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School of Electrical and Nuclear
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Motion Detector Circuit

دائرة كشف الحركة

**A Project Submitted in Partial Fulfillment for the Requirements of the
Degree B.Sc. (Honor) in Electrical Engineering**

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الآية

قال الله تعالى:

أَمَّنْ هُوَ قَانِتٌ آنَاءَ اللَّيْلِ سَاجِدًا وَقَائِمًا يَحْذَرُ الْآخِرَةَ وَيَرْجُو رَحْمَةَ رَبِّهِ ۖ قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ ۚ إِنَّمَا يَتَذَكَّرُ أُولُو الْأَلْبَابِ ﴿٩﴾

سورة الزمر

DEDICATION

To whom god enthrones with dignity and prestige ... to whom taught me tender without waiting ... to whom I carry his name proudly.

Dear father

To my angel in life ... to the meaning of love ... to the meaning of compassion and dedication ... to the secret of living and the smile of laugh.

To whom her prayers where the secret of my success and her affection cure my pain ... to the dear of the dearest.

Beloved mother

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ABSTRACT

Nowadays, there are many types of house controlled system which is too expensive and difficult to use. For that reason, an effective house controlled system at low cost is built where user can also program the system by their own. Sensor is considered from the major component in this circuit so should be known the definition, types and applications of each type. Also microcontroller, switches, fans, LEDs and LCD were used for different purposes to fulfill circuit operation.

So we found the passive infrared sensor and temperature sensor are an input components. While indicators LEDs, ventilation system, and LCD display are the output components, where it's all controlled by controller circuit, we used all this components to design our model.

المستخلص

في هذه الايام، هناك انواع عديدة من انظمة التحكم المكلفة والتي يصعب استغلالها. ولهذا السبب، تم بناء نظام رقابة منزلي فعال بتكلفة منخفضة حيث يمكن للمستخدم برمجة النظام بانفسهم. يعتبر المحساس من المكونات الأساسية في هذه الدائرة لذا يستوجب ذلك معرفة تعريف وأنواع وتطبيقات كل نوع. كما لابد من استخدام متحكم مصغر ومفاتيح ومرواح وثنائي الباعث الضوئي وشاشة LCD لتحقيق أغراض مختلفة لتشغيل الدائرة. لذا نجد أن محسّاسي الحرارة والأشعة تحت الحمراء هما مكونات الإدخال في حين نظام التهوية والإضاءة وشاشة LCD هي عناصر الإخراج، حيث كل المكونات تسيطر عليها وحدة التحكم، وتم استخدام كل هذه المكونات لتصميم النموذج.

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LIST OF ABBREVIATIONS

PIR	Passive Infra-Red
LM	Liner Monolithic
DC	Direct Current
ULN	Universal linear
LCD	Liquid Crystal Display
TTL	Transistor Transistor Logic

CHAPTER ONE

INTRODUCTION

The use of motion detectors goes back to ancient societies that developed agriculture. Modern motion detection of people and things can be traced back to the early decades of the 20th century, with many of the same principles still in use today. The first motion detector that acted as a burglar alarm was invented in the early 1950s by Samuel Bagno. Bagno applied the fundamentals of radar to ultrasonic waves, a frequency that humans cannot hear, to detect a thief or a fire. Bagno's motion detector also made use of the Doppler Effect, the difference in the frequency of waves of a moving object, like a train sounding louder as it gets closer.

Today's motion sensors work on some of the same basic principles that Samuel Bagno's motion detector employed. Microwave and infrared sensors still detect motion by distortions in the frequencies they emit. However, new motion detectors like microwave sensors can now be placed behind bookshelves and other barriers while still covering a wide radius.

1.2 Problem Statement

Since of the beginning of the time until now people are trying to make their life easier, less dangerous and reduce the time needed to do any of their life needs, let us take manufacturing field for example, its time and money wasting to use human workers in a product line than to dedicate a machine that can do the same function and even more accuracy could be achieved, also machines have higher reliability, because they will just stick on the program or methodology they were given unlike people who they are susceptible to Mistakes, tiredness and other human needs and feelings. PIR could be used instead of human workers to detect the product carried by a conveyor belt for example and stop the conveyor for specific time to do some processes on the

product. PIR could also be used in security to detect the motion of a thief and give an earlier warning to the house holder in order he can call the police. There are many and many other uses for PIR to serve the human comfort ability and save their time, money and life.

1.3 Objectives

This project design aims to:

- Detect human movement in specified area.
- Design a motion detector circuit with low cost and low power consumption.

1.4 Methodology

To achieve the objectives of this study the following will be performed:

- Designing the circuit and connecting it with the model.
- Building the code required to load in the microcontroller (see APPENDIX A).
- Testing the circuit and adjust it with required results.

1.5 Project layout

This project is divided into five chapters. Chapter one is about the introduction, problem statement, objectives and methodology. Chapter two represents definition of the sensors in general. Chapter three describes hardware implanted to control the room lighting and ventilation systems using Atmega16. Chapter four consists of an introduction, components role and the circuit operation. Finally chapter five presents the conclusion and the future recommendations.

CHAPTER TWO

SENSORS

2.1 Introduction

A sensor is a device that converts a physical phenomenon into an electrical signal. As such, sensors represent part of the interface between the physical world and the world of electrical devices, such as computers. The sensor's output signal may be in the form of voltage, current, or charge. These may be further described in terms of amplitude, polarity, frequency, phase, or digital code. This set of characteristics is called the output signal format. Any sensor is an energy converter. No matter what you try to measure, you always deal with energy transfer from the object of measurement to the sensor. The process of sensing is a particular case of information transfer, and any transmission of information requires transmission of energy [1].

2.1 Sensor Classification

Sensor classification schemes range from very simple to the complex. Depending on the classification purpose, different classification criteria may be selected [1].

2.1.1 Passive and active

A passive sensor does not need any additional energy source and directly generates an electric signal in response to an external stimulus. That is, the input stimulus energy is converted by the sensor into the output signal. The examples are a thermocouple, photodiode, and a piezoelectric sensor. Most of passive sensors are direct sensors. The active sensors require external power for their operation, which is called an excitation signal. That signal is modified by the sensor to produce the output signal. The active sensors sometimes are called parametric because their own properties change in response to an external effect and these properties can be subsequently converted into electric signals [1].

