DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED SECURITY SYSTEM

BY

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MATRIC NO 2006/24399EE

IN PARTIAL FULFILMENT OF THE AWARD OF

BACHELOR OF ENGINEERING (B.ENG)

A PROJECT SUBMITED TO THE DEPARTMENT

OF ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

NOVEMBER, 2011

DEDICATION

I dedicate this project to my personal LORD and SAVIOR JESUS CHRIST, in whose grace and mercy, this project was brought to a successful completion.

DECLARATION

I, DANLADI JOE, hereby declare that this thesis is an original work of mine, and has never being presented in any form for the award of degree certificate anywhere. All the information obtained from published and unpublished works have being acknowledged.

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ACKNOWLEDGEMENT

My thanks go to my LORD and SAVIOR JESUS CHRIST who has granted me an unmerited favor, build a wall of protection and provided everything I ever needed in accordance to his riches in glory.

My gratitude goes to my supervisor ENGR A.G.RAJI Head Of Department Electrical and Computer Engineering Department, for his assistance, guidance, kindness, understanding and being accommodating throughout this period. May God almighty continue to increase you in wisdom, knowledge and understanding. My thanks also go Mallam A. Umar for his guidance during the design and construction of this project. My appreciations also go to the entire staff of the Department Of Electrical and Computer Engineering, who has being providing me with all the brain tools used to carry out this project right from inception to actualization of this project.

My sincere gratitude goes to my Dad Mr. DANLADI N. KAURA. For ensuring that I complete my undergraduate studies by providing me with financial and relevant assistance. My gratitude also goes to my dear brothers (ALLAHYAYI and ATUNA) and my sisters(AMINA, BLESSING,PEACE and SHEKWOYEMI) you are special.

And to my dear friends[HENRY, COLLINS, JIBRIL ,DANBABA,JOHN,BONDI and GLORIA] just a few to mention, you are wonderful. I am not forgetting my dear friend JULIANA A. ABWAMI for her prayers. I pray that God rewards her abundantly.

ABSTRACT

This project presents the design and construction of a microcontroller based security system suitable for protecting a small office or home environment from intrusion. It uses a microcontroller chip (AT89C51), 555timer, laser light, light dependent resistor (LDR) all coupled to an alarm system. The system has been tested and found to work satisfactorily.

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CHAPTER ONE

1.1 GENERAL INTRODUCTION

The basic needs of human being are food, shelter and water. When these needs are met, the next is the security of life and property. Hence it is necessary to device a system that can monitor what happens around our office and home environments. Since any intrusion by human being is brought about by movement of his body or something, this makes it possible to device a system that can detect the presence of someone.

There are many ways these movements can be detected. For example, using strip wire in which any contact with the wire causes an alarm to switch on. Another example is the use of infrared light. When these lights are obstructed from the sensor due to the movement of any intruder across it, it causes the alarm to switch on. All these are not effective because one may need more than one infrared light in order not to cause false alarm. In the same vein, the trip wire must be planted so that the intruder will find it very difficult crossing it without latching the wire. This shows that one needs more than one strip wire in order to overcome the above mentioned challenges. This project intends to provide a solution to the challenges using an electronic system, a more effective and reliable means. This project uses the microcontroller chip (AT89C2051) as a controller. The laser light, the 555 timer and the light dependent resistor (LDR) forms the sensor circuit for each zone. The obstruction of the laser light by an intruder cast on the sensor (LDR) provides a kind of trigger for the alarm to go on. In addition to the above advantage of this project, the main

This design took into consideration the cost, sensitivity, efficiency, safety, reliability and availability of materials.

1.2 AIM AND OBJECTIVES

The ultimate aim of this project is to design and construct a microcontroller based security system that is capable of protecting a small office or home environment from intrusion at more reliable, cheaper and efficient rates.

1.3 METHODOLOGY

This project is achieved with the use of microcontroller, five sensory circuits and five indicators each representing a zone.

The sensing circuit is achieved using a laser light, 555timer, coupled with a light dependent resistor (LDR). The LDR is wired with a 555 timer configured in monostable mode. That is, when the voltage at pin 2 of the 555 timer is high there is an output at pin 3. Pin 3 remains high for four seconds depending on the values of the resistor and the capacitor used following the formula T=(1.1R*C 555 timer)seconds. Where T is the time in seconds it takes the alarm to stop in seconds. R is the value of the resistor used in ohms. C is the value of the capacitor farads. R and C are interfaced with the 555timer.

Five of these sensing circuits are wired and the outputs are interfaced with the microcontroller chip which does the monitoring and power the corresponding indicators. It also sounds the alarm to indicate an intrusion in any of the protected zones.

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CHAPTER TWO

2.1 Literature Review

The security system falls into two main categories, those concerned with fire protection and those concerned with protection against theft of properties and information. The second group includes burglar alarm of which this project is one of. The origin of security monitoring system is obscure, for example the use of locks and barred windows are very ancient.

As civilization developed, the distinction between passive and active security was recognized, and responsibility for active security measures were rested on the police and the fire fighting agencies, and similar public services. The inability of community policing and fire departments to provide all the securities desired by some individuals and organizations led to the supplemented effort by private group(s).

Not until seventeenth century, London had no organization which ensured the security of her citizens and inhabitants against crime. Only there were one thousand watchmen "they were not physically and mentally competent" said Henry Field, the magistrate and author. It was the appointment of Sir Robert Peel as home security officer in 1988 that police was instituted six years after. They were invested with powers for the prevention of crime. This was due to the increasing crime rate.

In 1883, George Lash Persian invented a system that would raise alarm by means of electronic communication. This was initially a revolving lamp on the exterior of the protected premises, or the use of bells to alert the security personnel of an intrusion.

Human beings have adopted and adapted many ways of providing alarms [1]. Early men kept barking dogs to alert of approaching danger. Through the centuries guards blew horns, lit hill top beacons, sent smoke signals, flashed mirrors, fired gunshots, and rang church bells, shot rockets to alert the tribe or army. Little bell attached to a door that rang when it was opened, tin cans tied to a string across a pathway and the like served. One day, someone placed a large bell in a metal enclosure and placed four lantern batteries inside it with a relay and mounted it on the outside of the building.

From the enclosure, there were two sets of wires, one for the door contacts and the other for the key switch that turns the bell ON and OFF. This technology is commonly referred to as the 'local bell'. Keeping the battery running was a major setback to its application.

This simple system uses relay to monitor the door contacts. The key switch was located outside, and the owner would close all the doors and turn the key at night. If the doors were opened with the key switch on, the bell would ring. Closing the door would not stop the bell because an intelligence device like the microcontroller was not used. Only by turning the key could one silence it. The local bell used a wiring scheme that latched the relay contact into an alarm condition. That was very popular for a while until people figured out that the bell could be yanked from the wall and quickly silenced [2].

Development and discoveries through the years in the technologies of electronic components like resistors, diodes, transistors, capacitors, etc. has also translated into technological load in the construction of burglar alarms. Engineers had to use vacuum tubes before the transistors. Just as the transistor, the vacuum tube can switch electricity either ON or OFF, or amplify the current. But there were several reasons to replace the vacuum tubes. It generated a lot of heat and had a tendency to burn out. Compared to the transistor, it was slow, big and bulky. The invention of transistors came as a revolution. It was small, fast, reliable and effective. It quickly replaced the vacuum tube. [3]

Hence, use of security alarms dated back far in time. From early available designs that involved mechanical configurations adapted from old mechanical alarm clocks to those applying highly sensitive sensors and automatic in operation. Traditional mechanical alarm clocks having a bell on top that rings was easily modified and replaced by electrically designed sound producers like buzzers, sirens and loudspeakers for security applications.

The development of solid state electronics has provided room for smaller advanced and effective security devices. The most interesting advantage of electronic security devices is the cognizance of present day reality, availability, reliability and low cost of installation. The closed contact alarm utilizes the simplest of components to give the much desired result, rendering it cost effective since components are readily available and reliable at regulated ratings.

