.1: Programming languages comparison

Language	Wide Support	Simplicity	Structure	Ease Troubleshoot
Assembly	√			
C	√		√	
PBP	√	√	√	√

5.2.1.1 Testing Program Module

Before starting further to next level, this testing module should be applied to ensure hardware can functioned properly with coding programmed. This project involved three main part; PIC microcontroller, Bluetooth Module and Motion Detector. Thus, part for mobile phone communication will be tested later because it require further configuration in mobile phone software.

To save time effectively, an automated testing program is coded to launch hardware functional checks. The outputs or indicators were determined by turning LEDs on and off. Figure 5.2 below shows program code for testing with explanations at the comment.

```
DEFINE OSC 4                           '20MHz crystal - 3us min delay
DEFINE HSER_TXSTA 24h                  'Enable continous transmit, BRGH
DEFINE HSER_RCSTA 90h                  'Enable continous receive
DEFINE HSER_BAUD 9600                  '9600bps @ 0.16% error
DEFINE HSER_CLROERR 1                  'Auto clear overflow error
DEFINE HSER_SPBRG 25                   'Value of SPBRG for 9600bps

HSEROUT ["+++",13]                     'BlueSmirf Enter command mode
PAUSE 3000                             'Delay 3s
HIGH PORTB.0                           'LED_1 ON

HSEROUT ["AT",13]                      'Send "AT" character with CR
HSERIN 3000,BT_CHECK,[WAIT("OK")]      'Wait for "OK" character max 3s
PAUSE 3000                             'Delay 3s
HIGH PORTB.1                           'Turn LED_2 ON
PAUSE 3000                             'Delay 3s

PORTB = %00000000                      'Turn All output OFF
PAUSE 1000                             'Delay 1s
PORTB = %00001111                      'Turn LED & Buzzer ON
PAUSE 1000                             'Delay 1s
PORTB = %00000000                      'Reset output
PAUSE 1000                             'Delay 1s


MAIN:                                  'Label

IF PORTD.1 = 1 THEN GOTO ALARM         'Sensor Detect Condition
IF PORTD.1 = 0 THEN GOTO MAIN          'Sensor No-Detect Condition


ALARM:                                 'Label
HIGH PORTB.2                           'PIR sensor detect, ON LED_3
PAUSE 60000                            'Delay 60s
HIGH PORTB.3                           'Turn Buzzer ON
PAUSE 60000                            'Delay 60s
PORTD = %00000000                      'Reset Sensor State
PORTB = %00000000                      'Turn LED_3 OFF
GOTO MAIN                              'Loop  to label MAIN

END
```

Figure 5.2: An automated program coding for hardware testing

5.2.1.2 Serial Communication Module

Serial communication is a heart for this project which determines how devices should communicate. For devices like PIC microcontroller and Bluetooth Module, baud rate is the main parameter that must defined properly. Regarding to mobile phone or PC build Bluetooth/Bluetooth dongle, the baud rate is not main concern since it is auto detect and after connect it will automatically adapt or matching the speed. Figure 5.3 shows how PIC16F877 baud rate configured using programming code. Detailed information for register involved such as TXSTA and RCSTA are attached in Appendix D.

```
DEFINE OSC 4                'Define Oscillator Value
DEFINE HSER_TXSTA 24h       'Set TXSTA Register
DEFINE HSER_RCSTA 90h       'Set RCSTA Register
DEFINE HSER_BAUD 9600       'Define baud rate = 9600bps
DEFINE HSER_CLROERR 1       'Auto clear overflow error
DEFINE HSER_SPBRG 25        'SPBRG value for 9600bps
```

Figure 5.3: PIC16F877 baud rate configuration

Same goes for BlueSmirf Silver, the baud rate must be set manually. For this part, configuration using PIC microcontroller is shown. In later, same configuration using HyperTerminal will be discussed. Figure 5.4showscoding for BlueSmirf Silver baud rate setting via PIC microcontrollers.

```
HSEROUT ["+++",13]                     'Enter Command Mode
PAUSE 3000

HSEROUT ["AT+BTAUT=1,1",13]            'Enable Auto-Connect
PAUSE 3000

HSEROUT ["AT+BTURT=9600,8,0,1,0",13]   'Set baud rate, data bit, stop bit & parity
PAUSE 3000

HSEROUT ["AT+BTSEC=0",13]              'Disable Security Mode
PAUSE 3000

HSEROUT ["AT+BTFLS",13]                'Save settings
PAUSE 3000

HSEROUT ["AT+BTSRV=1",13]              'Switch to Server Mode
PAUSE 1000
```

Figure 5.4: BlueSmirf configured using PIC16F877

5.2.1.3 Sensor Detection Module

Sensor used in this project, had uptime delay and also detection delay time. Thus the delayed alarming is one of this project features, the sensor delay specification also eventually gives advantages to the design. Delay occurrences in the device behavior are carefully considered to avoid too early detection and too early triggering. Same like program for switch monitoring, the PIR motion detector coding just need several delay for addition which is shown in Figure 5.5 below.

```
MAIN:                                   'Label

IF PORTD.1 = 1 THEN GOTO ALARM          'Monitor Sensor
IF PORTD.1 = 0 THEN GOTO MAIN           'Monitor Sensor

ALARM:                                  'Label
HIGH PORTB.2                            'Sensor trigger output_1
PAUSE 60000                             'Delay 60s
HIGH PORTB.3                            'Sensor trigger output_2
```

Figure 5.5: Program for sensor detection

5.3 Proteus 7

For simulation purpose, Proteus 7 is used because the parts library consists of PIC16F877. Moreover, the software also simulates within compiled program or HEX file which same as we burned into PIC microcontroller. Other additional features were like capable integrate with other software, wide library of parts and real time simulation.

As discussed before, this project did not benefit much from using Proteus 7 because lack of similar part as Bluetooth Module. As we not able to simulate the Bluetooth data transfer and motion detector function, we manage to use it for another purpose; voltage, current and signal measuring. Alternatively, push button and virtual terminal able to take part for replacement of motion detector and Bluetooth Module. Through Figure 5.6(a) to Figure 5.6(c) shows the process creating the simulation.

