

Major project

by Oliver Casey Ellement

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UNIVERSITY OF WALES

Trinity Saint David

SWANSEA - ABERTAWE

Home Security System for the Deaf and or blind

By

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Second Marker: Dr Gary Jones

Project submitted as part of the requirements for the award of
Beng(Hons) Electrical & Electronic Engineering

21st April 2016

Abstract

The aim of this project is to create home security system for the deaf and or blind. This will be achieved by placing sensor modules in the home which interact with a main alarm module which the home owner would carry with them.

If there were an intruder in the home when this system is in operation, the sensor would be set off by the intruder's movement. This would then signal the alarm module which, signal the owner with vibrations. Vibrations are used as touch is a common sense that everyone has. The alarm would vibrate to the tune of the specific module that has been triggered, telling the home owner where exactly in the home the intruder is. This would give the home owner time to decide on his/her strategy on how to deal with the situation.

Due to this project having to function as a viable option for the deaf and or blind the alarm cannot simply be a sound or light alarm; also if sound and light were used it could potentially alert the intruder to the alarm in certain situations, which would make the entire idea behind this project redundant. If the intruder was made aware of the alarm he/she would also be aware of the home owner being in the vicinity, which would also make the intruder aware that the home owner is deaf, or blind; which would give the intruder the option of taking advantage of this. This would lead to the opposite to what the alarm was intended to do. So as you can see, communication via vibrations is the only way forward.

The initial design will be based around a PIR sensor (infrared sensor) connected to a programmable pic which would in turn communicate with another programmable pic, in the alarm module, via a radio transceiver, and alert the clients via a vibration motor which is in some way attached to the client of close enough for the client to feel the vibrations.

DECLARATION FORM

DECLARATION

I, ...(FULL NAME)..... declare that I am the sole author of this Project; that all references cited have been consulted; that I have conducted all work of which this is a record, and that the finished work lies within the prescribed word limits.

This work has not previously been accepted as part of any other degree submission.

Signed :

Date :

FORM OF CONSENT

FORM OF CONSENT

I(FULL NAME)..... hereby consent
that my Project, submitted in candidature for the Beng (Hons) electrical and electronic
engineering degree, if successful, may be made available for inter-library loan or
photocopying (subject to the law of copyright), and that the title and abstract may be made
available to outside organisations.

Signed :

Date :

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Chapter 1.0

Introduction

For the last year of University at the University of Wales Trinity Saint David, the author was required to create a project to achieve a degree in electrical and electronic engineering. To this objective it would be to our benefit to create a project which covers a large electrical and electronic base. To achieve this it is in the author's interest to create device for potential clients to use in a house hold environment. To complete this project the author has been given two years, to research, design, assemble, and test with results.

This project will aid author by further developing an understanding and an ability to create an effective project using a range of electronic components, printed circuit boards designs, and also better understand how and what the equipment the author is making to achieves its goals.

1.1) Aims and vision

The aim of this project is to create a viable intruder alarm system for the home. This will be achieved by: researching the idea, understanding what needs to be achieved in specific time lines, creating a number of designs, and settling on a specific design. Then eventually create the project and, present and conclude the findings.

The aim of this design is to place trip modules in strategic point's through-out the home and connect to a main sensory alarm hub on the clients' person.

1.2) Gantt chart

The planning the planning stage when given a project and a deadline is of utmost importance. It was obvious at the beginning of this project that the amount of tasks that would require completion during the same time frame would be almost overwhelming for the author. Due to the author working full time, alongside this project, the author would need something that would highlight key dates, mile stones and tasks within the project to remain on track.

Below is a Gantt chart; Gantt charts are commonly used in project management, and it is one of the best ways of showing some one exactly what you plan on doing and achieving in a set time frame. On the left of the chart is a to-do list of what you plan on doing, on the top is a time scale, and on the right hand side there is a percentage column to show how much of that area you have completed and further again to the right hand side there are bars to represent the start date and duration and end of that section. For a more detailed Gantt chart please see appendix.

Major project proposal	Start Date	End Date	Duration	Predecessors	% Complete	Assigned To
1 ☐ Project brain storming	01/01/15	01/23/15	17		100%	
2 ☐ Coming up with a project idea	01/01/15	01/22/15	16		100%	
3 ☐ Create project proposal	01/23/15	01/23/15	1	2	100%	
4 ☐ Research	02/01/15	03/17/15	33		0%	
5 ☐ Market research	02/01/15	02/03/15	3		0%	
6 ☐ Component/parts research	02/11/15	02/13/15	3		0%	
7 ☐ Programming research	02/25/15	03/17/15	15		0%	
8 ☐ Concept brain storming	03/01/15	02/26/16	261		0%	
9 ☐ Concept design 1	03/01/15	03/01/15	1		0%	
10 ☐ concept design 1 research	04/05/15	04/05/15	1		0%	
11 ☐ concept design 2	03/01/15	03/01/15	1		0%	
12 ☐ concept design 2 research	04/05/15	04/05/15	1		0%	
13 ☐ concept design 3	03/01/15	03/01/15	1		0%	
14 ☐ concept design 3 research	04/05/15	04/05/15	1		0%	
15 ☐ Decision matrix	06/03/15	06/10/15	6		0%	
16 ☐ Create decision matrix chart	05/03/15	05/03/15	1		0%	
17 ☐ Pros and cons of each project	05/10/15	05/10/15	1		0%	
18 ☐ Weigh up pros and cons	05/10/15	05/10/15	1		0%	
19 ☐ Concept decision	05/17/15	05/17/15	1		0%	
20 ☐ Decided concept further research	06/07/15	07/05/15	21		0%	
21 ☐ Parts and cost research	06/07/15	06/07/15	1		0%	
22 ☐ Cost evaluation	06/21/15	06/21/15	1		0%	
23 ☐ Purchase of parts	06/28/15	07/05/15	6		0%	
24 ☐ Assembly of device	07/05/15	07/05/15	1		0%	
25 ☐ Programming of device	06/28/15	06/28/15	1		0%	
26 ☐ Device tests and documentation	08/02/15	10/23/15	61		0%	
27 ☐ Conclusion	01/03/16	02/26/16	41		0%	

Figure 1 Gantt chart

1.3) Outcome

This system would give the home owner time to react without alerting the intruder. The idea behind this is to give the home owner time to call the police and or help from a closer source to lead the intruder into a false sense of a security. This would allow the time needed for the authorities to arrive and arrest the intruder. This system would eventually spread word to people thinking about breaking into someone's home and make them think twice about carrying out the crime as they wouldn't know which home would have the system and which home doesn't even if the home owner did not have sight and or hearing.

1.4) Variables and parameters required

To create a security system for the deaf and or blind the following variables and parameters will be required in the design of the security system.

- Must be able to sense intruders
- Must be able to alert client to presence of intruder
- Must be portable
- Must last at least a day without recharging or replacing battery
- Must be able to differentiate between moving inanimate objects and life forms
- Must be functional for the deaf and or blind
- Must be able to communicate with client from a distance
- Must be affordable

1.5) Scope

This project will contain research into the market (to find what different kinds or security systems are out there), research into parts to find what pre-built parts are currently on the

market, and research into programming software (to help programme the device to do what we desire). Then progress to purchasing the relevant parts and assembling the device, after which product testing will begin. Also through all this documentation is extremely important, and will be kept in a project note book.

Chapter 2.0

Research

Below are the steps taken to accurately and clearly research what is required for this project through the means of the research onion.

The research onion is a tool used to aid in deciding what research approach to take.

Research like an onion has many layers, the first layer is research philosophy where you can decide on many different types of philosophies but in this case there is positivism, realism, and interpretivist. Then going to the second layer there is the research approaches, which consists of deductive and inductive approaches. The third layer is the research strategies, this is where everything starts to take shape, where you have your experimental research, surveys, case studies, action research and more. The fourth layer is time zones, as with everything research has time limits. Which leaves us with the final layer or core of the research onion, this is where you have almost finished what you set out to do, but conduct further research on your final product before release to iron out any details. Using the research onion, a clear method of research will be constructed to research the project from start to end.

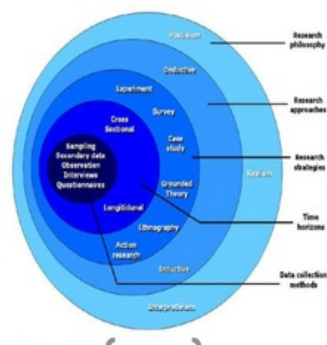


Figure 2 Research onion

2.1) Research methodology

There are three different types of research methods which could be used to collect research for this project: basic, Quantitative, and applied.

The basic research method is simply collecting information at random on the subject you're interested in. Quantitative research is the investigation into specific information required through statistical, mathematical, and computational techniques and applies them to create theoretical models. Applied research is very much like basic research but in a more structured fashion; which is the most used type of research for projects. Therefore the type of research employed in this project will be applied research.

2.3) Design Software

Design software is an extremely important tool to use in any design project. Design software can be used in a multitude of ways, from designing a circuit, programming a microcontroller, to simulation. No modern day design engineer would refuse to use these types of software, because it saves many hours of trial and error, which saves money.

1. Proteus

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB layout design. Proteus also supports C programming, which can also be used in the PCB design simulation. Proteus is widely used in industry and is currently in use at UWTSD which makes it available to electrical and electronic engineering students.

2. Easy PC

The Easy PC design Suite is a Windows application for schematic capture, simulation, and PCB layout design. Proteus is widely used in industry and is currently in use at UWTSD which makes it available to electrical and electronic engineering students.

3. CCS - Pic C compiler

CCS C Compiler is used by students to begin programming in C, at UWTSD. Key features of this compiler include: easy to define, set up and manage interrupts, easy migration between all microchip devices, and C++ style input and output streams with full data formatting.

4. MPLAB X IDE

MPLAB X IDE is a software program that runs on a PC, in conjunction with a pickit3 to programme microcontrollers.

2.4) Programming hardware

Programming hardware is as important as the software used to create designs and programs, as what is the point in creating a program if you cannot implement and test it.

MPLAB PICKit 3

The MPLAB PICKit 3 allows debugging and programming of microcontrollers. The PICKit 3 is connected to a PC using a USB interface and can be connected to a microchip with a bread board and wires, as depicted below.



Figure 3 Pickit 3 connections

2.5) Market Research

Market research shows how much of a market there is for your product, through successful market research you will be able to find out if people would actually purchase your product.

Market research is also extremely important for understanding the type of market you're competing in, finding out who will purchase your product and discovering your unique selling point (U.S.P for short). Your U.S.P (unique selling point) is what sets you out from the competition, and it's something you can high light when advertising your product to attract your customers and take away business from your competitors.

2.6) Target customers

As this project is a security alarm system for the deaf and blind home owner the target customers will be deaf and or blind individuals from the age of eighteen and up, as this is the age when people can begin deciding on whether to move out or not or leave for college or university. Also from the age of eighteen and up there is more of a chance the individuals will have a steady cash flow to purchase a product such as this as they should have a job or funding for college or university.

Facts on hearing loss and blindness/partially sighted in the UK:-

- There are more than twelve million people in the UK with some form of hearing loss.
- By the year two thousand and thirty five, it is estimated that there will be sixteen million people with hearing loss in the UK.
- Seventy percent of people over seventy years old and forty percent of people over fifty years old have hearing loss.

- There are around two hundred and fifty thousand people in the UK with both hearing loss and sight loss.
- Around nine hundred thousand people in the UK are profoundly deaf.
- In England there are around three hundred thousand people who are blind or are partially sighted.
- In Scotland there are around thirty five thousand people who are blind or are partially sighted.
- In Wales there are around sixteen thousand people who are blind or are partially sighted.
- In Northern Ireland there are around eight thousand people who are blind or are partially sighted.

2.7) Online survey

Further to help the author make decisions on this project he has created an online survey which was posted on social media websites such as Facebook. Below are sixteen questions aimed as possible consumers, fifteen of those questions aid in this project. There is also one control question which the survey creator requested be placed in the survey.

Question 1

The control question below was chosen from a list of suggestions by the website [surveymonkey.com](https://www.surveymonkey.com). The author decided on this control question as he felt a question on marmite might be in appropriate.