2.1.2 Absolute and relative

An absolute sensor detects a stimulus in reference to an absolute physical scale that is independent of the measurement conditions, whereas a relative sensor produces a signal that relates to some special case. An example of an absolute sensor is a thermistor, a temperature-sensitive resistor. Another very popular temperature sensor thermocouple is a relative sensor [1].

2.2 Sensor characteristics

Sensors have many characteristics, some of them as follows:

2.2.1 Transfer Function

The transfer function shows the functional relationship between physical input signal and electrical output signal. The input–output relationship may be expressed in the form of a table of values, a mathematical formula, or as a solution of a mathematical equation also this relationship is represented as a graph in Figure 2.1.

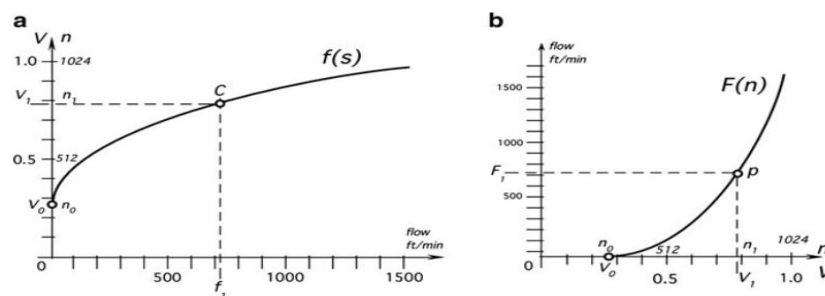


Figure 2.1: Transfer function (a) and inverse transfer function (b) of a thermo-anemometer

2.2.2 Sensitivity

The sensitivity is defined in terms of the relationship between input physical signal and output electrical signal. It is generally the ratio between a small change in electrical signal to a small change in physical signal. As such, it may be expressed as the derivative of the transfer function with respect to physical signal. Typical units are volts/Kelvin, mill volts/kilopascal, etc. A thermometer would have “high sensitivity” if a small temperature change

resulted in a large voltage change.

2.3 Types of sensors

There are many types of sensors as follow:

2.3.1 Ultrasonic detectors

These detectors as in Figure 2.2 are based on transmission to the object and receiving the reflected acoustic waves. Transmission and reception of ultrasonic energy is a basis for very popular ultrasonic range meters, and velocity detectors. Ultrasonic waves are mechanical acoustic waves covering frequency range well beyond the capabilities of human ears, i.e. over 20 kHz. However, these frequencies may be quite perceptive by smaller animals, like dogs, cats, rodents, and insects. When the waves are incident on an object, part of their energy is reflected. In many practical cases, the ultrasonic energy is reflected in a diffuse manner. That is, Regardless of the direction where the energy comes from, it is reflected almost uniformly within a wide solid angle, which may approach 180°. If an object moves, the frequency of the reflected wavelength will differ from the transmitted waves. This is called the Doppler Effect [1].



Figure 2.2: Ultrasonic detector

2.3.2 Microwave motion detectors

The microwave detectors as in Figure 2.3 offer an attractive alternative to other detectors when it is required to cover large areas and to operate over an extended temperature range under the influence of strong interferences, such as wind, acoustic noise, fog, dust, moisture, and so forth. These detectors (sensors) belong to the active sensors as they provide an excitation signal. That is, they

emit pulses of the electromagnetic energy. Thus they can operate at day or night and do not rely on the external sources of energy. The operating principle of a microwave detector is based on radiation of electromagnetic Radio Frequency (RF) waves toward a protected area. The electromagnetic waves backscattered (reflected) from objects whose sized are comparable with or larger than the wavelength of the excitation signal. The reflected waves are received, amplified, and analyzed. A time delay between the sent (pilot) signal and received reflected signal is used to measure distance to the object, while the frequency shift is used to measure speed of motion of the object. The microwave detectors belong to the class of devices known as radars. Radar is an acronym for Radio Detection and Ranging.



Figure 2.3: Microwave motion detector

2.3.3 Tribo-electric detectors

Any object can accumulate, on its surface, static electricity. These naturally occurring charges arise from the tribo-electric effect, which is a process of charge separation due to object movements, friction of clothing fibers, air turbulence, atmosphere electricity, etc. we can see examples of tribo-electric detectors as in Figure 2.4 [1].



Figure 2.4: Example of Tribo-electronic detector

2.3.4 Optoelectronic motion detectors

The most popular intrusion sensors are the optoelectronic motion

detectors. They rely on electromagnetic radiation in the optical range, specifically having wavelengths from 0.4 to 20mm. This covers the visible, near, and part of far Infra-Red (IR) spectral ranges. The detectors are primarily used for indication of movement of people and animals. They operate over distances ranging up to several hundred meters and, depending on the particular need, may have either a narrow or wide field of view. The operating principle of the optical motion detectors is based on detection of light (either visible or infrared) reflected or emanated from surface of a moving object into the surrounding space [1].

2.3.5 Passive Infra-Red motion detectors

The passive infrared (PIR) motion detectors as shown in Figure 2.5 became very popular for the security and energy management systems. The PIR sensing element is responsive to mid-and far-infrared radiation within a spectral range from approximately 4 to 20micrometer where most of the thermal power emanated by humans is concentrated (surface temperatures ranging from about 28 to 37). There are three types of sensing elements that are potentially useful for that detector: bolometers, thermopiles, and pyro-electrics [1].



Figure 2.5: PIR

CHAPTER THREE

CIRCUIT COMPENENTS

3.1 Microcontroller

A Microcontroller is a small computer on a single integrated circuit (IC) consisting a processor core, memory, and programmable input/output peripherals. Microcontrollers generally can be classified into 8-bit, 16-bit, and 32-bit Family based on the size of their arithmetic and index register(s). It generally consists of Read Only Memory (ROM), Random Access Memory (RAM) , Stack Pointers , Registers , Accumulator , Timers , Input / Output Ports , Analog to Digital Converter (ADC) , Digital to Analog Converter (DAC) , UART or SPI (for communication purposes). Some have special built in features that comes with Liquid Crystal Display Driver (LCD) that will enable them to drive LCD displays, EEPROM (Electrical Erasable Programmable Read Only Memory) which is a non-volatile memory that will enable to store data permanently.

