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Design and Simulation of Personal Computer Base Walls Crossed Security System Against Intrusion Using PIC Microcontroller

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Abstract*: We are living in a global computer age today were by every electronic appliance can be attaches or control by Computer or to say a personal computer. In this research, a reliable and cost less home security system was developed to secure any of the walls that were crossed. These walls are the north wall, east wall, south wall and finally the west wall. These walls are designed to be in a square environment, each of this walls has a Light Emitting Diode (LED) that function as a transmitter and a Light Dependent Resistor (LDR) that function as a Receiver. A closed circuit Television (CCTV) was used to capture the real-time video of any of the crossed wall. A Liquid Crystal Display (LCD) was used to display the status of these walls and display the name of the crossed walls. A magnetic buzzer was also used to alert the security personnel after a system has displayed the name of the crossed wall on the Liquid Crystal Display (LCD). A Microcontroller (PIC16F877A) is used as the brain of the developed security system. The Personal Computer (PC) is also used to display the system status through personal computer (PC) Parallel Port, to display the real-time video captured by CCTV camera, saving the video on personal computer (PC) hard drive, and also to control the developed system from the personal computer (PC) such as activating, deactivating and resetting the developed system*.

Keywords -*Closed-circuit television (CCTV), Home Security System, Liquid Crystal Display, Personal computer(PC), Parallel Computer (PC) Parallel Port, Real-time video.*

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I. INTRODUCTION

The most straightforward meaning of any security system originates in its name, it is exactly a means or process by which something is secured through a system of interworking mechanisms and appliances. In this example, I am speaking about home security systems, which are systems of combined electronic appliances functioning together with the help of a central control panel to defend against housebreakers and other possible home burglars[1]. Currently, Security Systems are mainly used in commercial areas, residential areas, industrial areas, schools areas, universities areas, hospital areas and military belongings for protection against theft or property damage, as well as personal protection against burglars[2]. Car alarms also protect automobiles and their contents[2]. The security system is also used in prisons in order to watch over the prisoners and their movements. Today, the home alarm security system and closed-circuit television(CCTV) system is an important part of any modern programmed home security system[3]. The simple design of any home security system starts with considering the needs of the residents, measuring existing hardware and technology, reviewing the costs of the system, taking into account the watching choices and lastly scheduling the installation[4]. Now if we are going to look at the worlds one of the richest countries which are united states of America (USA) we can see that they are placed 6th in auto theft and 9th in break-in[5]. Their investigation also indicates that most of the break-in happened in banks, residential area, as well as an office. Non-Automated home alarm security systems were found non-reliable. Doors were fitted with a lock and key system which can be opened easily[6]. Even with the help of human presence as a security watchman may not be absolutely reliable. Every system from the past has been found to be very much vulnerable[7]. Our home is a place where security is must need, to keep all the appliances and vulnerable safe. You as the homeowner should have the full assurance to step out from your house with the feeling that nothing is going to happened to your Home[8]. This feeling will only arise when the house is fully equipped with a reliable home alarm security system. For this purpose, in this research, it has focused on the upkeep of home security[9]. In this research, home security is only shown concerns on the four walls of the building. Each wall has a set of LED as a transmitter and LDR as a receiver. The LED is to transmit a beam of light directly to the LDR the receiver. If there is no wall cross the PIC detects 5v but If anything crossed the light beam then the PIC will detect a 0v that allow the PIC to display on the LCD the name of the wall that was crossed and sets the magnetic buzzer on at same time set the motor that carrying the CCTV camera in action that is to capture the real-time video and also the PIC communicate with the PC via parallel port to display the video and the name of the crossed wall on graphical user interface that was developed using visual basic programming language. The system is capable of displaying more than one name of the crossed walls both on the LCD interface and PC Graphical User Interface (GUI). The user has to activate the system from pc by clicking an activate button and can easily deactivate the system by clicking the deactivate button. The user can also reset the system from PC by clicking the reset button and make surveillance from the PC by clicking the rotate motor button. If all the four walls were not crossed the system will display on both LCD and PC that ALL THE FOUR WALLS ARE OK. If to say a north wall was crossed the system will set alarm and display on both LCD and PC that NORTH WALL CROSSED then the 5v dc motor will set to rotate just to display the real-time video on the PC graphical user interface via parallel port.

II. MATERIALS AND METHOD

2.1. Materials
The materials used in this research are shown in table I below

Table I: Materials used

S/N	Components	Number used
1	Peripheral Interface Controller	1
2	Liquid Crystal Display	1
3	Light Dependent Resistor	4
4	Light Emitted Diode	4
5	Capacitor	1
6	Voltage regulator	1
7	Magnetic Buzzer	1
8	Transistor	1
9	Diode	4
10	Oscillator	1
11	Resistor	17
12	Connections	36

2.1.1. Microcontroller (PIC16F877A)

The microcontroller is an extremely combined device, which includes one chip, all, or most of the parts needed to perform an application control function. The PIC (peripheral interface controller) is an integrated circuit (IC) which was established to control peripheral devices, improving load from the central processing unit (CPU). It also has a low memory capacity, it is also used in performing calculations and is controlled by software just like the central processing unit (CPU). It is used in the designs where a local resolution needs to be taken[14]. The PIC16F877A is a high performance, low-cost CMOS, 8-bit microcontroller with RISC (Reduced instruction set computer) architecture as it has been mentioned earlier before, there are about 40 pins of this microcontroller IC. It consists of two 8 bit and one 16 bit timer. Compare and capture modules, serial ports, parallel ports, and five input/output ports are also present in it[15]. Figure 1 shows the pin configuration of the pic16f877a microcontroller. Also, the pins functions are explained in details.

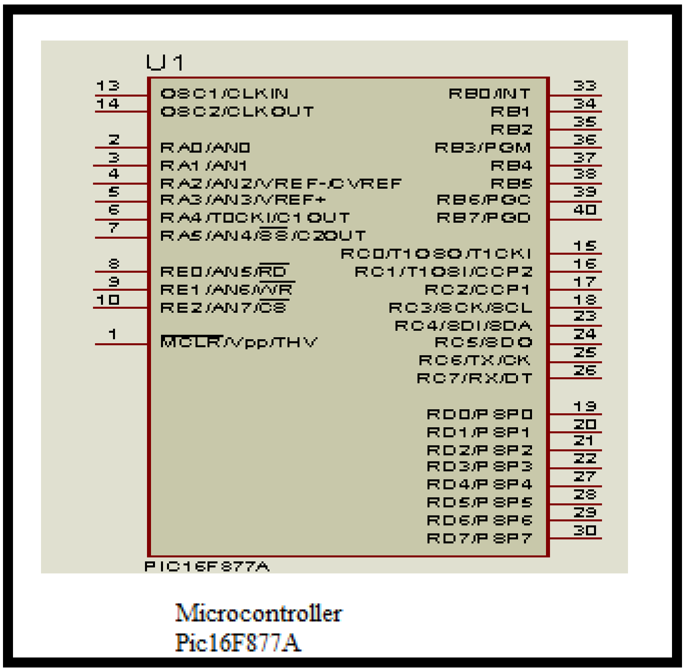


Fig. 1: Microcontroller (PIC16F877A)

2.1.2. Pin description of the microcontroller (PIC16F877A)

1.Vss and Vdd

The Vss and Vdd are pins 11 and 12, 31 and 32 respectively. They are power supply pins. Vss is the negative supply while the Vdd is a positive supply.

2.OSC1/CLKIN and OSC2/CLKOUT

The external clock is connected to these pins. The clock provides the required timing for the microcontroller.

3.MCLR

The MCLR is used to erase memory locations inside the PIC whenever there is the need to reprogram it. It is connected to the positive power supply in normal use.