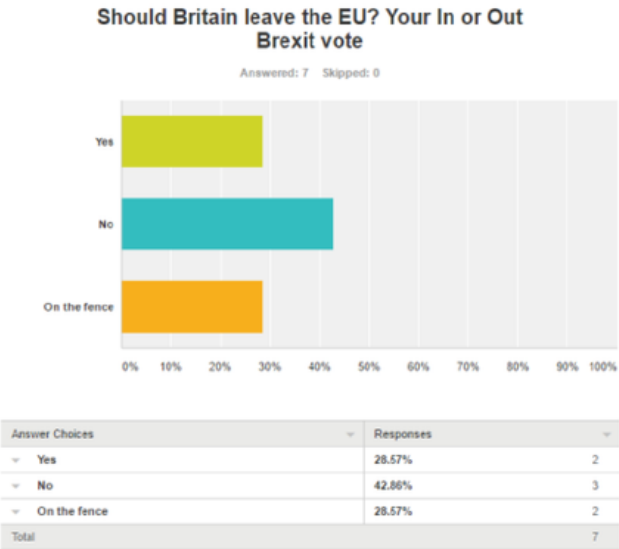


Figure 4 Question 1

Question 2

The first of these questions made by the author tried to get an idea on how many possible clients would be taking part in the survey. Unfortunately as you can see from the results, no clients did take part. Of course only seven people took part in the survey.

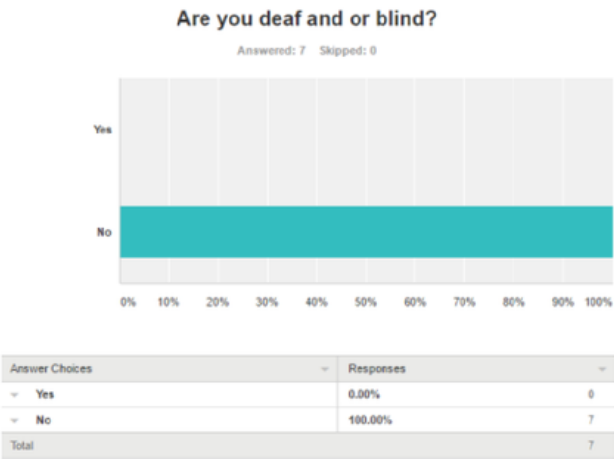


Figure 5 Question 2

Question 3

Question three made by the author tried to get an idea on how many people know a deaf or blind individual. Fortunately as you can see from the results, just over half the people who took part in this survey did know some possible clients.

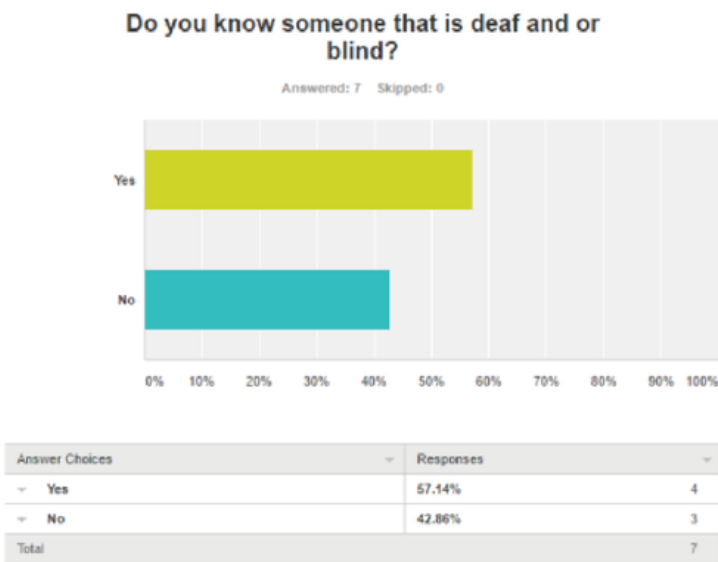


Figure 6 Question 3

Question 4

The fourth of the questions made by the author tried to get an idea on how many people were above the age of eighteen. Eighteen years old is considered to be the age when people usually start thinking of moving out, though this age is said to increase in the next few years. As you can see from the results, everyone that took part in this survey was eighteen years old or older. This is reinforced with the fact that the author knows many who took part in the survey, and they all started either thinking about moving out or already moved out at this age. This benefits this project by showing that if the project were a success then the age range for clients would be from eighteen years old and up.

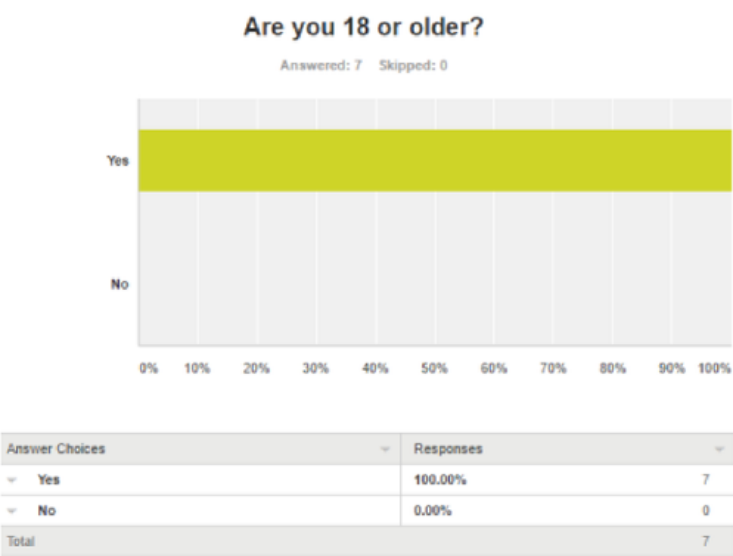


Figure 7 Question 4

Question 5

The fifth question made by the author tried to get an idea on how many people live alone. Unfortunately as you can see from the results, no one that participated in the survey lives alone. The author believes that if there were more participants then the results would show that there are people that live alone.

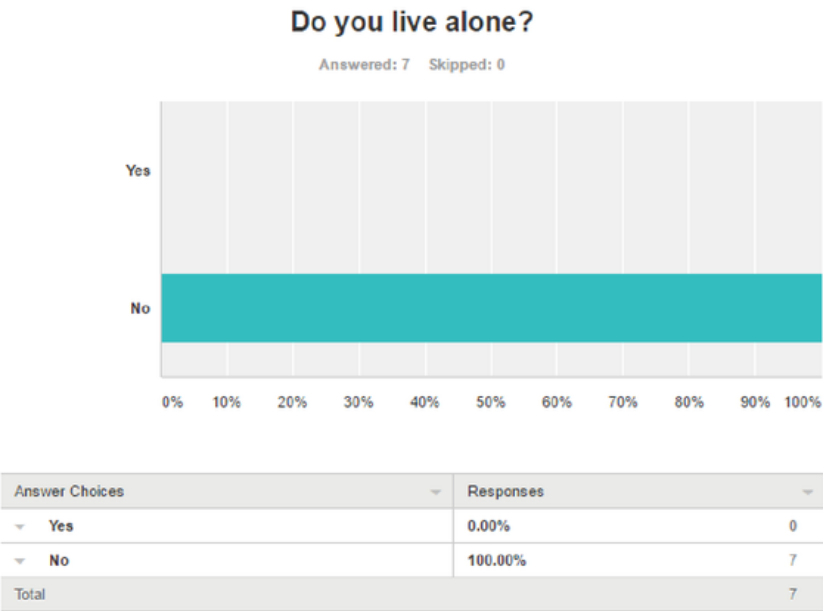


Figure 8 Question 5

Question 6

The sixth question made by the author tried to get an idea on how many people that participated in the survey live in the UK, as the survey was available over social media then it is of course world-wide.. Fortunately as you can see from the results, everyone that participated in the survey was from the UK.

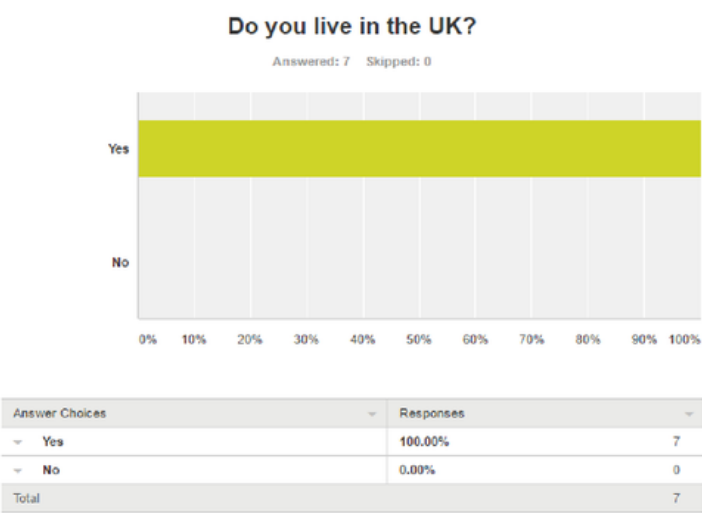


Figure 9 Question 6

Question 7

The seventh question made by the author tried to get an idea on how many people believe they would benefit from the authors product. Fortunately as you can see from the results, more than half of the participants believed they would benefit from the authors product.

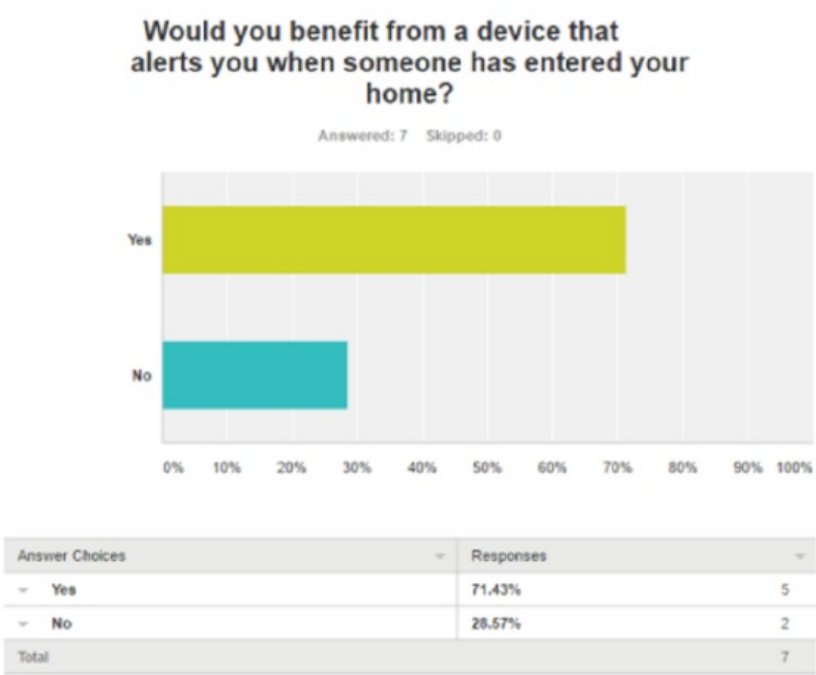


Figure 10 Question 7

Question 8

The eighth question made by the author tried to get an idea on how many people believe they could afford the finished product if it cost between twenty to fifty pounds. Fortunately as you can see from the results, more than half of the participants believed they could afford this. The author placed this price bracket on the finished product because one of the goals of

this project is to make it affordable to the average person but not so much so that he would not be making a profit.

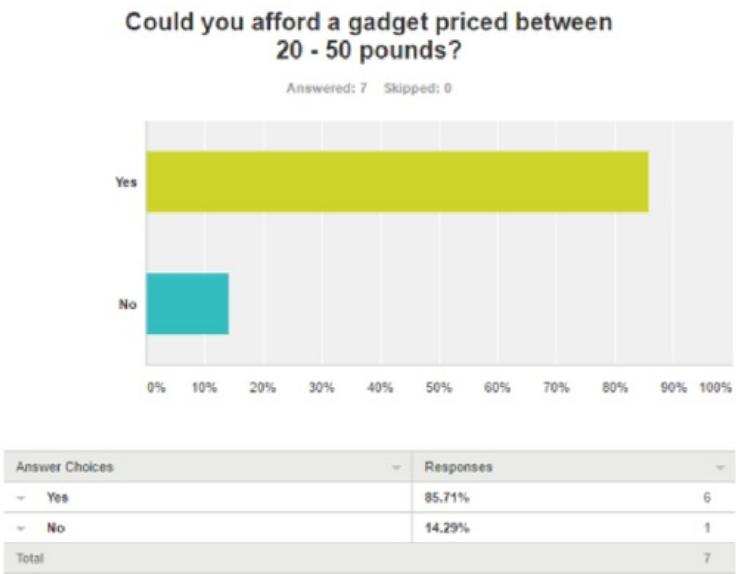


Figure 11 Question 8

Question 9

The ninth question made by the author tried to get an idea on how many people believe they know someone that would benefit from the authors product. Fortunately as you can see from the results, more than half of the participants believed they know someone that would benefit from the authors product.