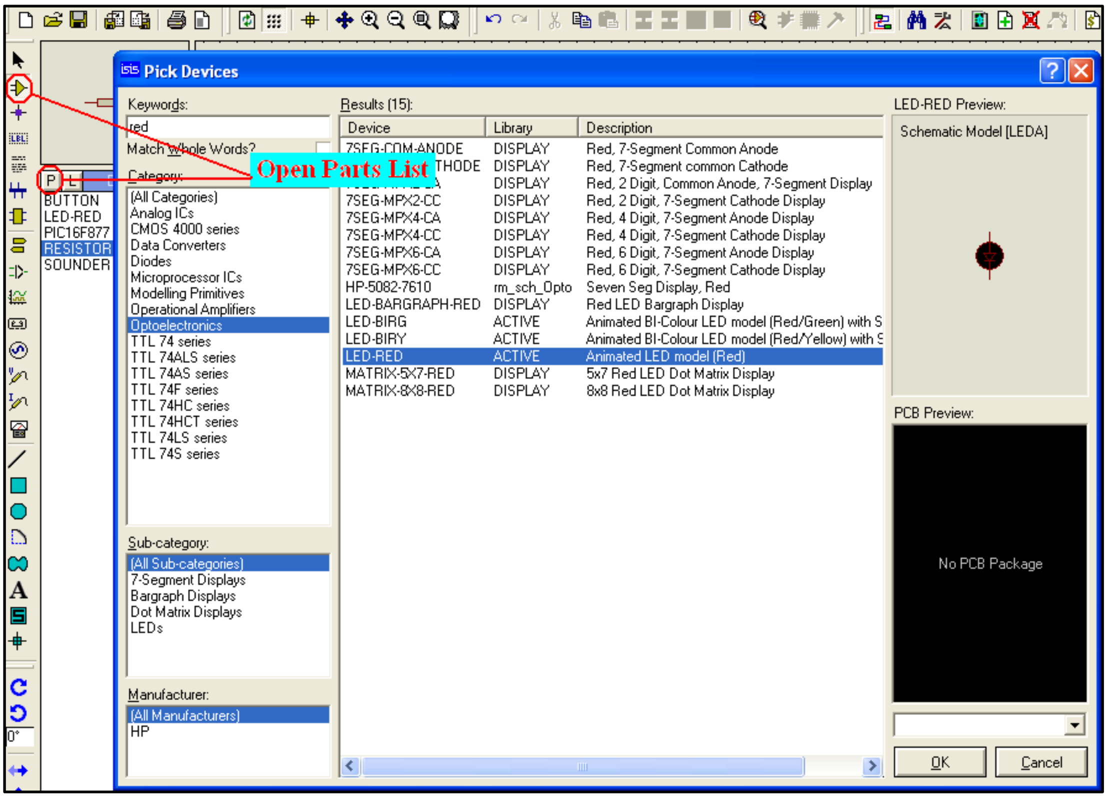

Figure 5.6(a): Pick devices for circuit design

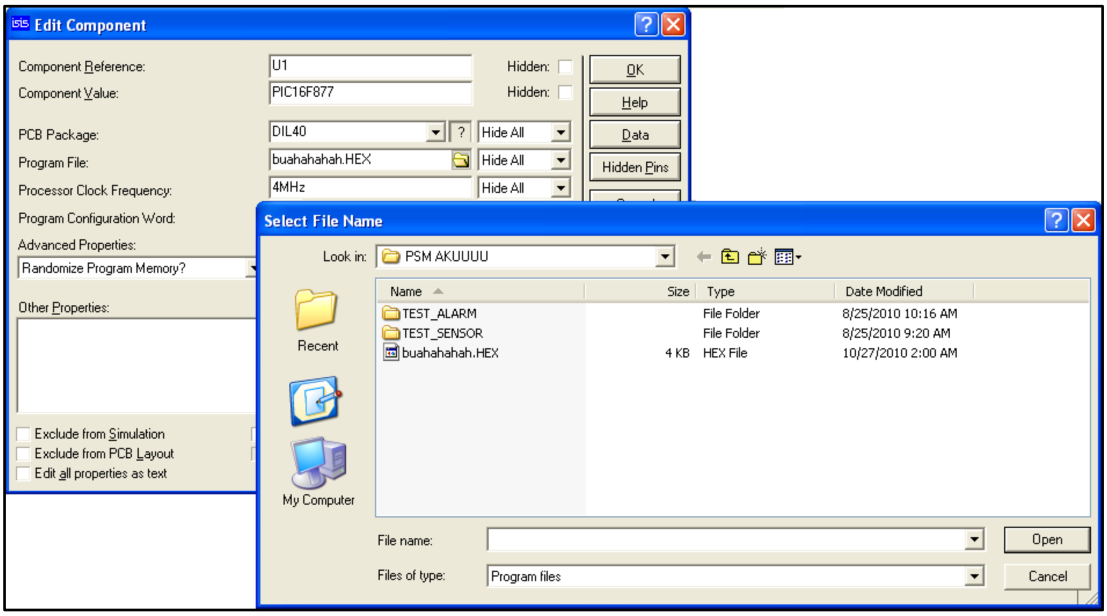

Figure 5.6(b): Load HEX file to microcontroller

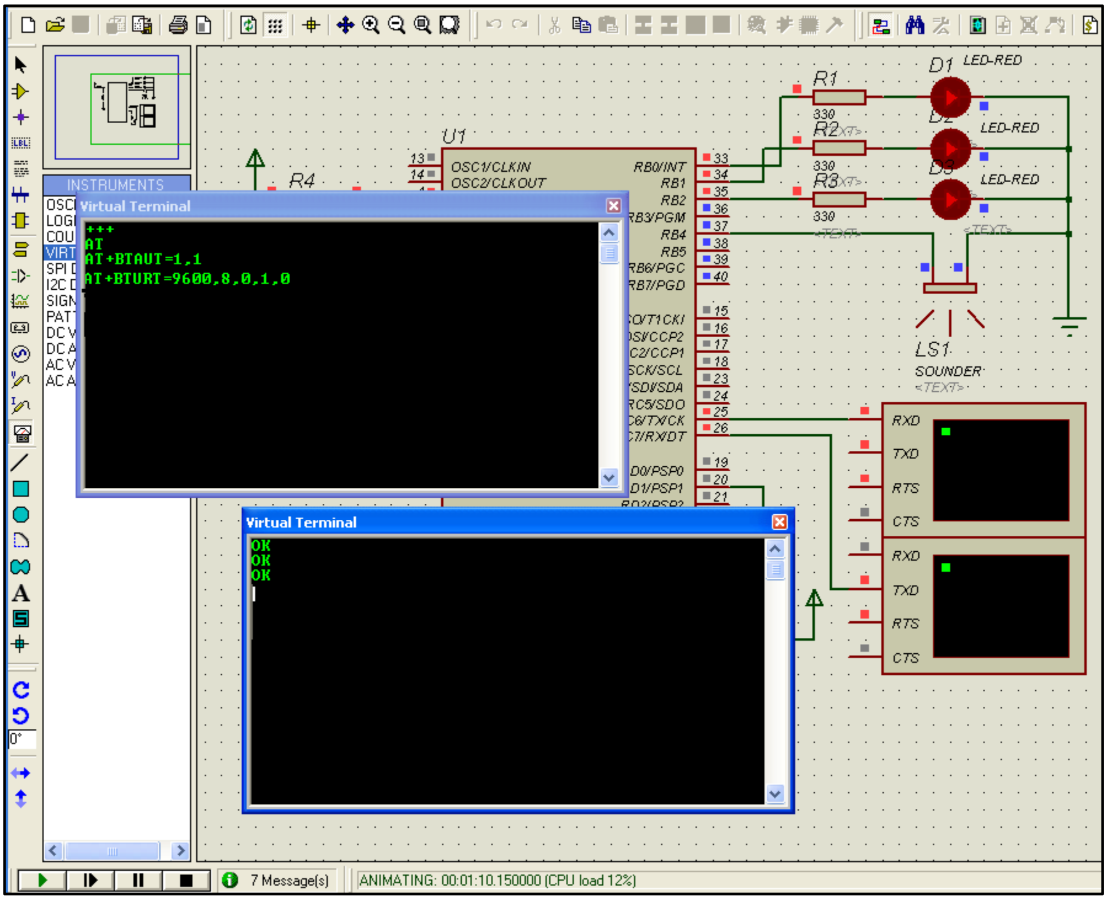

Figure 5.6(c): Running the simulation

Even the simulating is a good practice, certain important notes should be taken regarding the circuit simulation which is;

- PIC microcontroller clock is set in device properties (oscillator circuit had no effect)
- TX and RX link depend on actual device
- Actual result can be greatly differs from simulation
- Simulation result is not 100% accurate

5.4 melabs Programmer

Programming or burning software is required in order to program our PIC microcontroller. Using external programmer will help reduce complexity in circuit design and program codes. This software had implemented simple interface and support wide variety of PIC microcontrollers. Moreover, melabs Programmer actually developed by Microchip which is the PIC microcontroller manufacturer. For this reason, it is trustable to work fine with PIC16F877. The burning device and software are shown in Figure 5.7 including step by step instruction.

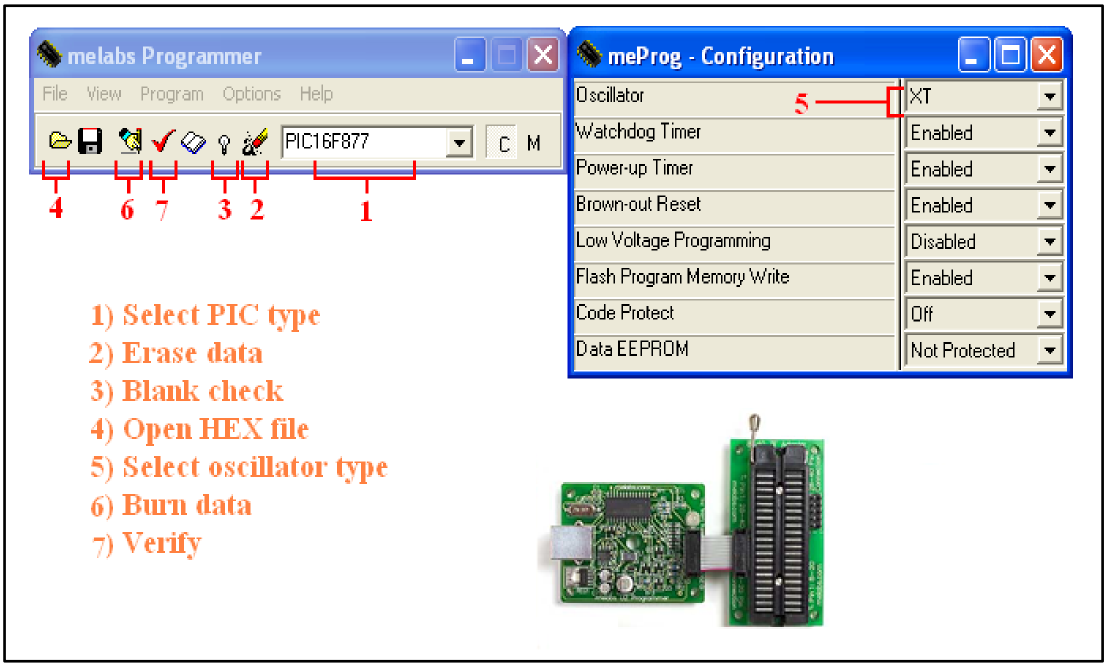

Figure 5.7: melabs Programmer device and instruction

5.5 IVT BlueSoleil

This software actually an open driver used for interfacing with various Bluetooth dongle made by IVT Corporation. We use this driver since the Bluetooth dongle model number being used is unknown hence only labeled with IVT logo. Offering many services, combination this Bluetooth dongle and IVT BlueSoleil software do much favor obtaining information required. Services offered by connected devices, connection status, port number and devices address quite easily obtained using this software. Screenshot through Figure 5.8(a) to 5.8(b) gives better explanation on the software interface.