4.The Input/output PORTS

These are a group of pins that can be simultaneously accessed. The PIC16F877A has 5 ports; portA, portB, portC, portD and portE which acts as physical connection of the central processing unit(CPU) to the outside world. On power up and reset, all the pins are configured as input pins by default. They can be however be reconfigured by the program.

i.PORTA

It is a 6 bits wide bi-directional port. RA0 – RA5 are purely bi-directional I/O pins while RA0 – RA3 can be used as an analog to digital conversion pins. RA4 – RA5 can be used as free run timers or counter in addition to Input/output function.

ii.PORTB

It is an 8 bits wide bi-directional port. RB0 – RB7are bidirectional Input/output pins. RB0 has an interrupt on change feature. RB1 to RB3 are purely bi-directional I/O pins while RB4 – RB7 also have the interrupt on change feature. The interrupt on change feature can be enabled only when the given pin is configured as an input pin.

iii. PORTC

It is an 8 bits wide bidirectional port. RC0 – RC7are bidirectional I/O pins.

iv. PORTD

It is an 8 bits wide bidirectional port. RD0 – RD7are bidirectional I/O pins.

v. PORTE

It is a 3 bits wide bi-directional port. RE0 – RE2are bidirectional I/O pins[16].

2.2. Methods

This section of the research handled the calculation and theoretical part of the design of a personal computer (PC) based wall crossed detecting security system against intrusion.

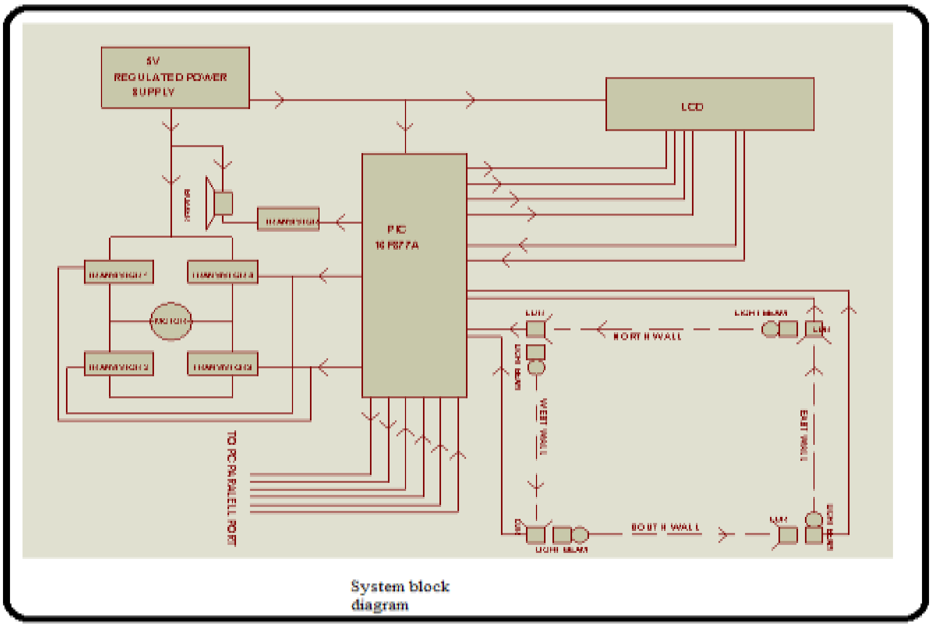


Fig. 2: System block diagram

The system block diagram that is shown above in figure 2 of this research shows the mode of operation of the whole system. If the system is powered on it display on the Liquid Crystal Display (LCD) that “please activate the device" so the user has to click a button from the graphical user interface (GUI) on the Personal Computer (PC) screen which is being developed using visual basic. if the system is being activated from the personal computer the system Liquid crystal display (LCD) will display "system activated" at that time the system will be able to detect any crossed walls[17]. Each wall has a set of a light dependent resistor (LDR) and Light-emitting diode (LED). The light emitting diode (LED) is to send a light beam to light dependent resistor (LDR), in the presence of light the light dependent resistor (LDR) will send a 5 volts to PIC16F877a microcontroller that means the wall is not being crossed and if the wall was crossed the light dependent resistor (LDR) will be in darkness and it will send a 0 volts to Pic16f877a microcontroller and the microcontroller will automatically display the name of the wall that has being crossed on liquid crystal display (LCD) and then send a signal to personal computer (PC) through parallel port displaying on the personal computer (PC) that the wall has been crossed and the persona; computer (PC) will display on the screen name of the wall that has been crossed while the microcontroller set the dc motor on that to carry the CCTV camera in order to capture the real-time video. The video will be sent to the personal computer (PC) and will be saved in the personal computer (PC) in a particular drive. If none of the four walls was crossed the microcontroller will display on the liquid crystal display (LCD) that "all the four walls are ok" and also send a signal to the personal computer (PC) displaying that none of the walls is being crossed and the personal computer (PC) will display that information on its screen. The system will be reset from the personal computer (PC) by a simple click on the reset button located on the graphical user interface (GUI). The system can also be deactivated from the graphical user interface (GUI) by clicking the deactivating button.

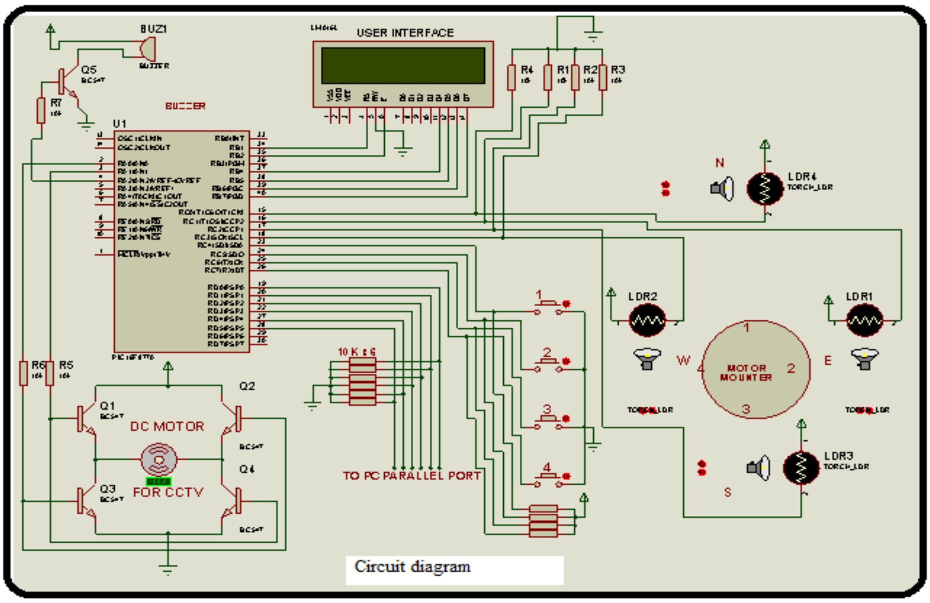


Fig. 3: Circuit diagram

Figure 3 above shows the system circuit diagram. The pin assignment of the whole system connection is as follows:

1. Pin 2 is connected to the base of transistor Q3 and Q2 through 10kΩ resistor in order to rotate the motor clockwise if the base of transistor Q2 and Q3 were biased.
2. Pin 3 is connected to the base of transistor Q1 and Q4 through 10kΩ resistor in order to rotate the motor anticlockwise if the base of transistor Q1 and Q4 were biased.
3. Pin 4 is connected to the base of transistor Q5 through a 10kΩ resistor in order to switch on/off the magnetic buzzer.
4. Pin 40, 39, 38 and 37 were connected to the liquid crystal display (LCD) data line.
5. Pin 34 and 35 are connected to the LCD control line.
6. Pin 15, 16, 17 and 18 were connected to a light dependent resistor (LDR) of the north, east, south, and west respectively through 10kΩ pull-down resistor on each line.
7. Pin 23, 24, 25 and 26 are connected to the buttons 1, 2, 3, 4 respectively to function as a dc motor stopper through 10kΩ pull-down resistor.
8. Pin 19,20,21, 22, 27 and 28 were connected to personal computer (PC) parallel port through 10kΩ pull-down resistors.