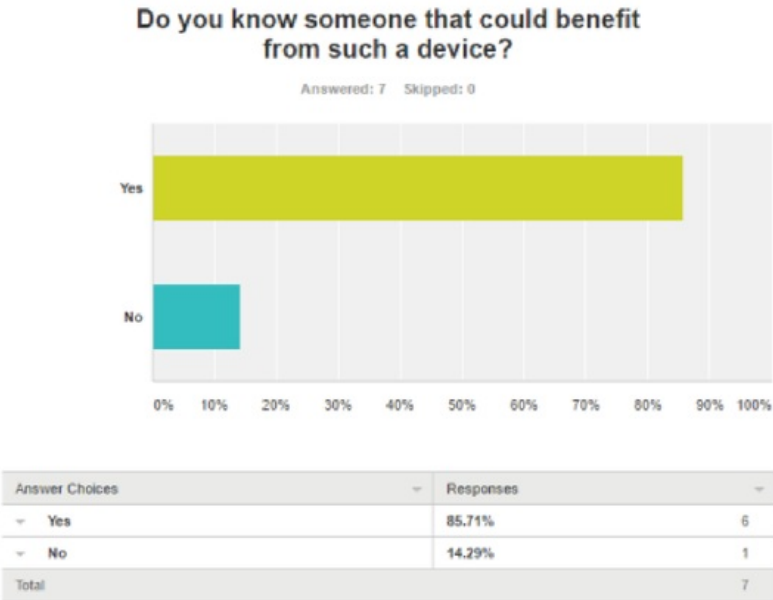


Figure 12 Question 9

Question 10

The tenth question made by the author, tried to get an idea on how many people know of burglaries in their area and if it is a common occurrence. This would also benefit the author as the finished product wouldn't be exclusive to the deaf and or blind, for financial reasons

the product would have to be available to everyone. Fortunately as you can see from the results, more than half of the participants know of burglaries occurring in their area. This means that because they know it happens in their area they will be more likely to look into purchasing a security system.

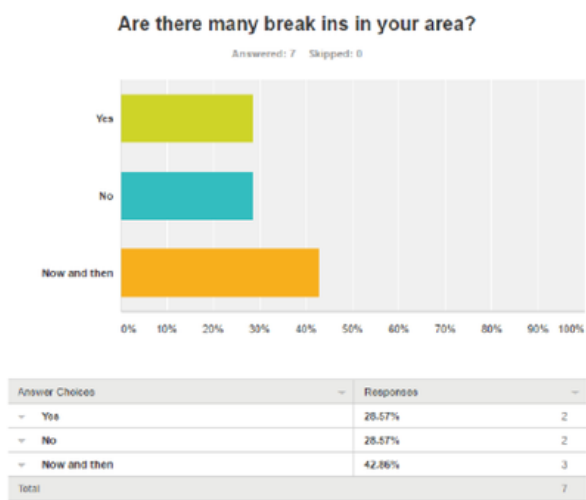


Figure 13 Question 10

Question 11

The eleventh question made by the author tried to get an idea on how many people actually own a security system. Fortunately as you can see from the results, more than half of the participants do not possess a security system, which means there are definitely people out there that might be looking into purchase one. Also this could mean they've been looking to purchase one but could not due to financial reasons or the current systems on the market aren't what they desire.

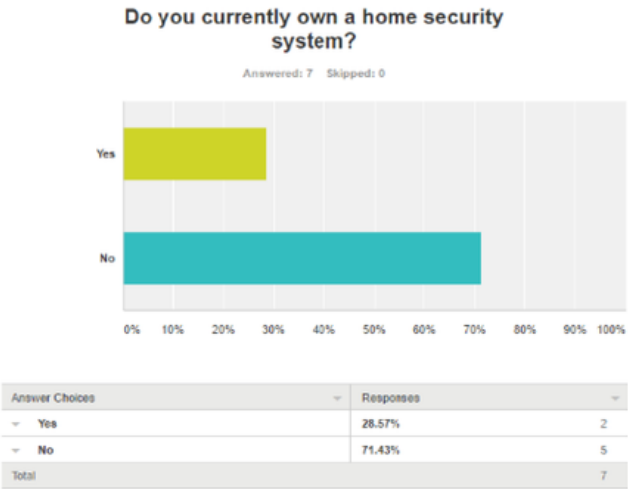


Figure 14 Question 11

Question 12

Question twelve made by the author tried to get an idea on how many people have a security system and how much it cost if they have one. Unfortunately as you can see from the results, more than half of the participants have said no which could mean they have a security system that costs under fifty pounds. Also this question could of benifited with a N/A option as after the author spoke to a few participants they told him they said no because there wasn't a N/A option, so this question isn't exactly accurate.

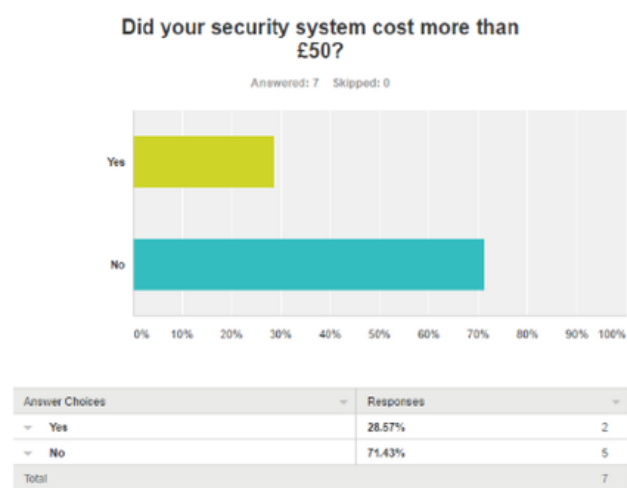


Figure 15 Question 12

Question 13

Question thirteen, made by the author tried to get an idea on how many people pay a subscription for their security system. Fortunately as you can see from the results, there is a percentage of people who do and there is a large percentage that do not have a security system which backs up previous questions. As the author suspected there is also a large percentage that do not pay subscription as not all systems to ask to pay subscription.

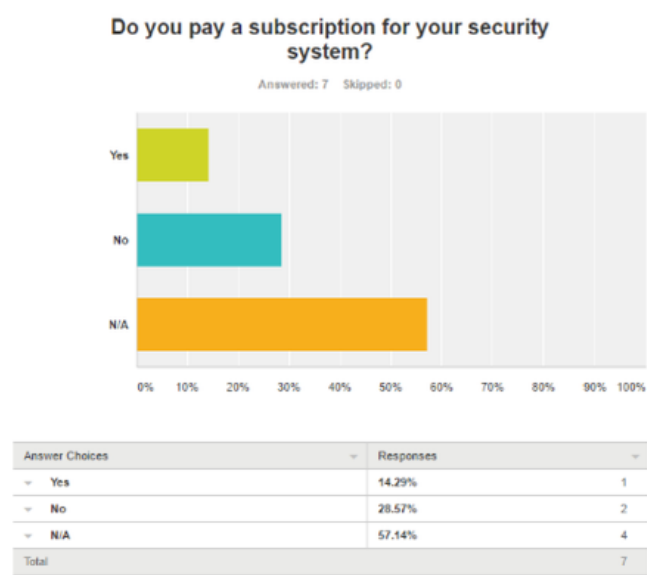


Figure 16 Question 13

Question 14

The fourteenth question made by the author tried to get an idea on how many people have a security system in plain sight, to witch an intruder might have the option of disabling it before the alarm is heard. Fortunately as you can see from the results, more than half of the participants chose the N/A option which backs up the previous question of do they actually have a security system to which this means they do not. Also there is an even percentage of people that have a security system in plain sight and of people who do not have one in plain sight.

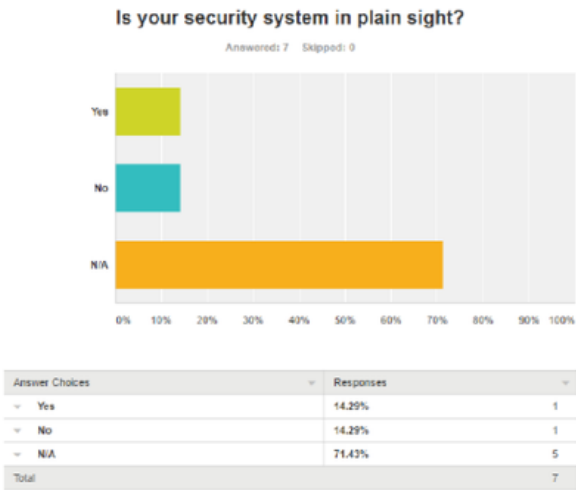


Figure 17 Question 14

Question 15

In question fifteen made by the author, tried to get an idea on how many people are happy with their current security system. As you can see from the results, there isn't a percentage of people who are not happy with their security system but this could be down to the lack of participants, to get a more accurate reading there would have to be more participants.

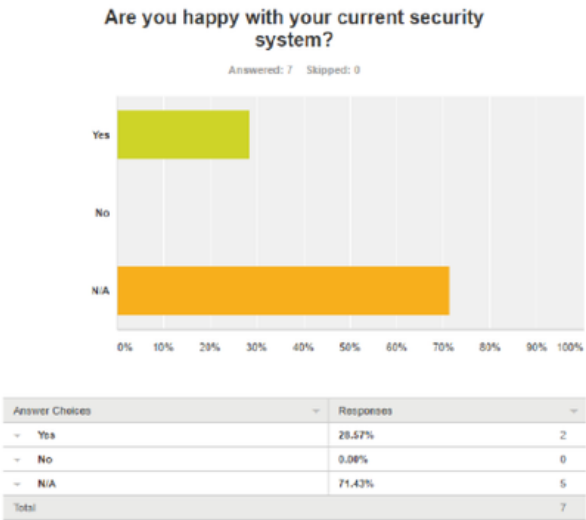


Figure 18 Question 15

Question 16

In the sixteenth question made by the author, he tried to get an idea on how many people have friends or family who just knock and enter. This could be due to the fact that the home owner did not hear the door-bell or the knock on numerous occasions'. So, friends or family just decide to walk in. Though this isn't a lethal type of intruder the author believes the home owner would still like to welcome people they know into their home rather than them just walking in. Also the authors' product fills this niche as there aren't many products on the market readily available that can alert a home owner in such a way like this product.

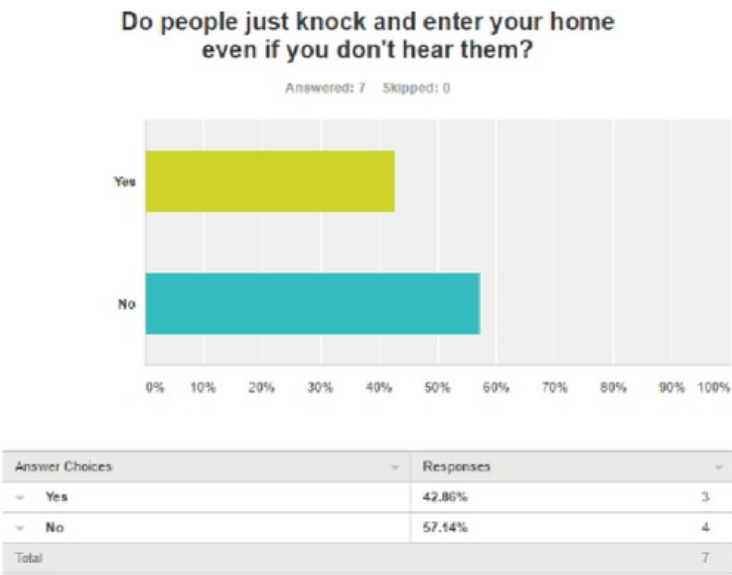


Figure 19 Question 16

2.8) Target customer conclusion

The above data was gathered from the office of statistics website and if they're accurate this would mean there are approximately twelve million one hundred and eighty four thousand potential clients. The survey has also helped the author understand his clients and potential clients a lot more than he would of otherwise, which will help in future products and marketing.

2.9) Competitors

[3][5]After an extensive google search under "security systems for the blind and or deaf", the following competitors were identified:-

- 1) Assistech special needs – central alert 360 wireless notification system.
- 2) The key to independent living – mini monitor (doorbell, car or burglar transmitter).
- 3) Maplin's - Wireless security beam alarm.

