CHAPTER 1: INTRODUCTION

1.1 SECURITY SYSTEM

security system are gaining increase importance in recent times to protect life and valuable resources, many advanced method of providing security have been developed and are in use in the last few decades. Of this one important area is the security system required for military /strategic applications, which has advanced greatly. But such systems being complex and expensive are useful to high end application only. However with recent progress in technology and the growing need for increased security in civilian and other applications, many low cost solutions for security system have now emerged. In the field of Burglar Alarm Systems using modern approaches has become a major means of providing security in all applications, both military and civilian. Due to high state of insecurity being experienced in the entire world the need to keep the occupants of the office aware of any intrusion in to their premises forms part of the project.

1.2 PREVIOUS WORK

In Kenya most security solutions are provided by security firms. These systems have been operation for some time which mostly is foreign developed. These translates that they tend to be expensive and hard to maintain because suppliers keep on producing new product and not supporting their older versions.

However this project is geared to development of office grown simple security system that meets the same needs as commercially available system.

The final product will be cheaper, easy to maintain and foolproof.

1.3 PROJECT OBJECTIVE

This project is aimed at designing, simulating and implanting a cheap and reliable alarm system using Small Scale Integrated and Medium Scale Integrated chips that can detect and warn on external intrusion.

The system has to satisfy the following:

1. Ensure the security of an office by deterring person intending to burglar and warning the occupants of office of any unauthorized entry into their premise.

2. Provide psychological satisfaction of being secure to the office occupant.

1.4 PROJECT STRUCTURE

Project was designed in the following modules:

1. **House Intrusion Module:**

   This module consists of motion detectors placed strategically in concealed location this sensors when activated should activate the following devices in the following sequence:-

   - Activate buzzer to warn the occupants.
   - If present, activate the cameras
   - Finally it should set off the alarm

2. **The Control Unit Module:**

   This is the decision making center that interprets the various inputs from the sensor and makes the appropriate logic decision.

3. **Arm and Disarm Module:**

   This is for arming and disarming the system.

4. **Alarm Module:**

   This is for warning and deterring the intruders.
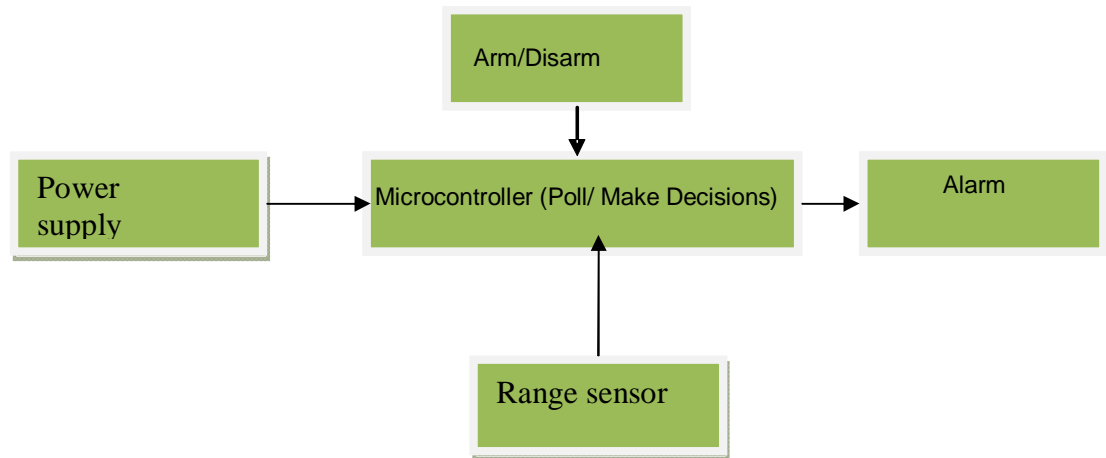
Block diagram:

Figure 1

CHAPTER 2: THEORETICAL BACKGROUND

2.1 Research

2.1.1 Burglar Alarms

Most burglar alarm systems run from a fixed 12V power supply. This is also the standard operating supply voltage for usual subsystems such as any ultrasonic, PIR, heat, pressure or magnetic sensors etc also the majority of the Strobe flashing lights and sirens available also run from 12V. Bearing this knowledge in mind, my burglar alarm control panel should run from a 12V supply, and when an alarm output has to be activated, a supply of 12V should be supplied.

A standard also exists for how input sensors operate. They normally use a normally closed (N.C.) loop for sensors, so that an alarm condition is signaled by a switch being opened within the sensor and cutting the circuit. This also means that should a burglar cut the wires to a sensor, then the loop will be cut and an alarm signal is generated.

Most commercial burglar alarms have the capability to monitor the input sensors separately, so that in the event of a burglary, it is known which sensors were and were not triggered so that the point of entry and extent of break in can be deduced.

2.1.2 MICROCONTROLLER

A microcontroller (also MCU or µC) is a small computer on a single integrated circuit consisting of a relatively simple CPU combined with support functions such as a crystal oscillator, timers, and watchdog, serial and analog I/O etc. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a, typically small, read/write memory.

Thus, in contrast to the microprocessors used in personal computers and other high performance applications, simplicity is emphasized. Some microcontrollers may operate at clock frequencies as low as 32 KHz, as this is adequate for many typical applications, enabling low power consumption (millwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes

2.1.3 Analog to Digital Converter

An **analog-to-digital converter** (abbreviated **ADC**, **A/D** or **A to D**) is a device which converts continuous signals to discrete digital numbers. The reverse operation is performed by a digital-to-analog converter (**DAC**).

Typically, an ADC is an electronic device that converts an input analog voltage (or current) to a digital number. However, some non-electronic or only partially electronic devices, such as rotary encoders, can also be considered ADCs. The digital output may use different coding schemes, such as binary, Gray code or two's complement binary

2.2 TRANSDUCERS

This section deals with the various possible sensor designs and how they function and which could be appropriate for particular case.

2.2.1 Infrared motion detector

2.2.1.1 Passive Infrared sensor (PIR sensor

Passive Infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. PIR sensors are often used in the construction of PIR-based motion detectors (see below). Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects emit what is known as black body radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term passive in this instance means that the PIR device does not emit an infrared beam but merely passively accepts incoming infrared radiation.

In passive infrared motion detectors, a sensor containing an infrared-sensitive phototransistor is placed in the area to be protected. Circuitry within the sensor detects the infrared radiation emitted by the intruder's body and triggers the alarm. The problem with using this type of detector is that it can be falsely triggered by warm air movement or other disturbances that can alter the infrared radiation levels in an area. In order to prevent this problem, newer systems use two infrared sensors which monitor different zones within a protected area. Logic within system triggers the alarm only when the two zones are activated in sequence, as would occur if a person walked through the protected area.

- **Pyroelectric Sensors**

The pyroelectric sensor is made of a crystalline material that generates a surface electric charge when exposed to heat in the form of infrared radiation. When the amount of radiation striking the crystal changes, the amount of charge also changes and can then be measured with a sensitive FET device built into the sensor. The sensor elements are sensitive to radiation over a wide range so a filter window is added to the TO5 package to limit detectable radiation to the 8 to 14mm range which is most sensitive to human body radiation.

Typically, the FET source terminal pin 2 connects through a pull down resistor of about 100 K to ground and feeds into a two stage amplifier having signal conditioning circuits. The amplifier is typically bandwidth limited to below 10Hz to reject high frequency noise and is followed by a window comparator that responds to both the positive and negative transitions of the sensor output signal. A well filtered power source of from 3 to 15 volts should be connected to the FET drain terminal pin 1.
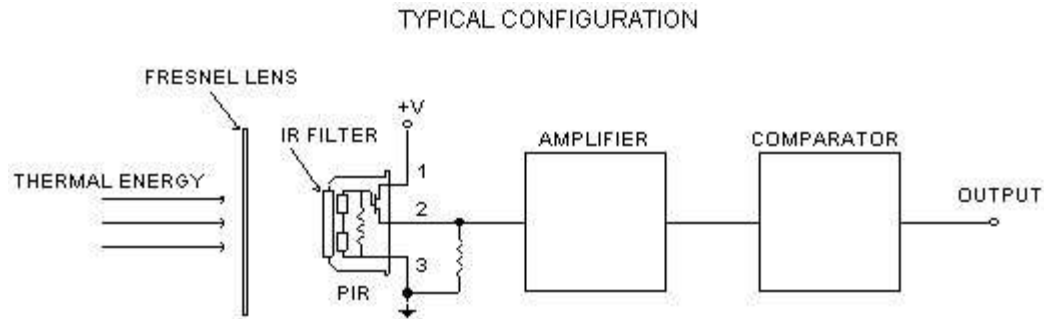
TYPICAL CONFIGURATION

FRESNEL LENS

IR FILTER

THERMAL ENERGY

+V

1

2

3

PIR

AMPLIFIER

COMPARATOR

OUTPUT

Figure 1.1

The PIR325 sensor has two sensing elements connected in a voltage bucking configuration. This arrangement cancels signals caused by vibration, temperature changes and sunlight. A body passing in front of the sensor will activate first one and then the other element whereas other sources will affect both elements simultaneously and be cancelled. The radiation source must pass across the sensor in a horizontal direction when sensor pins 1 and 2 are on a horizontal plane so that the elements are sequentially exposed to the IR source. A focusing device is usually used in front of the sensor.
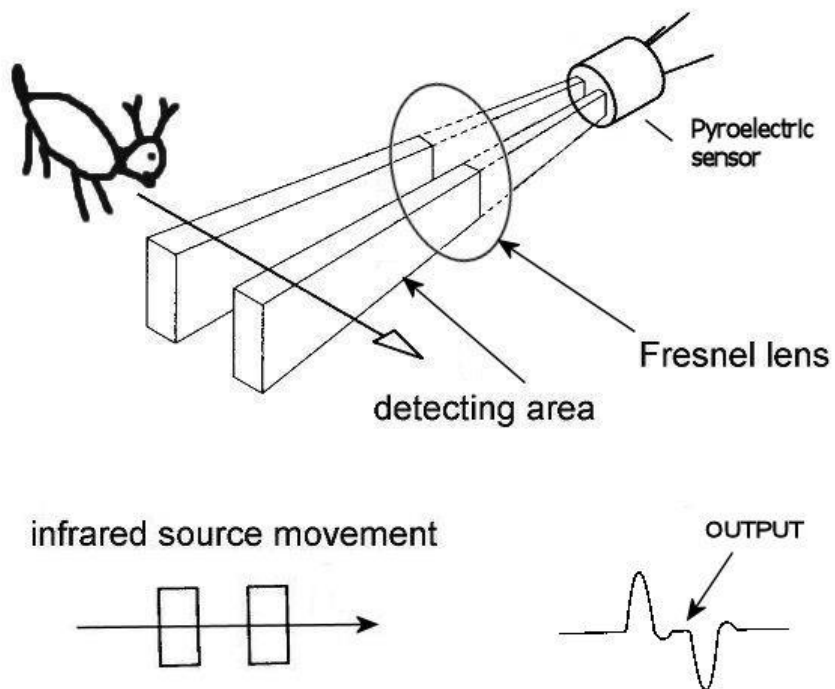
Pyroelectric sensor