2.2.1. Design equations

Below are the formula used in designing the system and their respective values obtained.

$$I_B = \frac{I_C}{\beta} \quad (1)$$

I_B is the transistor base current

I_C is the transistor collector current

β is the transistor current gain

$$V_C = I_B R_B + V_{BE} \quad (2)$$

V_{BE} is the transistor base-emitter voltage = 0.7v, for silicon

$R_B$is the transistor base resistor

$$\beta = \sqrt[2]{\beta_{min} \times \beta_{max}} \quad (3)$$

$$I_{Sinking} = \frac{V_C}{R_{pull-up}} \quad (6)$$

2.2.2. The datasheet of C945 transistor used

Table II:C945 datasheet

Parameter	Symbol	Test condition	Min	Max	Unit
Collector-base breakdown voltage	$V_{(BR)CBO}$	I_C=1mA, $I_E = 0$	60		V
Collector-emitter breakdown voltage	$V_{(BR)CEO}$	$I_C = 100uA$, $I_B = 0$	50		V
Emitter-base breakdown voltage	$V_{(BR)EBO}$	$I_E = 100\mu A$, $I_C = 0$	5		V
Collector cut-off current	I_{CBO}	$V_{CB = 60v}$, $I_E = 0$		0.1	µA
Collector cut-off current	I_{CEO}	$V_{CE = 45v,\ R = 10M\Omega}$		0.1	µA
Emitter cut-off current	I_{EBO}	$V_{EB = 5v}$, $I_C = 0$		0.1	µA
DC current gain	$H_{FE(1)}$	$V_{CE = 6v}$, $I_C = 1$ mA	70	700	
DC current gain	$H_{FE(2)}$	$V_{CE = 6v}$, $I_C = 0.1$mA	40		
Collector-emitter saturation voltage	V_{Cesat}	I_C =100mA, I_B = 10mA		0.3	V
Base-emitter saturation	V_{BE}	$I_C = 100mA, I_B = 10mA$		1	V
Collector output capacitance	C_{ob}	$V_{CB} = 10V, I_E = 0, f = 1MHZ$		3.0	pF
Transition frequency	Fr	$V_{CE = 6v}$, I_C=10 mA F = 30MHz	200		MHz

The values below are obtained from the datasheet of the transistor C945 above.

$$\beta_{min} = 70 \quad (4a)$$

$$\beta_{max} = 700 \quad (4b)$$

$$I_C = 100mA \quad (5)$$

2.2.3. Light dependent resistor

The light dependent resistor is a light controlled variable resistor. the resistivity of the LDR decreases with increasing incident light intensity, in other words, it will exhibit photoconductivity. LDR is made of high resistance semiconductor. In the darkness, its resistivity will increase as high as several mega ohms, while in light its resistivity will decrease as low as a hundred ohms. The light dependent resistor (LDR) is used to detect the crossing body, that is anything that will interrupt or block the light beam which is also known as the light emitting diode (LED) that makes the light dependent resistor (LDR) to be in darkness. Therefore, the calculation is going to be in two parts;

1. When the light dependent resistor is in light, it sees light, that is the light beam is not blocked or moved away from it.

$$I_{LDR} = \frac{V_{LDR}}{R_{LDR}}$$

$$I_{LDR} = \frac{5}{100} = 0.05mA$$

which is a high current, is the expected current passing through the LDR and 5volts is the voltage supplied by the microcontroller and 100ohms is the resistor of the light dependent resistor provided by the manufacturer. The light dependent resistor will be active at this stage indicating no walls crossed if all the walls are having a follow of such currents.

2. When the light dependent resistor is in dark, that is they is interruption between the light beam and light dependent resistor.

$$I_{LDR} = \frac{V_{LDR}}{R_{LDR}}$$

$I_{LDR} = \frac{5}{2000000} = 2.5 \times 10^{-6} A$very low value, if the light dependent resistor sees this current is showing that is not active it will output 0 volts and send it to the microcontroller, which is a sign of interruption between the LDR and the light beam(LED).

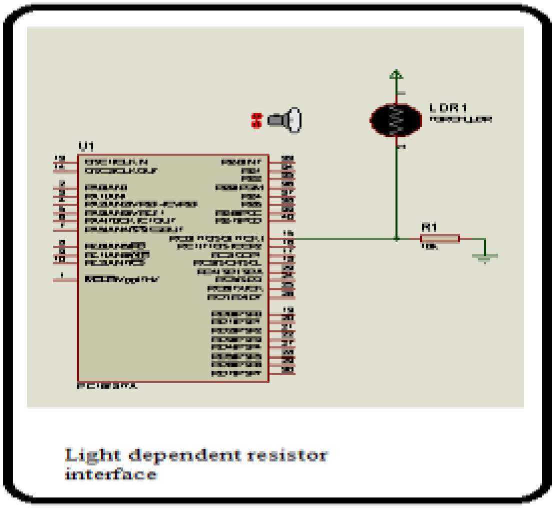


Fig. 4: Light dependent resistor interface

2.2.4. Light emitting diode

The following data are gotten from the datasheet of the light emitting diode (LED).

$I_{LED} = 25mA$, which is the current of the LED from the datasheet

$V_{LED} = 1.8V$, which is the voltage of the LED also obtained from the datasheet

$$R_{LED} = \frac{V_{CC} - V_{LED}}{I_{LED}} = \frac{5 - 1.8}{25 \times 10^{-3}} = \frac{3.2}{0.025} = 128\Omega$$

2.2.5. Transistor driven buzzer

Substituting Equation (4a) and (4b) in Equation (3) in order to obtain the DC current gain of the transistor (β)

$$\beta = \sqrt[2]{(700 \times 70)} = 221.4$$

Substituting β and equation (5) in equation (1)

Therefore,

$$I_B = \frac{I_C}{\beta} \tag{1}$$

$$I_B = \frac{I_C}{\beta} = \frac{100 \times 10^{-3}}{221.4} = 451\mu A$$

$$V_C = I_B R_B + V_{BE} \tag{2}$$

V_C is the voltage supplied to the microcontroller, which is 5 volts.

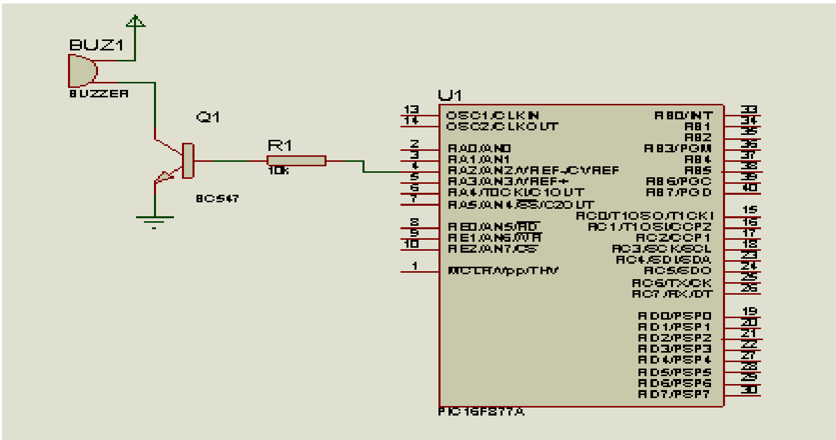
$$R_B = \frac{5 - 0.7}{451.7 \times 10^{-6}} = \frac{4.3}{0.0004517} = \frac{9519.59}{1000} = 9.52k\Omega$$

Is the base resistor obtained.

2.2.6. For 8 ohms buzzer

$$I_{buzzer} = \frac{V_{buzzer}}{R_{buzzer}} = \frac{5}{8} = 625mA$$

5 volts is the voltage supplied by the microcontroller and 8 ohms is the resistor of the buzzer that comes with it. And 625mA is the value of the current obtained from the calculations and is the current passing through the buzzer that is going to make the buzzer active in case they are any interruption between the LDR and its light beam.