2.91) Competitor product evaluation

1. Assistech product

Although the Assistechs product is attractive at first glance with its many different functions the Achilles heel to this product is that it has to be installed into the already established alarm system in the home by a trained technician. Also this product doesn't work in just any country, you would have to call up Assistech to check before ordering and it requires a wifi network to operate, which I plan on not using with my product due to its unreliability.

2. The key to independent living – mini door, car, and burglar transmitter

Although the mini door, car, and burglar monitor product is attractive at first glance with its many different functions the Achilles heel to this product is the price (prices start at \$295) and its operation is completely different to the proposed operation of the operation of the project, which means it lacks in efficiency as it operated from a pre-installed standard security system.

3. Wireless security beam alarm by Maplin's

The wireless security beam alarm system by Maplin's is an attractive product as it works well and cheaply. This alarm system consists of two units that project and receive an infrared beam when blocked it activates the alarm. When the alarm is triggered it lets out either a loud alarm or a chime depending on what the customer has set it to. This product is a good purchase and a strong competitor against the author's product; but it will only work for those people who are not hard of hearing, and since it is an audio alarm then the intruders have a chance to find it and turn it off before the customer hears it.

Market research conclusion

After reviewing the statistics and competitors' products the author has come to the conclusion that there is a large market available for this project, and also the competing products will not satisfy the niche of which this project fits in. The niche being, a cheap, portable, user friendly, alarm system for the deaf and or blind.

Chapter 3 Researched literature

3.1) Types of Sensors

To achieve the goals set out by the author for this project the use of specific sensors must be used. As this project is in aid of home security, the finished product must be able to detect the presence of a life form. Below are a few selected sensors and their descriptions to aid in the author in deciding which sensor to use.

1. Infrared sensors

[2]Pyroelectric devices (devices that would with heat), such as the PIR sensors, have components made materials that generate charge when exposed to infrared energy. The changes in the amount of infrared energy striking the PIR change the voltages generated, which are measured by an amplifier. The device contains a lens, which focuses the infrared signals onto the element. As the ambient infrared signals changes, the on-board amplifier trips the output to indicate motion. The amount of radiation detected depends on the surface temperature of the object and of what's in the surrounding area; objects around the home such as a chair with have very low levels of infrared radiation coming from it if any, but people are warm blooded so the amount of radiation coming from them is noticeable to a sensor.

The sensor converts the resulting change in the incoming radiation into an output voltage. Infrared sensors come in many different configurations for a huge variety of applications. The most common PIR sensors have numerous mirror segments, an effective range of about ten meters, and a sensing radius of up to 180 degrees, though you can get more powerful sensors with longer range and a larger field of view. Some sensors can even be programmed to let small infrared signals pass by and only outputting voltage for large lifeforms, these sensors are passive sensors. "To calibrate a PIR Sensor, it requires a warm-up time in order to function as it is supposed to. This is due to the settling time due to its new environment. This warm up could take up to fifty seconds. During this warm up period, the LEDs under the lens will be switched on.

2. Microwave sensors

Microwaves are electromagnetic waves with a wavelength, shorter than that of radio waves but longer than waves produced by infrared radiation. Microwaves are used in radar, communications, and heating in microwaves.

Microwave sensors send out pulses and measure what is reflected off moving objects. They can cover more area than infrared sensors, but they can be vulnerable to electrical interference such as mains electrical noise and they're a lot more expensive.

3. Ultrasonic

Ultrasonic waves are sound waves just like any other sound wave but a higher frequency than what the average human can hear.

Ultrasonic sensors send out pulses of ultrasonic waves and measure what is reflected off moving objects very much like the microwave sensor.

4. Vibration

Vibration sensors use a small mass on a lever, which is activated by a switch to an alarm when it vibrates, but these sensors are extremely unreliable as anything could set them off.

5. Video

Video cameras combined with advanced signal processing. This creates recordable motion sensors which start recording when there is motion in the surrounding area where the camera is recording. These sensors can be very costly with memory however as if there is a motion in the area it'll start recording and if for example there is a pet in the home then it'll record almost constantly.

3.2) Sensor research conclusion

The author has read and understood the sensor research above and has come to the conclusion that the use of PIR sensor would be the best match for this project. The author has come to this conclusion due to the fact that they're widely used in industry, there are many different variations of PIR sensor, and some PIR sensors can even differentiate between humans and small animals. Differentiating between animals and humans means that a clients' cat would not set off the sensors, and this means that potential clients would not be put off if they have some form of freely moving animal setting the system off accidentally.

3.3) Types of Transmission

To achieve the goals set out by the author for this project the use of specific communication devices must be used. As this project is in aid of home security system which alerts the deaf or blind client via vibrations, the alarm cannot simply be sound or physically attached to the sensor unit. Below are a few selected types of communication and their descriptions to aid in the author in deciding which communication device to use. Although, to cover a range of design concepts the author has also included a wired connection means of communication, which could be used for the bed ridden client.

1. Radio transmission

[4]Radio transmissions use radio waves to carry information from video, to data or code. This is done by modulating electromagnetic waves. When electromagnetic waves reach a conductor it creates AC in the conductor then the information can be extrapolated and turned back into its original format. A transceiver is a combination transmitter/receiver usually on a single PCB. Radio transceivers are mostly used in communication systems such as mobile phones and two way radios over a short distance. While transmitting, the receiver end of the transceiver is shut down so there is no cross communication while transmitting. When transmitting with a transceiver with this function, you can't receive signals while transmitting (this function is called half duplex). There are also transceivers out there designed to allow reception of signals during transmission (this is known as full duplex). These transceivers require the transmitter and receiver operate on different frequencies so the transmitted signal does not interfere with the reception.

2. Blue-Tooth

Bluetooth exchanges data over short distances between devices. Blue-tooth uses a specific radio frequency to transmit data, and creates a network. Blue-tooth can be very secure although there has been some security issues in the past; and blue-tooth is a very flexible

technology as it can be used anywhere at any time and can be used on a range of devices from mobile phones, to cars.

3. WI-FI

Wi-Fi creates a wireless network in your home or office, where your computers can get connected to your internet. WI-FI uses radio waves, like your phone or blue-tooth devices. Devices called wireless transmitters receives the information from the internet via your internet connection supplied usually but not always by your phone line. The transmitter converts the information into a radio signal and sends it to be received by your phones, computers or tablet devices.

4. Mains cable (wired connection)

Mains cable transmission is used in businesses, homes, and large projects such as smart grids which uses the power line connectivity to provide an Internet signal, just like a DSL service that uses an existing telephone line for the same purpose. This is achieved by connecting a transmission device to your internet source and into a mains socket and a second device where you require the internet to be broadcasted wirelessly or you can connect to the second device via an Ethernet cable if you prefer.

5. Ultrasound

"Ultrasounds are sound waves with frequencies higher than the upper audible limit of human hearing. Ultrasound is no different from 'normal' sound in its physical properties, except in that humans cannot hear it. This varies from person to person and is around 20 kilohertz in healthy, children and lowers considerably with age and exposure to loud noises. Ultrasound is used in many applications, from checking the health of a unborn child, to measuring distances.

3.4) Transmission research conclusion

The author has read and understood the sensor research above and has come to the conclusion that the use of radio transceivers would be the best match for this project. The author has come to this conclusion due to the fact that they're widely used in industry; there are many different variations of radio transceivers, and some can range for miles.

3.5) Types of motors

To achieve the goals set out by the author for this project the use of motors must be used. As this project is in aid of home security system which alerts the deaf or blind client via vibrations. The alarm unit must have a source of vibration and the only device for this goal is a motor. Below are a few selected types motors and their descriptions to aid in the author in deciding which motors to use.

A motor is an electrical machine that comes in various sizes that converts electrical energy into mechanical energy. Motors are assembled using a coil of wire that is free to rotate between two magnetic poles. When an electric current flows through the coil, the coil induces a force which in turn rotates the shaft.

1. DC motor

A direct current motor is an electric motor that uses electricity, from batteries, and a magnetic field to produce torque, which causes the shaft to rotate. DC motors require two magnets of opposite polarity and two or more poles with copper coil wrapped around them, which acts as an electromagnet. The repellent and attractive electromagnetic forces of the magnets provide the torque that causes the motor to rotate the shaft. At one point however the polarities of the magnets are switched off, so no torque is produced, this is because if

they were to remain on then it would cause the magnets to slow down due to the attractive forces on the peak of the turns, and this could even cause the motor to stall.

2. AC motors

An AC motor is a motor driven by an alternating current typically from the mains. The AC motor normally has two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. The rotor magnetic field is usually produced by permanent magnets.

3. Difference between AC & DC

While both A.C. and D.C. motors serve the same function of converting electrical energy into mechanical movement, they are constructed and powered differently. The biggest difference between these two motors is the power source. A.C. motors are powered from alternating current usually mains; while D.C. motors are powered from direct current such as batteries or an AC-to-DC power converter.

3.6) Motor conclusion

The author has read and understood the motor research above and has come to the conclusion that the use of small direct current motors would be the best match for this project. The author has come to this conclusion due to the fact that they're widely used in industry; and they come in a range of shapes and sizes, with powerful vibrations.

3.7) Communication between components

To achieve the goals set out by the author for this project the use of specific communication devices must be used. These communication devices may require certain types of connections and communication protocols, below are types of connections that are typically used in general.

1. RS232

RS232 is a protocol that highlights how to transfer data serially between devices using a wires or cables. RS232 uses a serial transmission method which bytes are outputted to a pin on the microcontroller one bit at a time onto a single wire or cable.

Data can only be transmitted in one direction for each pin so for bi-directional communication you need two pins hence RX (Receive) and TX (Transmit) the output signal is normally TX and the input is usually RX on the average microcontroller. To create a two way communication system a minimum of three wires are needed TX, RX and ground.

RS232 transfers a single byte of data over a serial cable having between three to twenty two signals and can run at speeds from one hundred to twenty thousand baud. Common baud rates used are two point four thousand, nine point six thousand, nine-teen point two thousand; the cable length can be up to fifteen meters. Baud rate is the rate at which information is transferred in a communication channel. A byte can be transmitted at any time as long as the previous byte has already been transmitted. The transmitted byte is not synchronized to the receiver - it is an asynchronous protocol which means there is no clock signal. For this reason software at each end of the communication link must be set up exactly the same so that each serial decoder can decode the data stream.

To make RS232 work over long cables high voltages are required from each transmitter due to cable resistance the voltage reduces the further the signal has to travel. The output voltage is usually from five volts to thirty volts.

At the receiver the input voltage is usually three volts, so to receive a logic zero the voltage

must be greater than three volts and to receive a logic one the voltage must be smaller than negative three volts. This takes into account for the losses as the signal travels down the cable and cancels out the noise.

2. Serial port interface

Serial to Peripheral Interface is a hardware/firmware communications platform developed by Motorola and then later adopted by many others in the electronics industry.

The Serial Peripheral Interface or SPI-bus is a simple four-wire serial communications interface which is used by many companies that create microprocessors and microcontrollers. SPI enables the controllers other devices to communicate with each other.

The SPI's are mostly used only in printed circuit board design, because there are a few things, which prevent us from using it outside the PCB area. SPI was designed to transfer data between various IC chips, at very high speeds. Due to this high-speed aspect, the bus lines cannot be too long, because their reactance increases too much, and then becomes unusable. It is possible to use the SPI on applications outside the PCB area, at low speeds, but this is not practical for most applications.

In a computer or on a microcontroller, a serial peripheral interface or SPI is an interface that enables the serial, serial meaning one bit at a time, exchange of data between two or more devices, one called a master and one or more called the slave . An SPI operates in full duplex mode (previously explained under radio transmission). This means that data can be transferred bi-directionally. The SPI is most often employed in systems for communication purposes between the central processing unit, otherwise known as a CPU, and peripheral devices, and two or more microcontrollers. It is also possible to connect two microprocessors by means of SPI. Serial interfaces have some advantages over parallel interfaces. The most significant advantage is serial interfaces have simpler

wiring. In addition, serial interface cables can be longer than a parallel interface, because there is a lot less crosstalk among the conductors in the cable.

There are many types of devices on the market that can be controlled by an SPI, including, sensors, displays, data converters, printers, data storage devices, registers, and microprocessors.

An SPI protocol specifies 4 signal wires.