Fresnel lens

detecting area

infrared source movement

OUTPUT

Figure 2.2

Fresnel lens

A Fresnel lens (pronounced Frennel) is a Plano Convex lens that has been collapsed on itself to form a flat lens that retains its optical characteristics but is much smaller in thickness and therefore has less absorption losses.
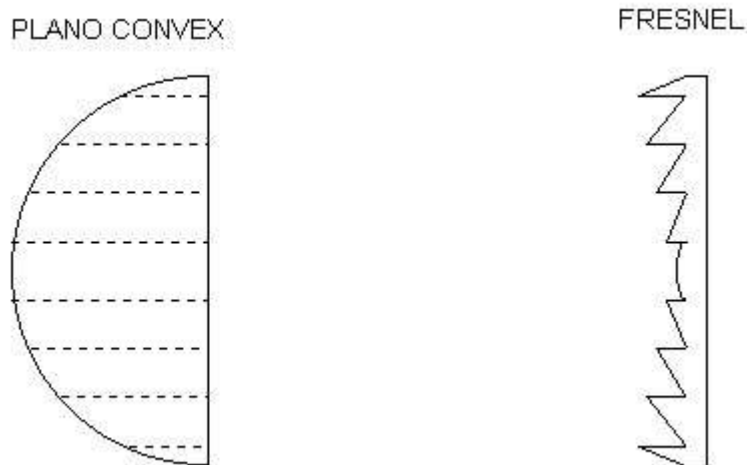
PLANO CONVEX   FRESNEL

Figure 2.3

Our FL65 Fresnel lens is made of an infrared transmitting material that has an IR transmission range of 8 to 14um which is most sensitive to human body radiation. It is designed to have its grooves facing the IR sensing element so that a smooth surface is presented to the subject side of the lens which is usually the outside of an enclosure that houses the sensor.

The lens element is round with a diameter of 1 inch and has a flange that is 1.5 inches square. This flange is used for mounting the lens in a suitable frame or enclosure. Mounting can best and most easily be done with strips of Scotch tape. Silicone rubber can also be used if it overlaps the edges to form a captive mount. There is no known adhesive that will bond to the lens material.

The FL65 has a focal length of 0.65 inches from the lens to the sensing element. It has been determined by experiment to have a field of view of approximately 10 degrees when used with a PIR325 Pyroelectric sensor.
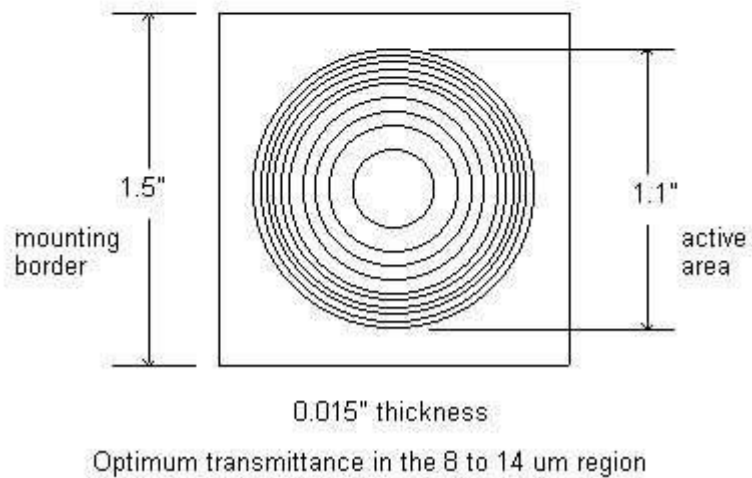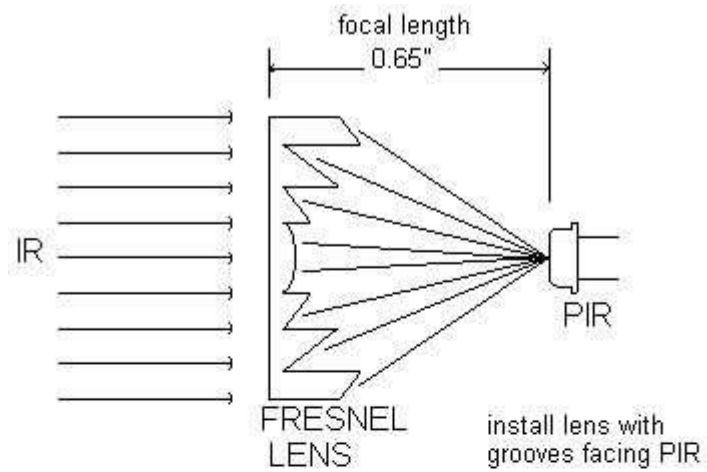
Figure 2.4

This relatively inexpensive and easy to use Pyroelectric Sensor and Fresnel Lens can be used in a variety of science projects, robots and other useful devices.
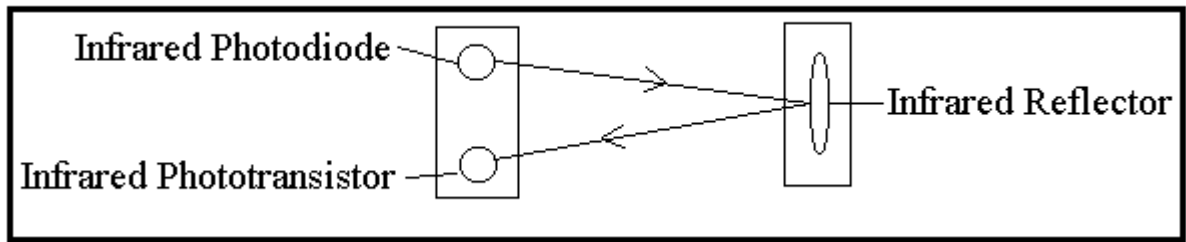
2.2.1.2 Active Infrared Motion Detector

Figure 2.5

Figure 2 shows the operation of an active infrared motion detector. In the active system each sensor consists of two housings. One housing contains an infrared-emitting diode and an infrared-sensitive phototransistor. The other housing contains an infrared reflector. When positioned in front of an entrance to a protected area, the two housings establish an invisible beam. A person entering the area interrupts the beam causing an alarm to be triggered. An active motion detector is much more reliable than a passive one, but it requires careful alignment when it is installed. The detector can be falsely triggered if one of the housings moves slightly and causes a discontinuous beam.

2.2.1.3 Magnetic reed switches

Though a house is well protected by installing break proof doors and windows it is necessary to monitor the conditions of the door. This can be done by installing small magnetic switches inside the frame. This activates the alarm when it is disturbed.
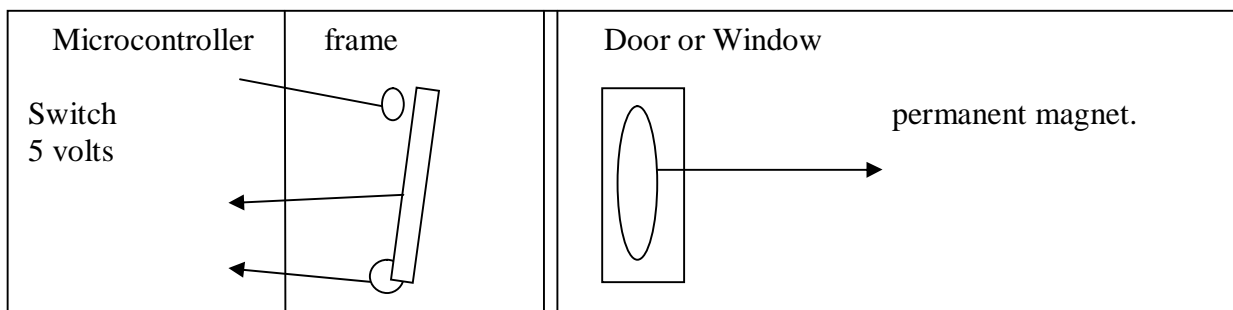

Figure 2.6

2.2.1.4 Breaking glass detector

Modern glass break detectors consist of small microphone connected to a sound processor. The microphone is tuned to the frequency of breaking glass, and the processor looks for a characteristic sound pattern. Additionally, the shock sensor detects the tiny shock wave that passes all through the building when a window suffers an impact. Only when there is sound of breaking glass, and a shock wave, will the alarm sound. Thus, they are tremendously immune to environmental noise which might cause a false alarm. Glass break detectors must be located within a range of the glasses to protected, usually ten feet or so. Additionally, heavy window treatments can significantly reduce the effective range. Up to now the windows and doors are covered

2.2.1.5 Ultrasonic Motion Detectors

Ultrasonic transducers can be used to detect motion in an area where there are not supposed to be any moving objects. This type of motion detector is most commonly used in burglar alarm systems since they are very effective in this application.

Figure 2.7 shows the operation of an ultrasonic motion detector. There are two transducers: one emits an ultrasonic wave and the other picks up reflections from the different objects in the area. The reflected waves arrive at the receiver in constant phase if none of the objects in the area are moving. If something moves, the received signal is shifted in phase. A phase comparator detects the shifted phase and sends a triggering pulse to the alarm.