.2 THEORETICAL BACKGROUND

Most burglar alarm systems involve a circuit that rings a bell or activates a siren when set OFF. A central control box can monitor more than one related detectors or sensors. The control monitors responses to corresponding signals from the sensors by triggering ON an alarm.

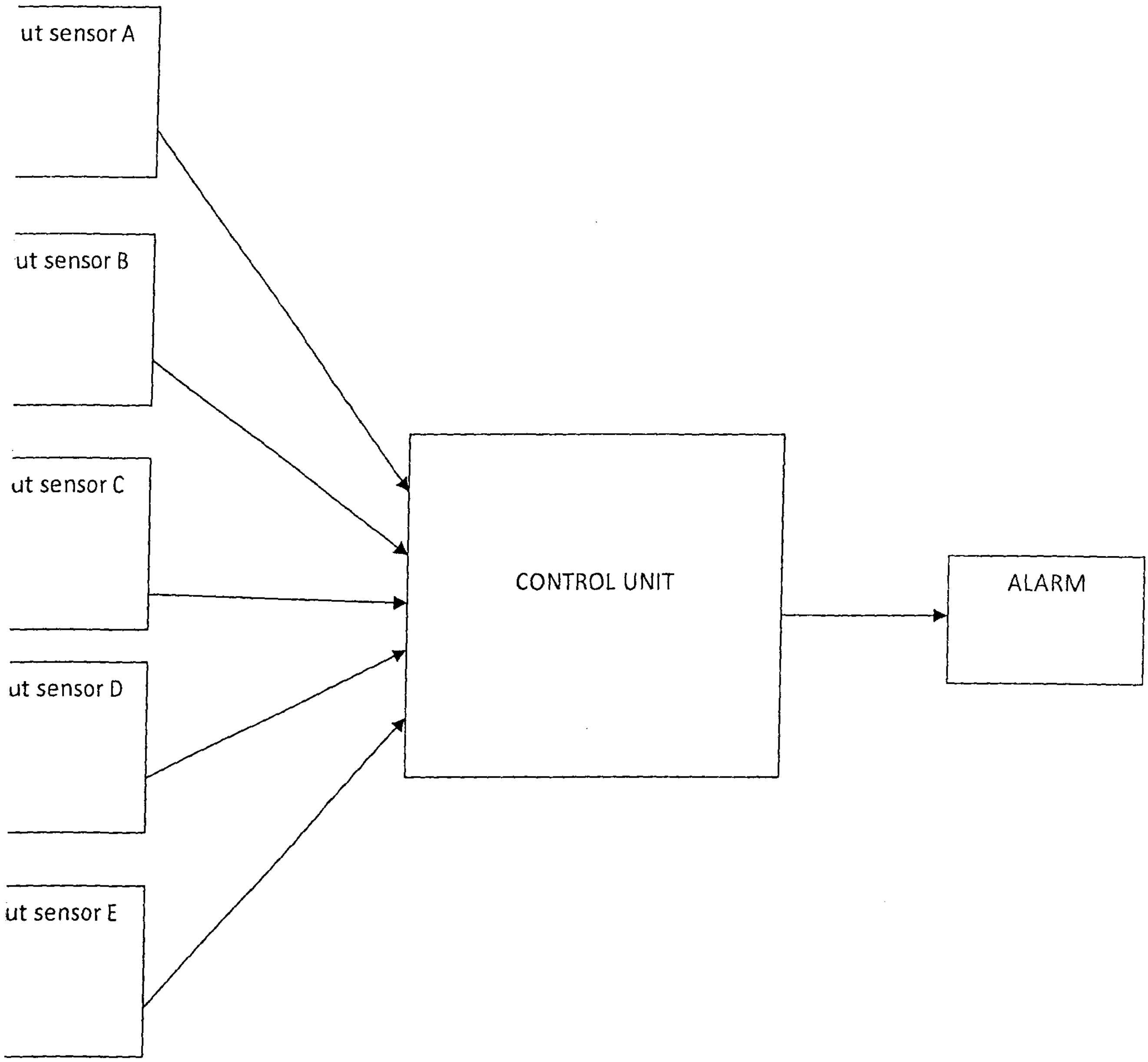


Fig. 2.1 A TYPICAL MICROCONTROLLER BASED ALARM SYSTEM BLOCK DIAGRAM.

TYPES OF INTRUSION DETECTORS

Intrusion detectors are generally of two classes namely:-

1. Point detectors
2. Area (or volume) detectors.

(1) Point detectors indicate an intrusion at a specific point, and types include mechanical or magnetic contacts on doors and windows to detect when they are open or broken, photocell or micro wave beams across pathways, pressure- sensitive mats, fiber- optic bend or stress sensors(e.g. for wire fences), proximity switches that detect humans and vibrations sensor among others.

(2) Area detectors indicate an intruder's presence within the protected area and use such technology as ultrasonic transducer, passive infrared(heat) detectors, and micro wave transducers(sometimes in combination with one sensor).

In general, area sensors detect a sudden change in the measurement being taken and trigger at some predetermined threshold. They are much more prone to false alarms than point sensors often because of improper aiming or other adjustment. [4]

ACCESS, CONTROL, AND BYPASS CODES

To be useful, an intrusion alarm system is deactivated or configured when authorized personnel are present. Authorization may be indicated in many ways, often with keys or codes used at the control panel or a remote panel near an entry or exit point. High security alarms may require multiple codes or a finger print, badge, hand geometry, retina scan, encrypted response generator or other means that are deemed sufficiently secure for the purpose.

Failed authorizations should result in an alarm or at least a time lock out to prevent 'experimenting' with possible codes. Some systems can be configured to permit deactivation of individual sensors or groups. Others can also be programmed to bypass or ignore individual sensors (once or multiple times) and leave the remainder of the system armed. This feature is useful for permitting a single door to be opened and closed before the alarm is armed, or to permit a person to leave, but not to return. High –end systems allow multiple access codes, and may even permit them to be used only once or on particular days, or only in combination with other user's codes. In any case, a remote monitoring centre should arrange an oral code to be provided by an authorized person in case of false alarms, so the monitoring centre can be assured that a further alarm response is unnecessary. As with access code, there can also be a hierarchy of oral codes, say, for furnace repair person to enter the kitchen and basement areas but not the silver vault in the butler's pantry. There are also systems that permit a 'duress' code to be entered and silence the local alarm, but still trigger the remote alarm to summon the police to a robbery. [5]

PRINCIPLE OF OPERATION

The system depends on the obstruction of a laser light cast on the light dependent resistor (LDR) at the entry and exit zones of the building. This obstruction, causes the 555timer which is configured in a monostable mode to be activated, that is, as the voltage at pin 2 of the 555timer is turned high , there is, a corresponding high output voltage at pin 3. Pin 3 remain high for four seconds depending on the values of the resistor and capacitor used following the formula T=0.69RC of 555timer. The outputs of the 555timer are interfaced with the microcontroller chip that does the monitoring, powers the corresponding indicator and also sounds the alarm to indicate an intrusion.

The main entry and exit zones of the building, have SET and RESET buttons. The buttons are concealed in positions known only to the user(s). These buttons enable the user(s) to ENABLE or DISABLE the system at any given time, while the other private exit zones may be permanently ENABLED depending on the circumstances at the moment.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

In this section the design analysis of various stages and steps undertaken to achieve the project is presented.

The design circuit was firstly simulated on multism (an electronic work bench application soft ware) to ensure the designed circuit is working perfectly before proceeding to the breadboard work (temporary construction) to temporarily test the project and to be sure that all the component used are in good working condition and later proceed to the veroboarding work (the permanent construction) The work space below shows how the project was implemented on the multism software.