It can be implemented using high level language or assembly language. Clock speed determines how much processing can be accomplished in a given amount of time by the MCU. Some have a narrow clock speed range. Sometimes a specific clock frequency is chosen to generate another clock required in the system, e.g. for serial baud rates. Generally the higher clock frequencies, the higher the system costs because not only does it cost more, but so do all the support chips required, such as RAMs, ROMs and bus drivers [2].

The advantages of microcontroller are that all MCUs have on chip resources to achieve a higher level of integration and reliability at a lower cost. An on chip resource is a block of circuitry built into the MCU which performs some useful function under control of the MCU. Built in resources increase reliability because they do not require any external circuitry to be working for the resource to function. They are pre-tested by the manufacturer and conserve board space

by integrating the circuitry into the MCU [2].

Other built-in resources may include computer operating properly (COP) watchdog system which can be hardware or software based. Microcontroller have got faster speed of execution than that of microprocessor. Also because of microcontroller embedded system got on the peak of its development to make new electronic devices. Disadvantage of microcontroller is a microcontrollers have got more complex architecture than that of microprocessors so to understand its functionality is quite difficult. The main block diagram of the microcontroller is represented in Figure 3.1.

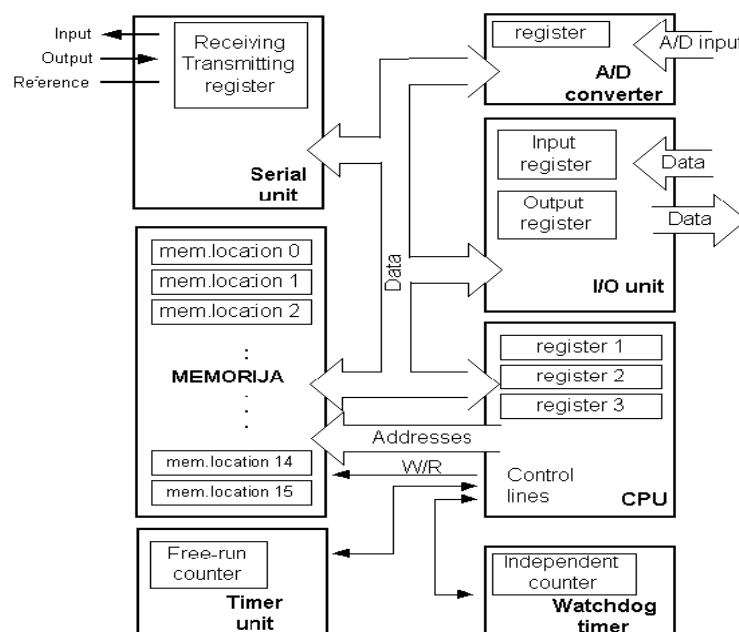


Figure 3.1: Microcontroller basic connection

3.1.1 The PIC microcontrollers family

The PIC microcontroller is a family of microcontrollers manufactured by the Microchip Technology Inc. Currently the PIC is one of the most popular microcontrollers used in education, and in commercial and industrial applications. The family consists of over 140 devices, ranging from simple 4-pin dual in-line Even though the family consists of a large number of devices; all the devices have the same basic structure, offering the following fundamental features [3]:

- Analog input channels.
- Analog comparators.
- Serial USART.
- Nonvolatile EEPROM memory.
- Additional on-chip timers.
- External and internal (timer) interrupts.
- PM output.
- USB interface.
- LCD interface.

3.1.2 AVR microcontrollers family

The architecture of the AVR microcontrollers was designed together with C-language experts to ensure that the hardware and software work hand-in-hand to develop a highly efficient, high performance code. To optimize the code size, performance and power consumption, AVR microcontrollers have big register files and fast one-cycle instruction. The family of AVR microcontrollers includes differently equipped controllers from a simple 8-pin microcontroller up to a high-end microcontroller with a large internal memory. The Harvard architecture addresses memories up to 8 MB directly. The register file is "dual mapped" and can be addressed as part of the on-chip SRAM, whereby fast context switches are possible. [4]

Atmega AVR microcontrollers (MCUs) are the ideal choice for designs that need some extra muscle. For applications requiring large amounts of code, atmega AVR devices offer substantial program and data memories with performance up to 20 MIPS. Meanwhile, all atmega AVR devices offer self-programmability for fast, secure, cost-effective in-circuit upgrades. You can even upgrade the Flash memory while running your application. Based on proven, industry-leading technology, the atmega AVR family offers our widest selection of devices in terms of memories, pin-counts and peripherals. These

include everything from general-purpose devices to models with specialized peripherals like Peripheral Touch Controller (PTC), USB, LCD controllers, LIN and Power Stage Controllers (PSC) [4].

- **At-mega16**

The Atmel ATmega16 is a register-based architecture. In this type of architecture, both operands of an operation are stored in registers collocated with the central processing unit (CPU). This means that before an operation is performed, the computer loads all necessary data for the operation to its CPU. The result of the operation is also stored in a register. During program execution, the CPU interacts with the register set and minimizes slower memory accesses. Memory accesses are typically handled as background operations [5]. The at-mega 16 has 40 pins and its description is shown in Figure 3.3:



Figure 3.2: Microcontroller at-mega 16 symbol

(XCK/T0) PB0	1	40	PA0 (ADC0)
(T1) PB1	2	39	PA1 (ADC1)
(INT2/AIN0) PB2	3	38	PA2 (ADC2)
(OC0/AIN1) PB3	4	37	PA3 (ADC3)
(SS) PB4	5	36	PA4 (ADC4)
(MOSI) PB5	6	35	PA5 (ADC5)
(MISO) PB6	7	34	PA6 (ADC6)
(SCK) PB7	8	33	PA7 (ADC7)
RESET	9	32	AREF
VCC	10	31	GND
GND	11	30	AVCC
XTAL2	12	29	PC7 (TOSC2)
XTAL1	13	28	PC6 (TOSC1)
(RXD) PD0	14	27	PC5 (TDI)
(TXD) PD1	15	26	PC4 (TDO)
(INT0) PD2	16	25	PC3 (TMS)
(INT1) PD3	17	24	PC2 (TCK)
(OC1B) PD4	18	23	PC1 (SDA)
(OC1A) PD5	19	22	PC0 (SCL)
(ICP1) PD6	20	21	PD7 (OC2)

Figure 3.3: at-mega 16 pins description

3.1.3 Microcontroller Hardware

It consist of:

- **Central Processing Unit**

The CPU consist of registers that are operate as memory locations whose role is to help with performing various mathematical operations or any other operations with data wherever data can be found.