Ultrasonic motion detectors have certain advantages and disadvantages when compared with other types of motion detectors. The main advantages are that they are very sensitive and extremely fast acting. However, the largest problem with this type of motion detector is that it sometimes responds to normal environmental vibration that can be caused by a passing car or a plane overhead. Some types of motion detectors use infrared sensors to avoid this problem, but even these detectors have some problems
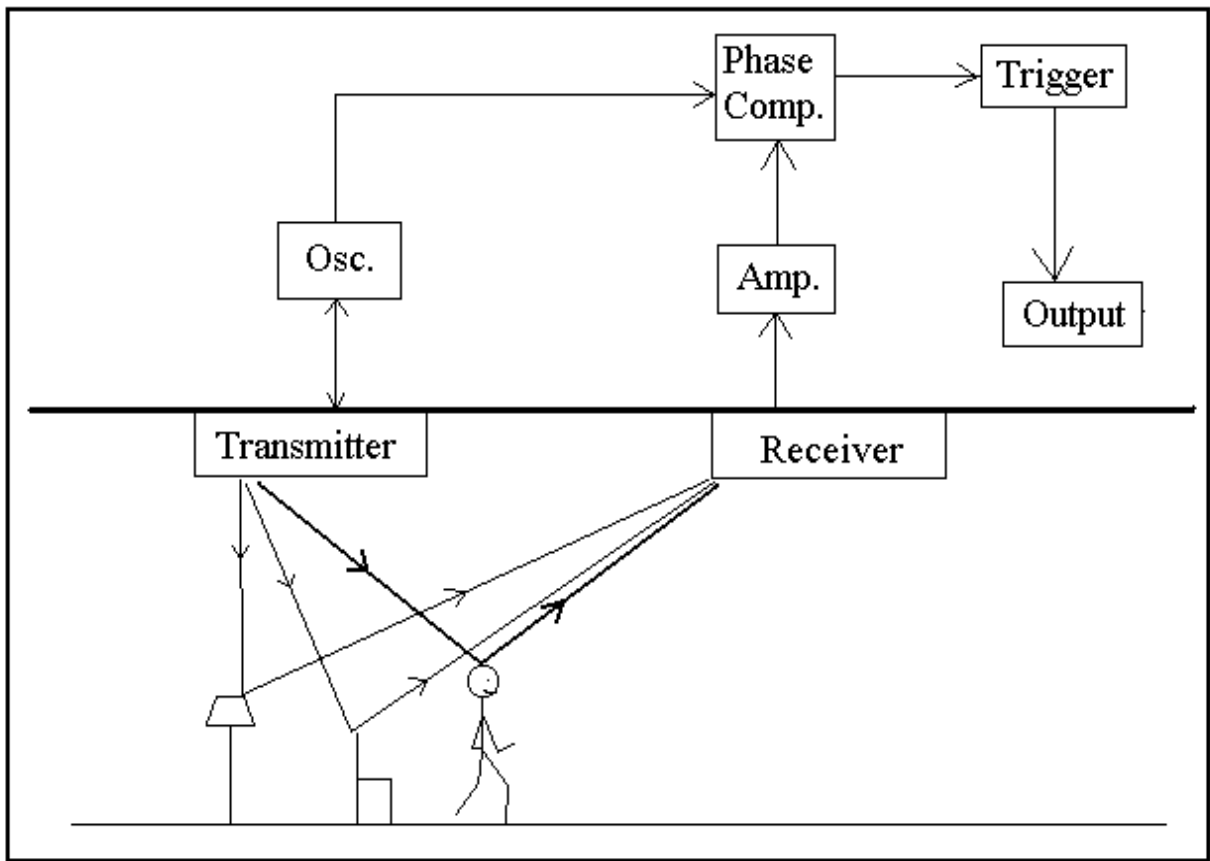
Figure 2.7

2.2.1.5.1 LV-MaxSonar-EZ1High Performance Sonar Range Finder

With 2.5V - 5.5V power the LV-MaxSonar-EZ1 provides very short to long range detection and ranging, in an incredibly small package. The LV-MaxSonarEZ1detects objects from 0-inches to 254-inches (6.45-meters) and provides sonar range information from 6-inches out to 254-incheswith 1-inch resolution. Objects from 0-inches to 6-inches range as 6-inches. The interface output formats included are pulse width output, analog voltage output, and serial digital output.

Features

· Continuously variable gain for beam control and side lobe suppression

· Object detection includes zero range objects

· 2.5V to 5.5V supply with2mA typical current draw

· Readings can occur up to every 50mS, (20-Hz rate)

· Free run operation can continually measure and output range information

· Triggered operation provides the range reading as desired

· Designed for protected indoor environments

· Sensor operates at 42 KHz

Benefits

- Very low cost sonar ranger

- Reliable and stable range data

- Sensor dead zone virtually gone

- lowest power ranger

- Quality beam characteristics

- Mounting holes provided on the circuit board

- Very low power ranger, excellent for multiple sensor or battery based systems

- Can be triggered externally or internally

- Sensor reports the range reading directly, frees up user processor

Beam Characteristics

People detection requires high sensitivity, yet a narrow beam angle requires low sensitivity. The

LV-MaxSonarÒ-EZ1Ô balances the detection of people with a narrow beam width.

Sample results for measured beam patterns are shown below on a 12-inch grid. The detection

Pattern is shown for;

(A) 0.25-inch diameter dowel, note the narrow beam for close small objects,

(B) 1-inch diameter dowel; note the long narrow detection pattern,

(C) 3.25-inch diameter rod, note the long controlled detection pattern,

(D) 11-inch wide board moved left to right with the board parallel to the front sensor face and the sensor stationary. This shows the sensorøs range capability.

Note: The displayed beam width of (D) is a function of the secular nature of sonar and the shape of the board (i.e. flat mirror like) and should never be confused with actual sensor beam width.

2.2.2 VARIOUS APPROACH.

In order to design this project the main decision I need to make is what approach I will take for the main alarm processing. In this chapter discussion of these designs dealt with and the reason why one design was chosen.

2.2.2.1 Discrete Component Based Design

This is one of the earliest forms of design which involve discrete components to build the digital systems.

Disadvantages:

- Huge power consumption
- Large size of a complete system
- Difficult to debug the complete system

These systems includes the use of digital gates such as NAND, AND , NOR gates etc .such as 74yy series.

To build the system as stated the following components would be used

- AND, OR gates
- Delay circuits that can be implemented using flip-flop,555 timer ICS.
- Motion detector such as infrared motion detector would involve infrared sensitive transistor that are biased to conduct by infrared emitted energy

Generally if these project where to be implemented using this way it would be quite bulky   expensive and very hard to trouble shoot it in case of failure.

2.2.2.2 COMPUTER BASED DESIGN

Computers are very powerful device that can implement the control unit with minimum components .the only important part is the interface between the sensors, switches, alarm and buzzer to the computer .This can be done through the 1pt printer port (parallel port) which has eight pins and five input pins. To get more pin one can add another input card or include a microcontroller to communicate with the computer serially. By writing software to manipulate the voltage at these pins one is able to scan the conditions of the

sensor and perform the appropriate action .However to interface the circuit to computer one as to be careful as the parallel port only accept up to a maximum of 5volts.while things like relay switches ear usually accompanied by the transient which are be harmful to the printer port. These demands use of optiosolator to electrically separate the computer from the external circuits

Limitations for computer based design:

- High cost of computer
- The computer has to be continuously, this means the need for dedicated computer which is uneconomical
- Due to constant power losses there is need to include power backups which and the cost.

2.2.2.3 MICROCONTROLER BASED DESIGN

Circumstances that we find ourselves in today are in the field of microcontrollers which had their beginnings in the development of technology of integrated circuits. This development has made it possible to store hundreds of thousands of transistors in to one chip. That was a perquisite for production of microprocessors, and the first computers were made by adding external peripheral such as memory, input óoutput lines timers and other .further increasing of the volume of the package resulted in creation of integrated circuits .these integrated circuits contained both processor and peripherals. That is how the first chip containing a microcomputer, or what would later be known as microcontroller came about.

Microcontroller differs from microprocessor in many ways. First and fore most important is its functionality. In order for a microprocessor to be used other components such as memory, or components for receiving and sending data must be added to it .in short that means that microprocessor is very heat of computer in other hand microcontroller is designed to be all of that in one. No other external component are needed for its application because all necessary peripherals are already built into it ,thus we save the time and space needed to construct devices.

16

In this project microcontroller will form the heart of the system. This would perform the function of polling sensors interpreting input and perform the necessary action. This is so because using instead of using intelligent sensor s that would be reporting to central unit the project will utilize dump sensors.

Most microcontrollers come with several ports than several bit wide for example in this case the Atmega168 from Atmel Company has two 8bit ports and one 7bit port.

These ports can be connected to the various sensors whose high condition are 5.5volts and low are 1.8volts.

Advantages of microcontroller based design

- Can be produced in small packages that users can be able to configure on their own

- Low Power Consumption thus cheap to maintain can be run by batteries
  ó Active Mode: 250 A at 1 MHz, 1.8V15 A at 32 kHz, 1.8V (including Oscillator)
  ó Power-down Mode: 0.1 A at 1.8V

- They stand alone equipments that require little maintenance.

- They are easy to debug in case of fault as they consist of very few copheriperial components.

- They are easy to upgrade due to compatibility of AVR microcontrollers of differed series for example the code written for ATmega48 can be run in ATmega88 with minor modification.

- The ATmega48/88/168 has Advanced_RISC_Architecture (reduced instruction set computer).

  ó 131 Powerful Instructions ó Most Single Clock Cycle Execution

  ó 32 x 8 General Purpose Working Registers

  ó Fully Static Operation

  ó Up to 20 MIPS Throughput at 20 MHz

  ó On-chip 2-cycle Multiplier

  Thus they are easy to learn and develop software having in mind the need to shorten development time and reduce time to market. This is very important aspect in modern world.

ÉHigh Endurance Non-volatile Memory segments

    ó 4/8/16K Bytes of In-System Self-programmable Flash program memory

    ó 256/512/512 Bytes EEPROM

    ó 512/1K/1K Bytes Internal SRAM

    ó Write/Erase cycles: 10,000 Flash/100,000 EEPROM

    ó Data retention: 20 years at 85°C/100 years at 25°C

    ó Optional Boot Code Section with Independent Lock Bits

    In-System Programming by On-chip Boot Program

    True Read-While-Write Operation

    ó Programming Lock for Software Security

Thus reduce cost of field up grades since the cost of upgrading a system code can be dramatically reduced. with very little effort and planning, flash based system can be designed to have code upgrades in the field for AT mega FLASH device the entire code can be rewritten with new code new code segments and parameter tables can be easily added in program memory areas left blank for upgrade purpose, only portion of code (such as key algorithm) require update.

- Calibration and customization of your system

  Calibration need not be done only in factory .during installation of the system can be calibrated to actual operating environment. In fact recalibration can be easily done during periodic servicing and maintenance.

  Customization need not to be done in factory only. In many situations customizing a product at installation time is very useful. .a good example is a home or car security systems where ID code, access code and other such information can be burned in after the actual configuration is determined.

- Add unique Id code to your system during manufacturing.

- Many products require a unique ID number or a serial number. An example application would be remote keyless entry device. Each transmitter has a unique õbinary keyö that makes it very easy to program in the access code at the very end of the manufacturing process and prior to final test. Serial number, revision code, date code, manufacture ID and a variety of other useful information can also be added to any product for traceability

CHAPTER 3: SYSTEM DESIGN

3.1 Microcontroller circuit design.

Considering the advantages of the microcontroller motioned in chapter two earlier. In this project choose to use ATmega168 microcontroller from ATMEL Company as my control unit.