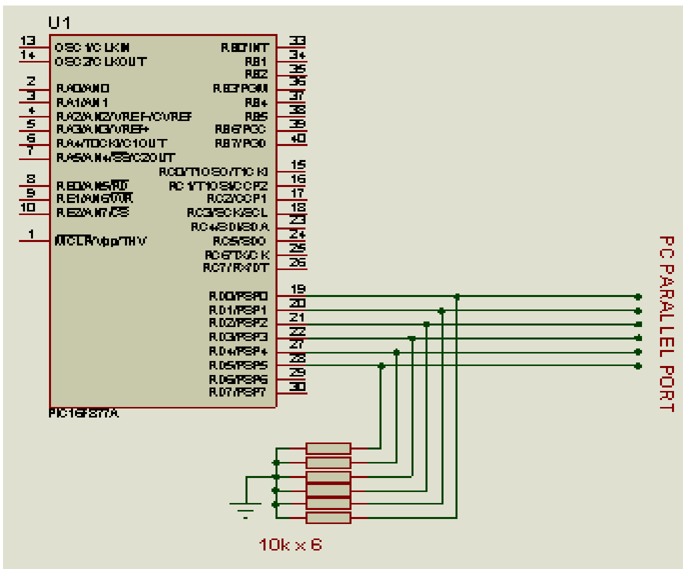
For 8 ohms buzzer

Fig. 5: Buzzer used for alerting intrusion

2.2.7. The personal computer connections activating the system

This is just like a push button were by the personal computer (PC) will send a signal via a parallel port to pin 19 of the microcontroller through a pull-down resistor.

$I_{sinking} = \frac{V_C}{R_{pull\ -down}} \frac{5}{10} = 0.5mA$, 0.5mA is the sinking current.



Personal computer interfacing microcontroller

Fig. 6: Personal computer interfacing microcontroller

2.2.8. Direct current(DC) motor

The DC motor is responsible for rotating the closed-circuit television either clock-wise or anti-clock in case there is an intrusion.

$$I_{motor} = \frac{V_{motor}}{R_{motor}} = \frac{5}{8} = 625mA$$

I_{motor} is the current drawn by the motor
V_{motor} is the voltage of the motor which is 5v
R_{motor} is the resistance of the motor which is 8Ω
The calculation of the transistor driven motor is the same with the transistors driven buzzer.

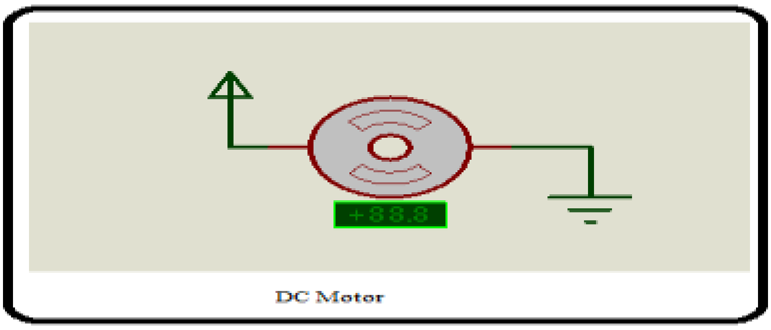


Fig. 7: Direct current motor

2.2.9. Parallel port

A Parallel port is a port in a computer, a port is a set of signal lines that the microprocessor, or CPU, uses to exchange data with other components. Typical uses of ports are communicating with printers, modems, keyboards, and displays, or just about any component or devices except system memory. Most computer ports are digital, where each signal is 0 or 1. Parallel port transfer multiple bits at once, while serial port transfers a bit at a time. Figure 8 shows the pin configuration of the parallel port. The parallel port of the computer uses a DB-25 female connector with 25 pin contacts, located on the rear panel of the computer. Of the 25 contacts, 17 are used as signal lines and 8 are ground lines. The signal lines are divided into three groups.

Control lines (4 lines)
Status lines (5 lines)
Data lines (8 lines)

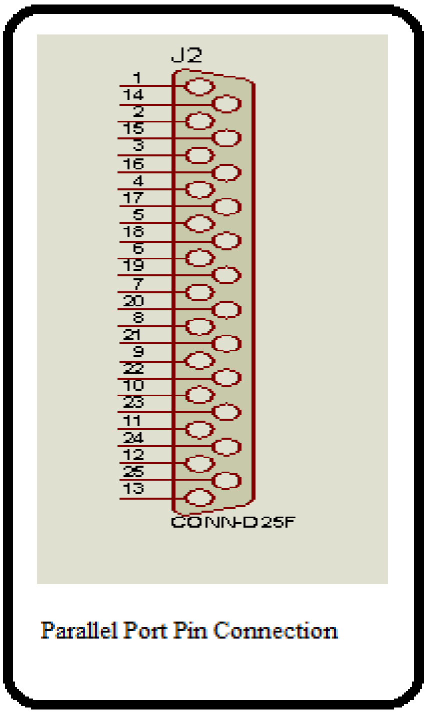


Fig. 8: Parallel port pin connection

2.2.10. Personal computer graphical user interface software

Visual Basic is a tool that allows u to developed windows (graphical user interface- GUI) applications. The applications have some familiar concept to the user. Is also called an event-driven, meaning code remains idle until called upon to respond to some event (button pressing, menu selection). The visual is governed by an event processor. Nothing happened until an event is detected. Once an event detected, the code corresponding to that event is executed.

III. RESULTS AND DISCUSSIONS

This section deal with the description of the test performed on the various sections of the overall system and their corresponding result obtained of the overall system. Table III shows the test and the result obtained.

Table III: Test and Results obtained

S/N	TEST CONDUCTED	RESULT OBTAINED
1	Press the play button on both Proteus (circuit) and visual basic (application)	PIC ports, LCD, sensors, PC parallel Port initializing. LCD display “activate the system from the PC” figure 9 shown
2	If the activate button was pressed from the visual basic application	LCD display “system activated” for 3 seconds figure 10 shows. Then LCD and application display “all four walls are ok” figure 11 and 12 shows.
3	If the north wall was blocked (crossed) from receiving light beam	LCD and PC display “North wall was crossed” figure 13 and 14 shows
4	If East wall was blocked (crossed) from receiving light	LCD and PC display “east wall was crossed” figure 15 and 16 shows
5	If the south wall was blocked (crossed) from receiving light	LCD and PC display “south wall was crossed” figure 17 and 18 shows
6	If the west wall was blocked (crossed) from receiving light	LCD and PC display “west wall was crossed” figure 19 and 20 shows
7	If the reset button is clicked from a PC VB application	The whole system will be reset
8	If the exit button is clicked from a PC VB application	The application will be closed
9	If the rotate motor button is clicked from a PC VB application	The PC will rotate the motor for 90 degrees (as surveillance and if pressed again it rotates to the next 90 degrees)