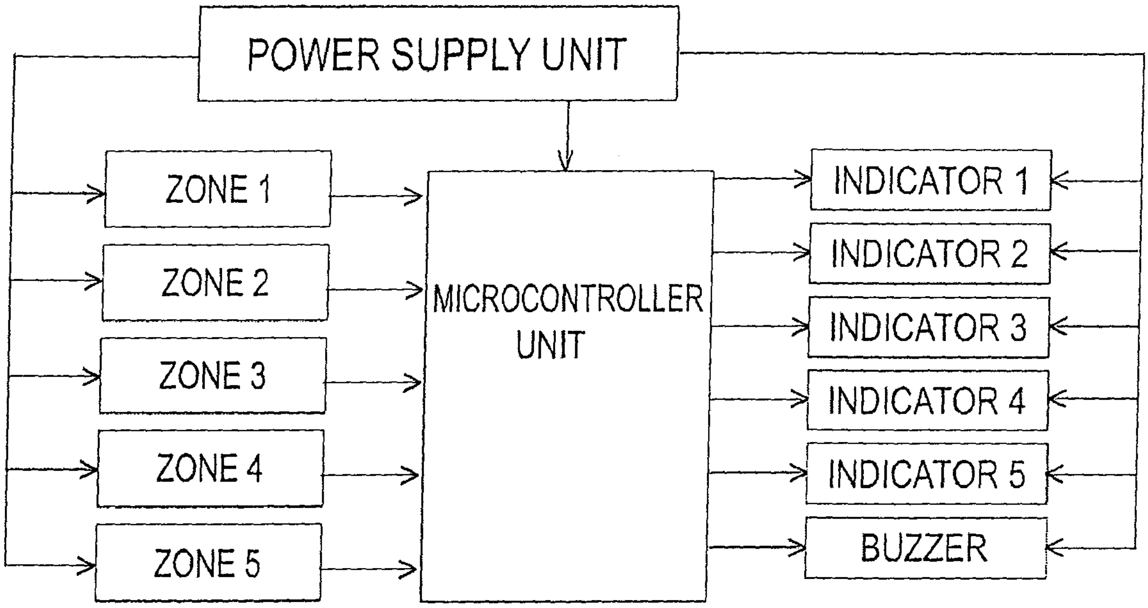
METHODOLOGY

The project was achieve using a laser light against an LDR (Light Dependent Resistor) as the motion sensor to detect human being approaching any of the five zones which are to be secured, while zone 1 is the main entrance that is not automatic, the resistance of an LDR varies with the intensity of light, and a microcontroller chip was used as the control that triggers the indicator (LED) corresponding with the zone that was interrupted.

The microcontroller performs the task of monitoring the output of each zone. Whenever any of the zones is high it will power the corresponding indicator together with the buzzer to alert the security of an intruder at that particular zone.

)ESIGN ANALYSIS

'his project is subdivided into different units in which the block diagram is shown below



'HE POWER SUPPLY UNIT

Most electronic devices and circuits require a DC source for their proper operation, and a typical

·egulation and load. The power supply unit comprise of the following listed below:

- A step down transformer
- A bridge rectifier
- Filtering capacitors
- Voltage regulators

The step down transformer

The mains voltage of 220V is stepped down by a 220V/15V step down transformer

Bridge rectifier

A rectifier was employed by the use of a full – wave bridge diode rectifier using a block d that contains four 1N4001A diodes.

Filtering Capacitor

It was then filtered by the use of an electrolytic capacitor of value 2200μF × 25V to filter out the AC ripples.

Voltage regulators

A 7805 voltage regulator was used to regulate the filtered DC signal to a fixed 5V to feed power to the motion sensor and the microcontroller chip, together with the indicators and the buzzer.

The complete circuit of the power unit is shown below:

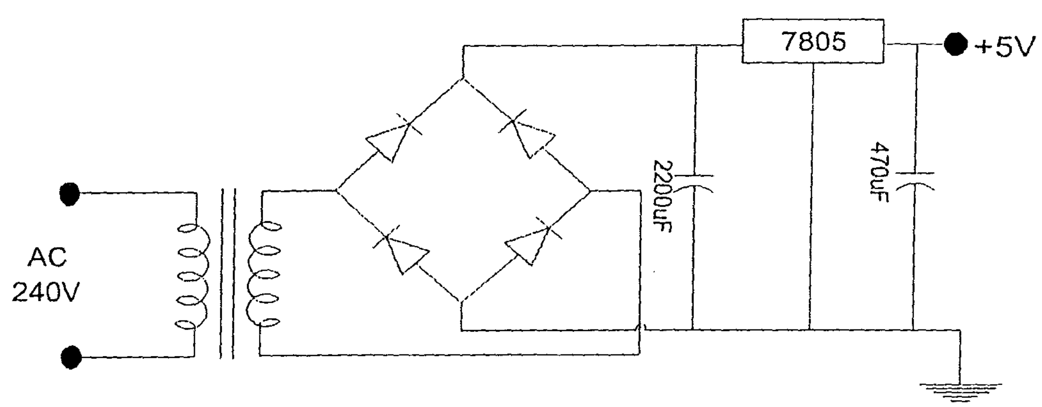
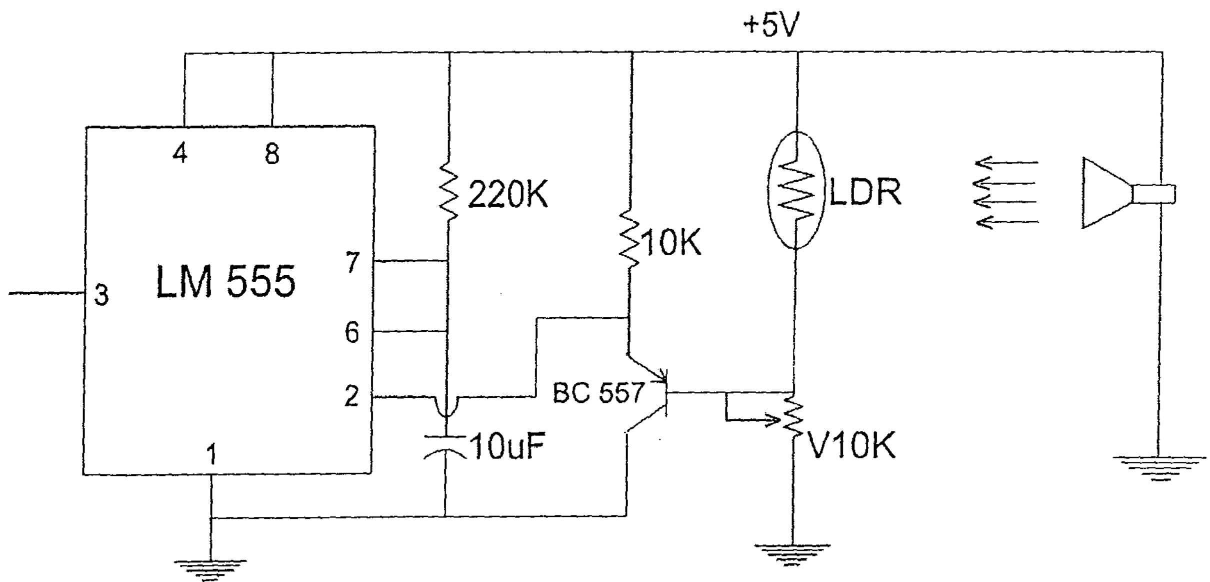


Figure 3.1 power supply unit

THE MOTION SENSING UNIT

In this unit a laser light was used against an LDR (Light Dependent Resistor) the resistance of an LDR varies with the intensity of light, the circuit was achieved using a 555 timer that was connected in monostable configuration where R and C was used to set a time of four seconds using the formula T= 1.1R*C where R is the value of the resistor used and C is the value of the capacitor used. in this configuration only when pin2 of the 555 timer goes low can it produce an output, the emitter of a PNP transistor(BC 557) was connected to pin 2 of the 555 timer with a pull up resistor of 10K, when the resistance of the LDR is high it pulls the base of the transistor low which switches on the transistor and in turn pull pin 2 of the 555 timer low to produce an output of 5V which was interfaced with the microcontroller for monitoring, and vice versa the circuit is shown below:

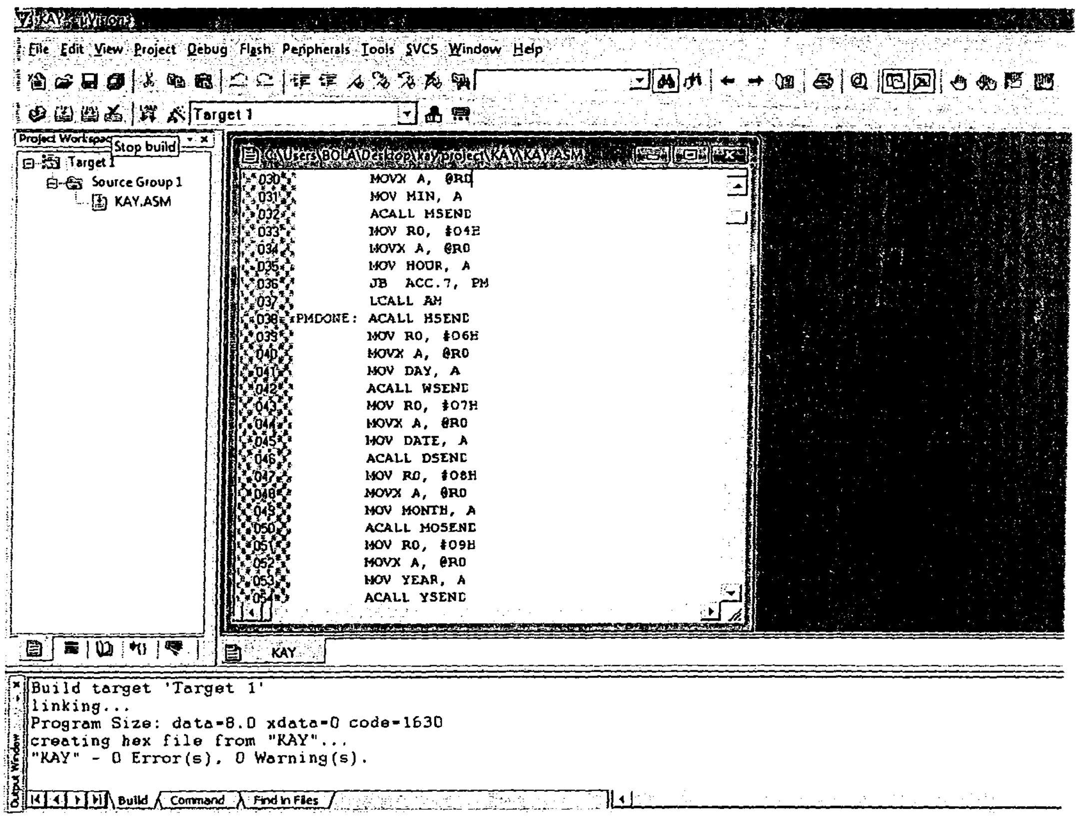


MICROCONTROLLER UNIT

This unit is sub divided into two i.e. the software part and the hardware part

Software Part

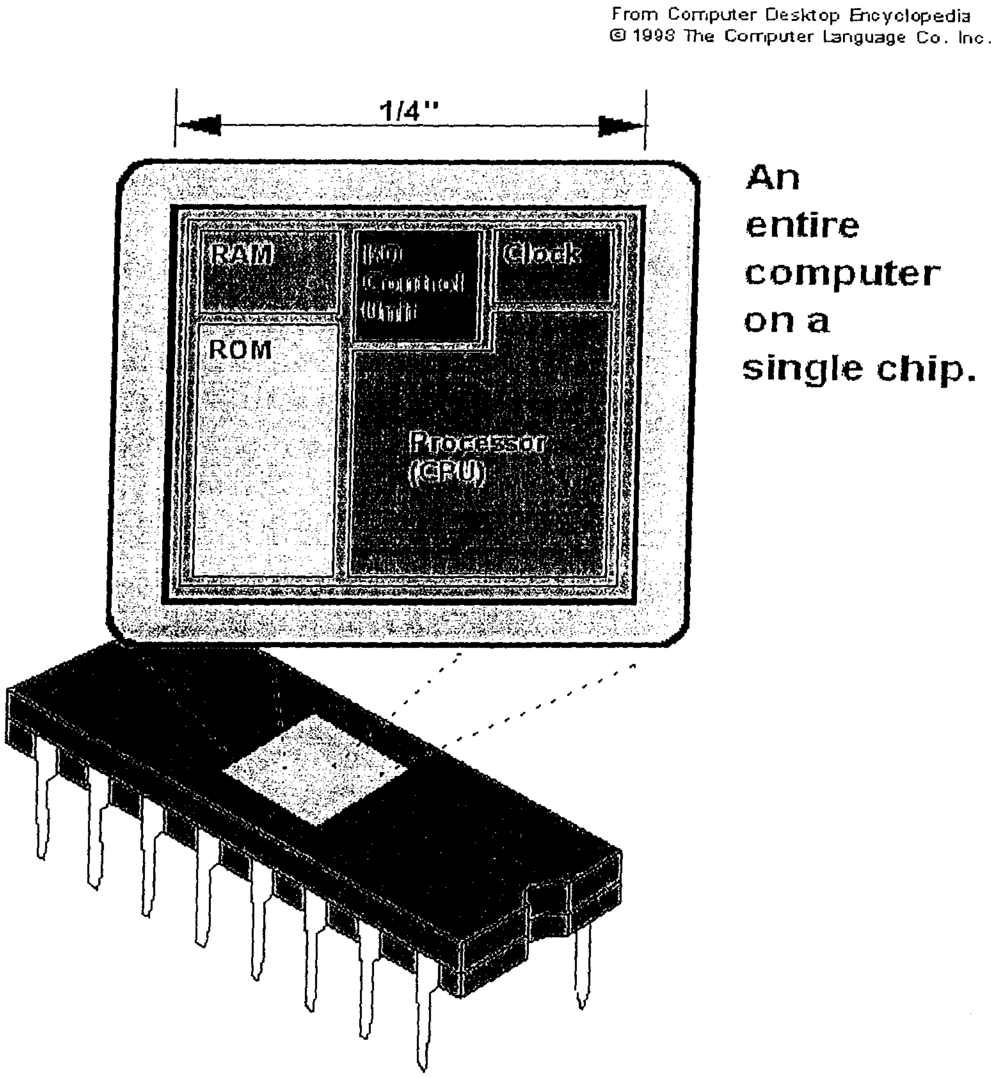
Keil Software was used to provide the software development tools for 8051 based microcontrollers. With the Keil tools, it was possible to generate an HEX file from an Assembly language commonly used in embedded applications for virtually every 8051 derivative. The supported microcontrollers are listed in the µ-vision, the picture of the software is shown below



This software was used to simulate the code and be sure the code is free from syntax error and logic error and finally help in generating the HEX file which was burned on the microcontroller chip to perform the control function in this project.