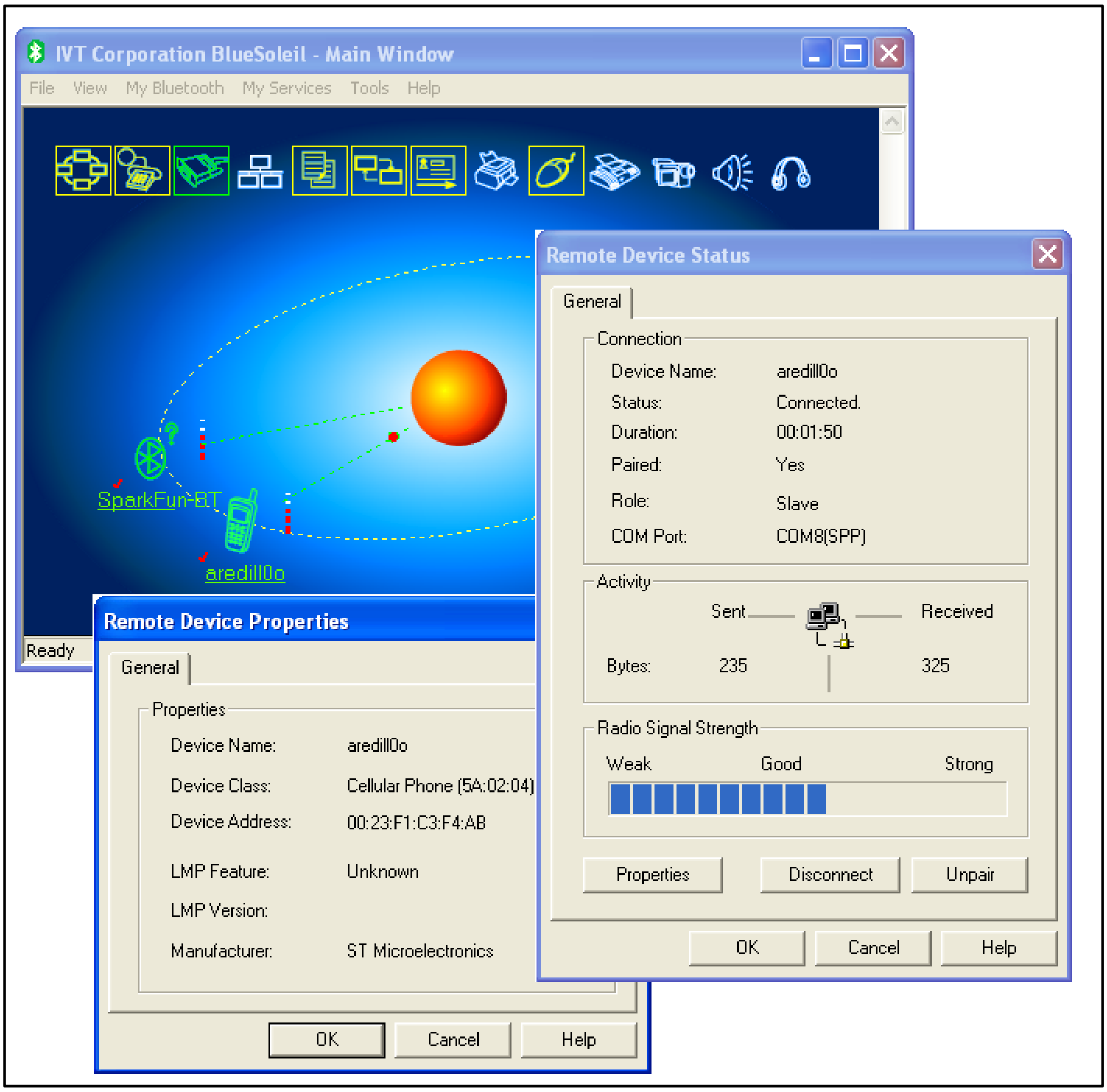

Figure 5.8(a): Obtaining information for mobile phone

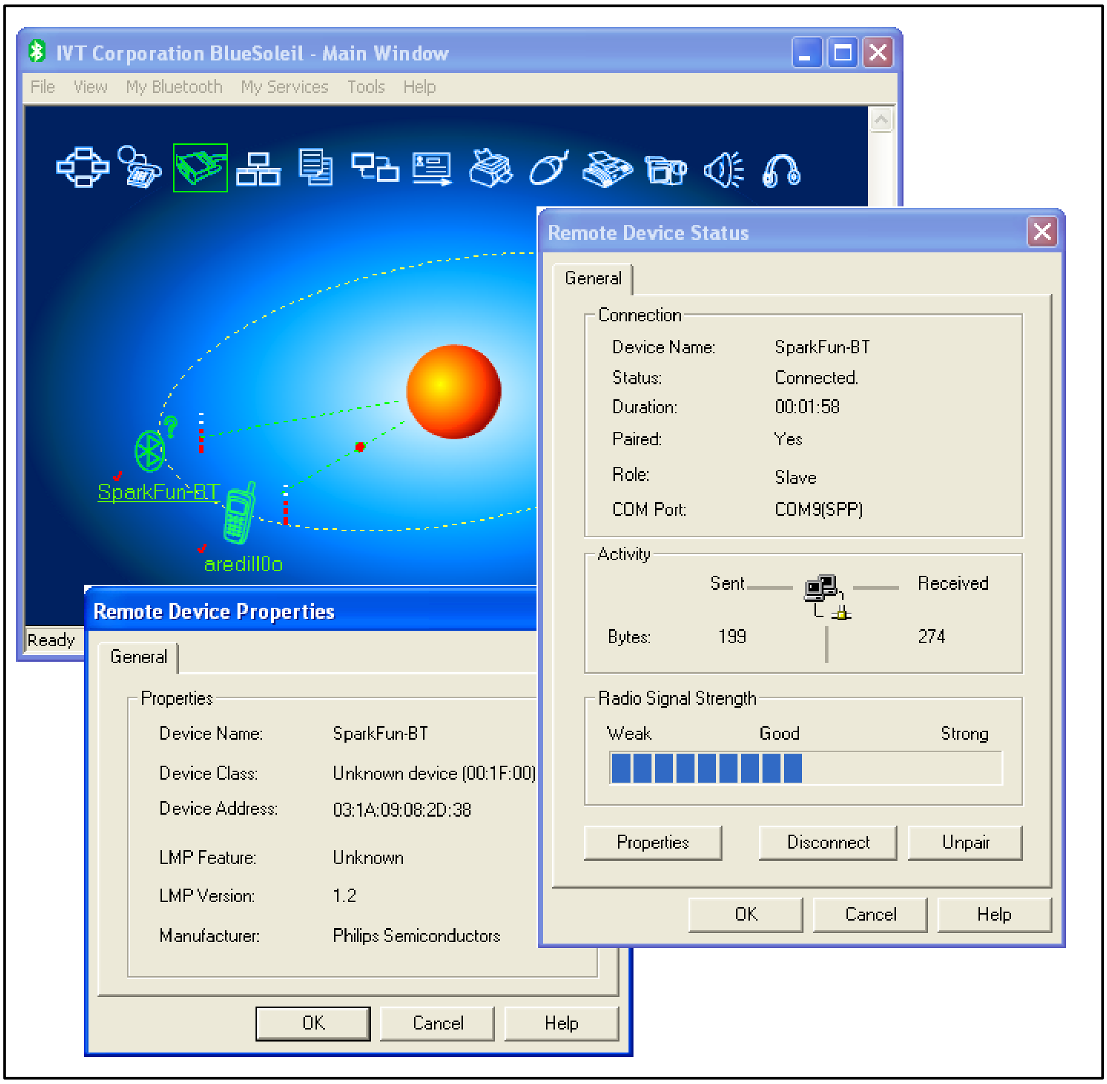

Figure 5.8(b): Obtaining information for Bluetooth module

5.5 HyperTerminal

HyperTerminal is bundled software from Microsoft which is included in Windows XP and previous version of Microsoft OS. The function is actually to emulate serial communication and data transfer. Settings for communication are highly customizable make it support various speed and devices.

For this project, HyperTerminal used as alternative way to configure BlueSmirf Silver settings. The RS-232 shifter must be used with BlueSmirf Silver for this this method as discussed earlier. Figure 5.8(a) through 5.8(d) will gives guide on how to use HyperTerminal to configure BlueSmirf Silver settings.

Figure 5.9(a): Create new connection

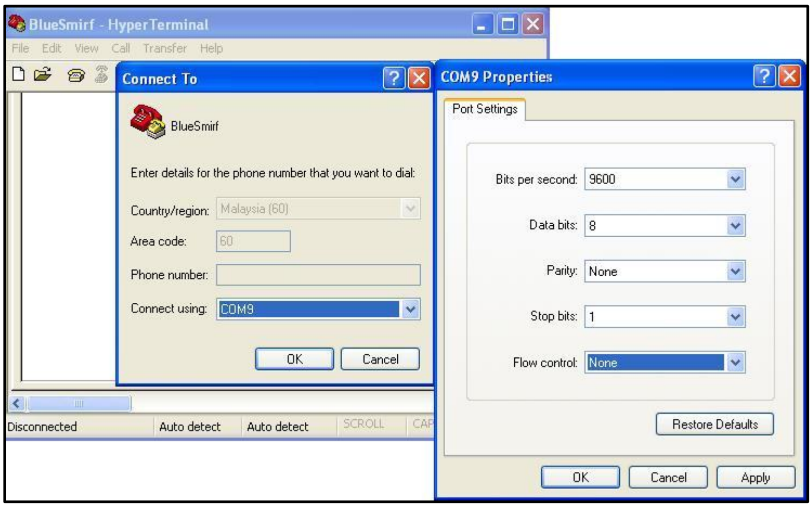

Figure 5.9(b): Connection settings

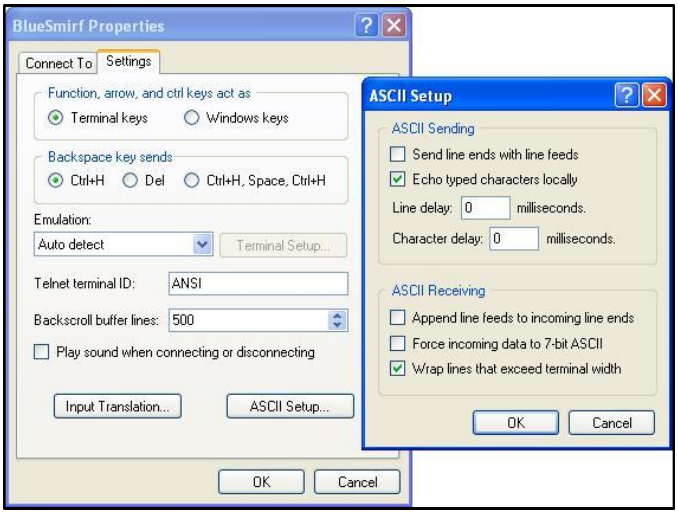

Figure 5.9(c): Text and data settings

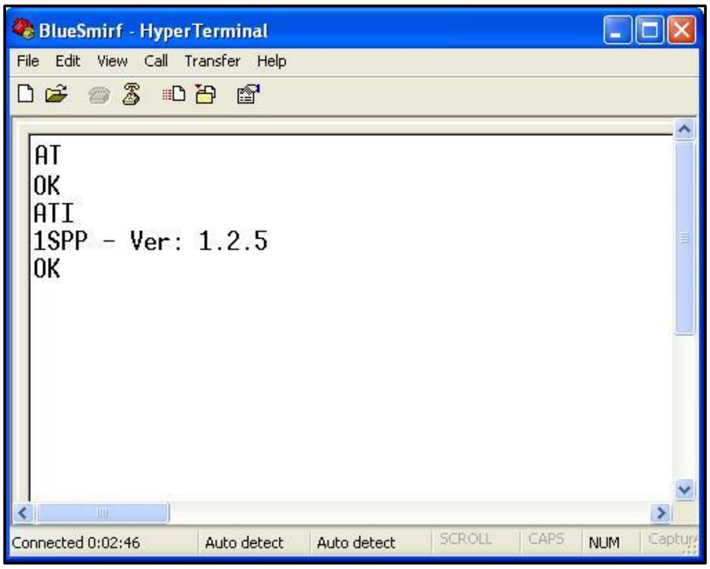

Figure 5.9(d): Typing command and receiving reply

5.5.1 AT-Commands

AT-Commands actually were command set consists of series of short text strings combine together for certain operation. However, these commands become more manufacturer custom where it commands set different for each manufacturer or model series. Table 5.2 listed the related and important AT-Command used in this project with essential to configure the BlueSmirf Silver. Complete list of AT-Commands for BlueSmirf Silver is attached in Appendix C.