- **Memory Unit**

Memory is part of the microcontroller whose function is to store data as shown in Figure 3.4. Memory consists of all memory locations. Control line is used in the following way: if read/write = 1, reading is done, and if opposite is true then writing is done on the memory location.

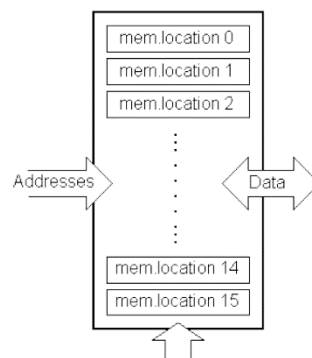


Figure 3.4: Memory unit

- **Input-output Unit**

The Input –Output unit are called "ports". There are several types of ports: input, output or bidirectional ports. When working with ports, first of all it is necessary to choose which port is needed to work with, and then to send data to or take data from the port. When working with it the port acts like a memory location. Something is simply being written into or read from it, and it could be noticed on the pins of the microcontroller.

- **Bus**

Physically it represents a group of 8, 16, or more wires there are two types of buses: address and data bus. The first one consists of as many lines as the amount of memory, and the other one is as wide as data. First one serves to transmit address from CPU memory, and the second to connect all blocks inside

the microcontroller, as shown in Figure 3.5.

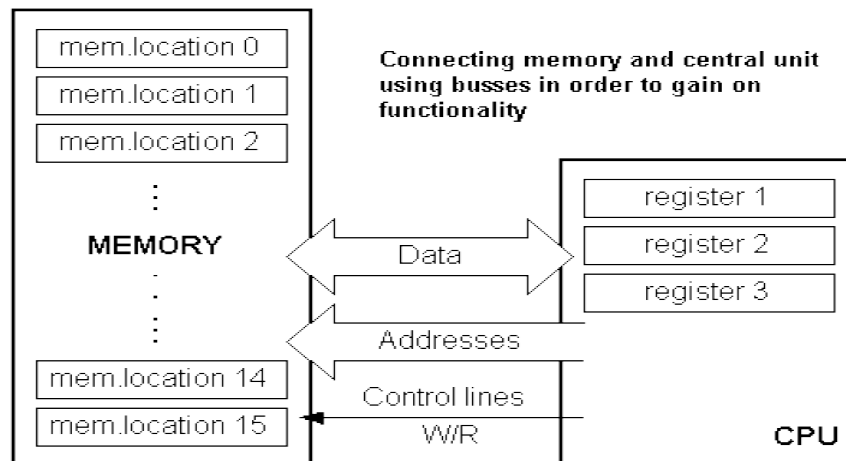


Figure 3.5: connecting memory and register using busses

- **Timer unit**

The timer block is significant unit because it can give us information about time, duration, protocol etc. The basic unit of the timer is a free-run counter which is in fact a register whose numeric value increments by one in even intervals, so that by taking its value during periods T1 and T2 and on the basis of their difference can determine how much time has elapsed. This is a very important part of the microcontroller which is shown in Figure 3.6.

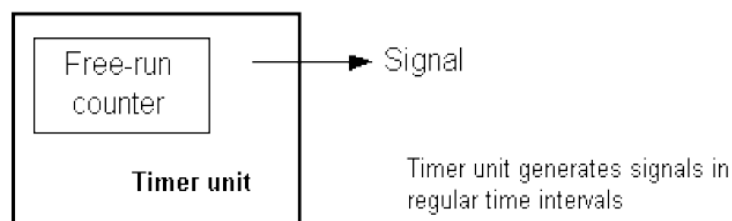


Figure 3.6: Timer unit

- **Analog to digital converter**

As the peripheral signals usually are substantially different from the ones that microcontroller can understand (zero and one), they have to be converted into a pattern which can be comprehended by a microcontroller. This task is performed by a block for analog to digital conversion or by an ADC. This block is responsible for converting an information about some analog value to a binary

number and for follow it through to a CPU block so that CPU block can further process it as shown in Figure 3.7 [6].



Figure 3.7: Analog to digital converter

3.2 LM 35

LM35 is a temperature sensor. It is a temperature-sensitive voltage source. Its output voltage increases by 10 mv for each 1°C increase in its temperature. Figure 3.8 shows the circuit connection for temperature sensor LM35. The voltage output from this circuit is connected to a negative reference voltage, V as shown, the sensor will give output for a temperature range of - 55 °C to 150 °C. The output is adjusted to 0 V for 0 °C. The output voltage can be amplified to give the voltage range you need for a particular application. The output voltage from LM35 can be applied to ADC and we can get digital equivalent of analog voltage corresponding to current temperature.