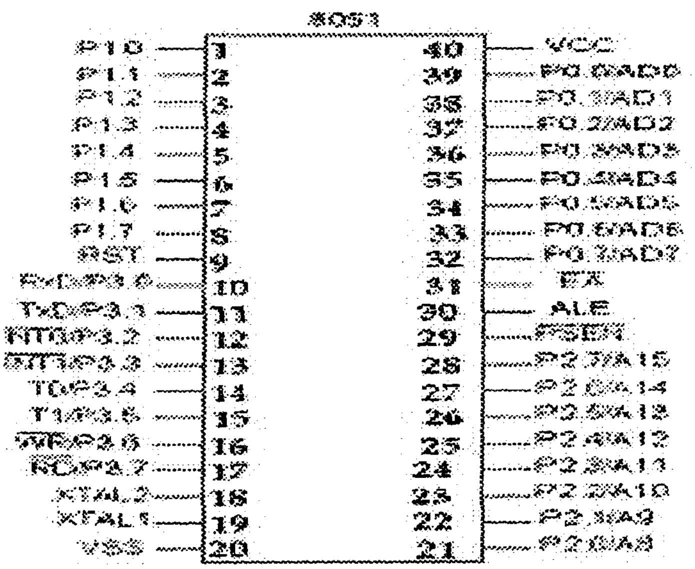
Hard ware Part

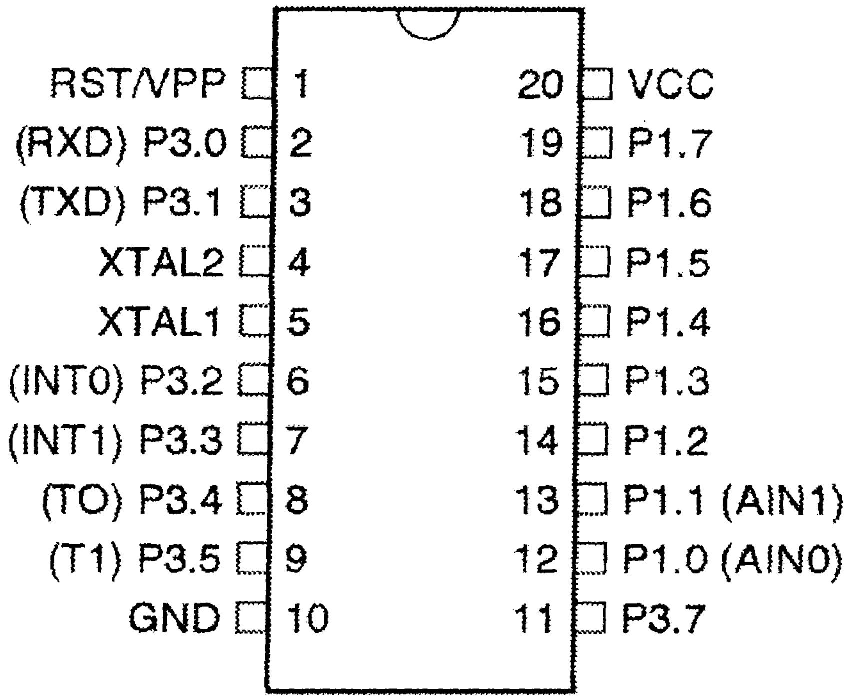
A microcontroller is a single chip that contains the processor (the CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit. Also called a "computer on a chip," billions of microcontroller units (MCUs) are embedded each year in a myriad of products from toys to appliances to automobiles. For example, a single vehicle can use 70 or more microcontrollers. The following picture describes a general block diagram of microcontroller.



AT 89C2051: The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 2K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 8051 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller, which provides a highly flexible and cost-effective solution to many, embedded control applications. The AT89S52 features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes.

The hardware is driven by a set of program instructions, or software. Once familiar with hardware and software, the user can then apply the microcontroller to the problems easily. The pin diagram of the 8051 shows all of the input/output pins unique to microcontrollers:





MICROCONTROLLER

Basic Pins

PIN 9: PIN 9 is the reset pin which is used to reset the microcontroller's internal registers and ports upon starting up.2 machine cycle should be high at this pin.

PINS 18 & 19: The 8051 has a built-in oscillator amplifier hence we need to only connect a crystal at these pins to provide clock pulses to the circuit.

PIN 40 and 20: Pins 40 and 20 are VCC and ground respectively. The 8051 chip needs +5V 500mA to function properly, although there are lower powered versions like the Atmel 2051 which is a scaled down version of the 8051 which runs on +3V.

memory is connected then PIN 31, also called EA/VPP, should be connected to ground to indicate the presence of external memory. PIN 30 is called ALE (address latch enable), which is used when multiple memory chips are connected to the controller and only one of them needs to be selected. We will deal with this in depth in the later chapters. PIN 29 is called PSEN. This is "program select enable". In order to use the external memory it is required to provide the low voltage (0) on both PSEN and EA pins.

Ports

There are 4 8-bit ports: P0, P1, P2 and P3.

PORT P1 (Pins 1 to 8): The port P1 is a general purpose input/output port which can be used for a variety of interfacing tasks. The other ports P0, P2 and P3 have dual roles or additional functions associated with them based upon the context of their usage.

PORT P3 (Pins 10 to 17): PORT P3 acts as a normal IO port, but Port P3 has additional functions such as, serial transmit and receive pins, 2 external interrupt pins, 2 external counter inputs, read and write pins for memory access.

PORT P2 (pins 21 to 28): PORT P2 can also be used as a general purpose 8 bit port when no external memory is present, but if external memory access is required then PORT P2 will act as an address bus in conjunction with PORT P0 to access external memory. PORT P2 acts as A8-A15, as can be seen from fig 1.1

PORT P0 (pins 32 to 39) PORT P0 can be used as a general purpose 8 bit port when no external memory is present, but if external memory access is required then PORT P0 acts as a multiplexed address and data bus that can be used to access external memory in conjunction with PORT P2. P0 acts as AD0-AD7, as can be seen from fig 1.1

Oscillator Circuits

The 8051 requires the existence of an external oscillator circuit. The oscillator circuit usually runs around 12MHz, although the 8051 (depending on which specific model) is capable of running at a maximum of 40MHz. Each machine cycle in the 8051 is 12 clock cycles, giving an effective cycle rate at 1MHz (for a 12MHz clock) to 3.33MHz (for the maximum 40MHz clock).

The following are some of the capabilities of 8051 microcontroller;

- ✓ Internal ROM and RAM
- ✓ I/O ports with programmable pins
- ✓ Timers and counters
- ✓ Serial data communication

The AT89C51 architecture consists of these specific features:

- 16 bit PC & data pointer (DPTR)
- 8 bit program status word (PSW)
- 8 bit stack pointer (SP)
- Internal ROM 2k
- Internal RAM of 128 bytes.
- 4 register banks, each containing 8 registers
- 80 bits of general purpose data memory

- 16 input/output pins arranged as four 8 bit ports: P1 and P3
- Two 16 bit timer/counters: T0-T1
- Two external and three internal interrupt sources Oscillator and clock circuits.

THE OUTPUT UNIT

At the output of the microcontroller five LEDs was connected each representing a zone which will come on any time the corresponding sensor goes high and remain on as long as the sensor is high but go off immediately the sensor goes low. Mean while the buzzer also remains on as long as any of the zones is high.