Table 5.2: List of important AT-Commands

AT-Command	Function
AT+BTFLS	Store settings to Flash – writes current configuration to Flash
AT+BTBDA	Bluetooth Address – read local Bluetooth device address
AT+BTAUT	Automatic Connection Mode – configure automatic connection settings
AT+BTSRV	UART – read/write current UART configuration settings
AT+BTSEC	Server – configure device to accept SPP connections (incoming)

5.6 Btterm

Developing software and GUI for mobile phone is quite tedious work. Realizing this, we use open source software that freely distributed over internet. Btterm is a software for Java mobile phone having function like HyperTerminal in Windows. This software is hosted in SourceForge website for study and commercial purpose. Since Btterm is just release a few months, the supported devices are limited. Figure 5.10 shows few of screenshots on how to use the software. For this project, we use this software in purpose to receive the emergency alert from security system and also to trigger the system. The resultant screenshot during operation will be shown later in next chapter.

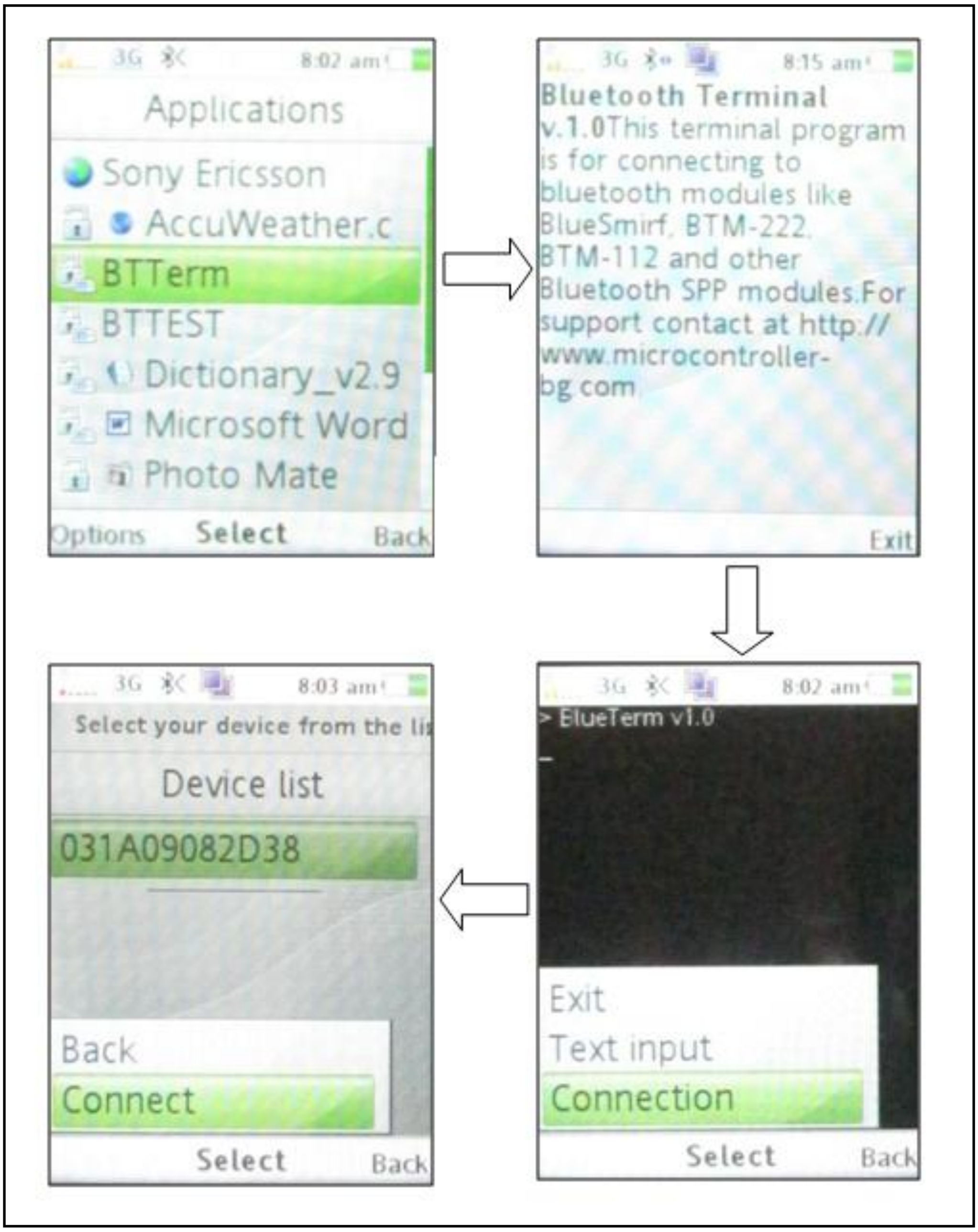

Figure 5.10: Using Btterm software

CHAPTER 6

RESULT & DISCUSSION

6.1 Chapter Overview

This chapter discusses the result after the complete circuit has been developed. The input which mean human detected comes from motion detector while the output is the sounding buzzer, lit LED and alert text to mobile phone. The systems is said to be functioned if the buzzer activated after defined time delay and alert text sent to mobile phone. Actual situation for functionality is based from assumptions that were discussed earlier. This chapter also includes result obtained from simulation in Proteus software.

Additionally, the limitations in this project also discussed as to provide clear information on how the hardware functioned. The total cost estimation to build this hardware is presented as evidence of low cost for production.

6.2 Process Flow

The alarm security system process flow is developed in early of the project to have guidelines how the hardware works. Both for simulation and actual circuit, this project successfully functioned as it desired as show in flowchart in Figure 6.1.

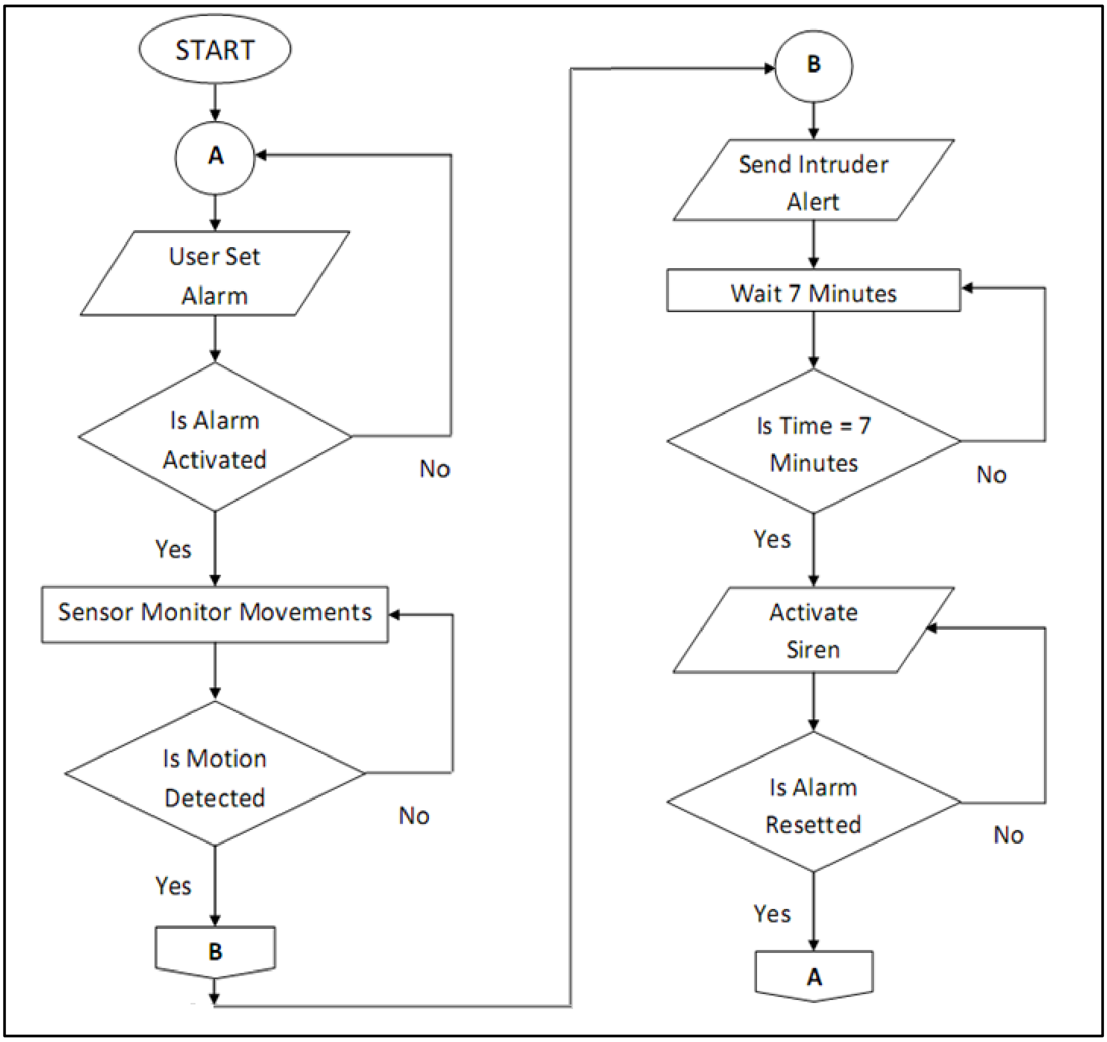

Figure 6.1: Result process flowchart

6.3 Simulation Result

For this project, simulation result also determines the success possibility of actual circuit. Lacks of several important parts in Proteus had made its result less accurate but still reliable. Figure 6.2 and Figure 6.3 below shows results in simulation which mostly focused at virtual terminal and LEDs.