1. Master Out Slave In (MOSI) - MOSI signal is generated by Master, and is sent to the Slave.
2. Master In Slave Out (MISO) - Slaves generates MISO signals and is sent to the Master.
3. Serial Clock (SCLK or SCK) - SCLK signal is generated by the Master to synchronize the data transfers between the master and the slave.
4. Slave Select (SS) from master to Chip Select (CS) of slave - SS signal is generated by Master to select individual slave/peripheral devices..

Different types of SPI configurations:

1. Daisy-chained slaves also known as cascaded slaves
2. Parallel configuration also known as independent slaves
3. Queued Serial Peripheral Interface (QSPI)

Daisy-chained slave configuration:

In Daisy chained slave configuration, the clock lines (SCLK) are connected together. Also all the chip select (CS) pins are connected together. The data outputs from the microcontroller, through the peripherals, and back to the microcontroller. The data output of the next slave-device is tied to the data input of the next, which forms a wider register. So the daisy chained

slave-devices are looked at as one big device and receive there the same chip select signal. This means, only a single SS line is required from the master, rather than a separate SS line for each slave.

Independent slave configuration:

The normal mode of operation in SPI devices is the independent slave configuration. This configuration, the MOSI pins are tied together and the all MISO pins are tied together while each slave has an independent slave select connection to the master microcontroller.

Queued Serial Peripheral Interface

The queued serial peripheral interface or QSPI is another type of SPI controller.

The difference is that it uses a data queue with programmable queue pointers that allow data transfers without a central processor unit intervention. It also has a wrap-around mode that allows continuous transfers. This way the slaves appear to the central processing unit as memory-mapped parallel devices.

Advantages of SPI

1. Full duplex communication.
2. Not limited to 8-bit words in the case of bit-transferring.
3. Simple hardware interfacing.
4. Typically lower power requirements than I²C due to less circuitry.
5. Slaves use the master's clock, and don't need precision oscillators.

Disadvantages of SPI

1. No hardware flow control
2. No in-band addressing.
3. No slave acknowledgment

4. Only handles short distances compared to RS-232, or CAN.

3. USART

USART stands for Universal Synchronous Asynchronous Receiver Transmitter. A USART is a microcontroller that has the option for communication through a computer's serial port using the RS-232. A USART provides the computer with the interface necessary for communication with modems and other devices. USART has the option of a synchronous mode. Synchronous mode demands that each end of an exchange respond without initiating a new communication. Asynchronous operation means that a process operates independently.

4. UART

UART stands for Universal Asynchronous Receiver Transmitter. UART is a microcontroller with programming that controls a computer's interface to its serial devices. it provides the computer with the RS-232 data terminal equipment interface so that it can exchange data with modems and other devices. Modern UARTs provide some amount of buffering some as high as sixteen bytes. This is so computers and other device data streams remain organised.

5. USBs

USB stands for Universal Serial Bus. USB is a plug interface that allows a computer to communicate with other devices. USB-connected devices are the most common devices on the market. USB devices can be keyboards and mice, flash drives, Lights, and USBs are used to charge devices.

USB 1.x is an external bus standard that supports data transfer rates of 12 Mbps and is capable of supporting up to 127 peripheral devices.

USB 2.0, also known as hi-speed USB. Hi-speed USBs are capable of supporting a transfer rate of up to or 60megabytes per second.

USB 3.0, also known as SuperSpeed USB, USB 3.0 supports transfer rates up to 5.0 gigabits per second.

USB 3.1, also known as SuperSpeed supports transfer rates up to 10 Gbps.

6. I2C

I2C is a bi-directional two-wire serial bus that provides communication between integrated circuits or ICs. There are three data transfer speeds for the I2C bus: standard, fast, and high-speed. Standard is 100 Kbps, fast is 400 Kbps, and high-speed can go up to speeds of up to 3.4 Mbps. The I2C bus supports 7-bit and 10-bit devices and devices that operate under different voltages.

3.8) Communication conclusion

The author has read and understood the motor research above and has come to the conclusion that the use of SPI would be the best match for this project. This is due to advantages such as; simple hardware interfacing and slaves use the master microcontrollers' clock, and don't need precision oscillators.

3.9) Programming

Programming is a vital part of this project and to this means the author has researched different programming languages. Below are a few programming languages, with specific individual descriptions.

7. C Programming

C programming is a fast language to use and isn't as object oriented compared to other programming languages but not as powerful. C programming is also favoured among students due to the fact it is very popular in the gaming industry.

8. C++ Programming

C++ is more suited to large projects because it has an object-oriented structure. The object-oriented structure also allows code to be reused, which shortens development time.

9. Assembly language

Assembly language is a low-level programming language used to interface with computer hardware. Assembly language uses structured commands as substitutions for numbers allowing humans to more easily read the code versus looking at binary.

10. Pseudo code

Pseudo-code is a detailed and readable description of what a computer program needs to do. Pseudo-code is usually shown in a natural language rather than in a programming language. Pseudo-code is sometimes used as a detailed step in the process of developing a program. Pseudo-code can be inspected by the team of designers and programmers as a way to ensure that actual programming is likely to match design specifications as a cost saving strategy.

3.91) Programming conclusion

The author has read and understood the programming research above and has come to the conclusion that the use of C programming would be the best match for this project. This is due to the fact that it is a powerful and fast language, which is favoured around beginners.

Chapter 4 Design and Implementation

4.1) Component selection Introduction

In this chapter the author selects between ranges of components and decides on which components will be used in the project.

4.2) Microcontrollers

To select an appropriate microcontroller, the following information has been gathered and placed in a table to achieve the goals of this project.

Micro-Controller & memory Selection Table		
Function	Scale	Further information
Temperature	0-100	N/A
SPI	1	N/A
Power	0-5v	N/A
Programmable memory	14-128KB	N/A
RAM	256-4096B	N/A
Program memory size	8-64Kwords	N/A
Internal oscillator	16MHz, 32kHz	N/A
watch dog timer	N/A	N/A

Table 1 microcontroller selection

4.3) Microcontroller sourcing

For this project the author used the search engine on the microchip website. After much deliberation the author has chosen to use "PIC16F1516" as it meets all the requirements set out in this project, and could even be used in upgraded versions of this project, as it exceeds the required specifications.

4.4) Packages

Containment for the finished product will be designed in a way which would make it impossible for an intruder to detect. This urban camouflage must be big enough to hold the finished product and protect it from hazards which may come with the camouflage. For instance if the project was fitted to the bottom of an umbrella stand then the project would have to be water proof, to deal with the amount of rain water. When the product is out of the prototype stage, the author will be able to adapt the design to fit in a range of house hold products allowing the finished product to hide in plain sight.

4.5) Connector specification

Connectors are a vital requirement in any PCB build, they're used to connect and disconnect PCBs from other PCBs or PCBs to an external connector.

Due to the way the author has designed this project there is no need for connectors as every component will be soldered to its respective PCB. The only connectors that will be required are: a nine volt PP3 battery connector and two crimped connections for the twelve volt battery. At this point there has been no cost involving these connectors. As this project is only on the prototype stage the author was able to find these connectors with no charge.

4.6) Power

The power supply for this assignment will have to be able to power the entire sensor and last for at least a couple of days as specified in the requirements for this assignment. Below is a table of the sensor and the power consumption to help determine how big of a battery is

Power supply table for alarm module		
Devices	Current	Number of devices
Rf Transceiver	26uA	1 per module
Battery capacity	(26uA)(1hr)	93.6mA
Battery over 24hrs	(26uA)(24hr)	2246.4mA
Battery over 1 month	(26uA)(30days)	67392mA
67Ahrs = 1 month		
134Ahr = 2 months		
201Ahr = 3 months		

Table 2 Power 1

required.

Power supply table for sensor module		
Devices	Current	Number of devices
Rf Transceiver	26uA	1 per module
PIR Sensor	3mA	2
Battery capacity	(6mA)(1hr)	23.7A
Battery over 24hrs	(26uA)(24hr)	520.6A
Battery over 1 month	(26uA)(30days)	15619.4A

Table 3 Power 2

4.6) Battery selection

The total estimated ampere hours required for the battery in this assignment for at least a couple of days, so below is a battery that has been selected to supply this.

Sensor module battery selected: Horizon 12v 7.2Ah Sealed VRLA battery, which should last a few days to a week.

Alarm module battery selected: Common brand 9v PP3 battery; which should last, in theory, a month.

4.7) Infrared sensors

Though there were many options between sensors for detecting movement, the author has decided that PIR sensors would be the best option for the project. Infrared sensors detect changes in the amount of infrared radiation in the area around the sensor. The amount of infrared radiation depends on the surface temperature of what's in the surrounding area; objects around the home such as a chair with have very low levels of infrared radiation coming from it if any, but people are warm blooded so the amount of radiation coming from them is noticeable to a sensor. Below are a range of PIR sensors and their features, which are found on the market and can be used in this project.

1. Wide Angle PIR sensor module (Wide-angle) from RS components, RS Stock No.843-0840

Features include: one hundred and eighty degree vision for wide area motion detection; a detection range of ten meters; optional night-time mode for better detection after dark; adjustable sensitivity; movement detected light emitting diode; optimised for infra-red wavelength range from fifty five hundred to fourteen thousand newton meters; power supplied is three to six volts with three milliamp current; Idle current for this device is one hundred and fifty micro amps; and operating temperature range is from zero to fifty degrees Celsius.

2. Dual Pyroelectric Infrared Sensor 45deg from RS components, RS Stock No.721-4912

Features include: gold-plated pins for better continuity; seventy degree motion detection; a detection range of ten meters; power supplied is two to fifteen volts; and operating temperature range is from minus forty to seventy degrees Celsius.

3. PIR (Passive Infra-Red) sensor module from RS components, RS Stock No.781-3024

Features include: Motion detection up to ten meters away, or up to five meters in reduced sensitivity mode; supply current up to twelve milliamps at three volts and twenty three milliamps at five volts; on board light emitting diodes that light up the lens for visual feedback when movement is detected; small size makes it easy to hide; easy interface to a microcontroller; power requires three to six volts, one hundred at thirty micro amps idle current and twenty three milliamps when activated; and operating temperature range is from zero to fifty degrees Celsius.

4. Gardtec PIR Motion Detector, White Light Immunity, 12m Gardscan from RS components, RS Stock No.493-1289

Features include: a one hundred and ten angle of coverage; range adjustment; three selectable pulse counts; high quality low noise pyro sensor; white light filter; and motion detection up to twelve meters away.

PIR Sensor selection										
Sensor name or stock number	Degree of vision	Length of vision	Voltage	Amperage	Idle current	Temperature range	Pulse count	Dimensions	Bonus features	Cost
RS stock No.843-0840	180°	10m	3-6v	3mA	150uA	0-50°C	N/A	36x36x20.2mm	Night time mode	£7.85
RS stock No.721-4912	70°	N/A	2-15v	N/A	N/A	0-70°C	N/A	4.7x4.7x2.4mm	N/A	£1.76
RS stock No.781-3024	180°	10m	3-5v	12-23mA	130uA	0-50°C	N/A	35.8x25.4x20.3mm	reduced sensitivity mode & easy to interface with microcontrollers	£7.20
RS stock No.493-1289	110°	15m	9.5-15v	N/A	N/A	N/A	4	36x51x78mm	Tamper proof, white light immunity, adjustable	£10.61

Table 4 PIR sensors

4.8) PIR Sensor selection conclusion

After gathering all the relevant information on the PIR Selection spread sheet above the author concludes that the PIR sensor that is most suitable to this project is RS stock No.781-3024. This is due to the fact that it has one of the highest degrees of vision, one of the longest vision lengths, with one of the lowest power consumptions, and it is easy to interface with microcontrollers.

4.9) Transceivers

Though there were many options between communication devices, the author has decided that radio transceivers would be the best option for the project. A transceiver is a combination transmitter/receiver usually on a single PCB. Radio transceivers are mostly used in communication systems and two way radios over a short distance. Applications include: Wireless PC Peripherals, Sports watches & sensors, RF remote controls for consumer electronics, Home & commercial automation, Active RFID, and tracking systems. Below are a range of radio transceivers and their features, which are found on the market and can be used in this project.

1. RFM12B-S2 Wireless Transceiver - 915MHz from Robotshop.com

Features include: SPI compatible interface; a high data rate of up to one hundred and fifteen killer bits per second, in digital mode; a wakeup timer; a two to three point eight volt power supply; analogue and digital RSSI outputs; a differential antenna input; automatic antenna tuning; sixteen-bit RX data FIFO; PLL and zero IF technology; high resolution PLL with two point five Killer Hertz step; programmable TX frequency deviation from fifteen to two hundred and forty killer Hertz; programmable receiver bandwidth from sixty seven to four hundred killer Hertz; analogue and digital signal strength indicator; internal data filtering and clock recovery; and a ten Mega Hertz crystal for PLL timing.