3.1.1 Features of AVR ATmega 168 microcontroller

In this project microcontroller used is AT mega 168. This belongs to a class of 8 - bits Microcontrollers of advanced RISC (reduced instruction set computer) Architecture. Its general structure is shown on the following block diagram representing the basic blocks.
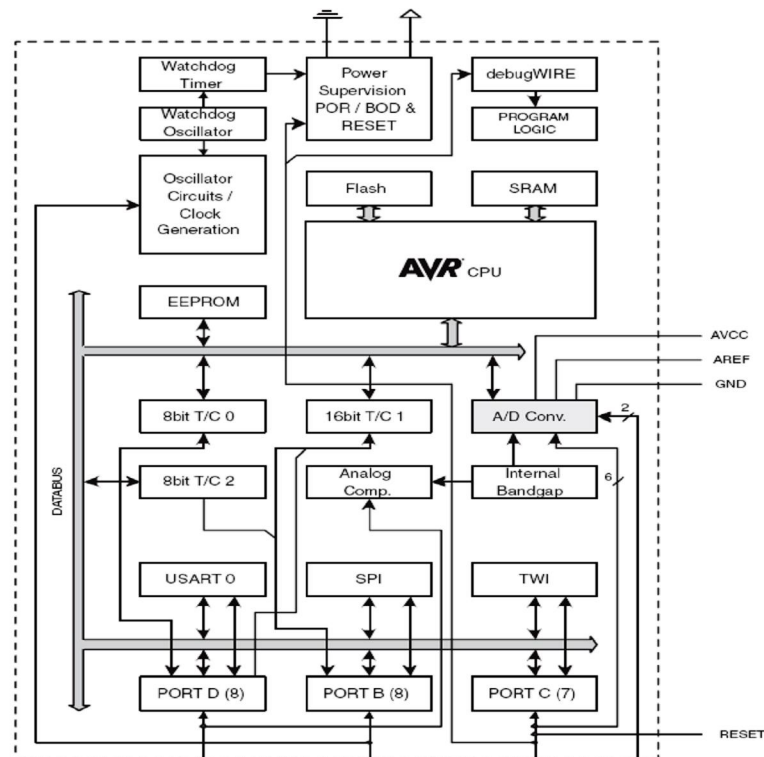
BLOCK DIAGRAM:

Figure 3.1

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in

one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega48/88/168 provides the following features: 4K/8K/16K bytes of In-System Programmable

Flash with Read-While-Write capabilities, 256/512/512 bytes EEPROM, 512/1K/1K bytes

SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible

Timer/Counters with compare modes, internal and external interrupt a serial programmable

USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset.

In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.

The device is manufactured using Atmeløs high density non-volatile memory technology. The

On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit

RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega48/88/168 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega48/88/168 AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, and Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.

- **Program Memory** (FLASH) ó For storing a written program.

  Since memory made in FLASH technology can be programmed and cleared more than once, it makes this microcontroller suitable for device development.

- **EEPROM** ó data memory that needs to be saved when there is no supply.

  It is usually used for storing important data that must not be lost if power supply suddenly stops. For instance, one such data is assigned password in security applications. If during a loss of power this data was lost, we would have to make the adjustment once again upon return of supply. Thus our device looses on self ó reliance.

- **RAM** ó Data memory used by a program during its execution.

- **PORTS** are physical connections between the microcontroller and the outside world. Port B and port D has eight pins and Port C has seven pins.

- **FREE – RUN TIMERS** is an 8 ó bit register inside a microcontroller that works independently of the program. On every sixteenth clock of oscillator it increments its value until it reaches the maximum (555), and then it starts counting again from zero. As we know the exact timing between each two increments of the timer contents, timer can be used for measuring time which is very useful with some devices.

- **CENTAL PROCESSING UNIT** has a role of connective element between other blocks in the microcontroller. It coordinates the work of other blocks and executes the user program.

- **CISC, RISC**

  It has already been said that AT mega 168 has advanced RISC architecture. This term is often found in computer literature, and it needs to be explained here in more detail. Harvard architecture is a newer concept than von ó Neumann's. It

rose out of the need to speed up the work of a microcontroller. In Harvard architecture, data bus and address bus are separate. Thus a greater flow of data is possible through the central processing unit, and of course, a greater speed work. Separating a program from data memory makes it further possible for instructions not to have to be 8 – bit words. PICI16F84 uses 14 bits for instructions which allows for all instructions to be one word instructions. It is also typical for Harvard architecture to have fewer instructions than von – Neumannøs, and to have instructions usually executed in one cycle.

Microcontrollers with Harvard architecture are also called õRISC microcontrollersö. RISC stands for Reduced Instruction Set Computer. Microcontrollers with von – Neumannøs architecture are called õCISC microcontrollersö. Title CISC stands for complex Instruction Set Computer

Since AT mega 168 is a RISC microcontroller, that means that it has reduced set of instructions,. (131 powerful instructions most single clock circle execution) all of these instructions are executed in one cycle except for jump and branch instructions.

3.1.1.1 Applications

ATmega microcontrollers perfectly fit many uses, from automotive industries and controlling home appliances to industrial instruments, remote sensors, electrical door locks and safety devices. It is ideal for smart cards as well as for battery supplied devices because of its low consumption.

EEPROM memory makes it easier to apply microcontrollers to devices where permanent storage of various parameters is needed (Codes for passwords, receiver frequencies, e.tc)

Low cost, low consumption, easy handling and flexibility make **ATmega Microcontrollers** applicable even in areas where microcontrollers had not previously been considered (for example: timer functions, interface replacement and in larger systems, coprocessor applications, etc)

In system programmability of this chip (along with using two pins in data transfer makes possible the flexibility of a product, after assembling and testing

have been completed. This capability can be used to create assembly ó line production, to store calibration data available only after final testing, or it can be used to improve programs on finished products.

3.2.1 Pin description

AT mega 168 have a total of 28 pins. It is most frequently found in a PDIP type of case but can also be found SMD case which is smaller from a PDIP. PDIP is an abbreviation for Dual in Package. SMD is abbreviation for surface mount Devices suggesting that holes for pins to go through when mounting arenǿt necessary in soldering this type of a component.
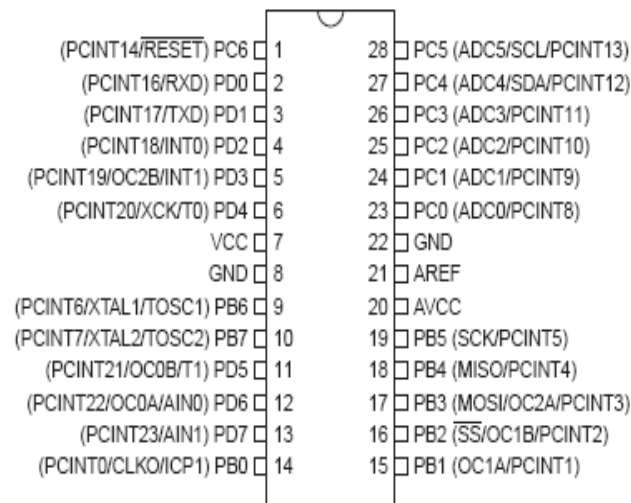
PIN CONFIGURATION – PDIP

Figure 3.2. Atmega168 PDIP

- **VCC** Digital supply voltage.
- **GND** Ground.
- **Port B** (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2

  Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source Capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The

Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7..6 is used as TOSC2.1input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

The various special features of Port B are elaborated in

- **Port C (PC5:0)**

  Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5..0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **PC6/RESET**

  If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristic of PC6 differ from those of the other pins of Port C.

  If the RSTDISBL Fuse is un programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running.

  Shorter pulses are not guaranteed to generate a Reset.

- **Port D (PD7:0)**

  Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- **AVCC**

  AVCC is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC6..4 use digital supply voltage, VCC.

- **AREF**

  AREF is the analog reference pin for the A/D Converter.

3.2.2 Overview

The ATmega168 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega168 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

From the above features of the microcontroller, it is clear that itøs easily applicable in security systems as one can store passwords, implement delays with use of timers, connect to computer to

Monitor status; implement real time clock and many more.

3.3.1 Interfacing Components

This section deals with how to connect the ATmega microcontroller with other peripheral components or devices when developing control system.

3.3.1.1 Power Supply to the Microcontroller

Generally speaking, the correct voltage supply is utmost for the proper functioning of the microcontroller system.

For a proper function of any microcontroller, it is necessary to provide a stable source of supply; sure rest when you turn it on and an oscillator. According to technical specifications by the manufacturer of AT mega microcontroller, supply voltage should move between 1.8 V to 5.5V in all versions.

The alarm system requires two voltage levels for operation. One is the 12V supplied to the control panel, which is in turn distributed to the sensors and to the alarm outputs. The microcontroller however requires a 5V power supply.

In order to supply this voltage, I can use a regulation IC, such as the L7805CV chip, and I have obtained the following information and pictures from the data book for this IC:
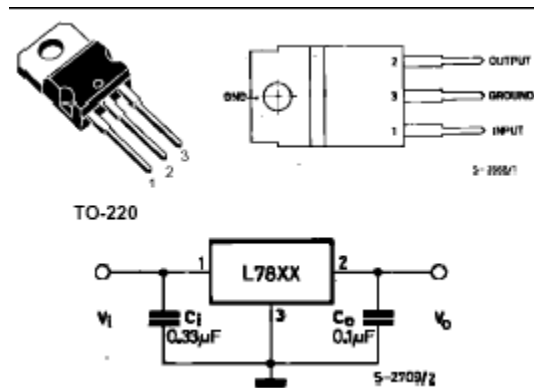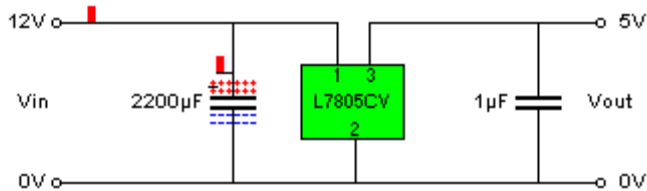
Wiring Diagram

Figure 3.3

Figure 3.4

Pin 1 is connected to the 12V Positive power supply rail

Pin 3 is connected to the 0V Negative power supply rail

Pin 2 is used as the 5V positive rail, with the existing negative rail

- **Problems**

Immediately after connecting the voltage regulator to the 12V power supply, the power supply's current limiter activated. The current was displayed at over 2A, so obviously there was a problem. On inspecting the wiring diagram and pin out of the IC I could see that I had wired up the chip wrongly, and this was the cause of the excessively high current. The IC was very hot, but a heat sink was attached so the heat was dissipated.

After inserting the IC the right way round everything was fine, and it appears the chip was not damaged.

- **Testing**

After wiring up the IC properly, the potential difference across the V of the IC and ground was measured, using a multi-meter to be 5.01V, so the IC and subsystem was deemed to be working fine.

3.3.2.1 Push buttons

Buttons are mechanical devices used to execute a break or make connection between two points. They come in different sizes and with different purposes. Buttons that are used here are also called õdip ó buttons.

Figure3.5 Push buttons and green led for showing status of the system

Figure 3.5 is connection of push buttons and led to microcontroller.

The action pushing a button in this case are used to reset the microcontroller incase switching of the alarm or case to change the status.