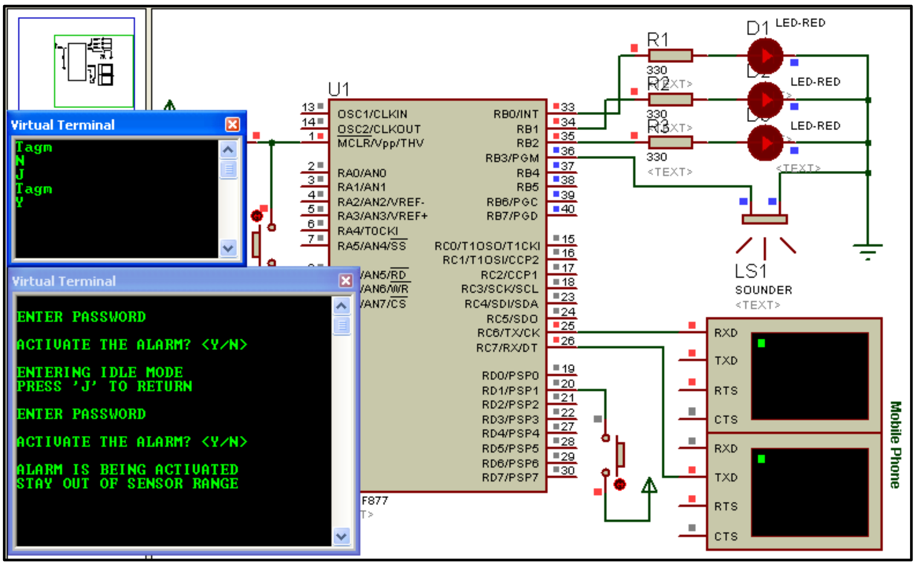

Figure 6.2: Simulating idle mode and arming

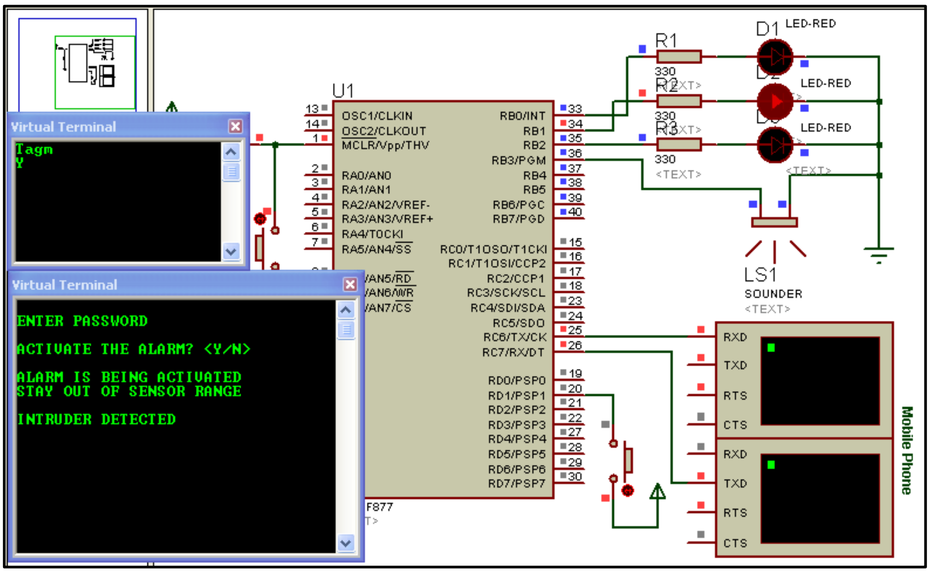

Figure 6.3: Simulating sensor triggering

6.4 Discussion for Simulation

Referring to Figure 6.2 and Figure 6.3, there are two virtual terminal for determine serial data transfer. Both virtual terminals which labeled as 'Mobile Phone' represent mobile phone used. Characters appeared in both virtual terminal will as well displayed in mobile phone screen. Motion detector is replaced by push button so it can be manually triggered.

During the simulation, character 'Tagm' sent to PIC to activate or arm the alarm system. The interface which can be said part of GUI will ask for confirmation before arming the alarm system. If the user decides to not arming the alarm system, it will enter idle mode or standby state. The escape code, defined as 'J' character will wake up the system and then password will be asked afterward.

When alarm system is confirmed to be activate, whole three indicator LED's will lit and user will prompted to stay out of sensor range. The alarm system then will start monitor the switch continuously. When push button which representing the motion detector is press, indicating LED will lit on and character 'INTRUDER DETECTED' will sent to mobile phone. To deactivate the alarm sensor, the code 'Tagm' need to be entered again.

6.5 Actual Circuit Result

For actual circuit, the results seem the same as simulation. The programming codes for configure BlueSmirf Silver were not include since it only one time configuration and to increase stability. Figure 6.4(a) to 6.4(d) shows how the circuit works.