2. MICROCHIP MRF24J40MA-I/RM RF MODULE, TXRX, 250KBPS, PCB ANT, from Farnell, stock No.1630202

Features include: a data Rate Max of two hundred and fifty Killer bits per second; a frequency of two point five Giga Hertz; supply voltage of two point five volts and a max supply voltage of three point five volts; a supply current of twenty three milliamps; an operating temperature Range of minus forty to eighty five degrees Celsius; frequency Range of two point five gigahertz; an integrated 20 MHz and 32.768 kHz oscillator drive; low current consumption; up to one hundred and twenty one meters range.

3. NRF24L01P-T, RF Transceiver 2.4 → 2.484GHz, GFSK, 1.9 → 3.6 V 20-Pin QFN – EBay £3.95

Features include: a radio frequency range up to two point four gigahertz; radio frequency power output of up to zero dBm; one to thirty two bytes dynamic payload length; packet assembly and disassembly; address and CRC computation; auto ACK and retransmit; host communication with serial SPI up to ten Mbps with Tx and Rx 32-byte FIFOs; Power Supply: od two to three point five volts.

4. eRIC9, RF Transceiver 868 → 870 MHz, 902 → 928 MHz, FSK, MSK, Dual Band 2.4 → 6 V 24-Pin TXCVR from RS components, RS Stock No.786-9578

Features include: a CC430F5137 SoC, MSP430-core, thirty two KB Flash memory, four KB RAM; an embedded eROS Operating System; a carrier Frequency of 868/915MHz ISM-Band; max RF Output Power of seven dBm; receiver Sensitivity of minus one hundred and ninety dBm at one thousand two hundred bps; max RF Data Rate of five hundred kbps; max host data rate of one hundred and fifteen kbps; AES-128 data encryption/decryption; a programmable user GPIO; a communication serial UART with RTS/CTS handshaking; on-board temperature sensor; U.FL connector for an external antenna; on-board three point three volt LDO voltage regulator; a power supply of two point four volts to six volts; and the operating temperature range is minus forty to eighty five degrees Celsius.

4.91) Radio Transceiver selection conclusion

After gathering all the relevant information on the Radio transceiver selection spread sheet above, the author concludes that the transceiver that is most suitable to this project is the NRF24L01P-T transceiver. This is due to the fact that it has a good voltage range, with low current consumption, auto packet handling, the longest range, it is the cheapest, and comes highly recommended.

Table 5 Radio transceiver

Radio Transceiver Selection										
Name of sensor or stock number	Voltage	Current	Idle current	SPI interface	Frequency range	Low power operation	Data rates	Auto packet handling	Range	Cost
RFM12B-S2	2.2-3.8v	25mA	0.3uA	yes	433/868/915MHz	yes	115.2kps	N/A	N/A	£4.88
Stock No.1630202	2.4-3.6v	23mA	2uA	no	2.4GHz	yes	250kps	N/A	61.8m	£6.40
NRF24L01P-T	1.9-3.6v	13mA	26uA	yes	2.4GHz	yes	250kps	yes	100m	£3.95
RS Stock No.786-9578	2.4-6v	15-33mA	1.8uA	no	915MHz	no	500kps	no	N/A	£9.54

4.92) Motors

Though there were many options in the way of alerting a deaf and or blind people such as light emitting diodes and sounds recordings, the only universal way to alert such people is via an electric motor. The author has decided that direct current motors would be the best option for the project due to their simple and small structures.

1. Coin DC vibration motor – Flux workshop Ebay £2.29

This vibration motor is a simple, very small, and capable of producing a vibration somewhat similar to a powerful mobile phone vibration.

Features include: a small compact coin shaped dc motor with one thousand two hundred revolutions per minute, at a three volt input.

2. DC 3.7V 66000RPM 4 x 12mm Wired Micro Coreless Motor – Ebay £2.65

Features include: a cylindrical shape with a power supply of three point seven volt at sixty six thousand revolutions per minute.

3. Pico Vibe 10mm Vibration Motor - 13mm Type, from Precision micro drives, model number: 310-112

Features include: a cylindrical shape with a power supply of one point five volt at five thousand revolutions per minute, and a typical operating current of thirty two milliamps.

4. Seeedstudio Grove Vibrating Motor by Robotshop.com, product code: RB-See-210

Features include: a cylindrical shape that is grove compatible, with low power consumption, high reliability, and at the same time programmable.

Motor selection							
Name or stock number	RPM	Voltage	Current	Shape	Dimensions	Weight	cost
Coin DC vibration motor	1200	3v	90mA	circular	10x10x3mm	2.68g	£2.29
DC micro coreless motor	66k	3.7v	N/A	cylindrical	3x0.7/4x12mm	4g	£2.65
Pico vibe motor	5k	1.5v	32mA	cylindrical	10x13	6g	N/A
Seedstudio Grove motor	N/A	3-5v	N/A	cylindrical	20x20mm	N/A	N/A

Table 6 Motors

4.93) Motor selection conclusion

After gathering all the relevant information on the motor selection spread sheet above, the author concludes that the motor that is most suitable to this project is the Coin DC vibration motor. This is due to the fact that it has a good voltage and current consumption range, its shape, dimensions and weight are perfect for the project, and it is the cheapest.

4.94) Table of components, costs, and quantities

Below is a table showing the list of components, products, & costs involved with assembling this project as a prototype. After concluding the selection of the main components on previous pages, the purchase of secondary components was needed to connect the primary components together. These secondary components are included in the table below as well as the primary components.

Table of components, costs, and quantities						
Components	Number of packs	Quantity	Costs	VAT	Retailer	Stock number
Linear voltage regulator, L7805CV 5v 1.5A	1	5	£1.60	20%	RS Components	No.298-8514
Reg standard lin fix pos 3.3v 0.5A 3-pin	1	5	£2.99	20%	RS Components	No.661-6737
MOSFET N-CH 0.23A 60v 3-Pin TO-92	1	25	£5.40	20%	RS Components	No.879-3274
MCU, PIC16F1516, 14KB Flash, 2.3v-5.5v	2	4	£4.62	20%	RS Components	No.737-7868
PIR (Passive infra-red) sensor module	1	4	£28.8	20%	RS Components	No.781-3024
Horizon 12v 7.2Ah sealed VRLA battery	2	2	£24.98	N/A	Flux Workshop -Ebay	N/A
NRF24L01 + 2.4GHz antenna, transceiver	1	10	£13.15	N/A	Flux Workshop -Ebay	N/A
3v Coin vibrator micro motor 10x3mm flat	2	4	£4.58	N/A	Flux Workshop -Ebay	N/A
9v PP3 Duracell battery	1	2	£9.85	N/A	Tesco	N/A
9v PP3 battery connector	1	1	£0.25	N/A	Market merchant - Neath	N/A
Bourns 91 Series, Potentiometer 10kΩ	1	1	£5.26	20%	RS Components	No.522-5210
Bread boards	0	4	0	0	UWTSD	N/A
10uf Capacitor	0	10	0	0	UWTSD	N/A
10k resistor	0	4	0	0	UWTSD	N/A
Total cost = 108.715						

Table 7 Costs

4.95) Table of components, costs, and quantities conclusion

The purchasing of these components was done solely by the author with no outside funding or sponsors. This is due to the job position the author currently possess and the company the author is currently employed, not requiring the author to complete a degree or needing the author to design such a product.

4.96) Flow charts

1. Software flow chart for sensor unit

Below is a prototype software design diagram created by the author for this projects finished product. The program will start then wait for the sensors to be triggered; if a sensor is triggered then a code will be transmitted, if the code is received on the other end the same code will be transmitted back to the receiver of this device which tells us that the program is working. If there are no problems then the code will proceed to buzz the motor, and then repeat the program. There is also a handshake code which lets the devices communicate with each other without triggering the direct current motor, this code tells the devices that they're both working correctly; if this code isn't received every hour then an error code is generated then the direct current motor is

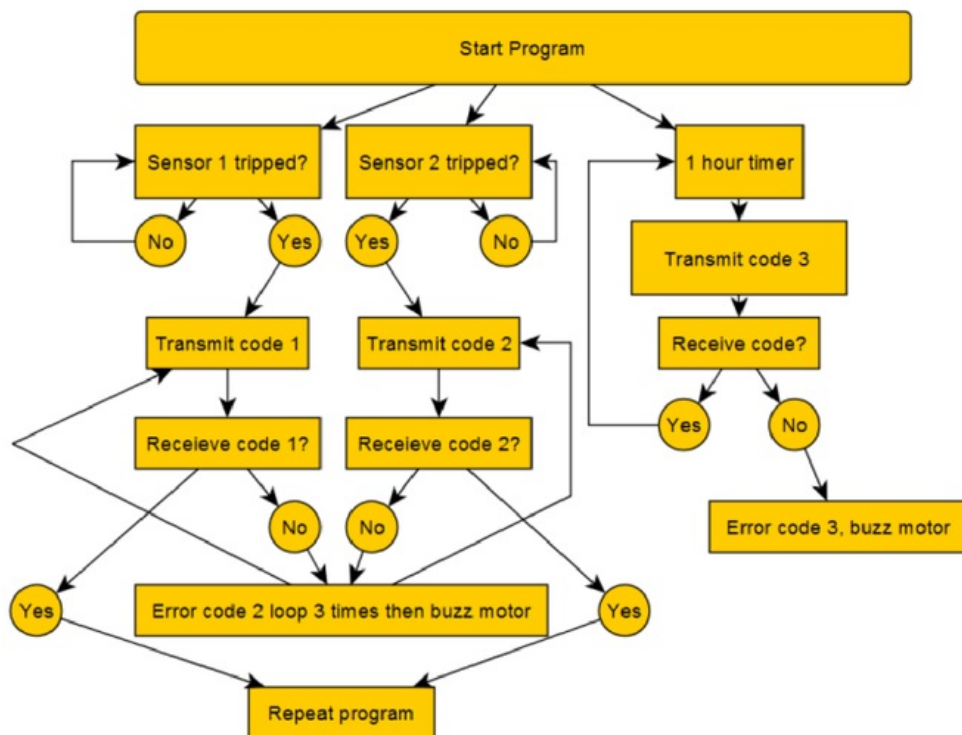


Figure 20 sensor unit diagram

2. Structure flow chart for sensor unit

Below is a prototype structure design diagram created by the author for this projects finished product. The structure will start with the power source, in this case a twelve volt battery, the power supply will then be regulated down to three volts and then in turn power the microcontroller. The microcontroller will then proceed to follow the program described on the previous page and control the function of the sensor one, sensor two, the direct current motor, and the radio transceiver.

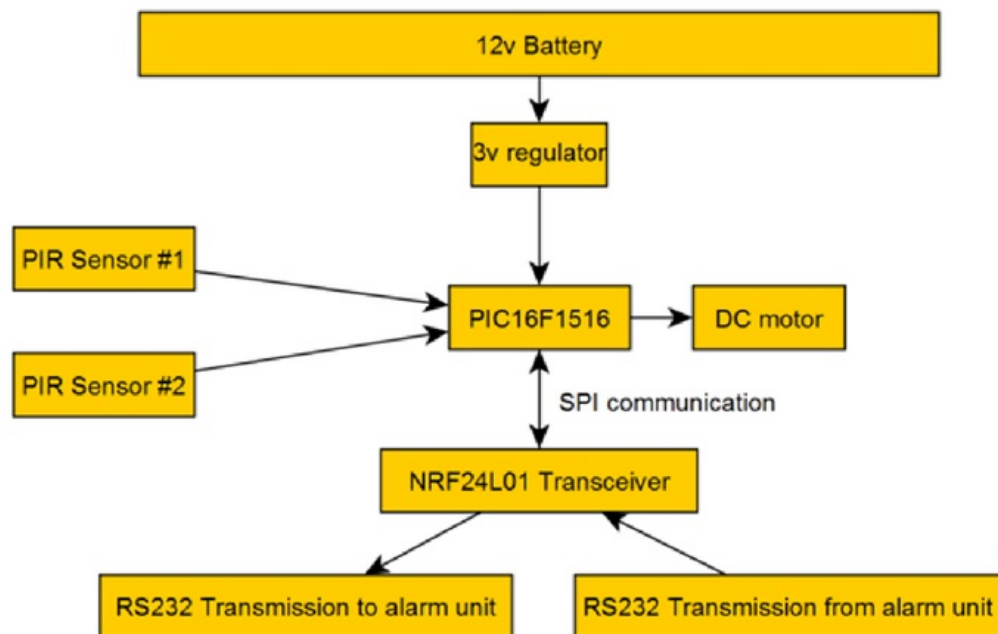


Figure 21 sensor unit structure

3. Software flow chart for Alarm unit

Below is a prototype software design diagram created by the author for this projects finished product. The program will start then wait for s code to be transmitted from the sensor device, the code will then be received on the device before then it will repeat to code and transmit it back to the sensor device to confirm operation. Depending on the code received the program will then proceed to buzz the direct current motor. There is also a handshake code which lets the devices communicate with each other without triggering the direct current motor, this code tells the devices that they're both working correctly; if this code isn't received every hour then an error code is generated then the direct current motor is triggered.