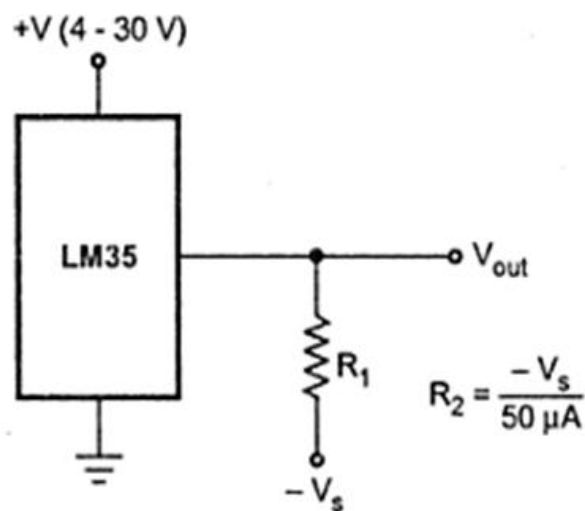


Figure 3.8 Circuit connection of LM35

Usually in electronic circuits, the bulky temperature sensors such as Thermistors are not preferred to be used. Instead we use LM35. It is a Semiconductor temperature sensor which operates with a -f5 volt DC on 0 V reference. The LM35 series of temperature sensors are rated to operate over a -55°C to 150°F temperature range. These sensors do not require any external Calibration and the output voltage is proportional to the temperature. The LM35 series are precision integrated-circuit temperature sensors, and its output voltage is linearly proportional to the Celsius temperature. It does not require any external calibration or trimming to provide typical accuracies of $\pm\frac{1}{4}^{\circ}\text{C}$ at room temperature and ($\pm\frac{3}{4}^{\circ}\text{C}$) over a full -55 to $\div 150^{\circ}\text{C}$ temperature range. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing Readout or control easily. In LM35 temperature sensor. If output is 300mV then the temperature is 30 degrees. It can be used with single or more power supplies and has very low self-heating that is less than 0.1°C because it only draws a 60 Micro Amper from its supply.

3.2.1 Working of LM35

LM35 is an analog sensor that converts the surrounding temperature to a Proportional analog voltage. The output from the sensor is connected to an analog to digital convertor to derive the equivalent temperature value in digital format. It has three pins shown in Figure 3.9 [6].

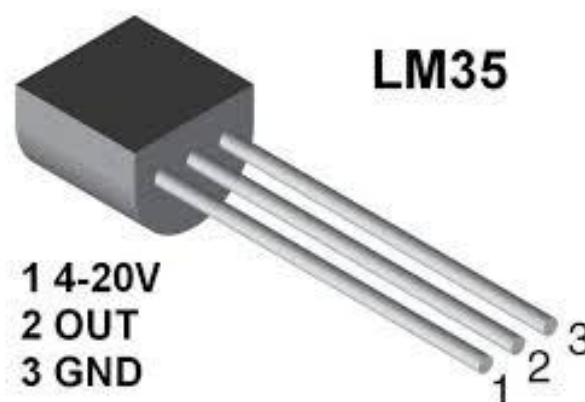


Figure 3.9: LM 35

3.3 Passive infrared sensor

PIR sensors are fundamentally made up of pyro-electric sensors .it can detects various levels of infrared radiation .PIR sensors are meanly used in application, involving detection of change in surrounding environment. PIR generally have three pins corresponding to ground, power supply, and output, respectively. Once the PIR gets calibrated to the static environment (which takes couple of seconds), the output remain is low , until a motion is detected .the settling time is attributed to the fact that the PIR sensor needs some times to study the pre-existing domain of nature . According to laws of thermal radiation, every object above 0c emits radiations of various wavelengths characteristic of each body .as the temperature of the material varies, the emitted wavelength of radiation also varies. Pyro-electric sensors respond due to a change in the radiation Incident upon them. They are designed to be most sensitive to the Wavelength. A key component of the (PIR) sensor is the Fresnel Len. This gives the PIR the ability to respond to radiation from a wider angle of positions as the lens effectively focuses the incident radiation to produce a series of “peaks” as an emitting body moves across the path of the lens [8]. Figure 3.10 shows the PIR symbol [7].



Figure 3.10: PIR symbol

3.4 Switches

As distinct from a linear circuit, in which the transistors and IC never saturate under normal operating conditions, the switching circuits, however, may

re-shape the signal and open the feedback loop during the operation, The major benefit of using such design is its extremely low power consumption and lower heat production that makes it popular for use in calculators, watches, satellites, and power sources. Such circuits are usually much smaller physically. They can provide large load currents at low voltages although they produce more electrical and audible noise. In addition, these circuits are somewhat more costly to produce. An ideal switch has no on-resistance, infinite off impedance and zero time delay, and can handle large signal and common-mode voltages. Real switches do not meet these criteria fully, but most of limitations can be overcome [8]. Figure 3.11 shows switch symbol.



Figure 3.11: switch symbol

- **Transistor switches**

Transistorized base bias is usually designed to operate in switching circuits by having either low output voltage or high output voltage. For this reason, variations in operating point do not matter, because the transistor remains in saturation or cutoff when the current gain changes. In figure 3.13 the transistor is in hard saturation when the output voltage is approximately zero. This means the Q point is at the upper end of the load line. When the base current drops to zero, Q point sets to the cutoff. Because of this, the collector current drops to zero. With no current, all the collector supply voltage will appear across the collector-emitter terminals. Therefore, the circuit can have only two output voltages: 0 or U_{CE} . That is why the switching circuits are often called two-state circuits, referring to the low and high outputs, and the operating devices of these circuits

are called switches [8]. Figure 3.12 shows transistor switches.

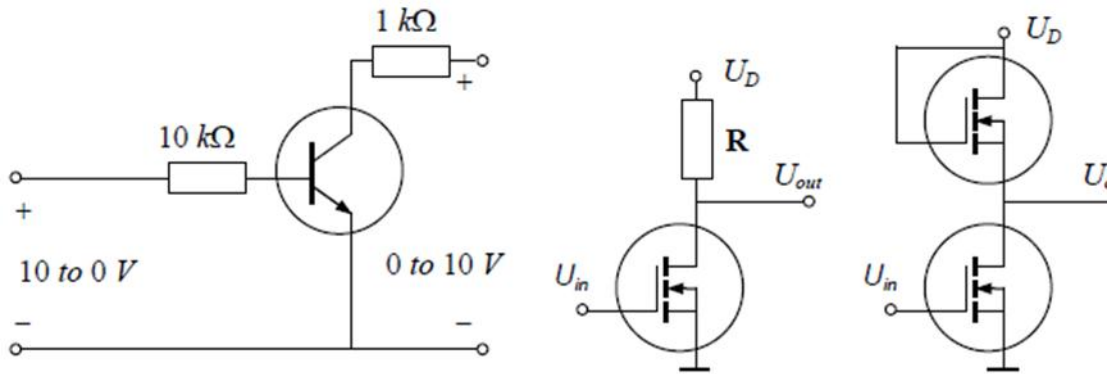


Figure 3.12: Transistor switches

3.5 Dc Motor

The DC motor is a mechanical workhorse that can be used in many different ways. Many large pieces of equipment depend on a dc motor for their power to move. The speed and direction of rotation of a dc motor are easily controlled. This makes it especially useful for operating equipment, such as winches, cranes, and missile launchers, which must move in different directions and at varying speeds [9].