3.7 CIRCUIT DIAGRAM OF THE PROJECT

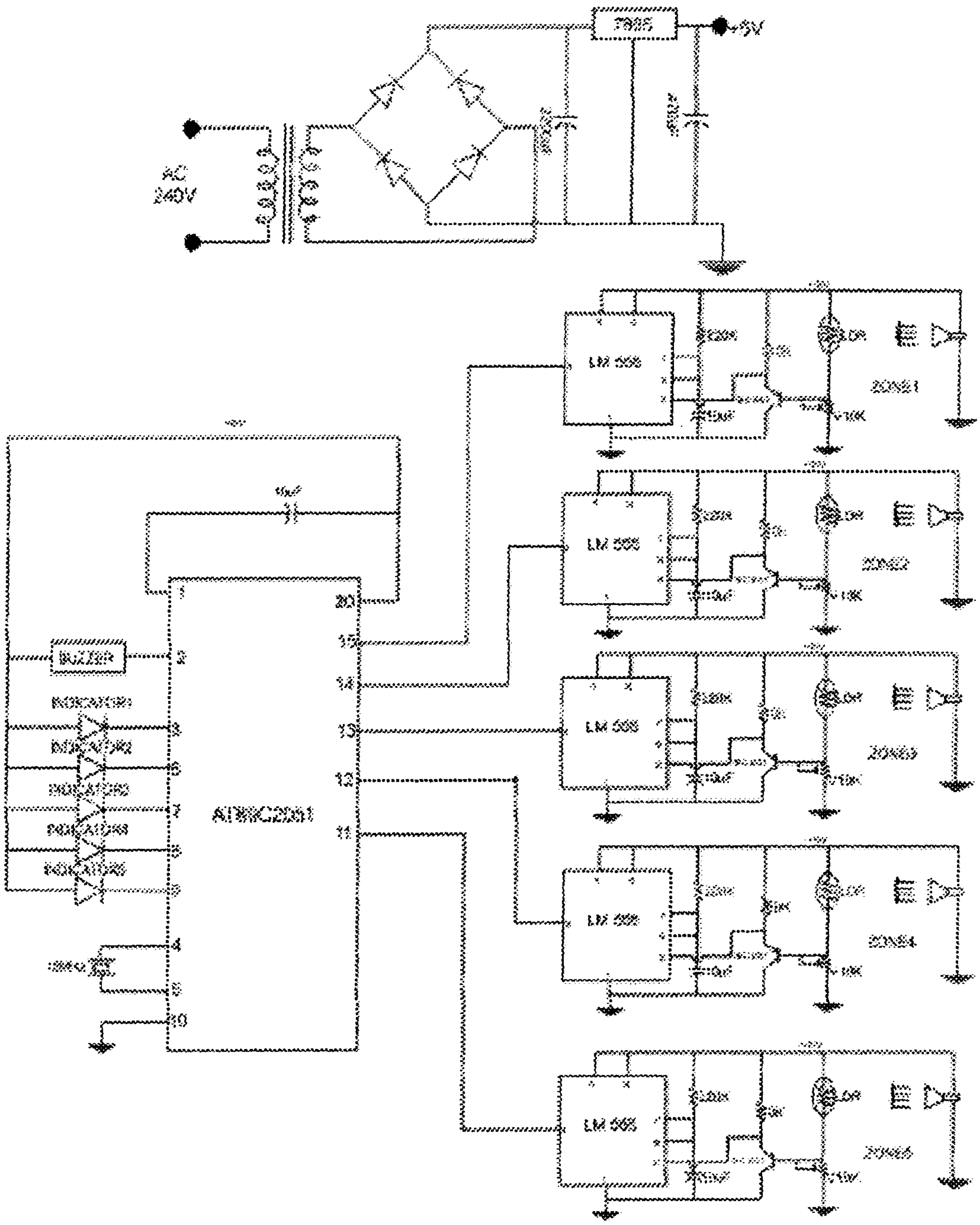


Fig. 3.5 Complete Circuit Diagram of the Project

CHAPTER FOUR

I.0 CONSTRUCTION, TESTING AND DISCUSSION OF RESULT

I.1 CIRCUIT CONSTRUCTION

The first step in the construction of the project was the purchase of the needed components and materials. Each part was independently and properly tested for any malfunction or defect.

The power supply circuit, the control unit and the five sensor circuits were first mounted on the breadboard in order to have proper understanding of the project construction. Afterwards, the constructed work was permanently soldered on the Vero board which was cut into proper shape to fit the estimated size of the entire circuit. Integrated circuits' sockets were used to protect the components from heat related damage that may occur during soldering. The soldering operation was done as fast as possible to avoid damage of components due to heat. Connecting wires were used for connecting the components in line with the circuit diagram . Some of these wires needed to be glued to the Vero board in order to avoid unwanted removal. Afterwards the circuit connections were properly tested for any wrong placement.

, CASING CONSTRUCTION

The casing was made of wood which is readily available in the market at very cheap rate. Suitable positions were selected for each part of the complete circuit and holes were bored in the case to provide ventilation (cooling air) for the components.

3 TESTING

The testing was done after all components were connected to their proper points. One of the sensor circuits of the zones was obstructed the corresponding zones' name was displayed and the alarm rang. Similar tests were conducted on the other sensor circuits of each zone and discovered to work. The RESET button at zone one was properly tested in order to be sure it performed its prescribed function. The alarm unit was also tested and discovered to work as intended. These tests were properly carried out to ensure true results.

Table 4.1 Table showing test results

ZONES	LIGHT DEPENDENT RESISTOR(LDR)	OUTPUT OF 555 TIMER	VOLTAGE EQUIVALENT (V)	INDICATOR	BUZZER
ZONE 1	Obstruction	High	+5	On	On
	No Obstruction	Low	0	Off	Off
ZONE 2	Obstruction	High	+5	On	On
	No Obstruction	Low	0	Off	Off
ZONE 3	Obstruction	High	+5	On	On
	No Obstruction	Low	0	Off	Off
ZONE 4	Obstruction	High	+5	On	On
	No Obstruction	Low	0	Off	Off
ZONE 5	Obstruction	High	+5	On	On
	No Obstruction	Low	0	Off	Off

RESULT AND DISCUSSION

It was observed that the power unit, the sensors unit, the control unit and the alarm section, all gave the required output as designed. When any of the sensors was being obstructed, the alarm was triggered and the name of the corresponding zone was being displayed as designed.

4.5 PICTURES OF THE PROJECT

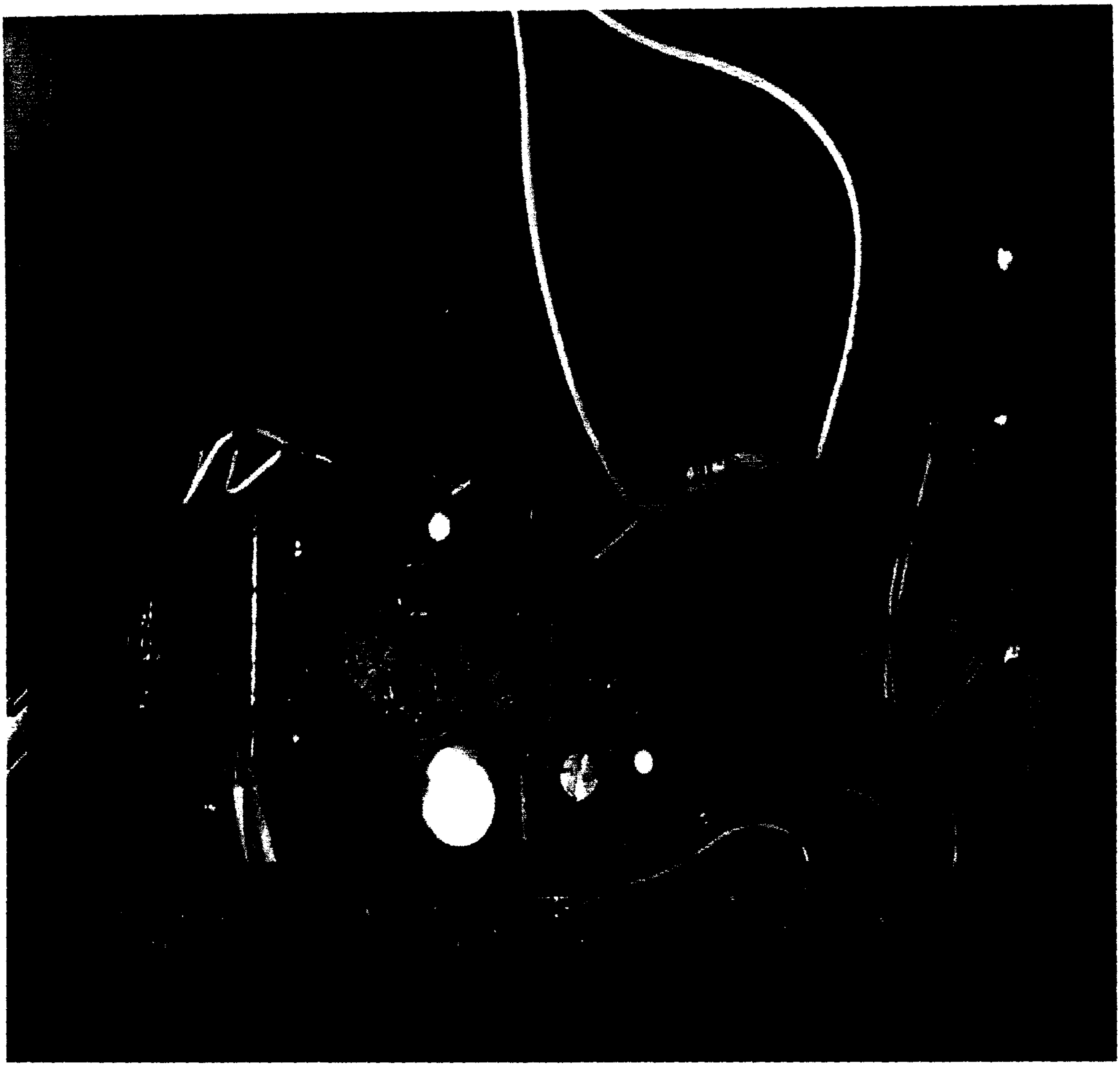


Fig. 4.1 Picture Of The Project Circuitry [Internal View]