3.3.2.2 LOAD (ALRM, SPEAKER)

Since microcontroller cannot provide sufficient supply for a relay coil (approx 100+mA is required; microcontroller pin can provide up to 25 mA), a transistor is used for adjustment purposes. When logical one is delivered to transistor base, transistor activates

the load, which then, using its contacts, connects other elements in the circuit. The purpose of the resistor at the transistor base is to keep a logical zero on base to prevent the load from activating by mistake. This ensures that only a clean logical on pd5 activates the load
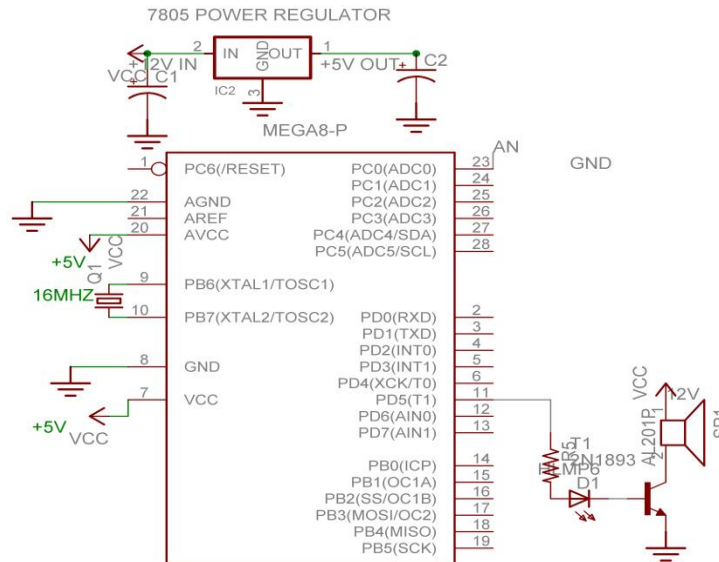

Figure 3.6 Connecting a Transistor, red Led and Load to the Microcontroller

3.3.2.3 Transducers Design

The theory on these has been dealt with exhaustively in chapter 2 on transducer theory. However in this section I will enumerate the sensor I used to connect the microcontroller
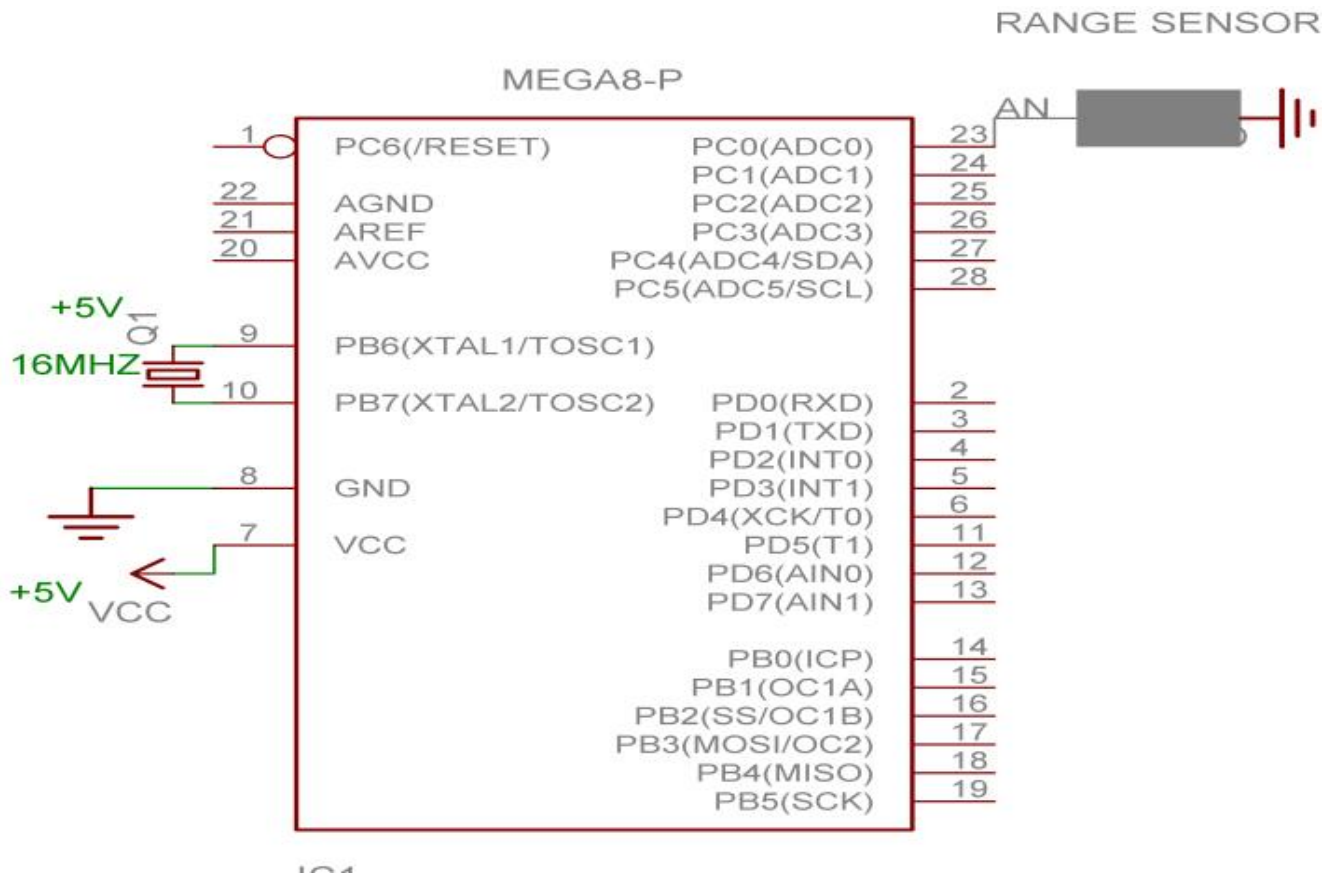
- Indoor Maxsonar range sensor.

Figure 3.7 connection of sensor to the microcontroller

3.3.3 Block Diagram

In order to come up with final design I first designed the block diagram illustrated her below
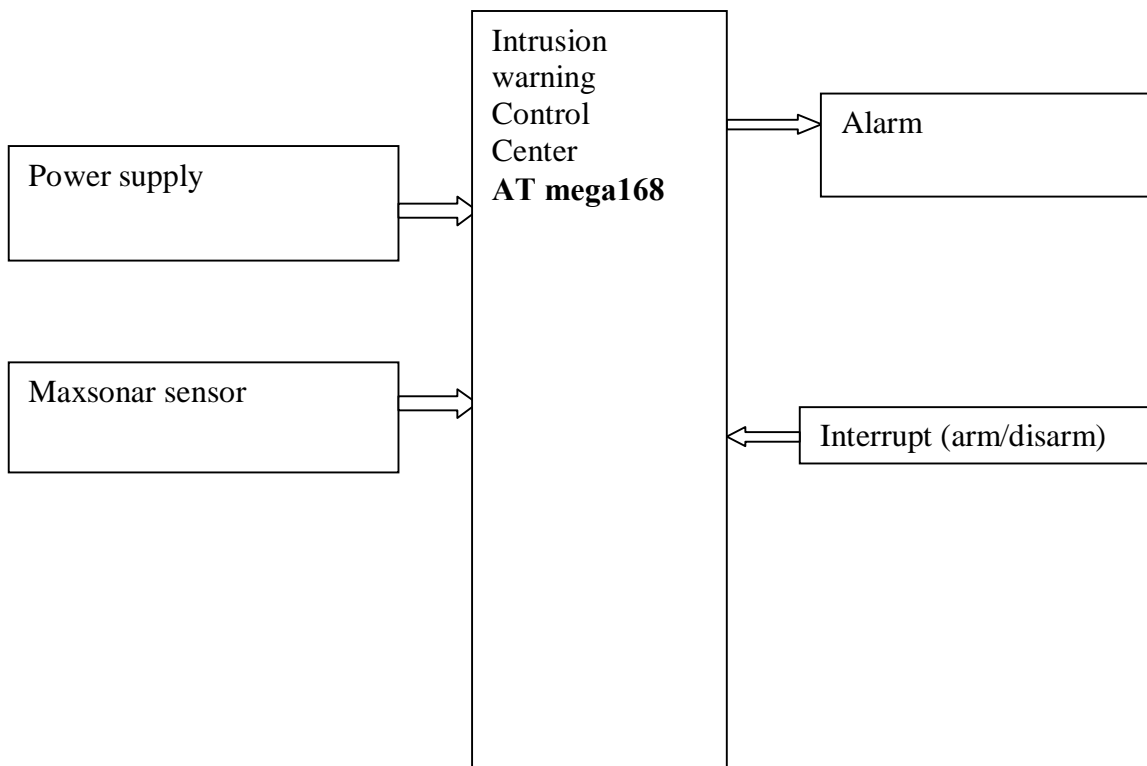

Figure 3.8 Block Diagram the system

Figure 3.8 Block diagram showing various components intrusion warning system.

The various components and their connection have been explained in chapter 3.

From this block diagram the circuit in chapter 4 on implementation was developed.