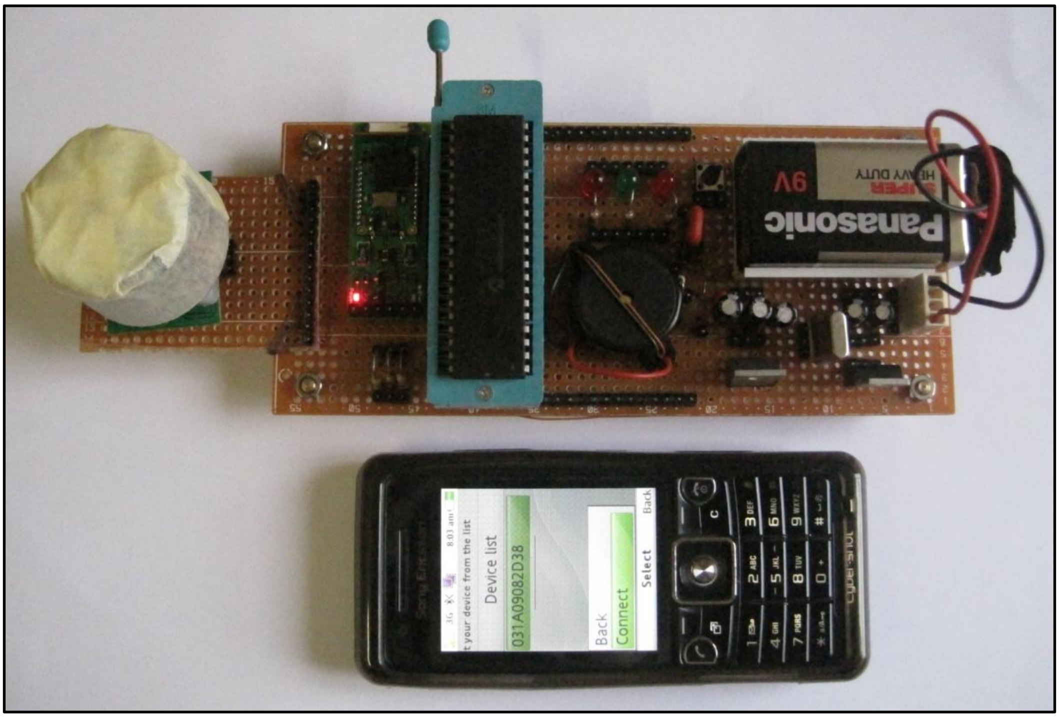

Figure 6.4(a): Establishing connection

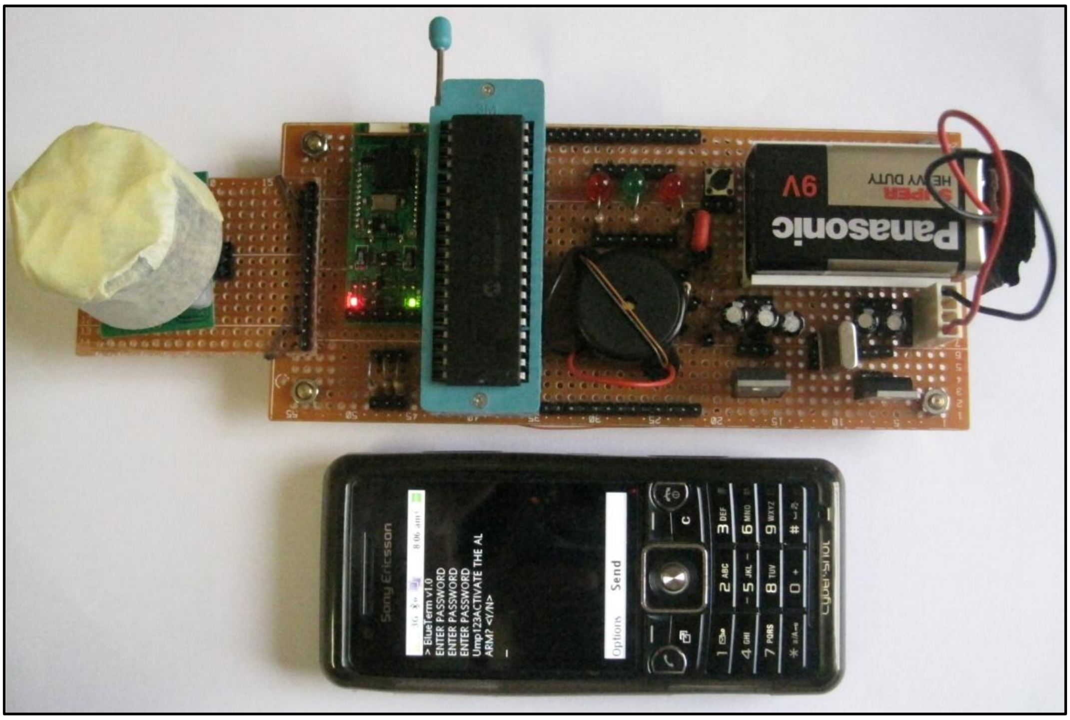

Figure 6.4(b): Input the password

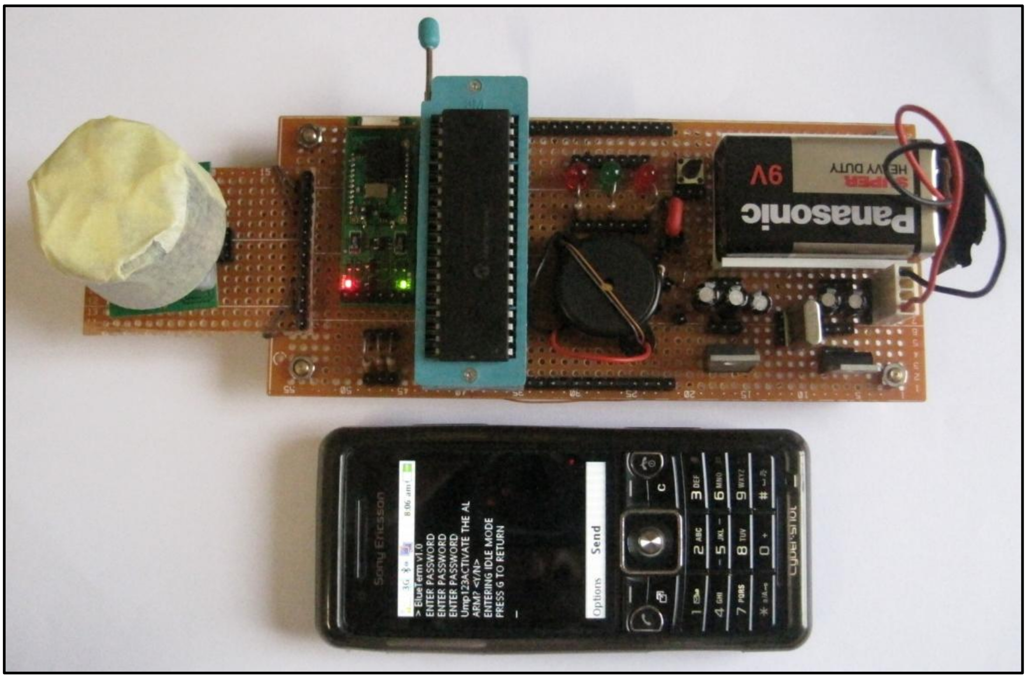

Figure 6.4(c): Idle mode entered

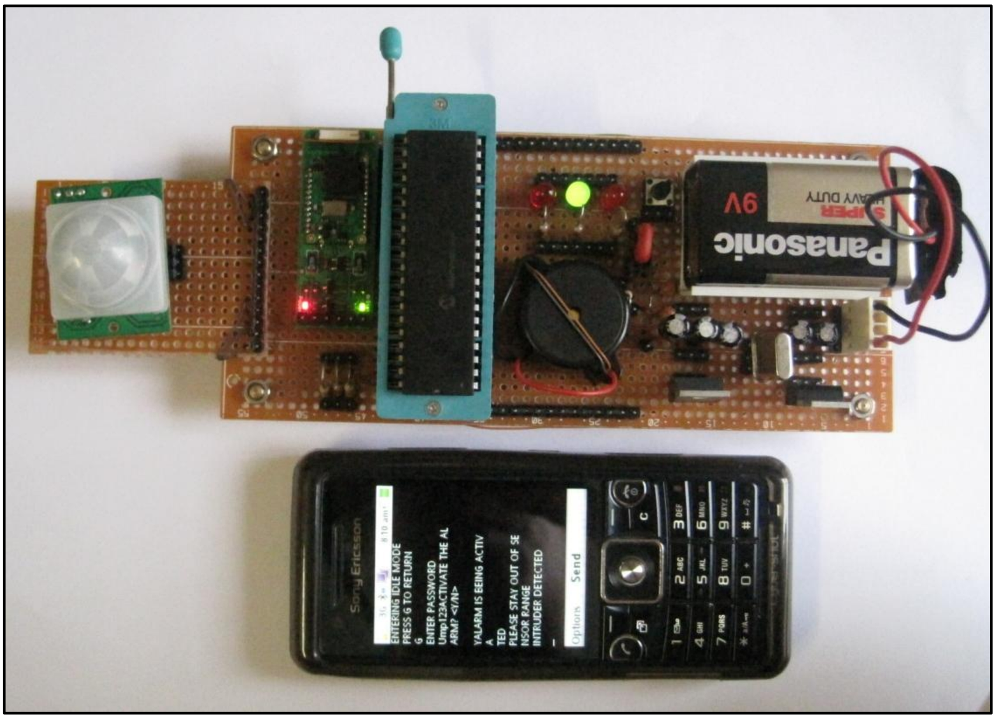

Figure 6.4(d): Intruder detected and alert is sent

6.6 Discussion for Actual Circuit

Referring to Figure 6.4(a) to 6.4(d), the desired output had been achieved such as expected in simulation. Arming the system by sending character 'Tagm' which works as a password will proceed to confirmation part. Entering character 'Y' for confirmation to arm the system will proceed to next step where user will prompted by LED's and text input.

In other way, if user entering character 'N' for confirmation to arm the system, or no input entered, the system will enter idle mode. Idle mode is one of security feature designed for this system. Escaping from idle mode by entering character 'J' will follow by password confirmation afterward. This can make this system functioned securely in continuous period of time.

While armed, the motion detector will start monitor human presence. If human presence is detected, the intruder alert will send to mobile phone then after seven minutes system will sound the buzzer. The buzzer will continue on until reset code which is the password is entered. Moreover, user also can deactivate the alarm system anytime. Software coding for this functional system is attached in Appendix B.

6.7 Cost Analysis

As stated in Table 6.1, the cost to build the project is very low compared to other security system on market. Moreover, the cost can be reduced more if the alarm system produced in mass volume. Need to mention here, this is only hardware cost. Tools and software cost is discarded since it was supported by university and some of it was production utilities cost.

Table 6.1: Cost for project development

Component	**Price/Unit**	**Quantity**	**Total Price**
330 Ω Resistor	RM0.05	3	RM0.15
4.7 kΩ Resistor	RM0.10	1	RM0.10
10 kΩ Resistor	RM0.15	1	RM0.15
68 kΩ Resistor	RM0.20	1	RM0.20
120 kΩ Resistor	RM0.20	1	RM0.20
PCB Header	RM1.50	4	RM6.00
Header Base	RM1.50	2	RM3.00
4-Pin Socket	RM0.80	2	RM1.60
LED	RM0.60	3	RM1.80
Push Button	RM0.10	1	RM0.10
10 µF Capacitor	RM0.15	3	RM0.45
0.1 µF Capacitor	RM0.10	2	RM0.20
10 pF Capacitor	RM0.10	2	RM0.20
LM7805	RM2.50	1	RM2.50
LD1117	RM2.50	1	RM2.50
4 MHz Crystal	RM5.00	1	RM5.00
5V Piezo Buzzer	RM2.00	1	RM2.00
Vero board	RM6.00	1	RM6.00
Motion Detector	RM20.00	1	RM20.00
ZIF Socket	RM8.00	1	RM8.00
BlueSmirf Silver	RM275.00	1	RM275.00
PIC16F877	RM16.90	1	RM16.90
Total Cost			**RM352.05**

CHAPTER 7

CONCLUSION & RECOMMENDATIONS

7.1 Conclusion

In a nutshell, this alarm system is built within low cost. Moreover, the system can be implemented in a various type of building like apartment, double storey or even warehouse due to efficient sensor. However, to have fully operated system, nearby neighborhood house must within Bluetooth range to make sure intruder alert successfully sent. In addition, this wireless system can be armed or disarmed individually with customizable specific code which is proven highly secure since password is needed to operate the system. Status of the alarm system can be easily determined by observing the LEDs and buzzer sound. In overall, it can be concluded that the system functions as intended and meet the objectives of this project.

7.2 Recommendations

Since this project is important to effectively reduce the burglary and catch the criminal cases in Malaysia by providing advanced feature at low cost, some recommendations to improve this project are hereby proposed. Some of the suggestions are listed as below:

- The communication should be more wide and support multipoint connection like using GSM, ZigBee or active RFID
- More sensor type used such as magnetic contact and smoke detector to integrate additional features like fire alert
- Using it as wireless key too such as SOREX product that had been reviewed earlier in this thesis
- The software for mobile phone should be more universal which is suitable for many types of mobile phones
- Using bigger battery pack for supply that can last longer and rechargeable

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22. http://nchc.dl.sourceforge.net

APPENDIX A
FULL PROGRAM CODE FOR ALARM SYSTEM

```
'************************************************************
'*  Name        : BLUETOOTH TRIGGERED ALARM SYSTEM           *
'*  Author      : MUHAMMAD FADHIL B. ABDUL MALEK             *
'*  Date        : 09/10/2010                                 *
'*  PIC         : 16F877                                     *
'************************************************************
```

INITIALIZATION

```
DEFINE OSC 4                 '4MHz crystal - 3us min delay
DEFINE HSER_TXSTA 24h        'Enable continuous transmit, BRGH=1
DEFINE HSER_RCSTA 90h        'Enable continuous receive
DEFINE HSER_BAUD 9600        '9600bps @ 0.16% error
DEFINE HSER_CLROERR 1        'Auto clear overflow error
DEFINE HSER_SPBRG 25         'Value of SPBRG for 9600bps

TRISB = %00000000            'Set port as output
PORTB = %00000000            'Initial low value output
TRISD = %11111111            'Combination i/o
PORTD = %00000000            'Initial low value output
i VAR BYTE
```

CONFIGURE BLUESMIRF SILVER

```
BT_CHECK:

HSEROUT ["+++",13]                    'Enter Command Mode
PAUSE 3000

HSEROUT ["AT+BTAUT=1,1",13]           'Enable Auto-Connect
PAUSE 3000

HSEROUT ["AT+BTURT=9600,8,0,1,0",13]  'Set Properties
PAUSE 3000

HSEROUT ["AT+BTSEC=0",13]             'Disable Security Mode
PAUSE 3000

HSEROUT ["AT+BTFLS",13]               'Save settings
PAUSE 3000

HSEROUT ["AT+BTSRV=1",13]             'Switch to Server Mode
PAUSE 1000
```