PICTURE SHOWING FULL INTRUSION of THE FIVE ZONES

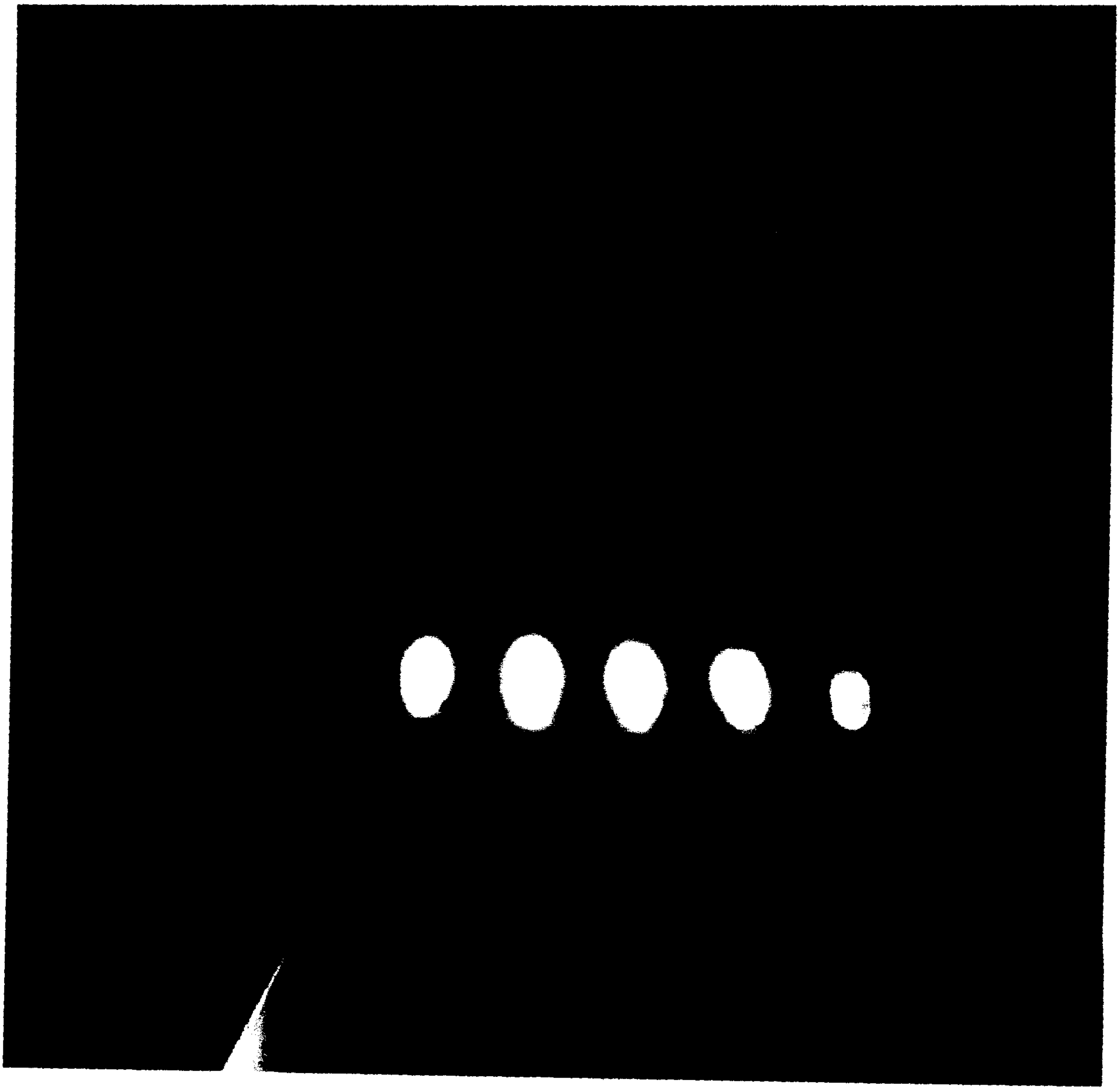


Fig. 4.2 Picture Showing Full Intrusion Of The Five Zones

PICTURE SHOWING FULL INTRUSION OF THE THREE ZONES

Fig. 4.3 Picture Showing Full Intrusion Of The Three Zones

PICTURE SHOWING THE EXTERNAL VIEW

OF THE PROJECT CIRCUITRY

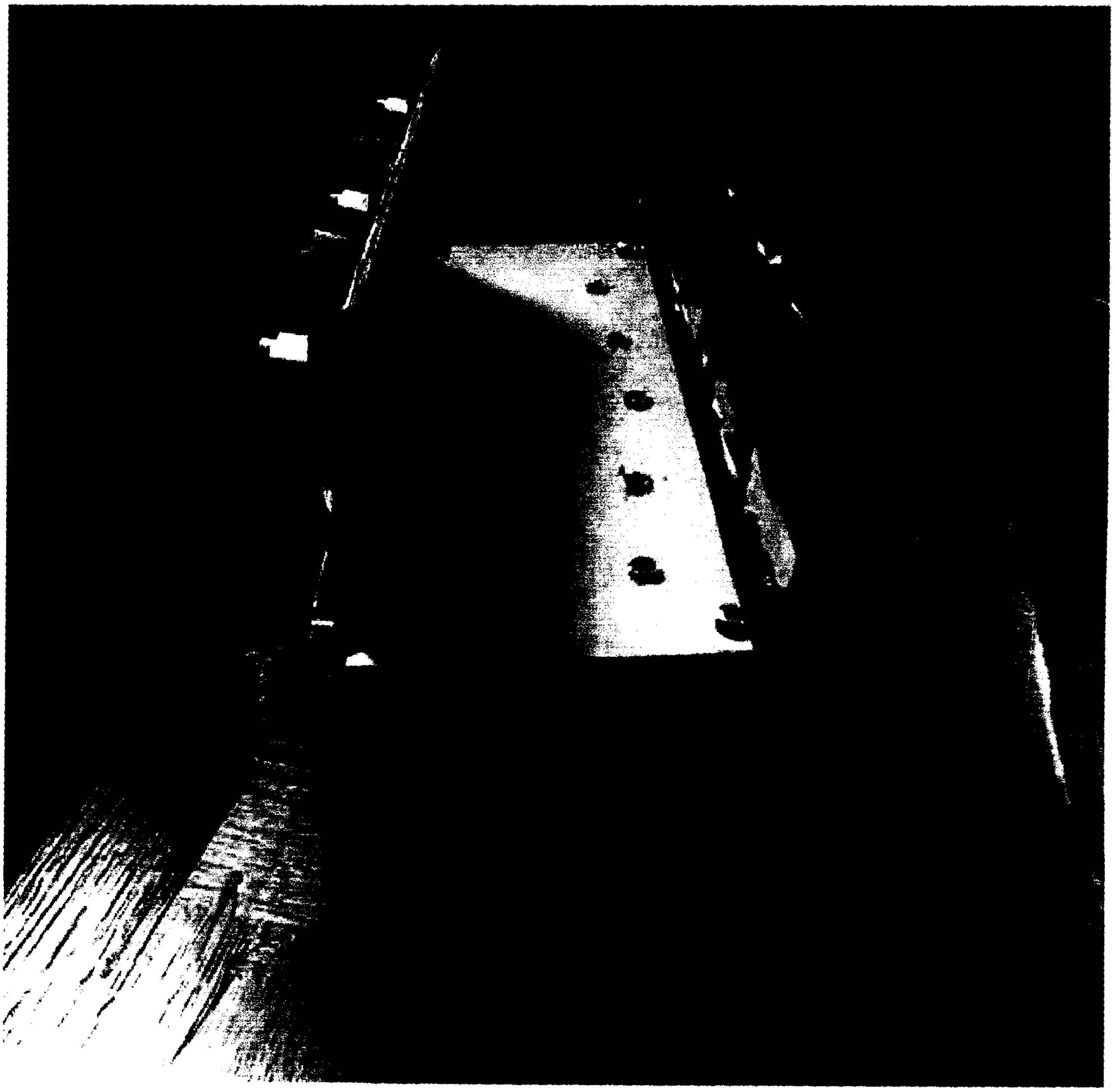


Fig. 4.4 Picture Showing The External View Of The Project Circuitry

PICTURE SHOWING THE EXTERNAL VIEW OF THE PROJECT CIRCUITRY

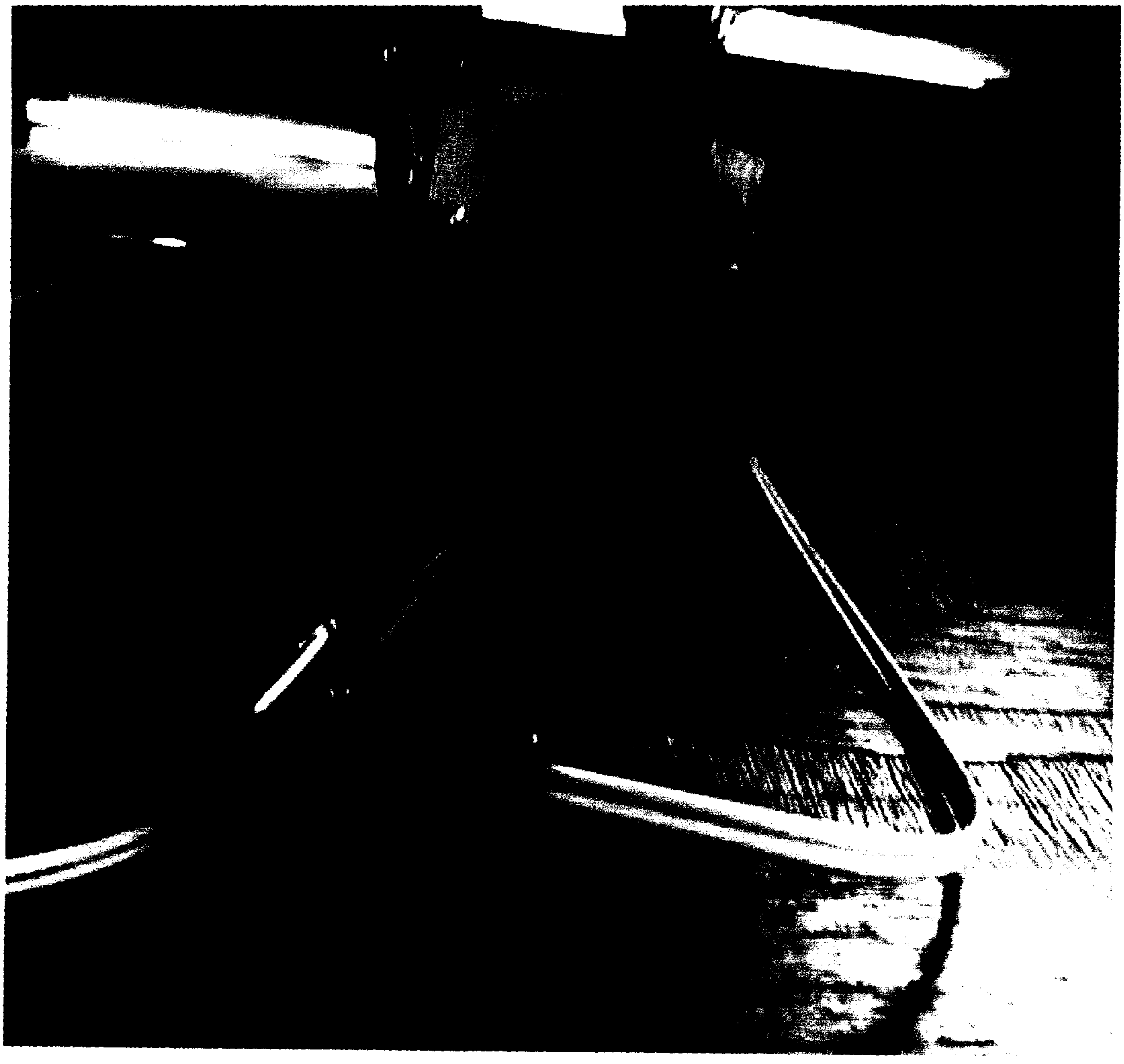


Fig. 4.5 Picture Showing The External View Of The Project Circuitry

CHAPTER FIVE

CONCLUSION, PRECAUTIONS AND RECOMMENDATIONS

CONCLUSION

The project demonstrated the application of microcontroller for security related purposes. It provided an interesting practical experience of microcontroller and electronics as well as their economic values.

Moreover, the main aim of the project, which was to design and construct a microcontroller based security system using intrusion sensors and an alarm system, was a success.

PROBLEMS ENCOUNTERED

- The acquisition of related components was quite a task.
- The initial design went through numerous modifications before success.
- The access to relevant information was quite challenging.

RECOMMENDATION

- The circuit could be improved upon by the incorporation of intruder visual display.
- More sensors could be incorporated into the system to secure more points.
- Different alarms could be used for different intrusion points.