The intrusion warning block diagram was based on the assumption that the number of room was one. However if there are more rooms the circuit and the code may have to be adjusted.
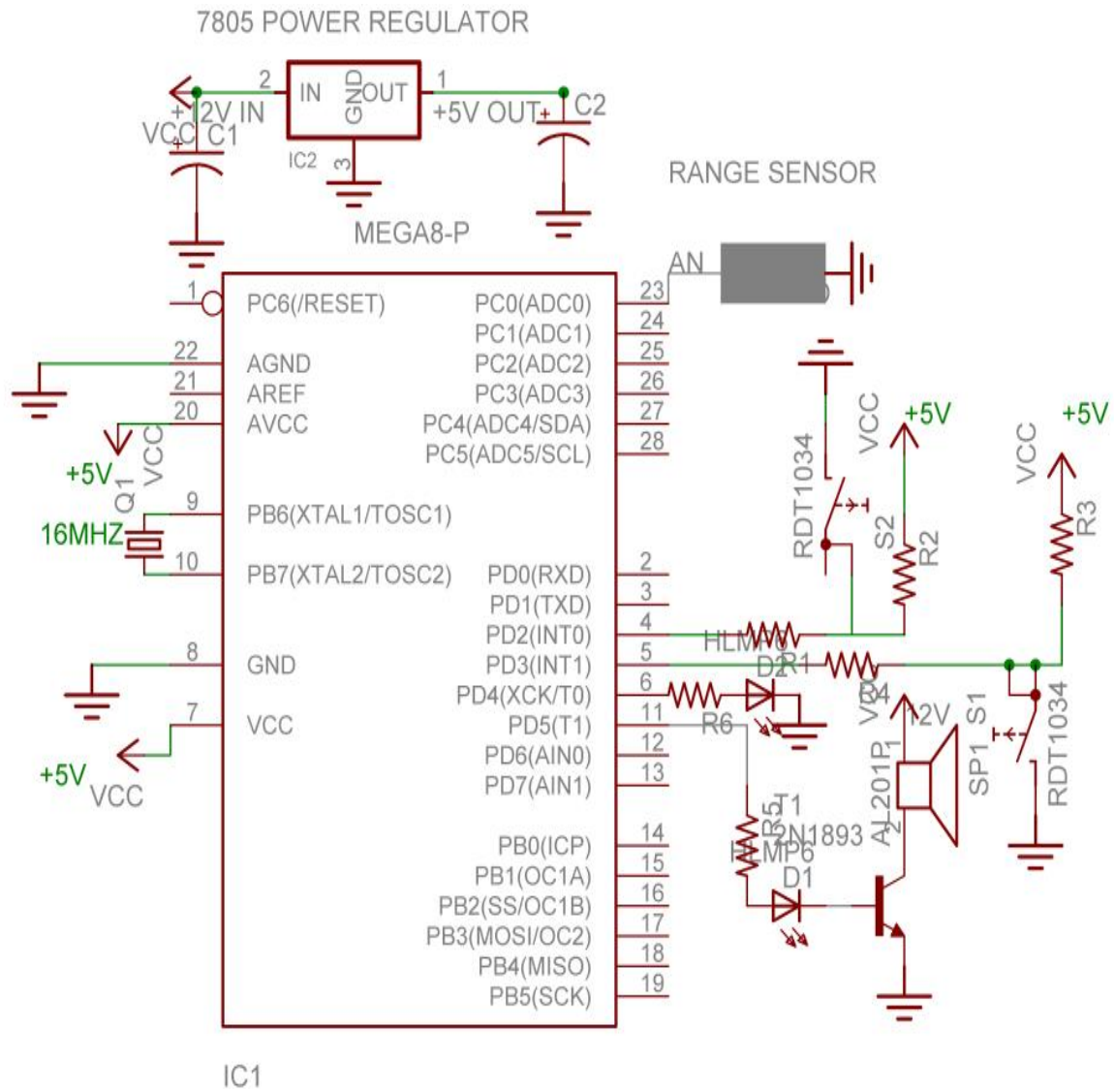
3.3.4 Schematic Diagram

Figure 3.9

CHAPTER 4: SOFTWARE DEVELOPMENT AND SIMULATION

4.1 Introduction

After the design of the system the software to run system had to be written, complied and simulated before the actual construction of the system. This part i consider the basic step to go through to designed the software.

4.1Intrusion warning

The software to control the system should scan for the preset conditions then scan the active sensor and incase sensor is triggered perform a certain task.

First consider which port the sensor was to be connected to and which would be the output. The Atmega 168 has two 8 bit ports and one 7 bit port thus the sensor and output could be connected as follows.

4.2 PORT PIN ASSIGNMENT

Table 1 port b

PIN NUMBER	NAME	CONNECTION
9	PB6	Connected to crystal
10	PB7	Connected to crystal

Table 2 port c

PIN NUMBER	NAME	CONNECTION
23	PC0(ADC0)	Connected to maxsonar range sensor

Table 3 port d

PIN NUMBER	NAME	CONNECTION
4	PD2(INTO)	Push button for arming the alarm system.
5	PD3 (INTI)	Push button for disarming the alarm system
6	PD4	L.E.D (Light emitting diode for indicating whether or not the alarm is armed.
11	PD5	Connected to the transistor that switches the buzzer

4.3 Program Flow

On power óup the microcontroller configures pin PD4 and PD5 as output pins. It uses the crystal (16MHZ) connected on pins PB6 and PB7 for clocking the microcontroller system (Note that AVR controller has two clock options) internal RC clock, or the external clock that is in our case connected on pins PB6 and PB7)

The microcontroller starts immediately to scan interrupt pins PD2, PD3 (INTO, INTI) to check for a signal to either arm or disarm the system.

If INTO is pressed the microcontroller arms the system and sends a signal to pin PD4 to light the LED to indicate an armed STATUS; else if a signal is detected on the disarm Pin INT1; the microcontroller disarms the system and sends a LOW signal to PD4 to switch off the LED to indicate disarmed status.

At the same time the microcontroller is scanning PIN PC0 (ADC0) where the Maxsonar range sensor is connected then reading the signal (voltage) reported by the sensor; then doing analog to digital conservation on the signal then doing an arithmetic computation to determine whether or not a person is seen within close proximity of the sensor.

If the signal from the sensor indicates that a person is detected; then the microcontroller moves on to check whether at that particular moment the alarm is armed or not if the alarm is armed the microcontroller calls a module to activate the system by sending a high signal to the transistor connected to PD5 then the transistor upon switching on switches on the buzzer connected as load.

To turn ó off the alarm buzzer then the system must be dismissed by sending a signal to PD3.

4.4 Algorithm

Variable X = true or false.

Arm {

X= true

}

Disarm {

X= false

}

Create interrupts

Interrupt ó Arm {

Call Arm module

}

Interrupt disarm {

Call disarm module

 }

Enable all interrupts

Read sensor {

Is X true or false

}

Trigger system {set pin = High

}

Get voltage proportional to distance of nearest object, such that

If value >=250

ARM-SYSTEM

If value= <250

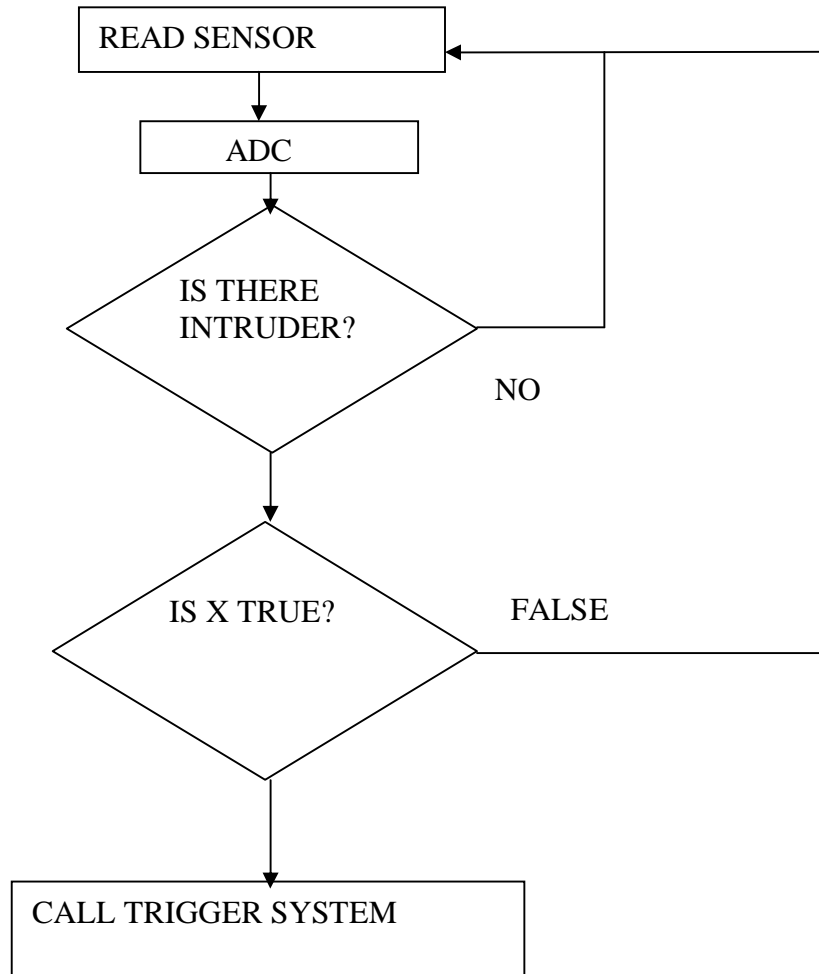DISARM-SYSTEM

4.5 Flow Chart

Figure 4.1.Flow chart

Loop

1. Read sensor (PC0)

2. Perform analog digital conversion.

3. Compare value read with a fixed value that determines the proximity of intruder.

4. If value is less than the give value goes to loop.

5. If the value is greater (theirs intruder) check if the system is armed

6. If the system is not armed go to loop. (PD3(INT1) is LOW)

7. If system is armed (PD2(INT0)is HIGH) activate alarm system ό set pin PD5 high

   Go to loop

Interrupts

1. If a signal (HIGH to LOW(Pulse)) is detected at INT0 an interrupt is generated and arms the system

2. If the signal (Pulse)(HIGH to LOW) at INT1 an interrupt is generated and disarms the systems.

Using the above algorithm a software code was written in assembly language using AVR STUDIO SOFTWARE PACKAGED AND ARDUINO SOFTWARE PACKAGE.

The code was converted to a Hex file and burned into AVR microcontroller (ATMEGA 168) using a device programmer.

4.6 SIMULATION AND RESULTS

After the program was developed and complied and loaded to simulation software the simulation was done. In this section an attempt is made to analyze the results and compare with the project object.

After the code was written using ARDUINO SOFTWARE PACKAGE and complied into the hex file.

The hex file was simulated AVR SIMULATOR .This software gave the visual indication of the status of the pin and allowed one to set the input pins HIGH or LOW.

Before loading the hex file I had to specify the following

- Microcontroller
- The operating frequency
- The speed of simulation.

Then start the simulation and simulate various conditions by setting the pin PC0 either HIGH or LOW. And simulate the effect of sensor by setting the PD2, and PD3 (INT0, INT1) of PORTD HIGH and LOW and observing the effect on the PD5.

4.6.1 RESULTS

Set PD2 LOW

In this case there was no effect on the output pins regardless of the condition of the PC0, PD4and PD5 pins. Then set PD2 HIGH, PD3 went HIGH simulating a condition that the system is armed. In the same case if PC0 is HIGH then PD5 went high simulating a condition that someone is near the protected area and alarm went on to deter the intruder.

CHAPTER 5: CONSTRUCTION

5.1 Introduction

This deals with a sample system setup in a typical Kenyan Room.

Basically most of Kenyan homesteads and offices consist permanent house surrounded by concrete wall probably with broken glasses on top of the wall and a very firm iron gate. Generally to many Kenyans this is sufficient security. However this kind of setting has many draw backs. It offers no warning to intrusion.

With this in mind as the starting point of assumption was that the system was to be installed in a one room building already with a concrete wall surrounding it. Therefore maxsonar range sensor was to be installed that should have a range of about two to five meters. Install it in room preferably near the door or the windows.

In this sections I will deal with the development of the actual circuit that is to be implemented.

The diagram below represent a sample room with the sensor installed.