CHECK PASSWORD

```
CHECKPASS:
PAUSE 3000
HSEROUT [13,"ENTER PASSWORD",13]              'Verify password
HSERIN 20000,CHECKPASS,[WAIT("Tagm",13)]
PAUSE 1000
HSEROUT [13,"ACTIVATE THE ALARM? <Y/N>",13]
PAUSE 1000
HSERIN 10000,IDLE1,[WAIT("Y",13)]             'Ask conformation
GOTO STAT
```

IDLE MODE

```
IDLE1:
PAUSE 1000
HSEROUT [13,"ENTERING IDLE MODE",13]          'GUI dialogue
PAUSE 1000
HSEROUT ["PRESS 'J' TO RETURN",13]            'Escape key


IDLE2:
PAUSE 1000
HSERIN 10000,IDLE2,[WAIT("J",13)]             'Scan for escape key
GOTO CHECKPASS
```

STATUS INDICATOR

```
PAUSE 500
HSEROUT [13,"ALARM IS BEING ACTIVATED",13]    'GUI dialogue
PAUSE 1000
HSEROUT ["STAY OUT OF SENSOR RANGE",13]
PAUSE 2000
PORTB = %00000111                             'Indication LEDs
PAUSE 2000
PORTB = %00000000                             'Reset LED state
```

SENSOR MONITORING

```
MAIN:
PAUSE 1000
IF PORTD.1 = 1 THEN ALARM                ‘Scan sensor input
IF PORTD.1 = 0 THEN MANUAL
```

DETECT INTRUDER

```
ALARM:
PORTB = %00000101                        'PIR sensor detect, ON LED
PAUSE 1000
PORTB = %00000000
PAUSE 1000
HSEROUT [13,"INTRUDER DETECTED",13]      'SENT ALERT
GOSUB BLINKER
HIGH PORTB.3                             'Buzzer sounds
```

DISARMING METHODS

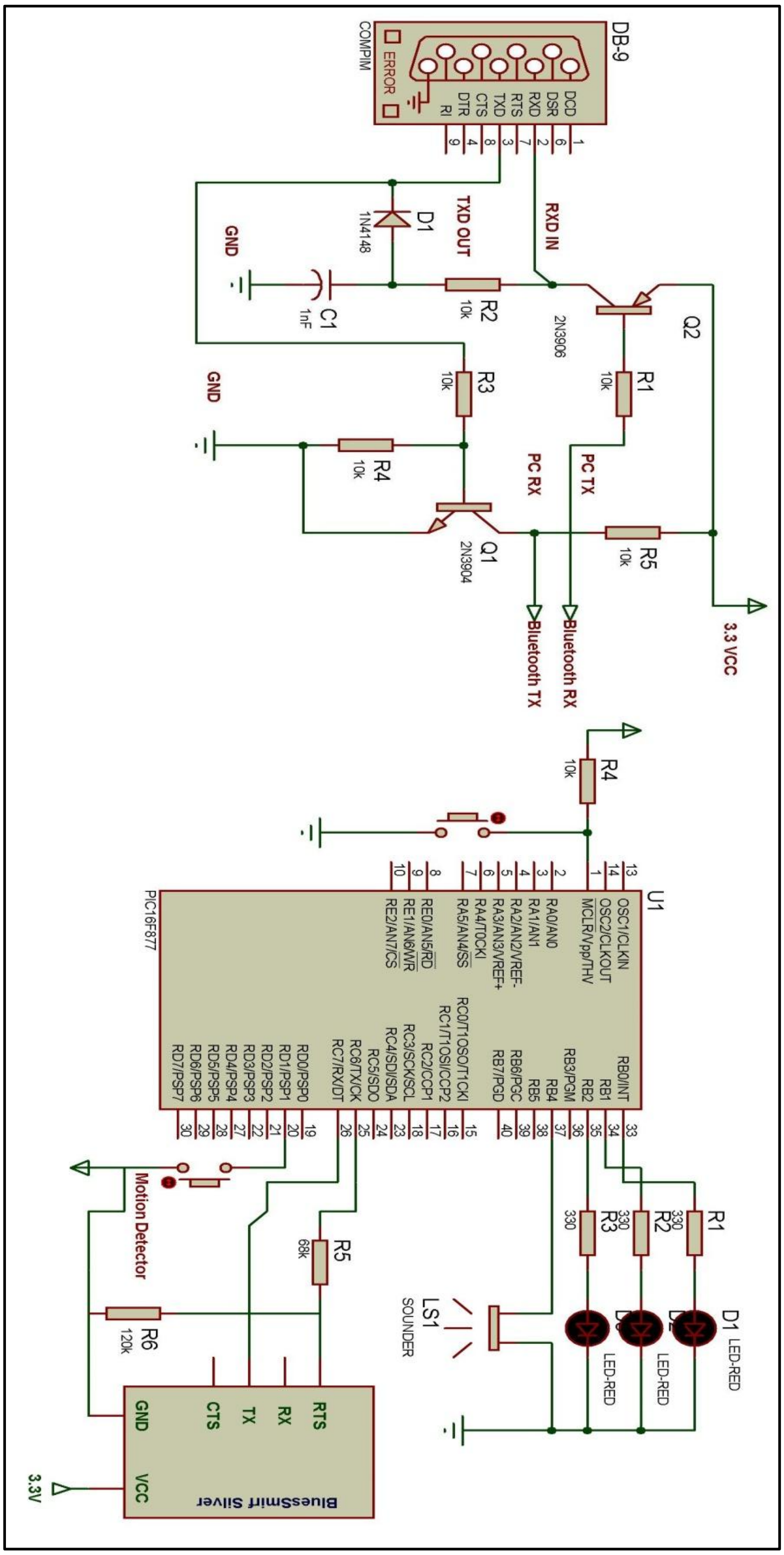
```
DISARM:
HSERIN 15000,DISARM,[WAIT("Tagm",13)]    ‘Wait reset codes/password
PAUSE 1000
LOW PORTB.3                              ‘Turn OFF buzzer
HSEROUT [13,"ALARM DEACTIVATED",13]
PAUSE 2000
GOTO IDLE1


MANUAL:
HSERIN 5000,MAIN,[WAIT("Tagm",13)]       ‘Manual override
PAUSE 1000
HSEROUT [13,"ALARM DEACTIVATED",13]
PAUSE 2000
GOTO IDLE1
```

FLASHING LED

```
BLINKER:
FOR i=1 TO 20                 'Blink +Delay
HIGH PORTB.1                  '0.5s X 20 delay
PAUSE 500
LOW PORTB.1
PAUSE 500
NEXT i
RETURN
```

APPENDIX B
SCHEMATIC CIRCUIT DIAGRAM



APPENDIX C
PIC16F877 DATASHEET

MICROCHIP

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

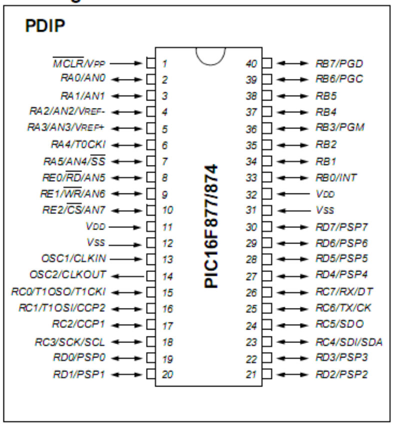
Devices Included in this Data Sheet:

- *PIC16F873*
- *PIC16F874*
- *PIC16F876*
- *PIC16F877*

Microcontroller Core Features:

- *High performance RISC CPU*
- *Only 35 single word instructions to learn*
- *All single cycle instructions except for program branches which are two cycle*
- *Operating speed: DC - 20 MHz clock input*
  DC - 200 ns instruction cycle
- *Up to 8K x 14 words of FLASH Program Memory,*
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- *Pinout compatible to the PIC16C73B/74B/76/77*
- *Interrupt capability (up to 14 sources)*
- *Eight level deep hardware stack*
- *Direct, indirect and relative addressing modes*
- *Power-on Reset (POR)*
- *Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)*
- *Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation*
- *Programmable code protection*
- *Power saving SLEEP mode*
- *Selectable oscillator options*
- *Low power, high speed CMOS FLASH/EEPROM technology*
- *Fully static design*
- *In-Circuit Serial Programming™ (ICSP) via two pins*
- *Single 5V In-Circuit Serial Programming capability*
- *In-Circuit Debugging via two pins*
- *Processor read/write access to program memory*
- *Wide operating voltage range: 2.0V to 5.5V*
- *High Sink/Source Current: 25 mA*
- *Commercial, Industrial and Extended temperature ranges*
- *Low-power consumption:*
  - *< 0.6 mA typical @ 3V, 4 MHz*
  - *20 µA typical @ 3V, 32 kHz*
  - *< 1 µA typical standby current*

Pin Diagram



Peripheral Features:

- *Timer0: 8-bit timer/counter with 8-bit prescaler*
- *Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock*
- *Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler*
- *Two Capture, Compare, PWM modules*
  - *Capture is 16-bit, max. resolution is 12.5 ns*
  - *Compare is 16-bit, max. resolution is 200 ns*
  - *PWM max. resolution is 10-bit*
- *10-bit multi-channel Analog-to-Digital converter*
- *Synchronous Serial Port (SSP) with SPI™ (Master mode) and I^2C™ (Master/Slave)*
- *Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection*
- *Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)*
- *Brown-out detection circuitry for Brown-out Reset (BOR)*

15.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Ambient temperature under bias .... -55 to +125°C
Storage temperature .... -65°C to +150°C
Voltage on any pin with respect to V_{SS} *(except* V_{DD}, $\overline{MCLR}$. *and RA4)* .... -0.3 V to (V_{DD} + 0.3 V)
Voltage on V_{DD} *with respect to* V_{SS} .... -0.3 to +7.5 V
Voltage on $\overline{MCLR}$ *with respect to* V_{SS} **(Note 2)** .... 0 to +14 V
Voltage on RA4 with respect to Vss .... 0 to +8.5 V
Total power dissipation **(Note 1)** .... 1.0 W
Maximum current out of V_{SS} *pin* .... 300 mA
Maximum current into V_{DD} *pin* .... 250 mA
Input clamp current, I_{IK} (V_I < 0 or V_I > V_{DD}) .... ± 20 mA
Output clamp current, I_{OK} (V_O < 0 or V_O > V_{DD}) .... ± 20 mA
Maximum output current sunk by any I/O pin .... 25 mA
Maximum output current sourced by any I/O pin .... 25 mA
Maximum current sunk by PORTA, PORTB, and PORTE (combined) **(Note 3)** .... 200 mA
Maximum current sourced by PORTA, PORTB, and PORTE (combined) **(Note 3)** .... 200 mA
Maximum current sunk by PORTC and PORTD (combined) **(Note 3)** .... 200 mA
Maximum current sourced by PORTC and PORTD (combined) **(Note 3)** .... 200 mA

Note 1: Power dissipation is calculated as follows: $Pdis = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum(V_{Ol} \times I_{OL})$

2: Voltage spikes below V_{SS} at the $\overline{MCLR}$ pin, inducing currents greater than 80 mA, may cause latch-up. Thus, a series resistor of 50-100Ω should be used when applying a "low" level to the $\overline{MCLR}$ pin, rather than pulling this pin directly to V_{SS}.