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10] Design and Construction Of a Four Point Closed Contact By Alarm Unit By Edoh Azumdialo Olisaemeka , Department Of Electrical and Computer Engineering. Federal University Of Technology Minna, Niger State.

APPENDIX

```
 0000H
:1 EQU P1.7
:2 EQU P1.6
:3 EQU P1.5
:4 EQU P1.4
:5 EQU P1.3
!ER EQU P3.0
!ER1 EQU P1.2
:1LED EQU P3.1
:2LED EQU P3.2
:3LED EQU P3.3
:4LED EQU P3.4
:5LED EQU P3.5
 P3, #0FFH
 P1, #00H
RT1: JB ZONE1, A1
RT2: JB ZONE2, A2
RT3: JB ZONE3, A3
RT4: JB ZONE4, A4
RT5: JB ZONE5, A5
RT6: JNB ZONE1, B1
RT7: JNB ZONE2, B2
RT8: JNB ZONE3, B3
RT9: JNB ZONE4, B4
RT0: JNB ZONE5, B5
              SJMP START1
              CLR ZONE1LED
              CLR BUZZER
              CLR BUZZER1
              AJMP START2
              CLR ZONE2LED
              CLR BUZZER
              CLR BUZZER1
              AJMP START3
              CLR ZONE3LED
              CLR BUZZER
              CLR BUZZER1
              AJMP START4
              CLR ZONE4LED
              CLR BUZZER
              CLR BUZZER1
              AJMP START5
              CLR ZONE5LED
              CLR BUZZER
              CLR BUZZER1
              AJMP START6
:             SETB ZONE1LED
              SETB BUZZER
              SETB BUZZER1
              AJMP START7
:             SETB ZONE2LED
              SETB BUZZER
              SETB BUZZER1
              AJMP START8
:             SETB ZONE3LED
              SETB BUZZER
              SETB BUZZER1
              AJMP START9
:             SETB ZONE4LED
              SETB BUZZER
              SETB BUZZER1
              AJMP START0
:             SETB ZONE5LED
```

```
SETB BUZZER
SETB BUZZER1
AJMP START1
END
```