Figure 5.1 a room diagram

Dr ó Door

Rgs ó Range Sensor

5.2 Components Required

From the block diagram the following components were needed to build the system

Table 5.1 components required

NO	COMPONENT	DESCRIPTION	QUANTITY
1.	AVR Microcontroller - ATMEGA 168	PDIP, 28 Pins, 16 MHZ	1
2.	7805 Power Regulator	5 Volts	1
3.	Range Sensor	Maxsonar Range Sensor 0 ó 5 meters	1
4.	Light emitting diodes	Green and red color	2
5.	Power transistor	(NPN) ó 2CS3858 or any with IC>=2A, >= 12 volts.	1
6.	Buzzer (Speaker)	5 WATTS	1
7.	Crystal	16MHZ	1
8.	Resistors	330 ohms	4
		1k	2
		680ohms	3
9.	Push buttons		2
10.	Wire connectors		4
11.	IC sockets (For holding the microcontroller)	28 pins.	1
12.	Adapter	12 volts	1

5.3 Circuit Development

In the circuit development I decide to use the above mentioned component whose connection to the Microcontroller was extensively covered in the design theory chapter four.
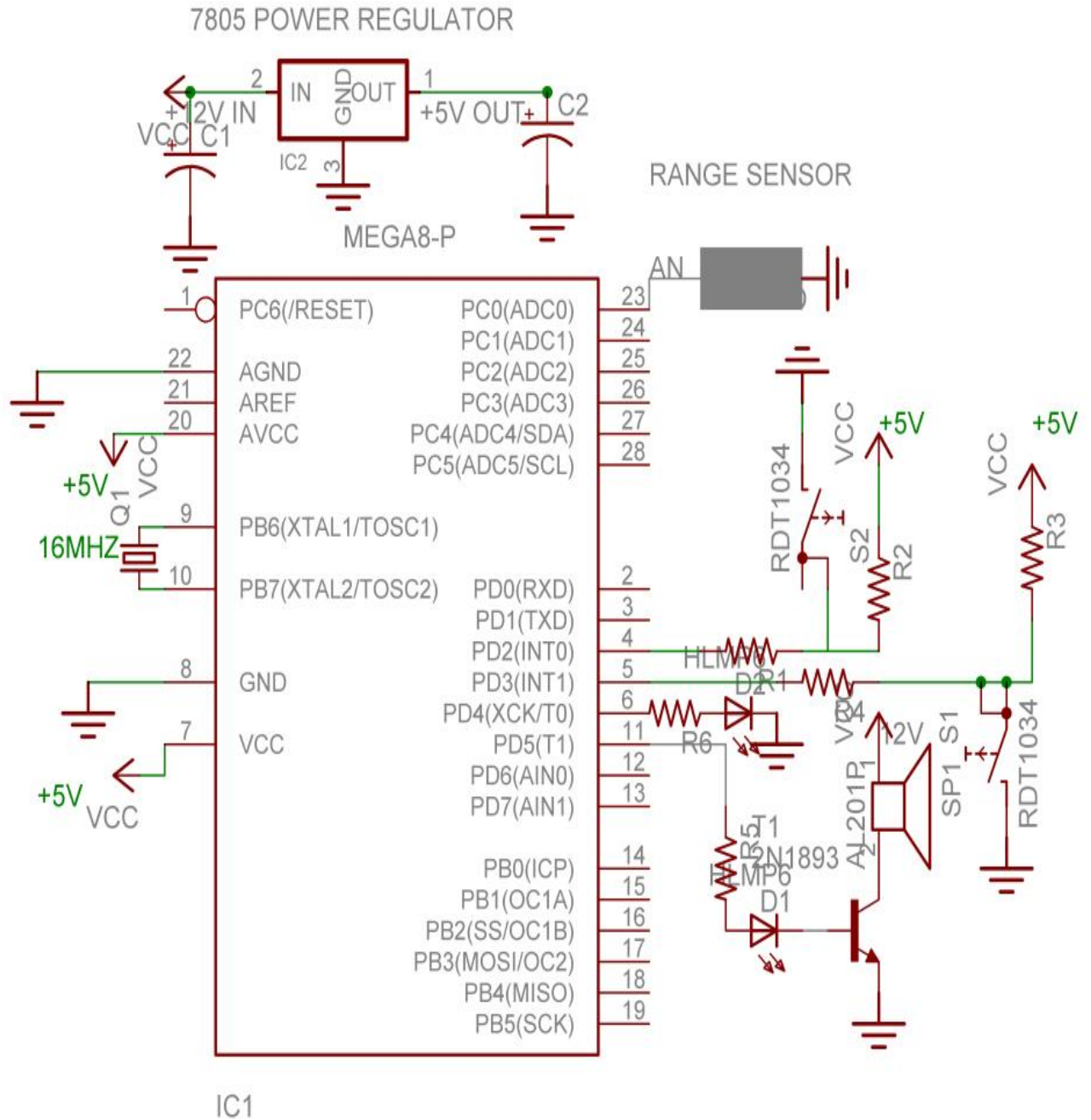

Figure 5.2 circuit development

5.4 Fabrication

After buying the basic components which include the Microcontroller, Maxsonar Range Sensor, and buzzer the project was simulated and implemented. The section dealing Microcontroller input and output was implemented as illustrated in the circuit diagram figure 5.3 .In this case the Microcontroller outputs were simulated by connecting a five volt steady source to the above circuit inputs. The input resistance were to prevent the transistor from being switched on by the microcontroller logical zero which is not necessarily zero voltage that only clean one can activate the load.

The protective diode was to protect the driver transistor from the high voltage in opposite direction produced by residual magnetic flux.

The various components such as lights alarm camera and buzzer were simulated

The power supply used was supplied through an adapter .The voltage regulators used 78l05 give voltages 5 volts. The five volt was used to light the LED.
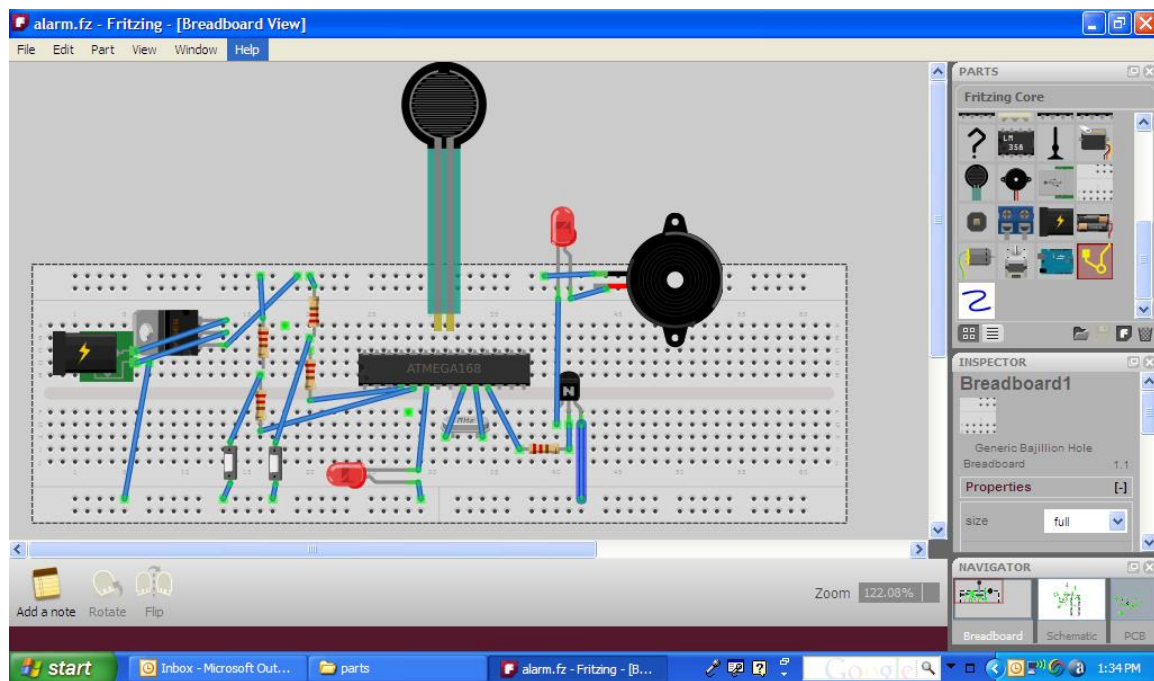

Figure 5.3Components on bread board

Integration Photograph

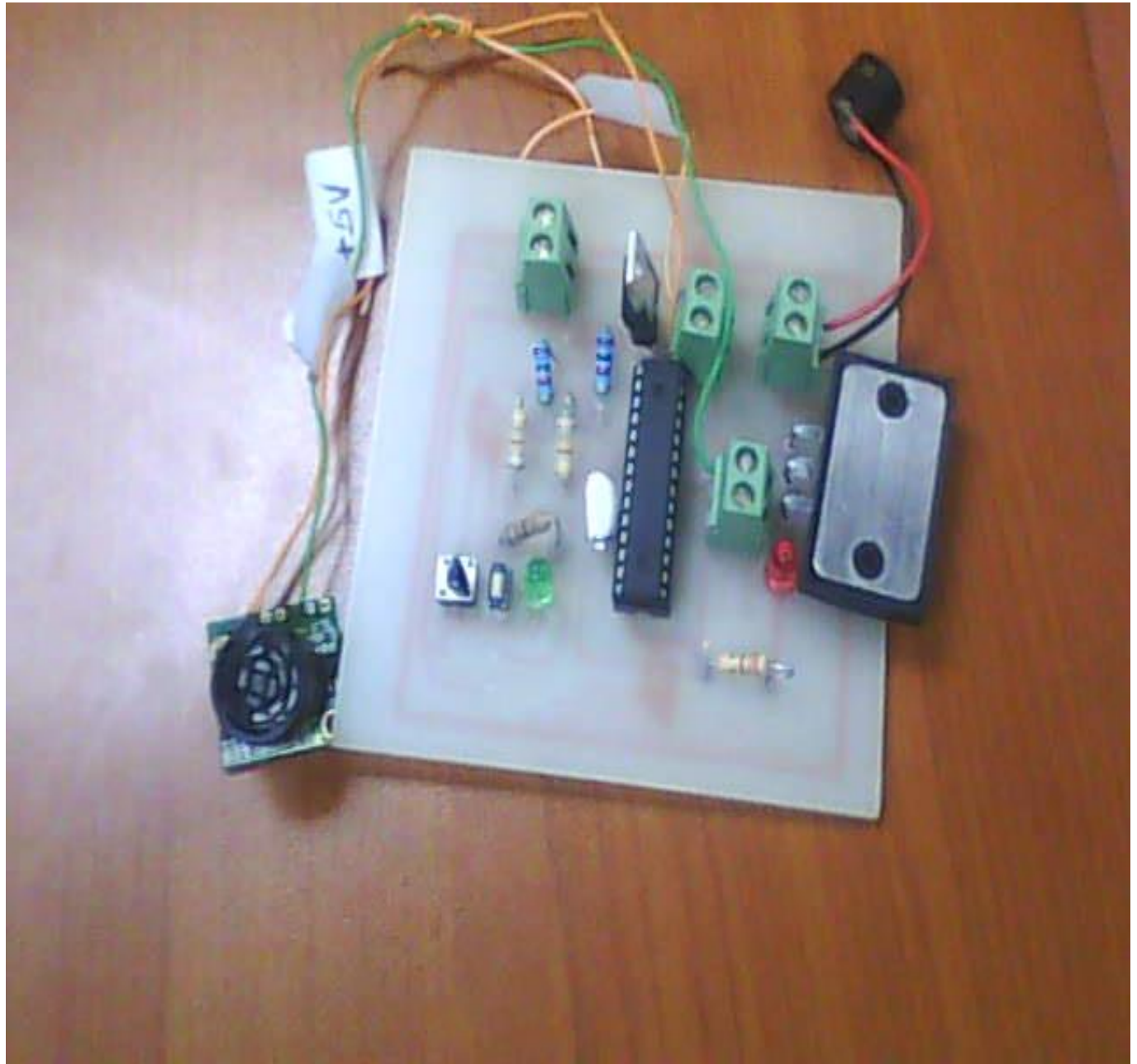This final picture shows the complete alarm system connected to speaker.