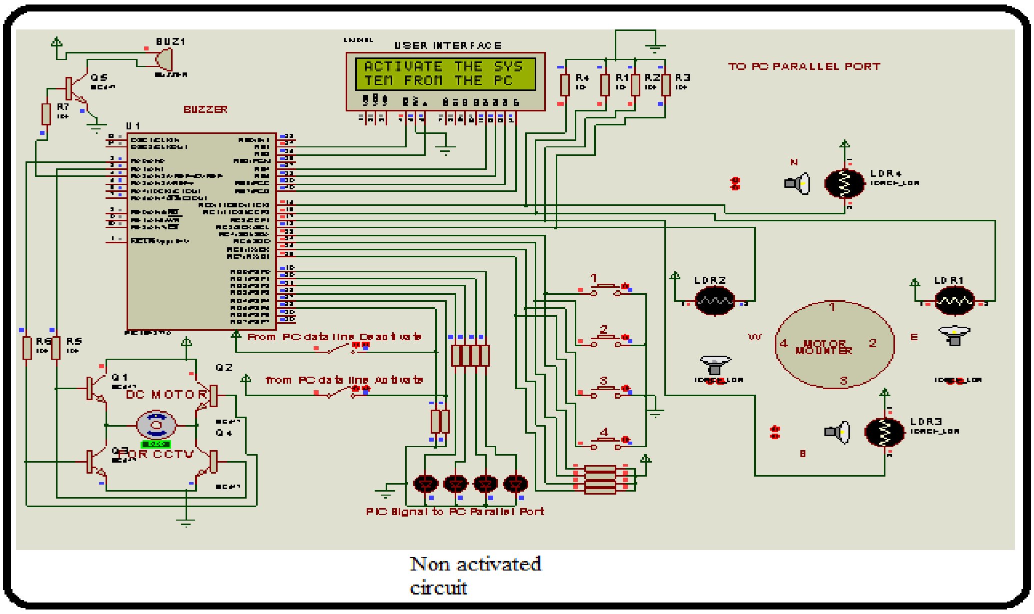


Fig. 9: Activate the system from the PC

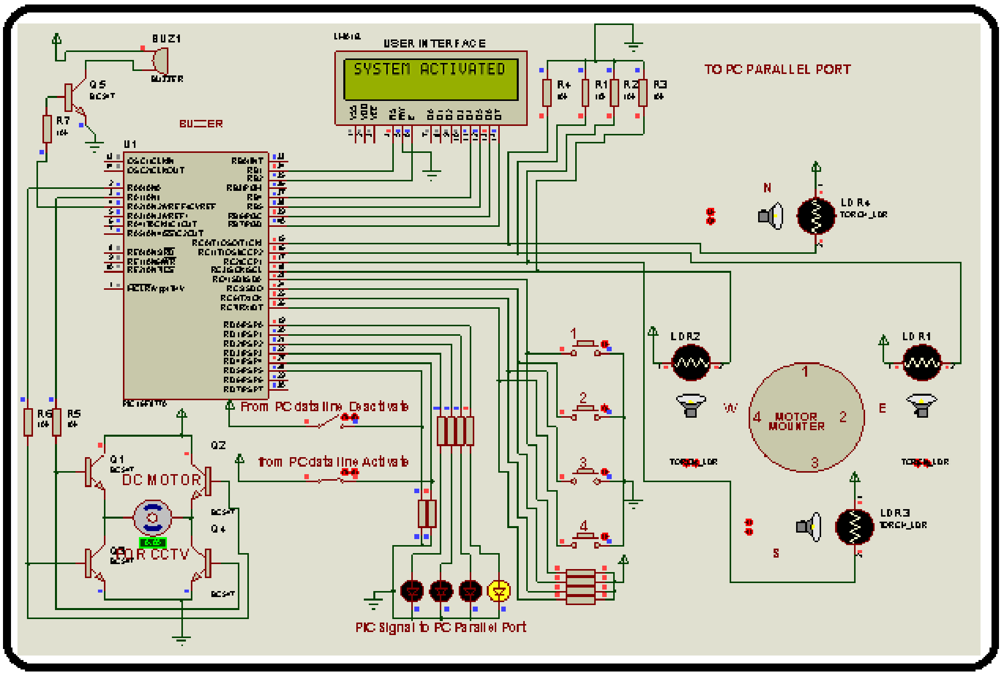


Fig. 10: System activated

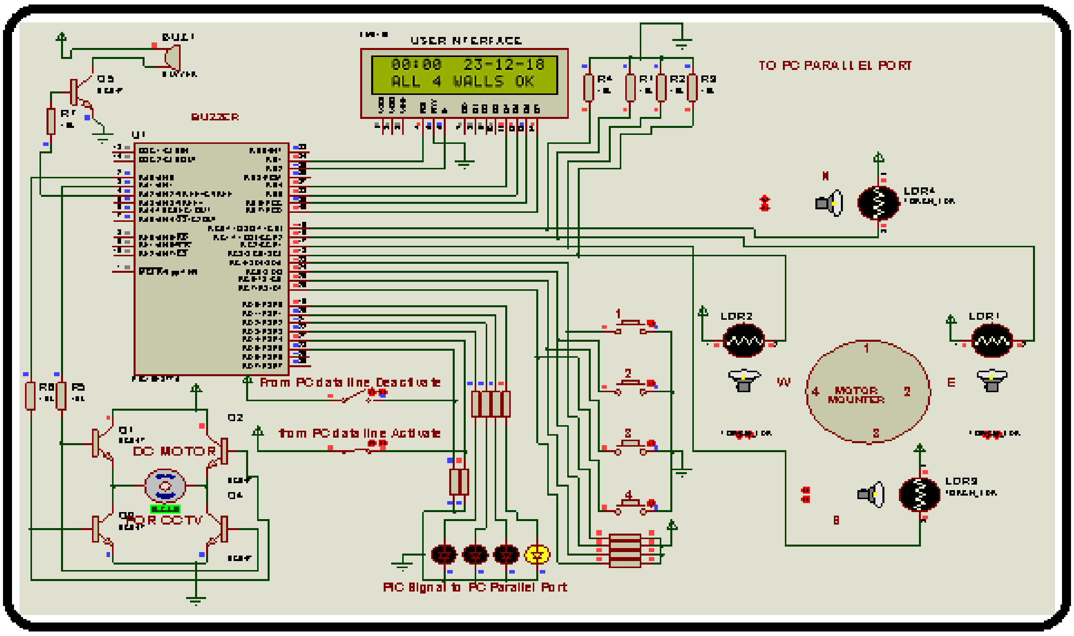


Fig. 11: All 4 walls ok

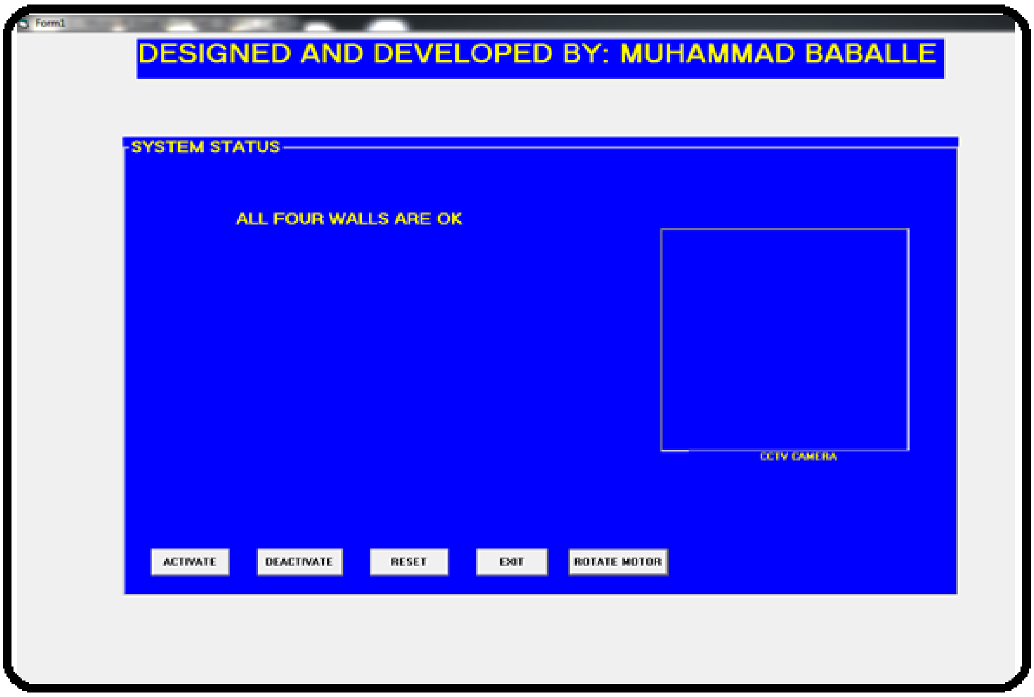


Fig. 12: From the personal computer all four walls are ok

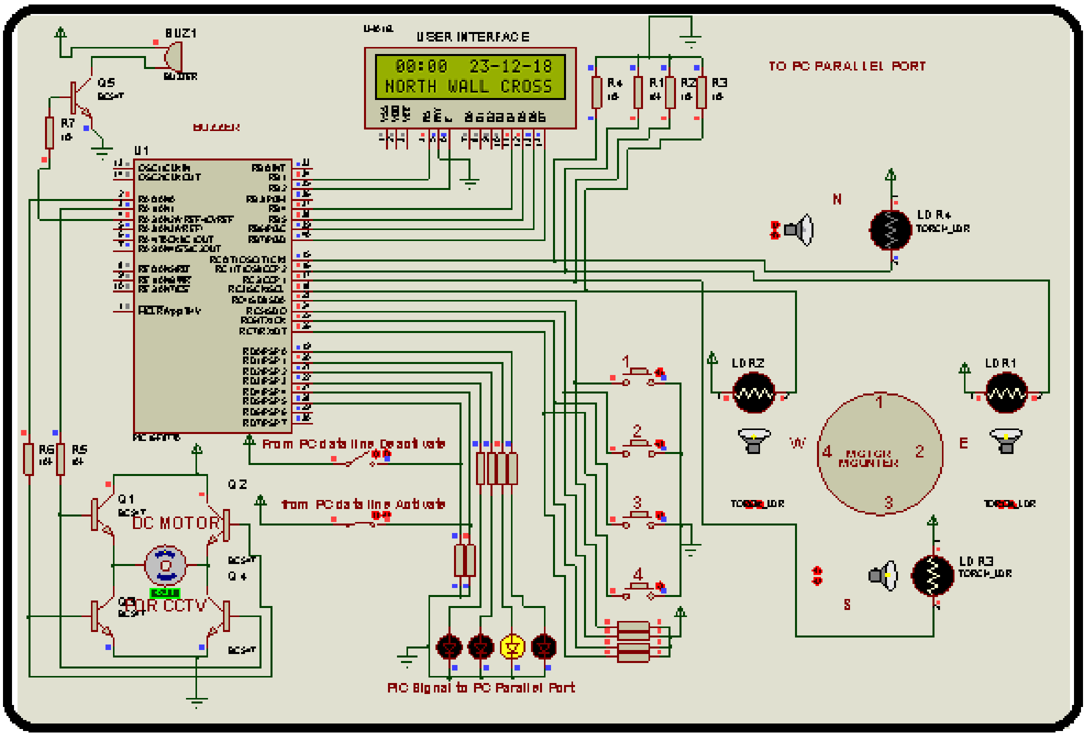


Fig. 13: North wall cross

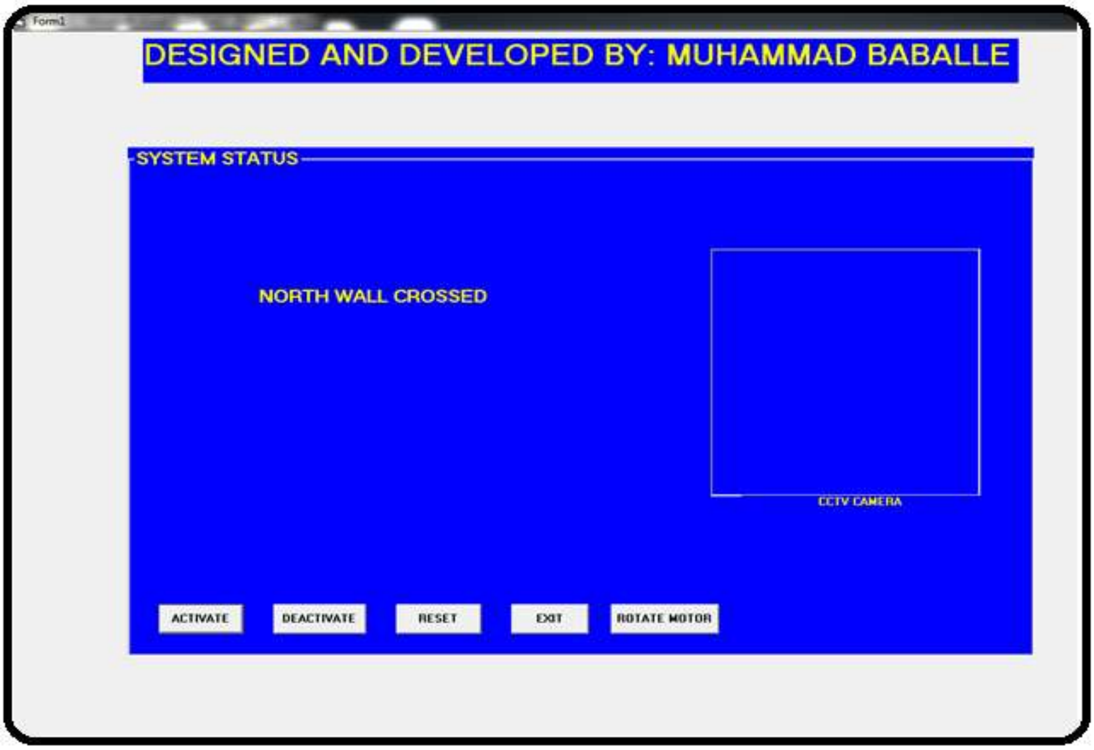


Fig. 14: From the personal computer north wall was crossed

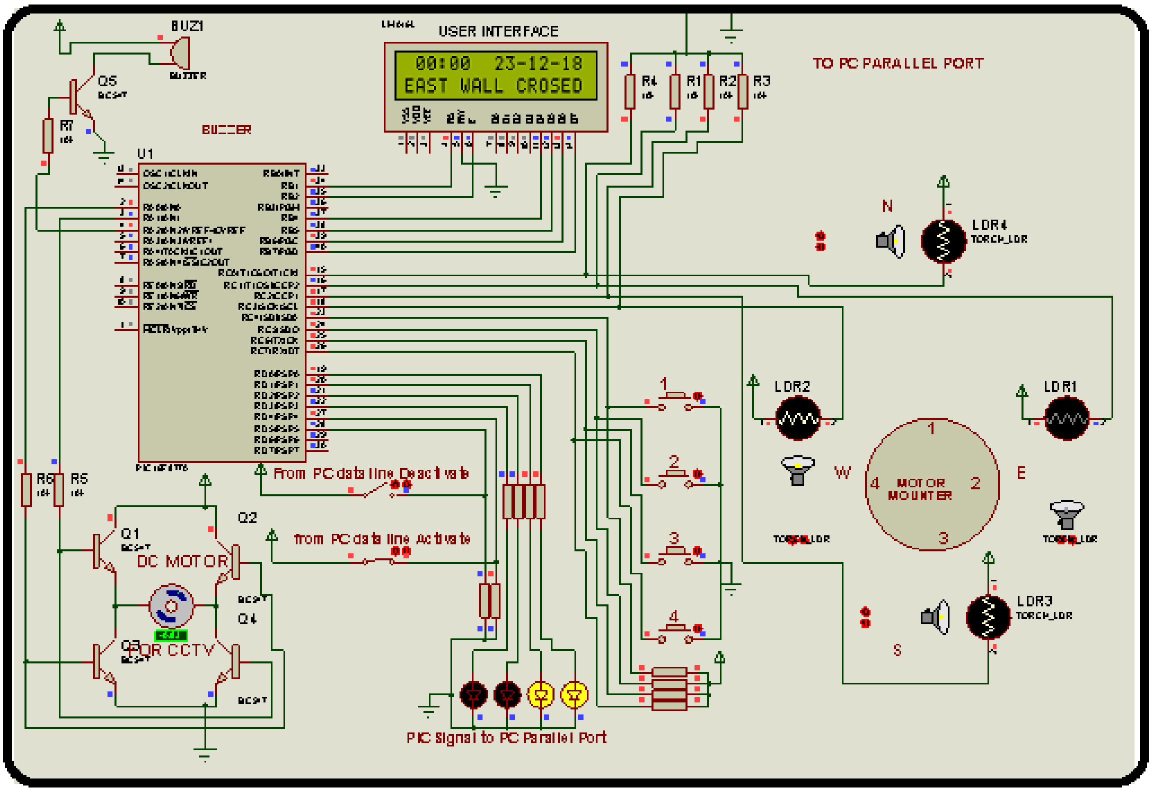


Fig. 15: East wall crossed

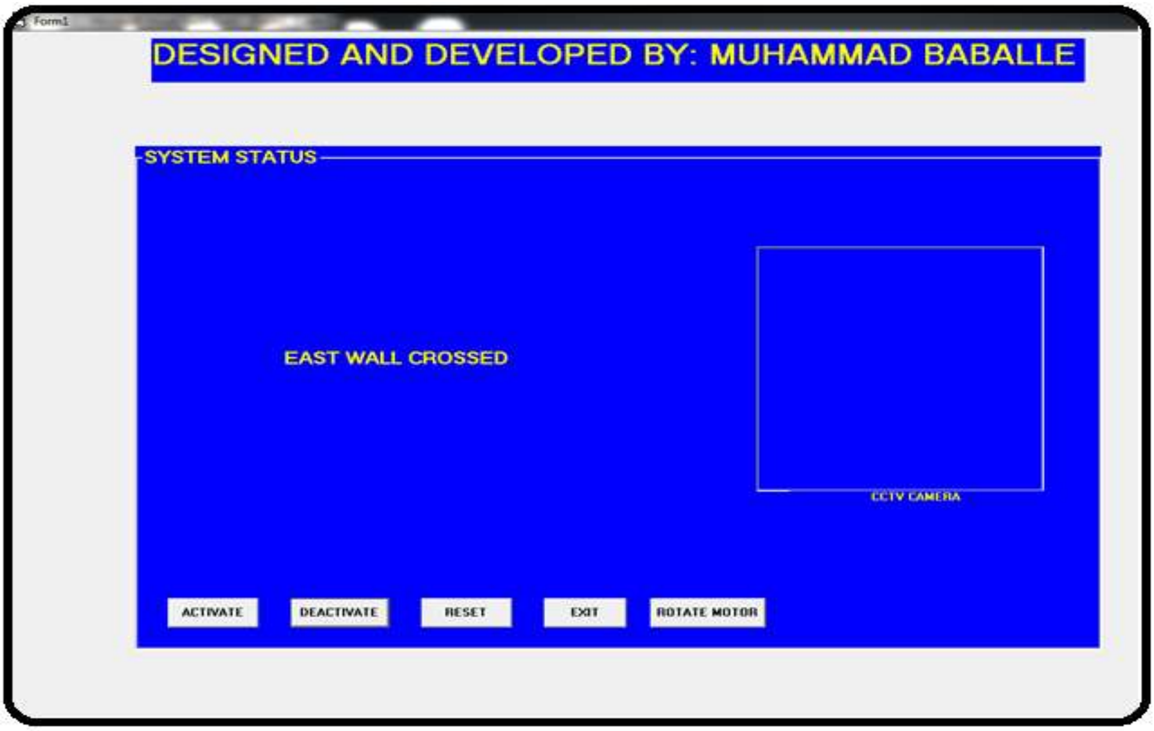


Fig. 16: From the personal computer east wall is crossed

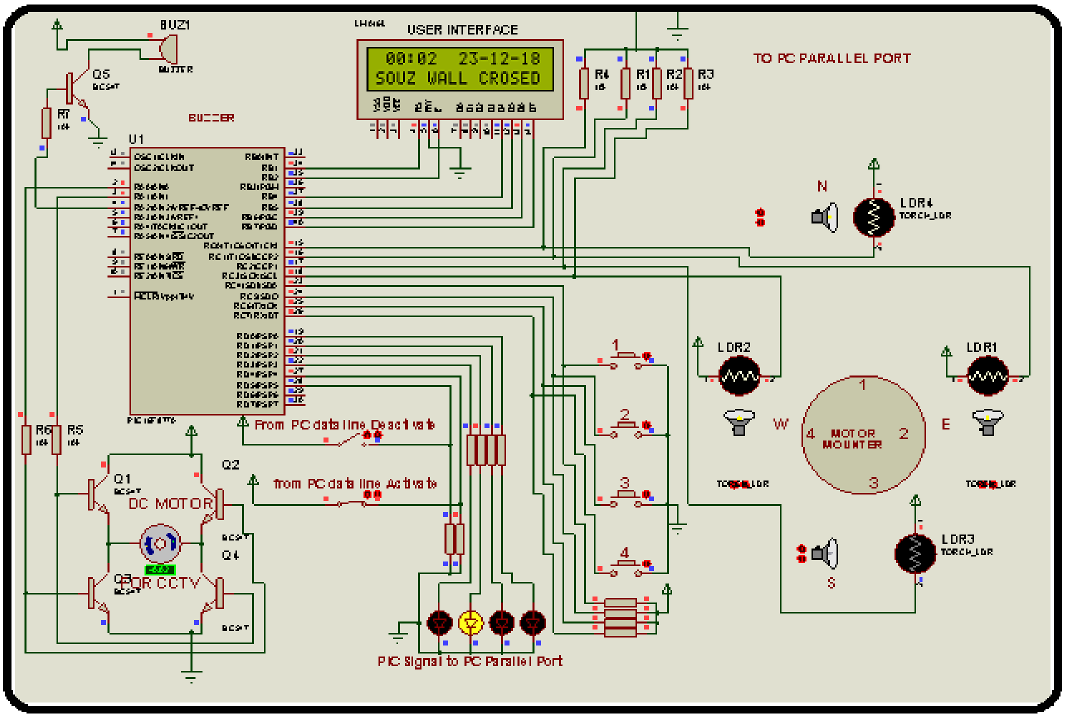


Fig. 17: South wall crossed

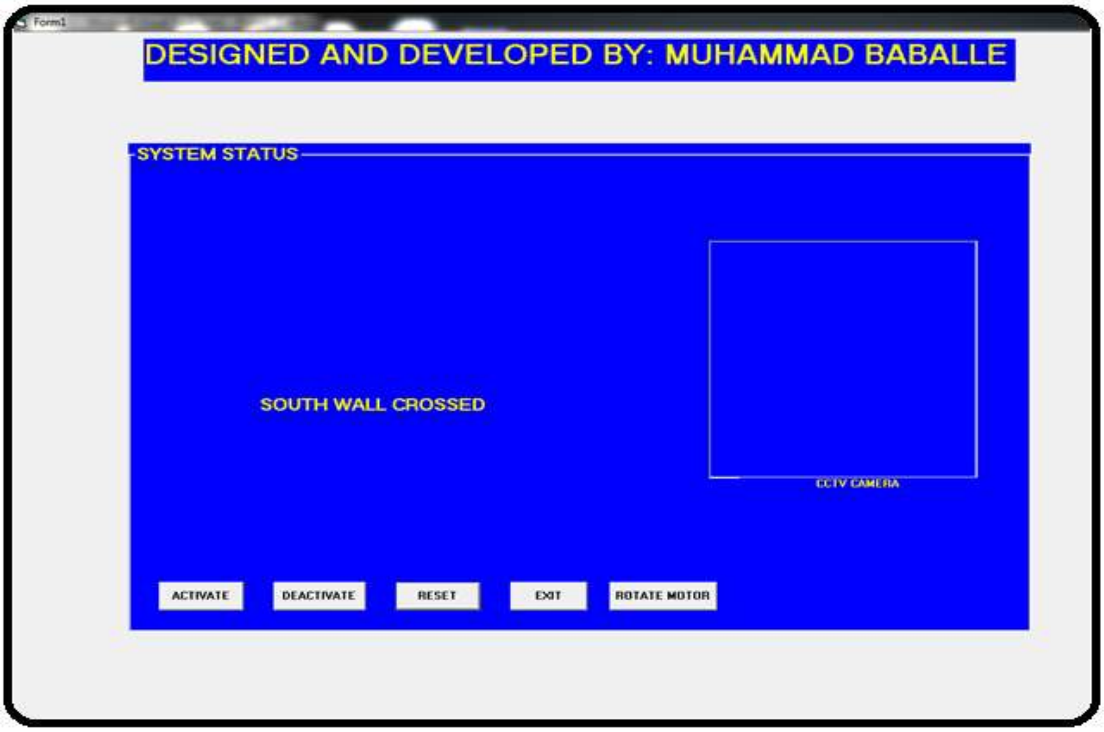


Fig. 18: From the personal computer south wall was crossed

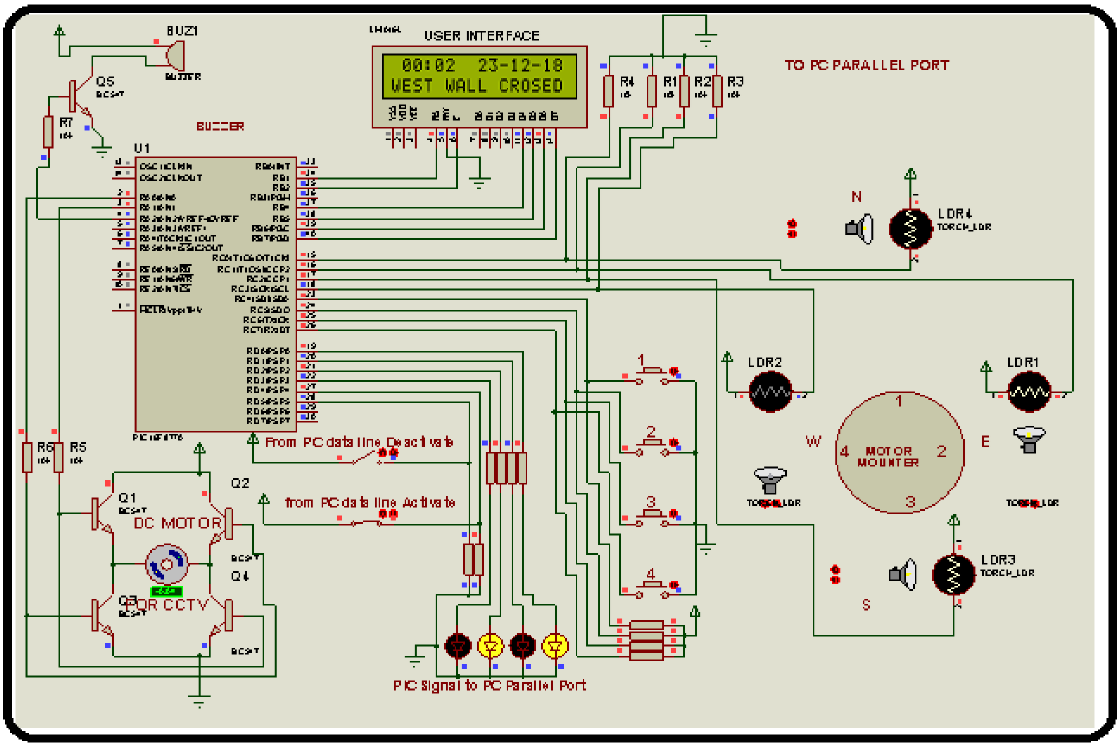


Fig. 19: West wall crossed

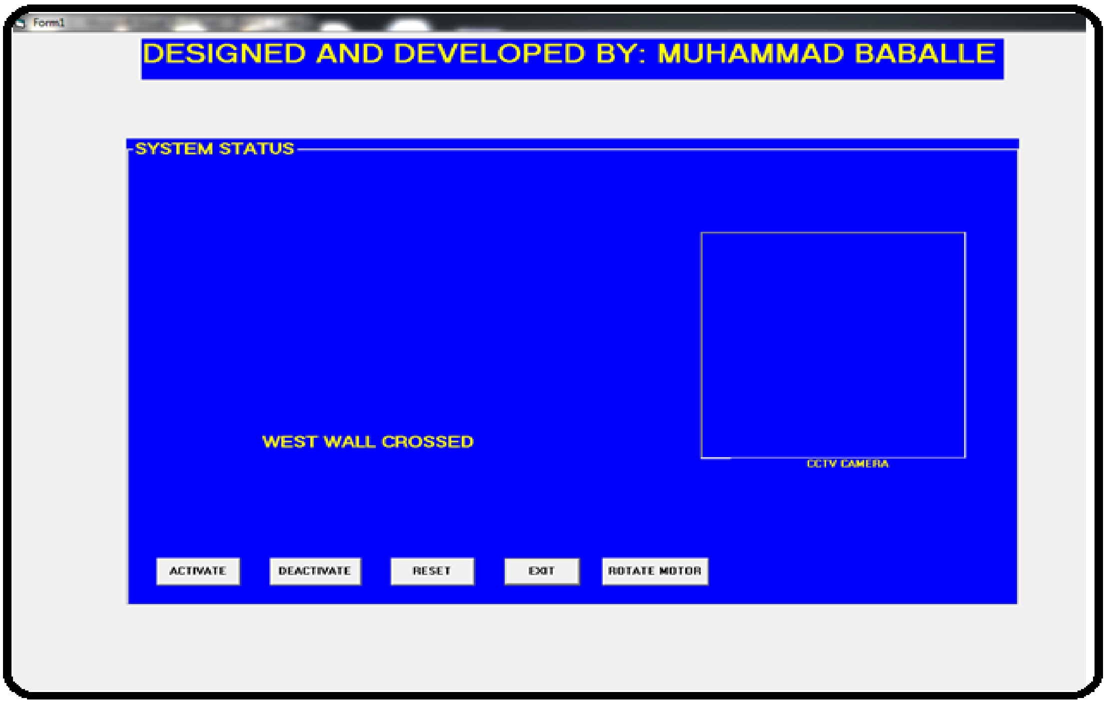


Fig. 20: From the personal computer west wall was crossed

Reliability testing of the components used to see if there are going to be reliable