3.5.1 Principles of operation

The operation of a DC motor is based on the following principle:

A current-carrying conductor placed in a magnetic field, perpendicular to the lines of flux, tends to move in a direction perpendicular to the magnetic lines of flux. There is a definite relationship between the direction of the magnetic field, the direction of current in the conductor, and the direction in which the conductor tends to move. This relationship is best explained by using the RIGHT-HAND RULE FOR MOTORS as shown in figure 3.13.

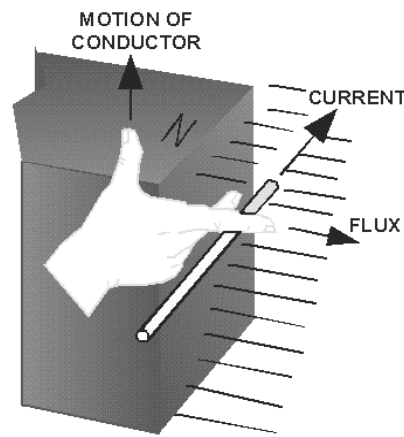


Figure 3.13: Right-hand rule for motors

To find the direction of motion of a conductor, extend the thumb, forefinger, and middle finger of your right hand so they are at right angles to each other. If the forefinger is pointed in the direction of magnetic flux (north to south) and the middle finger is pointed in the direction of current flow in the conductor, the thumb will point in the direction the conductor will move.

Stated very simply, a dc motor rotates as a result of two magnetic fields interacting with each other. The armature of a DC motor acts like an electromagnet when current flows through its coils. Since the armature is located within the magnetic field of the field poles, these two magnetic fields interact. Like magnetic poles repel each other, and unlike magnetic poles attract each other. As in the dc generator, the dc motor has field poles that are stationary and an armature that turns on bearings in the space between the field poles. The armature of a dc motor has windings on it just like the armature of a dc generator. These windings are also connected to commutator segments. A dc- motor consists of the same components as a dc generator. In fact, most dc- generators can be made to act as motors, and vice versa. Look at the simple dc motor shown in Figure 3.14. It has two field poles, one a North Pole and one a south pole. The magnetic lines of force extend across the opening between the poles from north to south.

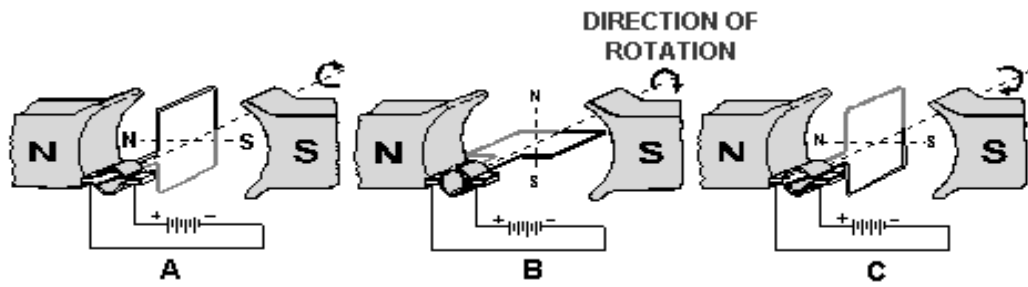


Figure (3.14) Dc motor armature rotation.

The armature in this simple dc motor is a single loop of wire, just as in the simple armature you studied at the beginning of the chapter on dc generators. The loop of wire in the dc motor, however, has (2-3) current flowing through it from an external source. This current causes a magnetic field to be produced. This field is indicated by the dotted line through the loops. The loop (armature) field is both attracted and repelled by the field from the field poles. Since the current through the loop goes around in the direction of the arrows, the north pole of the armature is at the upper left, and the south pole of the armature is at the lower right, as shown in Figure 3.14, (view A). Of course, as the loop (armature) turns, these magnetic poles turn with it. Now, as shown in the illustrations, the north armature pole is repelled from the north field pole and attracted to the right by the south field pole. Likewise, the south armature pole is repelled from the south field pole and is attracted to the left by the north field pole. This action causes the armature to turn in a clockwise direction, as shown in Figure 3.14 (view B).

After the loop has turned far enough so that its north pole is exactly opposite the south field pole, the brushes advance to the next segments. This changes the direction of current flow through the armature loop. Also, it changes the polarity of the armature field, as shown in figure 3.14 (view C). The magnetic fields again repel and attract each other, and the armature continues to turn.

In this simple motor, the momentum of the rotating armature carries the armature past the position where the unlike poles are exactly lined up. However,

if these fields are exactly lined up when the armature current is turned on, there is no momentum to start the armature moving. In this case, the motor would not rotate. It would be necessary to give a motor like this a spin to start it. This disadvantage does not exist when there are more turns on the armature, because there is more than one armature field. No two armature fields could be exactly aligned with the field from the field poles at the same time. [9]

3.5.2 Type of DC motors

Shunt, series, compound, and permanent magnet motors are all widely used. A shunt motor has the field circuit connected in shunt (parallel) with the armature, whereas a series motor has the armature and field circuits in series. A compound motor has both a shunt and a series field winding. A permanent magnet motor only has armature connections.

- **Shunt motors**

A shunt motor is basically a constant speed device. If a load is applied, the motor tends to slow down. The slight loss in speed reduces the CEMF and results in an increase of the armature current. This action continues until the increased current produces enough torque to meet the demands of the increased load. As a result, the shunt motor reaches a state of stable equilibrium because a change of load always produces a reaction that adapts the power input to the change in load. Applications of a shunt motor are [10]:

- For driving constant speed line shafting lathes
- Centrifugal pumps
- Blowers and fans (Figure 3.15)



Figure 3.15: DC motor fan

3.7 Universal Linear (ULN 2803)

The eight NPN Darlington connected transistors in this family of arrays are ideally suited for interfacing between low logic level digital circuitry (such as TTL) and the higher current/voltage as shown in Figure 3.16. Requirements of lamps, relays, printer hammers or other similar loads for a broad range of computer, industrial, and consumer applications. All devices feature open-collector outputs and freewheeling clamp diodes for transient suppression. The ULN2803 is designed to be compatible with standard TTL families while the ULN2804 is optimized for 6 to 15 volt high level CMOS or PMOS.