Figure 5.4 complete burglar alarm system

CHAPTER 6: PERFORMANCE EVALUATION AND RESULTS

6.1 Introduction.

This chapter deals with testing and evaluating the performance of the whole system as one. This includes simulating the various conditions that can be expected if the system was to be deployed in an office.

6.1.1 Load Module

Description

As the power output for the alarm has to drive at least 500mA of current, I need to use a system that can handle such loads. The module needs to be either a definite on or off output, and must be driven by the logical 0V / 5V 25mA output from the Microcontroller. In order to be able to supply not only this load, but also a range of higher and lower values of which the exact current requirements are not known, I have decided to use a NPN transistor like 2c3858 IC >=2A@500mA,be voltage drop 0.7. This component will switch a load up to the full potential of the power supply.

Protective Resistor Calculation

In order to ensure that the transistor is not destroyed, a protective resistor has to be used. The value of this depends on the current required to flow from the base to the emitter of the transistor. This base-emitter current controls the current allowed to flow through the relay and then from the collector to the emitter. The ratio of currents is the gain of the transistor

The first task I needed to do was to measure the current required to flow through the load. Using a multi-meter I was found to be 100-120mA. You can see that this is within C the maximum that can flow through the transistor, but exceeds the maximum that can flow through the

Controller, so the use of a transistor is justified. Knowing the gain of the transistor to be 100, the base current to produce this 120mA current is 100 times smaller, in this case 1.2mA.

Knowing the voltage of from the microcontroller will be 5V, and the transistor has a voltage drop of 0.7V, we can work out the required potential difference of the resistor:

V= 5.0 – 0.7 = 4.3V

Finally, the resistance of R can be calculated:

R= V/I= 4.3/0.0012 =3.6k

In practice a slightly smaller value of R is used to ensure that the transistor is fully saturated on

Testing

When connected to the Microcontroller, and activated, the current flowing to the base was measured as about 2mA, although this is mostly due to rounding. This is well within the current requirements and activated the external components with no problems.

6.1.2 MODULE RED ALARM AND GREEN ARMED LED'S

Description

Two outputs from the AT mega Controller are used to power light indicating diodes (LED's) to give a visual indication to the user of the mode and status of the alarm system. The LED's are rated as drawing 20-25mA of current with a voltage drop of 2 volts. I know that the Microcontroller can provide an output of 25mA from the data sheet so this is not a problem. The controller has a logical 1 output of 5V, so a protective resistor will be used to dissipate the other 3V. Both LED's are identical in specification apart from color, so the following Protective resistor calculation applies to them both.

Supply 5V   Current 25mA

PD over LED 2V

PD over Resistor 3V

R= V/ I= 3.0/0.025 =120ohms

Testing

This was initially tested by connecting it to the logical outputs from the Arm/Disarm switches module to check the resistors were of the right value and that the LED's were inserted with the correct polarity. The current did not exceed 25mA when tested, so the module was connected to theAtmega168 microcontroller

6.1.3 Control Module

The Atmega 168microcontroller was programmed. Burglar alarm program was then sent to the device and the modules connected together.

Success! All the modules reacted as expected with the ATmega 168controller, and the project was now fully functional.

6.1.4 System Details

When the alarm system is disarmed, no LEDøs are activated, so there is only the IC devices activated, and so the current reading for the entire program is only 10.0 ó 20.0mA. There is some slight variation because the microcontrollerøs current consumption is not constant and fluctuates with the program section being executed.

If the user then presses the Arm button, the armed LED (Green) lights to indicate the change in state. The current consumption at this point increases to 25-30mA, which is predictable as the only increase in load is that of the LED and protective resistor. As before, there are current fluctuations because of the nature of the controller.

In this armed state, if any one moves or causes disturbers within the proximity rage, then the microcontroller triggers the Alarm output pin. This is connected to the second status LED, the Alarm LED, and also to the base of the transistor. This fully saturates the transistor and allows enough current to flow to activate the load, which switches ON the load within another millisecond or so.

The current compunction at the moment is found by disconnecting the load so that only the

Projectøs readings are shown. In the state, the current has risen to 130-140mA, which when you remember the current though the load is 100-120mA, is a sensible figure.

When connected to the strobe and siren, each which draws an additional 200-300mA, the total current is about 700mA

Assuming a current of 700mA and a voltage of 12V, the total amount of power used by the project and the external alarm components can be calculated.

$$Power = Voltage \times Current$$
$$= 12V \times 0.7A$$
$$= 8.4W$$

6.1.5 SAFETY

In order to ensure that I was working safely, I ensured that the power supply voltage was constantly at a safe voltage and that it was the correct voltage for the module being tested. I always ensured that I switched off the power supply while modifying and building the project. I was careful to test each subsystem to ensure that its current requirements did not exceed the output of the previous system, and that all components were operating within their voltage and current (power) limits, and that protective resistors were used when necessary.

CHAPTER 7: CONCLUSION AND FUTURE WORK

7.1 Conclusion

The ideal security system is yet to be designed so far. In this project an attempt has been made to come up with a cheap but effective security for small offices.

The software developed to run the microcontrollers run according to the specifications and in simulation proved to be very effective as a security system.

Despite all the odds and difficulties encountered in regard to resource availability all the project objectives were achieved.

There was also an attempt to provide possible designs possible to implement this project. The design type was chosen here was mainly to deal with average standard Kenyan office. To secure large building and compounds this type of design needs to be improved. This could be by use of **addressed sensors** that would be sending information to control unit instead of use of **polling the sensors**. This would enable many sensors to be connected to the microcontroller thus resulting in a stable complex system that cover huge building and include other features such as fire alarm, employee clocking in and out, chemical gas warning and much more.

The design here is not conclusive but needs a lot of improvement and development before such system can commercially be available.

A few of improvement are mentioned here below.

7.0 RECOMMENDATION AND FUTURE WORK

As so far the system not yet perfect. This indicated that there is still huge room for future development. As the need of more secure and complex system keeps on growing there is need in depth research and development to keep up with the needs of customers as there are the most important people who keep designers in business as the profit is all we look for.

This project has a lot of future expansion this would be as follows

1. Use of SMS (short massage services) to send control command as for example to arm or disarm the system.

2. The Atmel Company provides various components such as keelog that makes it possible to   include wireless control. this could enable disabling of the system as one enters to the protected area and enable all the sensors on leaving. This can also be applied to remote sensor to avoid wired connection.

3. Use of addressed remote sensors that sends request to the control unit instead of polling damp sensors.

4. Possibility of dial tone control if connected to analogue telephone .In this one need to connect the system to analogue telephone and call from anywhere the send DTMF tones to configure the systems.

Appendix

```
.INCLUDE "m168def.inc"
.DEF temp = R16 ; Multipurpose register
;


;
; ========================================
; R E S E T A N D I N T V E C T O R S
; ========================================
;
.CSEG
.ORG $0000
rjmp Main ; Reset vector


; ***** INTERRUPT VECTORS **********************************************
.org   INT0addr  ;  = 0x0002   External Interrupt Request 0
rjmp ARM
reti


.org   INT1addr  ;  = 0x0004   External Interrupt Request 1
rjmp DISARM
reti


.
;
; ========================================
; I N T E R R U P T S E R V I C E S
; ========================================
;
; [Add all interrupt service routines here]
;
; ========================================
; M A I N P R O G R A M I N I T
; ========================================
;
Main:
; Init stack
ldi temp, LOW(RAMEND) ; Init LSB stack
out SPL,temp

ldi temp, HIGH(RAMEND) ; Init LSB stack
out SPH,temp

; Init Port B
```

```
ldi temp,(1<<DDB1)|(1<<DDB0) ; Direction of Port B
out DDRB,temp
; [Add all other init routines here]

sei
;
; ==========================================
; P R O G R A M L O O P
; ==========================================
;
Loop:


;READ SENSOR AND IF VALUE > THAN A GIVEN VALUE THEN CALL ACTIVATION MODULE
sleep ; go to sleep
nop ; dummy for wake up
rjmp loop ; go back to loop
;

ARM:
sbi PORTB,0
ret

DISARM:
cbi PORTB,0
rcall DEACTIVATE
ret

ACTIVATE:
sbi PORTB,1
ret

DEACTIVATE:
cbi PORTB,1
ret
```

REFERENCES

[1] www.mathworks.com

[2] http://www.intel.com/technology/computing/opencv/

[3] http://www.atmel.com/

[4] http://winavr.sourceforge.net/

[5] http://www.lancos.com/prog.html

[6] Dr. Jianping Fan. Toward facial feature locating and verification for Omni-face
detection   in video/images. http://www.cs.uncc.edu/~jfan/

[7] Jay P. Kapur. Face detection in color images. University of Washington Department
of
   Electrical Engineering.1997

[8] C. Cortes and V. Vapnik. Support Vector network. Machine learning, vol 20, pp 1-
25, 1995.

[9] Oliver Jesorsky, Klaus J. Kirchberg, and Robert W. Frischholz. Robust face
    detection using the Haussdorf distance. Third International Conference on Audio-
and
   Video-based Biometric Person Authentication, Springer, Lecture Notes in Computer
    Science, LNCS-2091, pp. 90ᴼ95, Halmstad, Sweden, 2001.

[10] P. Viola and M. Jones. Rapid Object Detection using a Boosted Cascade of Simple
Features.
    Accepted conference on computer vision and pattern recognition, 2001

[11] Matthew A. Turk and Alex P. Pentland. Face recognition using Eigenfaces. Vision
and
   Modeling Group , the Media Laboratory, Massachusetts Institute of Technology

[12] M. Turk and A. Pentland, "Eigenfaces for Recognition", Journal of Cognitive
Neuroscience,
   vol.3, no. 1, pp. 71-86, 1991, hard copy

[13] www.maxbotix.com/MaxSonar-EZ1