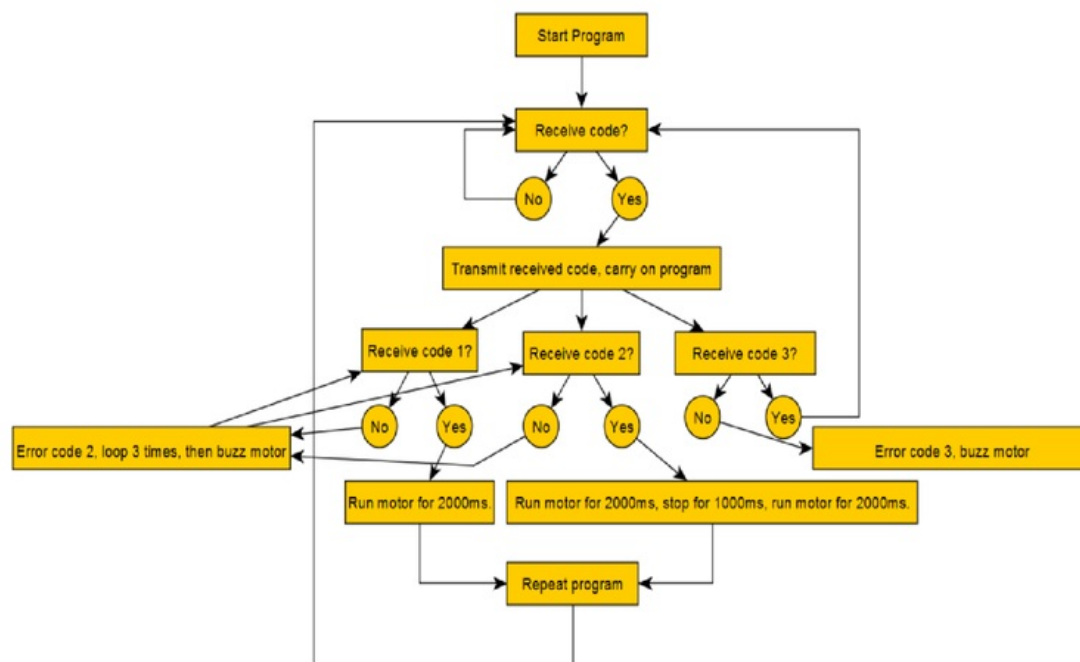


Figure 22 alarm unit diagram

4. Structure flow chart for Alarm unit

Below is a prototype structure design diagram created by the author for this projects finished product. The structure will start with the power source, in this case a nine volt battery, the power supply will then be regulated down to three volts and then in turn power the microcontroller. The microcontroller will then proceed to follow the program described on the previous page and control the function of the direct current motor, and the radio transceiver.

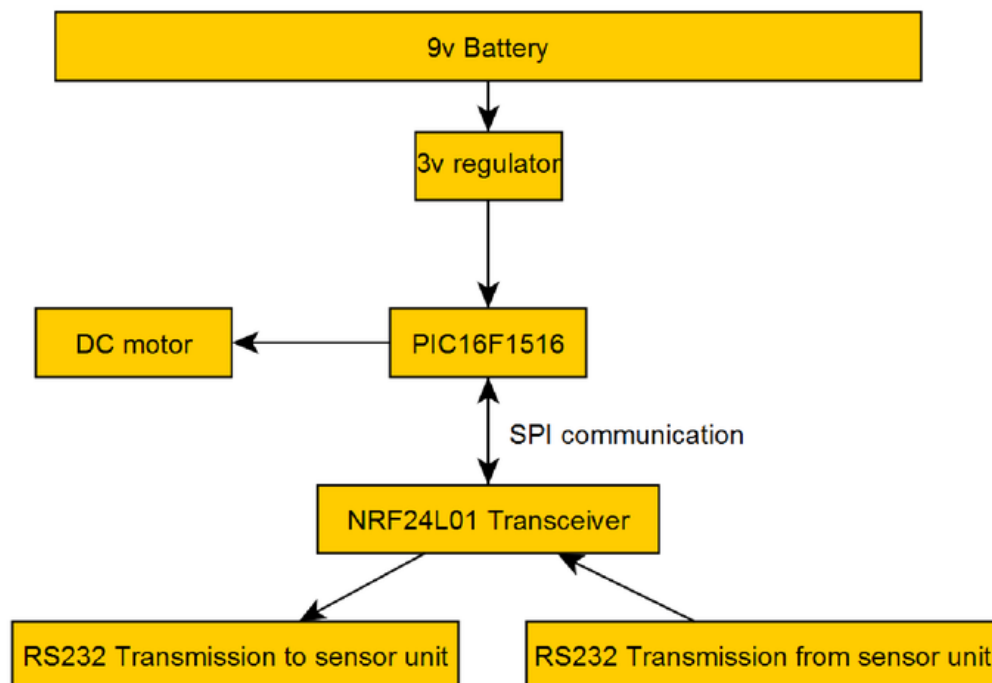


Figure 23 alarm unit structure diagram

4.97) Proteus design of sensory unit

Below is a Proteus design of the authors' sensory unit. This unit is designed to pick up motion via the PIR sensors, the PIR sensors would then trigger a high output which the microcontroller will pick up. The microcontroller will then proceed to send this data via the radio transceiver to the alarm module (alarm Proteus design found on next page). The below sensory unit is powered by a twelve volt battery which is then regulated down to three point three volts. The radio transceiver and the microcontroller are fitted with a ten micro farad capacitor across its input voltage and ground to smooth out the noise in the circuit. In this circuit you can also see that there are push button switches attached to the PIR sensor connections; these switches are used to simulate the high output that the PIR sensors create when motion is detected. Unfortunately Proteus does not possess PIR sensors in the component register, this is why the switches are used. The code for this unit is described in the software flow chart in previous pages named "Software flow chart for Alarm unit". In SPI terms the microcontroller in this circuit is the master microcontroller, and the microcontroller in the alarm unit is the slave.

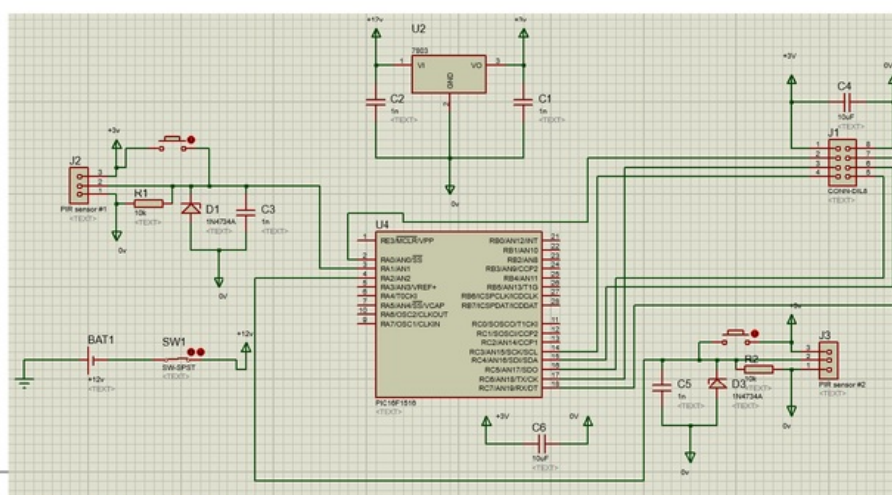


Figure 24 Proteus sensor unit

4.98) Proteus design of alarm unit

Below is a Proteus design of the authors' alarm unit. This unit is designed to pick up the radio transmissions from the sensory unit (found on previous page) via the radio transceiver, send the microcontroller will read the code that it has received and act on that code by turning on the voltage to the direct current motor. In this circuit the power is supplied by a nine volt battery which is regulated down to three point three volts. The code for this unit is described in the software flow chart in previous pages named "Software flow chart for Alarm unit". In SPI terms the microcontroller in this circuit is the slave microcontroller, and the microcontroller in the sensor unit is the master.

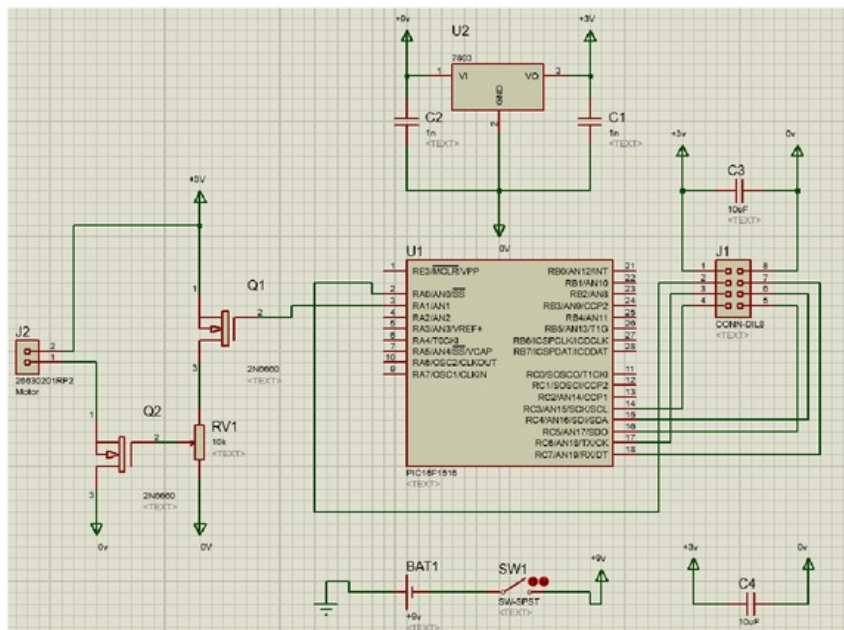


Figure 25 *Proteus* alarm unit

Chapter 5

5.1) Conclusion

In the beginning of this project there were a few key aims and objectives that were stated.

Firstly the finished prototype must be able to sense intruders; this objective was accomplished as after the author tested the components, the PIR sensors were shown to have a high output after movement. Secondly the finished prototype must be able to alert the client to the presence of an intruder; though the author hasn't been able to prove this before the hand in date for this project, the parts the author has purchased do work. Thirdly the device must be portable, after the author assembled the prototypes the author found that the individual devices are portable, but the sensory unit depends on its urban camouflage and this might affect its portability depending on what it is hiding within. Fourthly, the product must last at least a day without needing recharging; the author has made sure in the design stages that the power of both units should last at least a week without needing recharging. Fifthly, the product must be able to differentiate between moving inanimate objects and life forms; the author has made this possible by using PIR sensors which work off infra-red radiations so theoretically moving inanimate objects shouldn't set off the alarm. Sixthly, the finished product must function for the deaf and or blind; the author has achieved this by using a direct current motor to vibrate which both the deaf and the blind will be able to feel. Seventhly, the product must be able to communicate with the client over a distance; though at this time the author cannot prove this, the NRF24L01 transceiver should be able to communicate to over ten meters in doors according to the data sheet and online forums. Eighthly and lastly, the product must be affordable; the author believes that if this product was to be mass produced then parts would be bought in bulk which would lower the overall cost per unit and since the cost of the prototype was one hundred and eight pounds then even after further development and extra costs such as the urban camouflage and packaging the cost per unit can be reasonably halved, which makes the product cheap enough for the average person.

The author concludes that though the research is correct, and the selected components are correct, the finished prototype does not function at the time of the hand in of this report. This was found by testing each component separately in both the sensory unit prototype and the alarm unit prototype. The author believes that this is due to insufficient knowledge into C programming and it is the program that is preventing the project from functioning correctly. The author hopes that this issue will be resolved by the last viva.