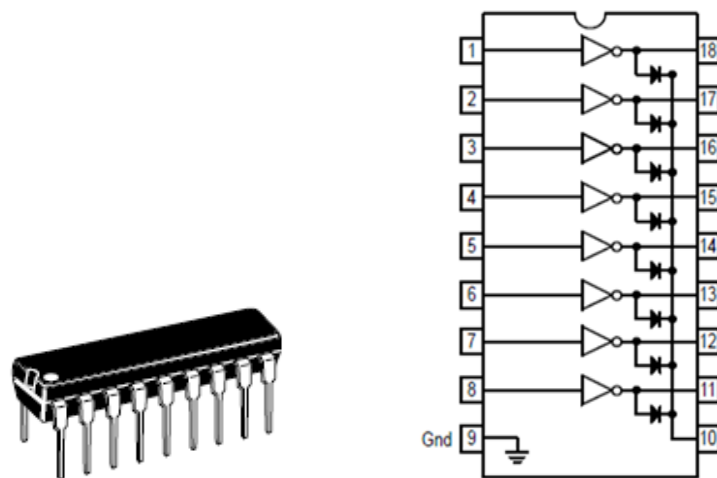


Figure 3.16: ULN symbol and pins description

3.7 Liquid Crystal Displays

The early 1970's, digital watches started showing up in the marketplace with a new and different type of display-the liquid crystal display or LCD. The LCD displays used in these early digital watches were very different from the LEDs they replaced. While even a tiny LED display consumes a few mill watts of power, the LCD consumes just microwatts of power. Hence, the LCDs are over 1000 times more efficient at their job than the LEDs. Since their commercialization in the '70s, LCDs are the most popular electronic display device, except one-the CRT. LCD flat full color panels are now challenging the CRT as displays for television and computers. There are also many hybrid systems that use LCD display technology. The 2 X16 Parallel LCD is an 8 bit parallel interfaced LCD shown in Figure 3.17. This unit allows the user to display text, numerical data and custom created characters [11]. The LCD has 16 pins and described in Table 3.1.



Figure 3.17: Parallel LCD (2 x16)

Table 3.1 LCD Pins out Description

Pin	Symbol	Description
1	GND	Ground
2	Vcc	Vcc (+5V) also powers backlight
3	V0	Contrast adjustment
4	RS	Register select: low = instruction, high = data
5	R/W	low = write, high = read
6	E	Enable (active high)
7	DB0	Data-bus bit 0 (not used in 4-bit mode)
8	DB1	Data-bus bit 1 (not used in 4-bit mode)
9	DB2	Data-bus bit 2 (not used in 4-bit mode)
10	DB3	Data-bus bit 3 (not used in 4-bit mode)
11	DB4	Data-bus bit 4
12	DB5	Data-bus bit 5
13	DB6	Data-bus bit 6
14	DB7	Data-bus bit 7
15	LED+	Positive backlight supply (if used)
16	LED-	Negative backlight supply (if used)

CHAPTER FOUR

APPLICATION

4.1 Introduction

Motion detectors have found wide use in domestic and commercial applications. One common application is activation of automatic door openers in businesses and public buildings. They are also widely used instead of a true occupancy sensor in activating street lights or indoor lights in walkways (such as lobbies and staircases). In such "Smart Lighting" systems, energy is conserved by only powering the lights for the duration of a timer, after which the person has presumably left the area. A motion detector may be among the sensors of a burglar alarm that is used to alert the home owner or security service when it detects the motion of a possible intruder. Such a detector may also trigger a security camera in order to record the possible intrusion. A motion detector is a device that detects moving objects, particularly people. It is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. They form a vital component of security, automated lighting control, home control, energy efficiency, and other useful systems.

4.2 Circuit Components

The circuit contains several electronic components:

4.2.1 Passive Infrared sensor

The function of the PIR sensor in this circuit is detecting any person enters the room .When a person passes in front of the PIR, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection.

4.2.2 Temperature sensor LM35

Temperature sensor is a device which senses variations in temperature across it. It give the readings in centigrade (degree Celsius) since its output voltage is linearly proportional to temperature. As temperature increases, the voltage across diode increases at known rate.

4.2.3 Microcontroller Atmega16

The function of the microcontroller is controlling and monitoring the lights and ventilation system (fan, air condition and heater) of the room according to the PIR sensor signal and the temperature sensor.

4.2.4 Liquid crystal display

A liquid-crystal display (LCD) is electronic visual display used to display the temperature and number of people inside the room.

4.2.5 ULN 2803

A ULN2803 is an Integrated Circuit (IC) chip with a High Voltage/High Current Darlington Transistor Array, the chip takes low level signals and acts as a relay of sorts itself, switching on or off a higher level signal on the opposite side.

4.2.6 DC fans

The DC fans are used as ventilation system.

4.2.7 Light emitted diode

We use the colored lights (red, yellow and green), as indicator for the operation situation of fans. And white LEDs for lighting system.

4.2.8 Switch

Switches are used to set or reset the modes (sleep, active)

4.3 Circuit Operation

Given a +5v to the circuit, the LCD displays “Welcome” and the room temperature based on the measurement of LM35. When PIR1 detects first, then PIR2 detects that means someone entered the room, in this case the light system

will turn ON and ventilation system will operate according to temperature sensor, (If room temperature less than 30 degree then red LED (indicator) and heater fan will turn on, and If room temperature more than 40 degree then green LED (indicator) and air condition will turn ON, otherwise yellow LED and normal fan will turn ON). If PIR2 detects first then PIR1 detects that means someone left the room the light and ventilation system will shut down.

When the SLEEP mode switch is pressed, the light system will turn OFF and the ventilation system remains the same according to temperature status .If another person enters the room while this mode is active one LED will turn ON and if this person exit, the light turns OFF. This mode is turned OFF if ACTIVE mode is pressed or the room became empty. (See Figure 4.1)

4.5 Practical Results

The program code (see Appendix A) loaded into Atmega16 microcontroller to do the specifications that are described in the methodology of circuit, and then it has been executed and achieved the object of our research.