The reliability of every system is very important. Especially a system like the one under consideration on which human life developed. In this section of the report will deals with how reliable this system will be seen. The reliability of a system falls within the range of 0 and 1or if calculated in percentage, within the range of 0% to 100%. It is not likely to have the extreme values of either 0 or 1 but lies between two extreme values.
The reliability assessment procedure consists of the following:

1. List of component parts of the equipment,
2. State the basic failure rate for each part,
3. Multiply by the number of similar parts,
4. Multiply by all available weighting factors,
5. Add up all the products from steps (1) through (4) to give overall failure rate,
6. Determine the equipment reliability R, for a given operating time t, using the expression, R = e-πt

Table IV: Reliability table for the system showing the individual failure rates of the components and their weighting factors

Component	**Number used**	**Basic failure rate,λi (%/10^{-3}hrs)**	**Weighting factor due to the environment**	**Weighting factor due to temperature**	**Weighting factor due to W_r**	**Overall failure rate, λoi**
Resistor	17	0.003	1.0	1.5	1.0	0.0765
LCD	1	0.02	1.0	1.5	1.0	0.03
PIC	1	0.02	1.0	1.5	1.0	0.03
LDR	4	0.002	1.0	1.5	1.0	0.012
Buzzer	1	0.002	1.0	1.5	1.0	0.003
Transistor	5	0.03	1.0	1.5	1.0	0.225
Oscillator	1	0.005	1.0	1.5	1.0	0.0075
LED	4	0.01	1.0	1.5	1.0	0.06
Connection	36	0.001	1.0	1.5	1.0	0.054

The overall failure rate of the system is the summation of the failure rates, λoi is given by
$\sum \lambda oi = \lambda T = 0.0765 + 0.03 + 0.03 + 0.012 + 0.003 + 0.225 + 0.0075 + 0.06 + 0.054$
= 0.498%/1000hrs = 0.498 = =4.98
For the operating time of one year, that is 365 days
t = 24hrs x 365 = 8760
Therefore, the failure rate of the device for a year, λT t = 4.98 8760 = 0.0436
The reliability, R(t) =e^(-λ_T×t)=e^(-0.0436)= 95.73%. From the value obtained, it can be seen clearly that the system would be quite reliable under favorable conditions and is going to be dependable for its operation.

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V. CONCLUSION

In this research, it has been seen that the simulation model of both the personal computer and Proteus works successfully without any basic error. So this research can be applied in the practical field. Besides the cost of this research is not too much expensive and the whole system is found to be reliable. Here the one closed-circuit television has provided utmost security than using four closed-circuit television mounted on each wall, so you can see it is quite impossible for any intruder to enter the secured environment without concern of the house owner. Some features can still be added for further research like triangular security system instead of using four LDR and LED you can use three in other to minimize the cost, SMS notification can also be added in case if an intruder enters the secured environment instead of to sound an alarm it will automatically send an SMS to the house owner. The operation of the complete research was simulated and expected results were obtained. Also after conducting reliability tests, the system was seen to be sufficiently reliable and capable of performing its function. With the introduction of the personal computer, you can activate, deactivate, reset and rotate the closed-circuit television of the whole simulation without only using the proteus circuit. Therefore, it can be concluded that the aim of this research has been achieved, which is a simulation of a security system against any kind of intrusion.

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