The authors' project on creating a security system for the deaf and or blind will improve people's lives across the UK by providing them with a sense of security which they have lost already or are losing gradually with time. This will be achieved by placing sensor modules in the home in plain sight with the aid of its urban camouflage. This urban camouflage will make the product invisible to potential intruders. These camouflaged sensory units will interact with a main alarm unit which the client will carry with them within their home.

If there were an intruder in the home when this system is in operation, the sensor would be triggered by the intruder's movement. This would then signal the alarm unit which will signal the owner with vibrations. Vibrations are used as touch is a common sense that everyone has. The alarm would vibrate to the tune of the specific module that has been triggered, telling the home owner where exactly in the home the intruder is. This would give the home owner time to decide on his/her strategy on how to deal with the situation.

Though this is an excellent goal for the future, the authors' lack of knowledge in C programming will have to be acknowledged, acted upon, and overcome to make this goal possible.

5.2) Recommendations

In conclusion, the author believes that it would work and achieve the goals set out in this project. But he also believes if this product were to be produced it would benefit from certain improvements.

Below are a few suggestions which could improve the design if found necessary:-

Longer battery life

If you were to increase the battery life, consumers would benefit from being able to use the end product more than once without re-charging or replacing the battery.

Wireless sensors

If you were to make the end products sensors wireless; consumers would benefit from easier installation of the end product, and reduce the time required to move the product from one place to another.

Built in solar panel

Adding a solar panel to the system would enhance the battery life of the system and could theoretically power the system so that it would not require recharging or replacing the battery.

Incorporating a PC

If you were to incorporate a PC into the design, consumers would be able to look at the data recordings throughout the day or night, and the data could be taken and presented without taking out the circuit hub and taking it to a PC; Which would increase the over-all attractiveness of the end product and give it more function-ability.

Logging Data

Adding memory to the product would make it able to record movement as well as alert the client, and if for some reason the alarm failed then the recordings would give a time and a place of the movement for future use.

Size

Currently the sensor unit is rather sizeable due to the size of the battery. If a smaller battery with the same out-put was used then it would be much easier to fit the unit into spaces and urban camouflage.

Chapter 6

Reflection

This project has supplied the author with a wealth of knowledge. It has shown the author how to go about designing a project, what to do while designing a project, and what not to do. It has also shown the author his strengths and weaknesses in designing a project.

The author has learn how to decide which components to select, how to place them into a circuit, and think outside the box when it comes to these circuits future possible problems, such as cooling or water proofing. One of the most important lessons the author has learned it how to properly source a microcontroller for the desired circuit, as the author ordered a slightly over powered and more expensive microcontroller than he needed, as since the author was funding this project the potential wasted funds due to this is not pleasing. The author also realises that making a mistake like purchasing an overpriced component which he did not need could potentially upset future employers.

The author has learnt the importance of accurate research, during the build of the final prototype of this project the author over looked a crucial part in the communication between the sensory unit and the alarm unit. The research the author has overlooked was SPI communication and the programming of this with C language, and this could very well be the cause of the lack of function with the finished prototypes. In future the author will do more research and implementation into serial peripheral interfaces and C programming to assure this problem will not reoccur.

The author believes that this project has also changed him as a person. During this project the author admits that he has procrastinated profusely which has caused him to lose a large amount of marks. In future project the author believes that he would have learnt from these mistakes and keep on top of any future work, to achieve a higher quality of work.

Chapter 7

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Appendix

1. Full size Gantt chart.

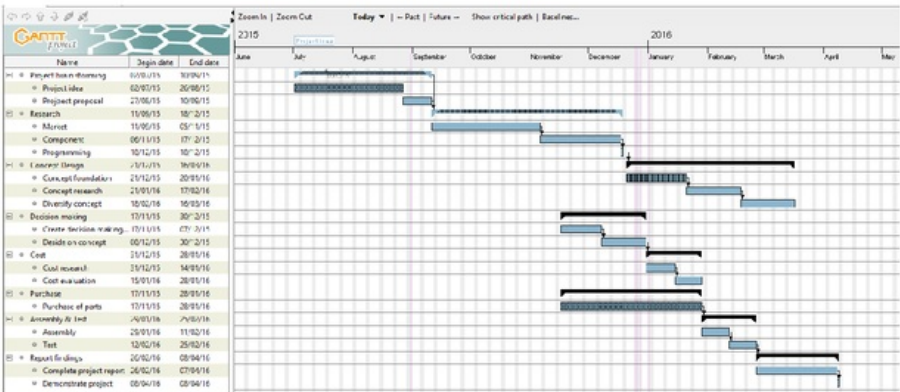


Figure 26 Full size Gantt chart

2. Program code for sensor unit

```

1  #include <main.h>
2  #use spi (MASTER, SPI1, MODE=0, BITS=8, STREAM=SPI_1)
3
4
5
6  void buzz_timeout(void);
7
8
9  unsigned long int counter=0;
10 short int timerflag=0;
11
12
13
14 #INT_TIMER1
15 void TIMER1_isr(void)
16 {
17     counter++;
18     output_toggle(PIN_B0);
19     // 1hour = 27480 131ms intervals
20     if(counter==100) // 27480
21     {
22         timerflag=1;
23         counter=0;
24     }
25 }
26
27
28 void main()
29 {
30
31     unsigned int byte_for_tx=0,data_in;
32     unsigned int timeout=0;
33
34     setup_timer_1(T1_INTERNAL(T1_DIV_BY_8); //131 ms overflow
35
36     setup_spi(SPI_MASTER | SPI_H_TO_L | SPI_CLK_DIV_16);
37     enable_interrupts(INT_TIMER1);
38     enable_interrupts(GLOBAL);

```

Figure 27 Sensor unit code 1

```

38 enable_interrupts(GLOBAL);
39 output_C(0);
40
41 while(TRUE)
42 {
43     /*
44     output_high(PIN_B0);
45     delay_ms(50);
46     output_low(PIN_B0);
47     delay_ms(50);
48     */
49     //TODO: User Code
50     byte_for_tx=0;
51     // check the inputs
52     if(input(PIN_A1)) // check pin a1 if set, then set pin b2
53     {
54         output_high(PIN_C6); // set pin B2
55         byte_for_tx=1;
56         while((byte_for_tx != data_in) & (timeout<4))
57         {
58             spi_write( byte_for_tx );
59             data_in = spi_read();
60             timeout++;
61             buzz_timeout();
62         }
63     }
64     else
65     {
66         output_low(PIN_C6); // Clear Pin B2
67     }
68     if(input(PIN_A2)) // check pin a2 if set, then set pin b3
69     {
70         output_high(PIN_C6); // set pin B3
71         byte_for_tx=2;
72         timeout=0;
73         while((byte_for_tx != data_in) & (timeout<4))
74         {
75             spi_write( byte_for_tx );
76             data_in = spi_read();
77             timeout++;
78         }
79     }
80 }

```

Figure 29 Sensor unit code 2

```

75         timeout++;
76         buzz_timeout();
77     }
78 }
79
80 else
81 {
82     output_low(PIN_C6); // Clear Pin B3
83 }
84
85 if(timerflag)
86 {
87     output_toggle(PIN_C6); //B4
88     timerflag=0;
89     byte_for_tx=0xAA;
90     while((byte_for_tx != data_in) & (timeout<4))
91     {
92         spi_write( byte_for_tx );
93         data_in = spi_read();
94         timeout++;
95         buzz_timeout();
96     }
97 }
98
99
100 // transmit the byte if >0
101 if(byte_for_tx)
102 {
103     printf("txbyte=%X\n",byte_for_tx);
104 }
105 delay_ms(100);
106 }
107 }
108
109
110
111 void buzz_timeout(void)
112 {
113 }

```

Figure 28 Sensor unit code 3

```

109
110
111 void buzz_timeout(void)
112 {
113     while(true)
114     {
115         output_toggle(PIN_A1);
116         delay_ms(500);
117     }
118 }
119
120 }

```

Figure 30 Sensor unit code 4

```

1 #include <16F1516.h>
2 #device ADC=10
3
4 #FUSES PUT           //Power Up Timer
5 #FUSES NOMCLR        //Master Clear pin used for I/O
6 #FUSES NOPROTECT     //Code not protected from reading
7 #FUSES BROWNOUT      //Reset when brownout detected
8 #FUSES NOCLKOUT      //I/O function on GSC2
9 #FUSES IESO          //Internal External Switch Over mode enabled
10 #FUSES FCMEN         //Fail-safe clock monitor enabled
11 #FUSES NOWRT         //Program memory not write protected
12 #FUSES NOVCAFP       //VCAFP pin disabled
13 #FUSES STVREN        //Stack full/underflow will cause reset
14 #FUSES BORV25        //Brownout reset at 2.5V
15 #FUSES LFBOR         //Low-Power Brownout reset is enabled
16 #FUSES NOLVP         //No low voltage prgming, B3(PIC16) or B5(PIC18) used for I/O
17
18 #use delay(internal=16MHz)
19 #use rs232(baud=9600,parity=N,xmit=PIN_C6,rcv=PIN_C7,bits=8,stream=PORT1)
20 #use spi (MASTER, SPI1, MODE=0, BITS=8, STREAM=SPI_1)
21

```

Figure 31 Fuses for sensor unit

3. Program code for Alarm unit

```

main.c
1  #include <main.h>
2
3  #use spi (MASTER, SPI1, MODE=0, BITS=8, STREAM=SPI_1)
4  #INT_TIMER1
5  void TIMER1_isr(void)
6  {
7
8  }
9
10 void main()
11 {
12     // setup_timer_1(T1_INTERNAL|T1_DIV_BY_8);    //131 ms overflow
13
14
15     // enable_interrupts(INT_TIMER1);
16     // enable_interrupts(GLOBAL);
17     int command;
18     while(TRUE)
19     {
20         output_high(PIN_B0);
21         delay_ms(1);
22         output_low(PIN_B0);
23         delay_ms(1);
24
25         //TODO: User Code
26
27         if(kbhit())
28         {
29             command=getch();
30             if (command=='1')
31             {
32                 // code for command 1
33                 // buzz motor once
34                 printf("%c",command);
35                 output_high(PIN_A1);
36                 delay_ms(50);
37                 output_low(PIN_A1);
38

```

Figure 32 Alarm code 1

```

29  command=getch();
30  if (command=='1')
31  {
32      // code for command 1
33      // buzz motor once
34      printf("%c",command);
35      output_high(PIN_A1);
36      delay_ms(50);
37      output_low(PIN_A1);
38  }
39
40  if (command=='2')
41  {
42      // code for command 2
43      // buzz motor 2
44      printf("%c",command);
45      output_high(PIN_A1);
46      delay_ms(50);
47      output_low(PIN_A1);
48      delay_ms(100);
49      output_high(PIN_A1);
50      delay_ms(50);
51      output_low(PIN_A1);
52  }
53
54  if (command=='AA')
55  {
56      // run the failsafe command
57      // return the command value
58      printf("%c",command);
59  }
60  }
61  }
62
63
64
65

```

Figure 33 Alarm code 2

```

1  #include <16F1516.h>
2  #device ADC=10
3
4  #FUSES PUT           //Power Up Timer
5  #FUSES NOMCLR        //Master Clear pin used for I/O
6  #FUSES NOPROTECT     //Code not protected from reading
7  #FUSES BROWNOUT      //Reset when brownout detected
8  #FUSES NOCLKOUT       //I/O function on OSC2
9  #FUSES IESO          //Internal External Switch Over mode enabled
10 #FUSES FCMEN          //Fail-safe clock monitor enabled
11 #FUSES NOWRT          //Program memory not write protected
12 #FUSES NOVCAP         //VCAP pin disabled
13 #FUSES STVREN         //Stack full/underflow will cause reset
14 #FUSES BORV25         //Brownout reset at 2.5V
15 #FUSES LPBOR          //Low-Power Brownout reset is enabled
16 #FUSES NOLVP          //No low voltage prgming, B3(PIC16) or B5(PIC18)
17
18 #use delay(internal=16MHz)
19 #use rs232(baud=9600,parity=N,xmit=PIN_C6,rcv=PIN_C7,bits=8,stream=PORT1)
20 #use spi (MASTER, SPI1, MODE=0, BITS=8, STREAM=SPI_1)

```

Figure 34 Fuses for alarm unit code

4. PDFs

All PDFs on components will follow this document in electronic format on a USB.