3: PORTD and PORTE are not implemented on PIC16F873/876 devices.

† NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

APPENDIX D
BLUESMIRF SILVER [WRL-08332] AT-COMMANDS

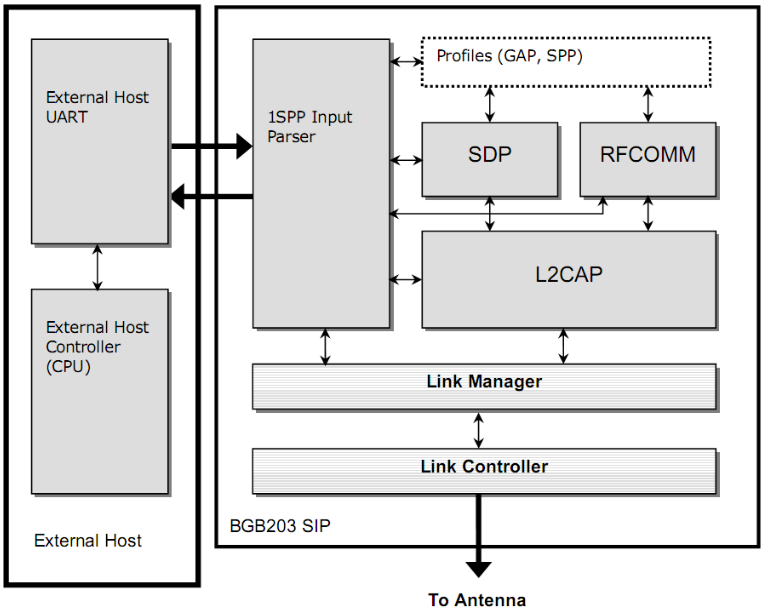


Figure 1:

The 1SPP firmware operates in one of two states. The states are called Command Mode and Data Mode. In Command Mode, the 1SPP firmware assumes that data coming from the UART are commands. The firmware parses the commands and processes them. In this mode, feedback is given (provided it is not disabled via configuration) about the status of the command.

Data Mode is entered when the device is attempting to make an SPP connection or has been configured to accept SPP connections. The device is always in Data Mode when there is an active SPP connection. There are two ways to enter Data Mode. One is by entering the Bluetooth SPP Server command (**AT+BTSRV**). The other is by entering the Bluetooth SPP client command (**AT+BTCLT**). While in Data Mode, everything that is received on the UART from the host processor will be transmitted over the Bluetooth SPP connection and all data that is received from the Bluetooth SPP connection will by transmitted to the host processor. Thera are two ways to enter Command Mode from Data Mode. The method used depends on how the device is configured).

In the first method of entering Command Mode from Data Mode, the host processor instructs the device to go into Command Mode. This can be done by the host processor issuing the escape sequence, or by the host processor lowering the DTR or DSR signal. The signal to lower depends on whether the device is configured to be a DTE or DCE

Table 29: Default Configuration Parameters

Parameter	Value	Command
Bluetooth Address	BDB203005511	AT+BTSET
RXTUN	0	AT+BTSET
Reference Voltage	0xAC	AT+BTSET[1]
Class 2 Trimming	0 (Disabled)	AT+BTSET[1]
Course Tuning	0	AT+BTSET[1]
Device type	DCE	AT+BTCFG
RI/CD/DTR/DSR pass-through	Disabled	AT+BTCFG[2]
Ignore escape sequence	False	AT+BTCFG
Suppress command responses	False	AT+BTCFG
DTR/DSR enter command mode	False	AT+BTCFG[2]
Connection active GPIO output	False	AT+BTCFG
Device name	BGB203 – 1SPP	AT+BTLNM
Class of device	001F00	AT+BTCOD
Link supervision timeout	20 seconds	AT+BTLSV
Echo characters in command mode	True	ATE
Escape Sequence	+++	AT+BTESC
PIN code	0000	AT+BTPIN
Security	No Security	AT+BTSEC
Enable low power mode use	False	AT+BTPWR
Low power mode inactivity timeout	30000 (30 sec)	AT+BTPWR
Low power minimum sniff interval	320 (200 ms)	AT+BTPWR
Low power maximum sniff interval	480 (300 ms)	AT+BTPWR
Low power sniff attempt	16 (20 ms)	AT+BTPWR
Low power sniff timeout	8 (10 ms)	AT+BTPWR
UART baud rate	115200	AT+BTURT
UART word length	8	AT+BTURT
UART parity	0 (None)	AT+BTURT
UART stop bits	1	AT+BTURT
UART RTS/CTS flow control	False	AT+BTURT
UART DTR/DSR flow control	False	AT+BTURT[2]
SDP search profile filter	0xFFFFFFFF (All)	AT+BTSDP
SPP server SDP service name	Serial Port	AT+BTSRV
SPP server flags	0 (Discoverable)	AT+BTSRV
SPP client number of connection attempts	1	AT+BTCLT
SPP client connection period	0	AT+BTCLT
Automatic connection mode	Disabled	AT+BTAUT

[1]= Rarely required to be changed from the default value
[2]= DTR/DSR flow control must be enabled to support DTR/DSR functions

APPENDIX E
MOTION DETECTOR DATASHEET

PARALLAX

Web Site: www.parallax.com
Forums: forums.parallax.com
Sales: sales@parallax.com
Technical: support@parallax.com

Office: (916) 624-8333
Fax: (916) 624-8003
Sales: (888) 512-1024
Tech Support: (888) 997-8267

PIR Sensor (#555-28027)

General Description

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for a high signal on a single I/O pin.

Features

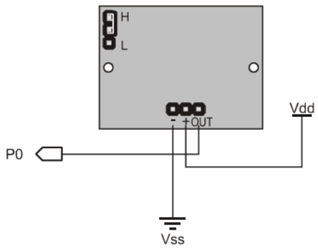
- Single bit output
- Small size makes it easy to conceal
- Compatible with all Parallax microcontrollers
- 3.3V & 5V operation with <100uA current draw

Application Ideas

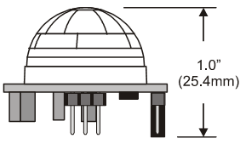
- Alarm Systems
- Halloween Props

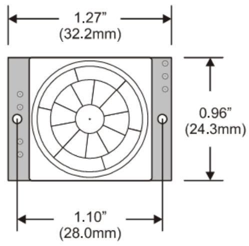
Quick Start Circuit

Note: The sensor is active high when the jumper (shown in the upper left) is in either position.



Module Dimensions





Theory of Operation

Pyroelectric devices, such as the PIR sensor, have elements made of a crystalline material that generates an electric charge when exposed to infrared radiation. The changes in the amount of infrared striking the element change the voltages generated, which are measured by an on-board amplifier. The device contains a special filter called a Fresnel lens, which focuses the infrared signals onto the element. As the ambient infrared signals change rapidly, the on-board amplifier trips the output to indicate motion.

Pin Definitions and Ratings

Pin	Name	Function
-	GND	Connects to Ground or Vss
+	V+	Connects to Vdd (3.3V to 5V) @ ~100uA
OUT	Output	Connects to an I/O pin set to INPUT mode (or transistor/MOSFET)

Jumper Setting

Position	Mode	Description
H	Retrigger	Output remains HIGH when sensor is retriggered repeatedly. Output is LOW when idle (not triggered).
L	Normal	Output goes HIGH then LOW when triggered. Continuous motion results in repeated HIGH/LOW pulses. Output is LOW when idle.

Connecting and Testing

Connect the 3-pin header to your circuit so that the minus (-) pin connects to ground or Vss, the plus (+) pin connects to Vdd and the OUT pin connects to your microcontroller's I/O pin. One easy way to do this would be to use a standard servo/LCD extension cable, available separately from Parallax (#805-00002). This cable makes it easy to plug sensor into the servo headers on our Board Of Education or Professional Development Board. If you use the Board Of Education, be sure the servo voltage jumper (located between the 2 servo header blocks) is in the Vdd position, not Vin. If you do not have this jumper on your board you should manually connect to Vdd through the breadboard. You may also plug the sensor directly into the edge of the breadboard and connect the signals from there. Remember the position of the pins when you plug the sensor into the breadboard.

Calibration

The PIR Sensor requires a 'warm-up' time in order to function properly. This is due to the settling time involved in 'learning' its environment. This could be anywhere from 10-60 seconds. During this time there should be as little motion as possible in the sensors field of view.

Sensitivity

The PIR Sensor has a range of approximately 20 feet. This can vary with environmental conditions. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change, but responds by making its output high when sudden changes occur, such as when there is motion.

Resources and Downloads

Check out the PIR Sensor product page for example programs and more:

http://www.parallax.com/detail.asp?product_id=555-28027