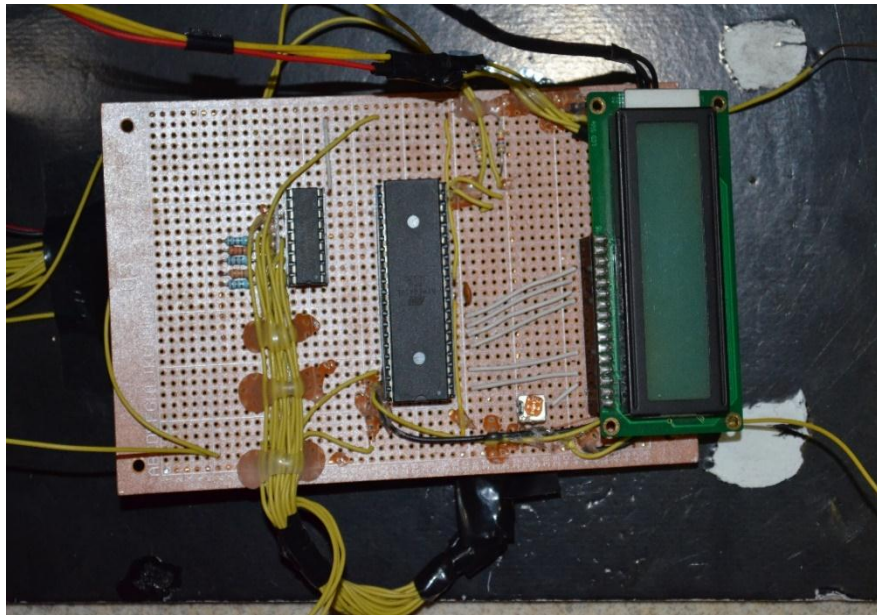


Figure 4.1 components connection and model

CHAPTER FIVE

CONCLUSION & RECOMMENDATIONS

5.1 CONCLUSION

The detection of human motion is done by developing an embedded system. This embedded system can be used for various applications like the home security system and home automations with slight modifications in software coding according to the requirements.

The motion detector practical circuit was designed by using several electronic components to detect human movement inside the room, and it was a low cost and a low power consumption.

5.2 RECOMMENDATIONS

After finishing this project we recommend:

- For more developing building a security system based on motion detection.
- Fixing the delay of PIR sensor; i.e. PIR sensor needs some time to calibrate itself, when connecting it with microcontroller.

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APPENDIX A

Bascom code to control the PIR circuit :

```
$regfile = "m16def.dat"
```

```
$crystal = 8000000
```

```
'////////////////////LCD Config////////////////////////////////////
```

```
ConfigLcd = 16 * 2
```

```
ConfigLcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 , Db7 =  
Portb.7 , E = Portb.2 , Rs = Portb.0
```

```
Cls
```

```
Cursor Off
```

```
Locate 1 , 4
```

```
Lcd "WELL COME"
```

```
Wait 1
```

```
Cls
```

```
Locate 1 , 1
```

```
Lcd "Please wait ..."
```

```
Wait 30
```

```
Cls
```

```
Config Pind.5 = Input 'SW
```

```
Config Pind.6 = Input 'SW
```

```
Config Portc.0 = Output 'FAN NORMAL
```

```
Config Portc.1 = Output 'FAN HOT
```

```
Config Portc.2 = Output 'FAN COOL
```

```
Config Portc.3 = Output 'LED W
```

```
Config Portc.4 = Output 'LED W
```

```
Config Portc.5 = Output 'LED R
```

```
Config Portc.6 = Output 'LED Y
```

Config Portc.7 = Output	'LED G
Config Pina.0 = Input	'pir
Config Pina.1 = Input	'pir

ConfigAdc = Single ,Prescaler = Auto , Reference = Avcc

Dim A As Byte

Dim B As Byte

Dim C As Byte

Dim Count As Byte

Dim D As Byte

Dim E As Byte

Dim T As Byte

Cls

C = 1

Do

T = Getadc(2)

T = T / 2

Locate 1 , 1

Lcd "temp = " ; T ; " C"

Wait 1

If Pina.0 = 1 And E = 0 Then

A = 1

Locate 2 , 1

Lcd "pir 0 +"

Wait 4

End If

If Pina.1 = 1 And A = 1 Then

A = 0

```
D = 1
Incr Count
B = 1
Locate 2 , 1
Lcd "pir1 " ;
Locate 2 , 9
Lcd "No. " ; Count
If C = 1 Then
Portc.3 = 1
Portc.4 = 1
End If
```

```
Wait 4
Locate 2 , 1
Lcd "    "
End If
```

```
If T > 40 And B = 1 Then
Portc.7 = 1
Portc.2 = 1
Else
Portc.7 = 0
Portc.2 = 0
End If
```

```
If T >= 30 And T <= 40 And B = 1 Then
Portc.0 = 1
Portc.6 = 1
Else
```

Portc.0 = 0

Portc.6 = 0

End If

If T < 30 And B = 1 Then

Portc.1 = 1

Portc.5 = 1

Else

Portc.1 = 0

Portc.5 = 0

End If

If Pind.5 = 1 Then

C = 1

Portc.3 = 1

Portc.4 = 1

End If

If Pind.6 = 1 Then

C = 0

Portc.3 = 0

Portc.4 = 0

End If

If C = 0 And Count > 1 Then

Portc.3 = 0

Portc.4 = 1

End If

```
If C = 0 And Count = 1 Then
Portc.3 = 0
Portc.4 = 0
End If
```

```
If Pina.1 = 1 And D = 1 Then
E = 1
Locate 2 , 1
Lcd "pir 0 -"
Wait 4
End If
```

```
If Pina.0 = 1 And E = 1 Then
E = 0
If Count > 0 Then
Decr Count
Locate 2 , 9
Lcd "No. " ; Count
Wait 4
Locate 2 , 1
Lcd "    "
End If
```

```
If Count = 0 Then
B = 0
Portc.0 = 0
Portc.1 = 0
Portc.2 = 0
Portc.3 = 0
```

Portc.4 = 0

Portc.5 = 0

Portc.6 = 0

Portc.7 = 0

C = 1

End If

End If

Loop

APPENDIX B

Circuit connection using proteus:

