Chapter one

INTRODUCTION

1.1 General

In the world where everything can be controlled and operated on its own, but still there are some important sectors where automation has not been adopted, because of several reasons such as cost. One such field is that of agriculture, it is the primary occupations of man since beginning. Greenhouses form an important part of the agriculture and horticulture sectors greenhouses can be used to grow plants under controlled climatic conditions for maximizing the crop yield. Automating a greenhouse includes monitoring and controlling of the climatic parameters which directly or indirectly govern the plant growth and hence their produce. Automation is process control of industrial machinery and processes, thereby replacing human operators.

1.2 Problem Statement

Early greenhouse control was as simple as pulling a chain to open or close a vent, turning a valve to control heat or irrigation, or throwing a switch to activate a pump or fan. Over the years this evolved as greenhouse systems themselves became more complex and more reliable. Early automated control consists of independent thermostats, humidistats, and timers. Even these simple devices allowed major advances in efficiency and product quality and made grower's lives simpler. However, many of these control devices and methods cannot deliver the level of automation and efficiency needed in today's dynamic and competitive environment

1.3 Objectives

The main objectives of this study are to:-

- Improve the control product ability system of the greenhouse.

- Design a control system for a greenhouse using microcontroller.
- Implementation of control system for a greenhouse using microcontroller.

1.4 Methodology

To achieve the objectives of the proposed research, the research is divided to small tasks as follow:

- Collect information about sensors and microcontroller to choose which is better.
- Study of all previous related work.
- Use of Atmega16 microcontroller as a main controller for the system.
- Use of BASCOM Software to program the microcontroller
- Simulate the system by using PROTEUS – SOFWARE

1.5 Layout

This thesis consists of six chapters. Chapter one gives an introduction to the work. Chapter two concentrates on the theoretical background and literature review. Chapter three presents the experimental work (design of control circuit). Chapter four discusses the real system simulation and the results using PROTUES software .Chapter five implementation and testing. Chapter six gives the conclusion and provides the future work in this area.

Chapter Two

THEORTICAL BACKGROUND AND LITERATURE REVIEW

2.1 Introduction

A greenhouse is a structure with different types of covering materials, like glass or plastic roof and frequently glass or plastic walls; it heats up because incoming visible solar radiation from the sun is absorbed by plants, soil, and other things inside the building. Glass is transparent to this radiation. The warmed structures and plants inside the greenhouse re-radiate this energy in the infra-red, to which glass is partly paque , and that energy is trapped inside the glasshouse. Although there is some heat loss due to conduction, there is a net increase in energy (and therefore temperature) inside the greenhouse. Air warmed by the heat from hot interior surfaces is retained in the building by the roof and wall. These structures range in size from small sheds to very large buildings. The greenhouses are filled with equipment like screening installations, heating, cooling, and lighting and may be automatically controlled.

Many research and projects have been done in order to improve the conditions and cultivation of crops under greenhouse. Often it is necessary to develop a control system to implement these studies.

2.2 Microcontroller

Microcontroller shown in Figure (2.1) is used in a large variety of applications. They can be found in the automotive industry, communication systems, electronic instrumentation, hospital equipment, industrial equipment and applications, household appliances, toys, and so forth.

Figure (2.1): Microcontroller

Microcontrollers have been designed to be used in applications in which low cost is required. They do this by executing a program permanently stored in their memory, whereas the input/output ports of the microcontroller are used to interact with the outside world. Therefore, the microcontroller becomes part of the application; it is a controller embedded in the system [5] complex applications can use several microcontrollers, each one of them focusing on a small group of tasks.

The following generic requirements are important for microcontrollers and rewrite using microcontrollers:

- Input/output resources. As opposed to microprocessors in which the emphasis is on computational power, microcontrollers put their emphasis on their input/output resources, such as the ability to handle interrupts, analog signals, number of different input and output lines, and so forth.

- Optimization of space. It is important to use the smallest possible footprint at a reasonable cost. Given that the number of pins in a chip depends on its packaging, the footprint can be optimized by having one pin able to perform several different functions.

- Using the most appropriate microcontroller for a given application.

Microcontroller manufacturers have developed families of devices with the same instruction set but different hardware aspects, such as memory size, input/output devices, and so forth.

This allows the designer to select the most appropriate device from a given family.

- Protection against failure. It is critical for safety to guarantee that the microcontroller is executing the correct program. If for any reason the program goes astray, the situation has to be immediately corrected. Microcontrollers have a watchdog timer (WDT) to ensure that the program is being executed correctly. Watchdog timers do not exist in personal computers.
- Low power consumption. Because batteries power many applications using microcontrollers, it is important to ensure the low power consumption of microcontrollers. Furthermore, the energy used when the microcontroller is not doing anything, for example, when it is waiting for an action from the user like a keyboard input, needs to be kept to a minimum. To do this, the microcontroller is set in sleeping state until it resumes the execution of the program.
- Protection of programs against copies. The program stored in memory needs to be protected against unauthorized reading. To do this, the microcontrollers incorporate protection mechanisms against coping [6].

2.2.1 **Components of a microcontroller**

Microcontrollers combine the fundamental resources available in a microcomputer such as the Central Processing Unit (CPU), memory, and Input/output resources in a single chip. Figure (2.2) shows the block diagram for a generic microcontroller.

Microcontroller has an oscillator to generate the signal necessary to synchronize all internal operations. Although this can be a basic Resistance Capacitor (RC) oscillator, a quartz crystal (XTAL) is normally used due to its high frequency stability. The frequency of the oscillator has a direct influence on the speed at which program instructions are executed.

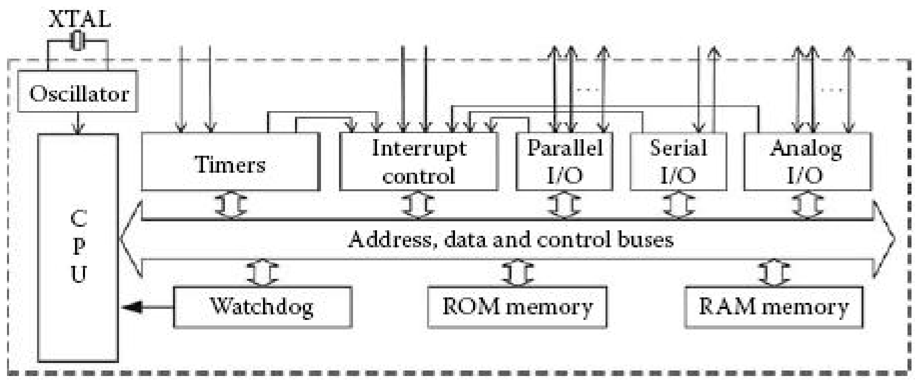


Figure (2.2): Components of microcontroller

- **Central processing unit**

Similar to microcomputers, the Central processing unit **(**CPU) is the brain of the microcontroller. The CPU fetches the program instructions from their locations in memory one by one, interprets or decodes them, and executes them. The CPU also includes the Arithmetic and Logic Unit (ALU) circuits for binary arithmetic and logic operations. The microcontroller's CPU has different registers.

Some of these registers are intended for general use, whereas others have a specific purpose. Specific purpose registers include: instruction register, accumulator, status register, program counter, data address register, and stack pointer. The Instruction Register (IR) stores the instruction that the CPU is executing. The programmer does not normally have access to the IR. The Accumulator (ACC) is a register associated with the arithmetic and logic operations that the ALU is carrying out. When executing any operation, one of the data needs to be in the ACC. The resulting value is also stored in the ACC. PIC microcontrollers do not have the ACC register. Instead, they have a working register that is very similar to the ACC. The status register (STATUS) contains the bits that show different characteristics [8].

- **Memory**

Any microcontroller has two types of memory: Random-Access Memory (RAM) and Read -Only Memory (ROM). RAM can be read and written. RAM is volatile memory, meaning that its data is lost when it is not powered. On the other hand, although ROM can only be read, it is non-volatile. The different types of technologies used for ROM such as Erasable Programmable Read-Only Memory(EPROM), Electrical Erasable Programmable Read-Only Memory(EEPROM), One-Time Programmable(OTP), both RAM and ROM are “random access” memories, meaning that the time to access specific data does not depend on its stored location. This is opposed to sequential access memories in which the time needed to access a specific memory cell depends on the location of the last accessed cell . ROM is used to permanently store the program for the microcontroller; Whereas RAM is used to temporarily store the data that will be manipulated by the program. An increasing number of microcontrollers use nonvolatile memory such as EEPROM to store some of the data that is changed only sporadically. The size of ROM is larger than the size of RAM for two main reasons: First, most applications require programs that manipulate a relatively small number of data. Second, RAM has a larger footprint compared to ROM, and therefore it is more expensive than ROM [3].

- **Interrupts**

Interrupts are an important concept in microcontrollers. An interrupt causes the microcontroller to respond to external and internal (e.g., a timer) events very quickly. When an interrupt occurs, the microcontroller leaves its normal flow of program execution and jumps to a special part of the program known as the Interrupt Service Routine (ISR). The program code inside the ISR is executed, and upon return from the ISR the program resumes its normal flow of execution. The ISR starts from a fixed address of the program memory sometimes known as the interrupt vector address. Some microcontrollers with multi-interrupt features have just one interrupt vector address, while others have unique interrupt vector addresses, one for each interrupt source. Interrupts can be nested such that a new interrupt can suspend the execution of another interrupt. Another important feature of multi-interrupt capability is that different interrupt sources can be assigned different levels of priority [4].

- **Timers**

Timers are important parts of any microcontroller. A timer is basically a counter which is driven from either an external clock pulse or the microcontroller's internal oscillator. A timer can be 8 bits or 16 bits wide. Data can be loaded into a timer under program control, and the timer can be stopped or started by program control. Most timers can be configured to generate an interrupt when they reach a certain count (usually when they overflow). The user program can use an interrupt to carry out accurate timing-related operations inside the microcontroller [8].

- **Input /Output resource**

Input/output (I/O) resources consist of the serial and parallel ports, timers, and interruption managers. Some microcontrollers also incorporate analog input and output lines associated with Analog-to-Digital (A/D) and Digital-to-Analog (D/A) converters. The resources needed to ensure the regular operation of the microcontrollers such as the watchdog are also considered part of the I/O resource. Parallel ports are normally structured in groups of up to eight lines of digital inputs and outputs. It is normally possible to manipulate each one of these lines individually. Serial ports can be of different technologies such as RS-232C (Recommended Standard 232, Revision C), I2C (inter-integrated circuit), Universal Serial Bus (USB), and ethernet. In general, a microcontroller will have the largest possible number of I/O resources for the number of available pins in its integrated circuit package. To increase the performance, one physical pin can be connected to several internal blocks, and therefore that pin may carry out different functions depending on how the microcontroller has been configured [8].

- **The watchdog**

The Watch Dog Timer (WDT) is a resource that can be found in most microcontrollers. As shown in Figure (2.3) the WDT consists of an oscillator and a binary counter of N bits. Although the oscillator can be the same oscillator used by the microcontroller, it is preferable to use an independent oscillator. The output of the counter is connected to the reset input for the microcontroller. The counting process can never be stopped, although the program being executed can periodically reset the counter to its initial value.

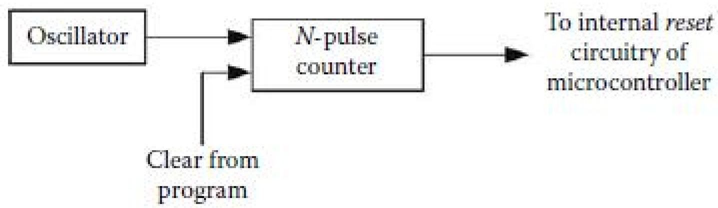


Figure (2.3): The Watchdog

Every pulse at the output of the oscillator becomes an input to the counter. When the counter reaches its maximum value, the output of the counter becomes active and gives a reset signal to the microcontroller. The goal of the designer is to avoid having the counter in the WDT reach its maximum value. Because, once started, the WDT cannot be stopped; the only way to avoid the reset signal is by setting the counter back to zero from the program that is being executed. This has to happen periodically and faster or the WDT counter will reach its maximum value. When the program is executed correctly, the WDT counter will never reach the maximum value. However, if the program becomes lost and stops executing the program, the WDT counter will reach its maximum value, will send the reset signal to the microcontroller, and the program will start executing from the beginning again. Therefore, the WDT is a critical element in a microcontroller, as it guarantees that the program will be executed continuously [4] .

- **Reset signal**

A reset input is used to reset a microcontroller externally. Resetting puts the microcontroller into a known state such that the program execution starts from address 0 of the program memory. An external reset action is usually achieved by connecting a push-button switch to the reset input. When the switch is pressed, the microcontroller is reset [8].

- **Low power consumption**

Because batteries power most applications using microcontrollers, power consumption has become a critical parameter. Power consumption in an integrated circuit depends on three factors: the technology used in the chip, the frequency of its oscillator, and the value of its voltage supply.

Complementary Metal-Oxide Semiconductor (CMOS) is the preferred technology for manufacturing microcontrollers due its low power needs.

In static conditions only a very small leakage current flows through the gates. Its power consumption is only significant when switching logic states. Increasing the frequency of the oscillator increases the number of switching actions, and therefore its power consumption also increases.

However, it is important to remember that in many applications the microcontroller is just waiting for an external event, such as a key being pressed, or an interrupt, before carrying out a task. Once finished, it returns to the waiting state. To further decrease its power consumption, it is a good idea to paralyze the microcontroller either totally or partially while it is waiting for an external event. The best method to paralyze the microcontroller is to stop its main oscillator.

This will force the main systems to be in a static mode waiting for an external action to start it again. When this happens, the microcontroller is said to be in idle state, power down, or sleep mode. Different microcontrollers have different methods to enter this low-power state. Some microcontrollers only need to modify a determined bit from a specific register, whereas other microcontrollers have a dedicated instruction for this purpose. The only way to leave this low-power mode is by means of an externalInterrupt or by a reset [3].

2.2.2 Applications of microcontroller

In addition to control applications such as the home monitoring system, microcontrollers are frequently found in embedded applications. Among the many applications that could be find one or more microcontrollers: automotive applications, appliances, automobiles, environmental control, instrumentation, and thousands of other uses.

Microcontrollers are used extensively in robotics. In this application, many specific tasks might be distributed among a large number of microcontrollers in one system. Communications between each microcontroller and central, more powerful microcontroller would enable information to be processed by the central computer, or to be passed around to other microcontrollers in the system. A special application that microcontrollers are well suited for is data logging. Stick one of these chips out in the middle of a corn field or up in a balloon, and monitor and record environmental parameters (temperature, humidity, rain, etc.). Small size, low power consumption, and flexibility make these devices ideal for unattended data monitoring and recording [6] .

2.3 Sensors

Sensors are sophisticated devices that are frequently used to detect and respond to electrical or optical signals. A Sensor converts the physical parameter (for example: temperature, humidity, speed, etc.) into a signal which can be measured electrically.

- **Temperature sensors**

This device collects information about temperature from a source and converts into a form that is understandable by other device or person. The best illustration of a temperature sensor is mercury in glass thermometer. The mercury in the glass and expands contracts depending on the alterations in temperature. The outside temperature is the source element for the temperature measurement. The position of the mercury is observed by the viewer to measure the temperature. There are two basic types of temperature sensors:

- **Contact sensors**

This type of sensor requires direct physical contact with the object or media that is being sensed. They supervise the temperature of solids, liquids and gases over a wide range of temperatures.

- **Non-contact sensors**

This type of sensor does not require any physical contact with the object or media that is being sensed. They supervise non-reflective solids and liquids but are not useful for gases due to natural transparency. These sensors use Plank's Law to measure temperature. This law deals with the heat radiated from the source of heat to measure the temperature. Working of different types of temperature sensors along with examples:

i. **Thermocouple**

Thermocouple is made of two wires (each of different homogeneous alloy or metal) which form a measuring junction by joining at one end. This measuring junction is open to the elements being measured. The other end of the wire is terminated to a measuring device where a reference junction is formed. The current flows through the circuit since the temperature of the two junctions are different. The resulted milli-voltage is measured to determine the temperature at the junction.

ii. **Resistance Temperature Detectors (RTD)**

This type of thermal resistor that is fabricated to alter the electrical resistance with the alteration in temperature. It is very expensive than any other temperature detection device.

iii. **Thermistors**

They are another kind of thermal resistor where a large change in resistance is proportional to small change in temperature.

- **Humidity and moisture sensors**

A humidity sensor also called a hygrometer, measures and regularly reports the relative humidity in the air. They may be used in homes for people with illnesses affected by humidity; as part of home Heating, Ventilating, and Air Conditioning (HVAC) systems; and in humidors or wine cellars. Humidity sensors can also be used in cars, office and industrial HVAC systems, and in meteorology stations to report and predict weather.

A humidity sensor senses relative humidity. This means that it measures both air temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.

The most common type of humidity sensor uses what is called "capacitive measurement." This system relies on electrical capacitance, or the ability of two nearby electrical conductors to create an electrical field between them. The sensor itself is composed of two metal plates with a non-conductive polymer film between them. The film collects moisture from the air, and the moisture causes minute changes in the voltage between the two plates. The changes in voltage are converted into digital readings showing the amount of moisture in the air.

A person with a respiratory illness or certain allergies might use a home humidity sensor because low humidity can exacerbate breathing problems and cause joint pain, while high humidity encourages bacteria, mold, and fungus growth. Home humidors and wine cellars often have a humidity sensor that helps to maintain a consistent relative humidity optimal to safe long-term storage. Humidity sensors can also be used in homes or museums where valuable antiques or artwork are kept, because these items can be damaged or degraded from constant exposure to too much moisture.

Commercial and office buildings often have humidity sensors in their HVAC systems, which help to insure safe air quality. Many automobiles use a humidity sensor as part their defrosting and defogging systems to automatically adjust the temperature and source of air used for heating and air conditioning. Humidity sensors also have industrial applications for production of materials that are sensitive to moisture. Humidity sensors give regular, ongoing readings of relative humidity, so they are used for data collection in oceanography and weather stations where humidity must be measured over time to analyze patterns and predict weather.

- **Light sensors**

A light sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called “light”, and which ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum.

The light sensor is a passive devices that convert this “light energy” whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because the convert light energy (photons) into electricity (electrons).

Photoelectric devices can be grouped into two main categories, those which generate electricity when illuminated, such as *Photo-voltaics* or *Photo-emissives* etc , and those which change their electrical properties in some way such as *Photo-resistors* or *Photo-conductors*. This leads to the following classification of devices.

- **Photo-emissive cells** – These are photo devices which release free electrons from a light sensitive material such as caesium when struck by a photon of sufficient energy. The amount of energy the photons have depends on the frequency of the light and the higher the frequency, the more energy the photons have converting light energy into electrical energy.
- **Photo-conductive cells** – These photo devices vary their electrical resistance when subjected to light. Photoconductivity results from light hitting a semiconductor material which controls the current flow through it. Thus, more light increase the current for a given applied voltage. The most common photoconductive material is cadmium sulphide used in LDR photocells.

- **Photo-voltaic cells** – These photo devices generate an emf in proportion to the radiant light energy received and is similar in effect to photoconductivity. Light energy falls on to two semiconductor materials sandwiched together creating a voltage of approximately 0.5V. The most common photovoltaic material is Selenium used in solar cells.
- **Photo-junction devices** – These photo devices are mainly true semiconductor devices such as the photodiode or phototransistor which use light to control the flow of electrons and holes across their PN-junction. Photo junction devices are specifically designed for detector application and light penetration with their spectral response tuned to the wavelength of incident light.

Chapter Three

DESIGN OF CONTROL CIRCUIT

3.1 Introduction

An embedded system is designed based on measuring of parameters like humidity, temperature, soil moisture and light intensity using a microcontroller ATmega16 which are display using a LCD display. Design part consists of hardware and software.

3.2 Hardware Configuration

To design hardware for green house monitoring, various sensors are used to control the environment. The parameters like temperature, humidity, light intensity, Soil moisture of the greenhouse environment. This thesis is designed to control all these parameters. The sensor has been used to measure various parameters, like temperature and humidity and Light and soil moisture. Output of all these sensors is in analog format, analog to digital converter are used to convert it to digital data. At this thesis at mega16 microcontroller.

The outputs of sensor are connected directly to the ADC input pins of AVR. AVR has 10 bit ADC with 8 analog inputs to the ADC.

Thus AVR ADC reads sensor output and compares them with a pre decided value which is stored in the AVR microcontroller program. Once the input value from sensor crosses set value then the microcontroller gives a high output to the relays connected to the output pins of the AVR. These relays are used to control the various parameters of the greenhouse environment. User can connect the first relay to the fan to control the temperature. Second relay to the intelligent light to control the light. Third relay to the sprayer to control humidity. Fourth relay to the water pump to increase the soil moisture. Liquid Crystal Display (LCD) is used to display / monitor values. User can see the values on the LCD. Design of control circuit hardware as shown in Figure (3.1)

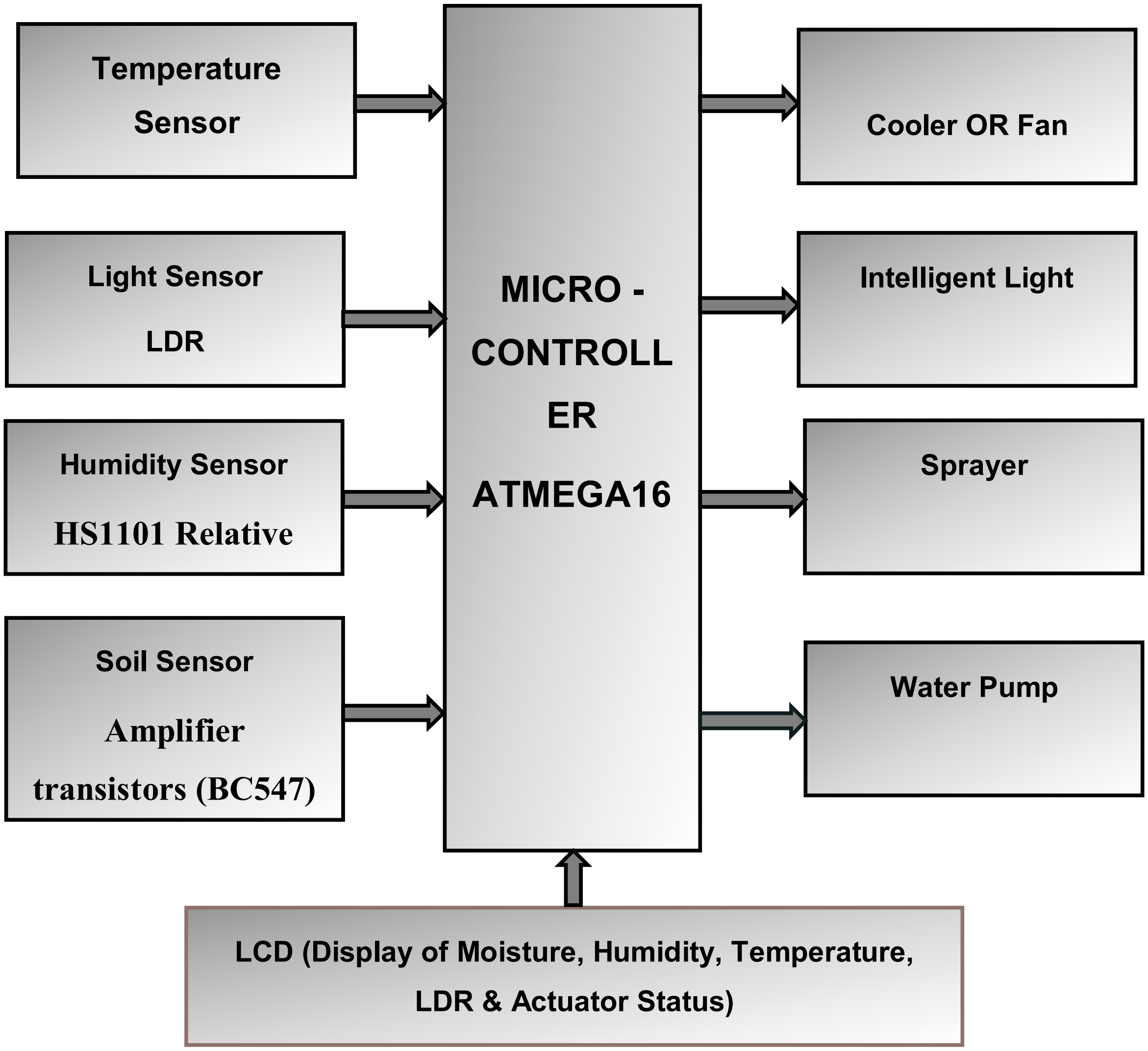


Figure (3.1): Green House Monitoring

3.2.1 ATmega16 microcontroller

The ATmega16 is equipped with 32 general purpose 8-bit registers that are lightly coupled to the processor's arithmetic logic unit (ALU) within the central processing unit (CPU). Also, the processor is designed following the Harvard Architecture format. That is equipped with separate, dedicated memories and buses for program and data information. The register based harvard architecture coupled with the RISC based instruction set allows for fast and efficient program execution .The atmega16 can execute 16 million instructions per second when operating at a clock speed of 16 MHz's Figure (3.2) shows the pin configuration of ATmega16.

- V_{cc} : Digital supply voltage.
- GND: Ground.
- Port A (PA7… PA0): Port A serves as the analog inputs to the A/D converter. Port A also serves as an 8-bit bi-directional I/O Port, if the A/D converter is not used.

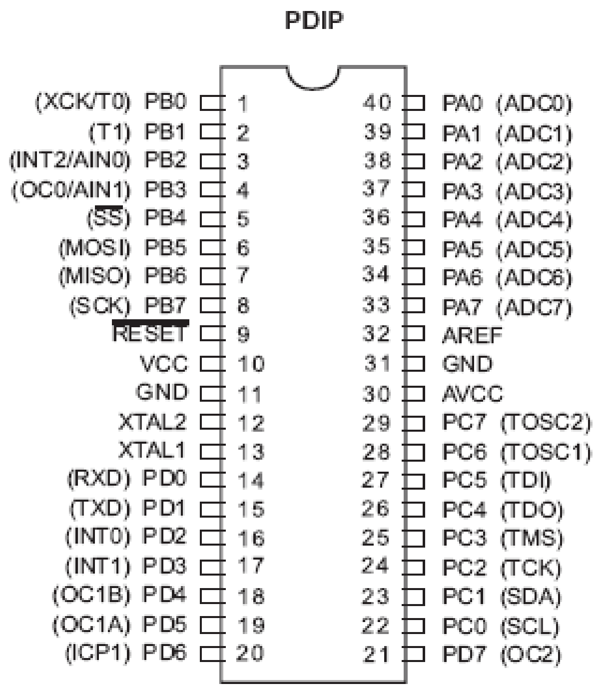


Figure (3.2): Pin configuration of ATmega16

- Port B (PB7… PB0): Port B is an 8-bit bi-directional I/O Port; Port B pins are tri-state when a reset condition becomes active, even if the clock is not running. Port B also serves the function of various special features of the ATmega16.

- Port C (PC7… PC0): Port C is an 8-bit bi-directional I/O Port; Port C pins are tri-state when a reset condition becomes active, even if the clock is not running. Port C also serves the function of JTAG interface and other special features of the ATmega16.

- Port D (PD7… PD0): Port B is an 8-bit bi-directional I/O Port; Port D pins are tri-state when a reset condition becomes active, even if the clock is not running. Port D also serves the function of various special features of the at mega16.

- Reset: reset input (active low).

-XTAL1: input to the inverting oscillator amplifier and input to the internal clock operating circuit.

-XTAL2: output from the inverting oscillator amplifier.

-AVCC: is the supply voltage pin for port A and the A/D converter.

-AREF: is the analog reference pin for the A/D converter.

- **Atmel ATmega16 microcontroller pin assignments**

Port D pin number (D4, D5, D6, D7) pin number [18, 19, 20, 21] are used as output connected to the LCD

Port A (A_0, A_1, A_2) pin number [40, 39, and 38] connected to the temperature sensor (LM35), amplifier transistor (BC547) and LDR sensor.

Port C (C0,C1,C2,C3,C4,C5) pin number[22,23,24,25,26,27] are output pin connected to drive.

- **ATmega16 programming**

Programming of at mega16 requires several hardware and software tools:

- **Software tools:** BASCOM software.
- **Hardware tools** A universal programmer is used to program the at mega16.This programmer provides the hardware interface between the host PC and the at mega16 for the machine code loading. 5V regulator is required because the microcontroller is operated from a 5V supply using a 12V.

3.2.2 Liquid Crystal Displays

Liquid Crystal Display (LCD) is the technology used for displays in notebook and other smaller computers. A LCD is an electronically-modulated optical device shaped into a thin flat panel made up of any number of color field with liquid crystals and arranged in front of a light source. It is often used in battery powered electronic devices because it requires very small a mounts of electric power .LCDs are considered as an output device to display text or numeric information as shown in Figure (3.3).

Figure (3.3): A16×2 Liquid Crystal Display

It comes in a wide variety of configuration including multi- character, multi-Line format. The most commonly used character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580.The LCDs are found today are 1 line , 2 line ,4 line LCDs , which have only one controller and support at most of 80 character , whereas LCDs supporting more than 80 characters make use of 2 HD44780 Controllers. Most LCDs with 1 controller has 14 pins, and LCDs with 2 controllers has 16 pins (two pins are extra in both for back – light LED connections). A 16×2 LCD format is the common. That , it has the capability of displaying two lines of 16 characters each .The characters are sent to the LCD via ASCTI format a single character at time . For parallel configured LCD, an 8 bit data path and two lines are required between the microcontroller and the LCD .A small microcontroller is mounted to the back panel to the LCD, translates the ASCII data characters and control signals to properly display the character. LCDs normally have 14 pins. Pin 3 is used to control the contrast of the display. Typically this pin is connected to the supply voltage using a potentiometer, and the contrast is changed by moving the arm of the potentiometer. The RS pin is used to send a control message or a text message to the LCD.

When the R/W pin is at logic 0, a command or a text message can be sent to the LCD, and this is the normal operating mode. When R/W is at logic 1, the LCD status can be read. The LCD is enabled when the E pin is at logic 0. Pins D0 to D7 are the data inputs.

LCD pin assignments

Pins D_4 to $D_{7,}$ RS and E are the data inputs from the microcontroller ATmega16.

VDD, VEE and RW pins are grounded.VSS pin connected to supply voltage +5v.

The common steps are summarized as follows:

- Move data to LCD port.
- Select command register.
- Select write operation.
- Send enable signal.
- Wait for LCD to process the command.

The common steps of data sending are summarized below:

- Move data to LCD port.
- Select data register.
- Select write operation.
- Wait for LCD to process the data.

3.2.3 Temperature sensor

Temperature sensor (LM35) has been used for sensing the temperature. It is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in degree centigrade). The temperature can be measured more accurately with it than using a thermistor. The sensor circuitry is sealed and not subject to oxidation, etc. The converter provides accurately linear and directly proportional output signal in millivolts over the temperature range of 0°C to 155°C. It develops an output voltage of 10 mV per degree centigrade change in the ambient temperature. Therefore the output voltage varies from 0 mV at 0°C to 1V at 100°C and any voltage measurement circuit connected across the output pins can read the temperature directly. LM35 temperature sensor shown in Figure (3.4).

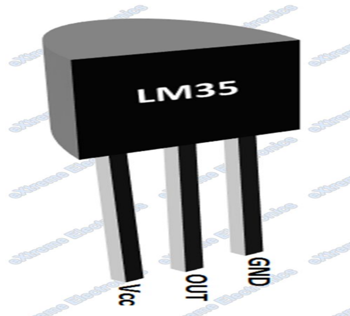


Figure (3.4): LM35temperature sensor

3.2.4 HS1101 Relative humidity sensor

Based on a unique capacitive cell, these relative humidity sensors are designed for high volume, cost sensitive applications such as office automation, automotive cabin air control, home appliances, and industrial process control systems. They are also useful in all applications where humidity compensation is needed. HS1101 humidity sensor shown in Figure (3.5).

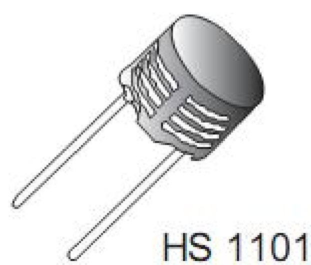


Figure (3.5):HS1101 humidity Sensor

3.2.5 Light sensor

Light Dependent Resistor (LDR) also known as photoconductor or photocell, is a device which has impedance that changes ac- cording to the amount of light falling on its surface. Since LDR is very sensitive in visible light range, it is well suited for the proposed application.

Features of the Light Sensor

i. Light Dependent Resistor (LDR) is made using semiconductor cadmium Sulphide
ii. The light falling on the brown zigzag lines on the sensor cause the resistance of the device to fall. This is known as negative co-efficient. There are some LDRs that work in the inversely i.e. their impedance increases with light (called positive co- efficient).
iii. The resistance of the LDR decreases as the intensity of the light falling on it increases. Incident photos drive electrons from the valence band into the conduction band.

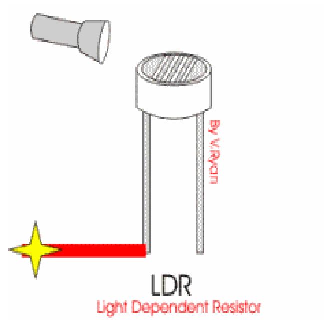


Figure :(3.6) LDR Sensor

3.2.6 Amplifier transistors or Soil moisture sensor

Functional description of soil moisture:

The copper plate act as the sensor probes. They are immersed into the specimen soil whose moisture content is under test. The soil is examined under three conditions:

- **Low (Dry) condition-** The probes are placed in the soil under dry conditions and are inserted up to a fair depth of the soil. As there is no conduction path between the two copper leads the sensor circuit remains open. The output in this case ranges from 0 to 30%.
- **Medium (Optimum) condition-** When water is added to the soil, it percolates through the successive layers of it and spreads across the layers of soil due to capillary force. This water increases the moisture content of the soil. This leads to an increase in its conductivity which forms a conductive path between the two sensor probes leading to a close path for the current flowing from the supply

to the sensor probes . The output of the circuit in the case ranges from 31% to 60% approximately.

- **High(Excess water) condition -** With the increase in water content beyond the optimum level, the conductivity of the soil increases drastically and a steady

conduction path is established between the two sensor leads and the voltage output from the sensor increases no further beyond a certain limit. The maximum possible value for it is selected between 61 % to 100%.

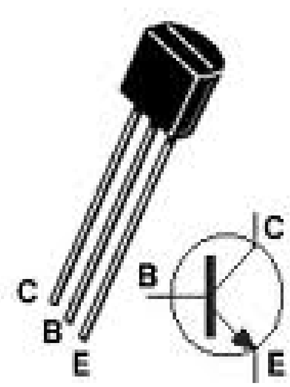


Figure (3.7) Amplifier transistors (BC547)

3.2.7 Cooler

A greenhouse structures its design and nature can become too warm, thus greatly affecting production and quality of the crop. Cooling is a critical part of your controlled environment. Greenhouses cooling by used fans are great for winter heating or summer cooling and eliminate condensation, ceiling fans help to deliver maximum airflow over wide areas. To maintain plant health during the warm summer month.

3.2.8 Water pump

There are two general types of water pumps: centrifugal pumps and positive displacement design type. Both types follow the same purpose, which is to move water from one point to another continuously.

3.2.9 Sprayer

A sprayer is a device used to spray a liquid.In agriculture, a sprayer is a piece of equipment that spray nozzles to apply herbicides, pesticides, and fertilizers to agricultural crops. Sprayers range in size from man-portable units (typically backpacks with spray guns) to trailed sprayers that are connected to a tractor, to self-propelled units similar to tractors, with boom mounts of 60–151 feet in length

3.2.10 Intelligent light

Since 1984, Intelligent Light has been a leader in providing advanced visualization products and services to the engineering community. Our flagship product, field view, is in use worldwide in aerospace, automotive, chemical processing, turbomachinery, and many other industries where computational fluid dynamics is mission critical field view., an advanced, easy-to-use post-processor designed specifically for computational fluid dynamics (CFD), lets you input data from any computational fluid dynamics data source, analyze critical areas in your data volume interactively, and make high-impact presentations and animations.

3.3 Software Configuration

The main program consists of:

- Definition
- Function prototypes.
- Global and local variables.
- Subroutine program.

The main program begins with definition of file type, initializing the ports, LCD, timers of at mega 16 and enters a continuous loop. Within the loop, the at mega 16 monitors for a status change on PORTA and PORTC. When the user depress the switch, the at mega detects the status change and executes the appropriate program.

- **Control circuit programming**

The Atmel ATmega16 is programmed using BASCOM program .The BASCOM programming allows for direct control of the microcontroller hardware .when BASCOM program is compiled during the software development process, the program is converted to the machine code for the specific microcontroller.

- **Programming procedure**

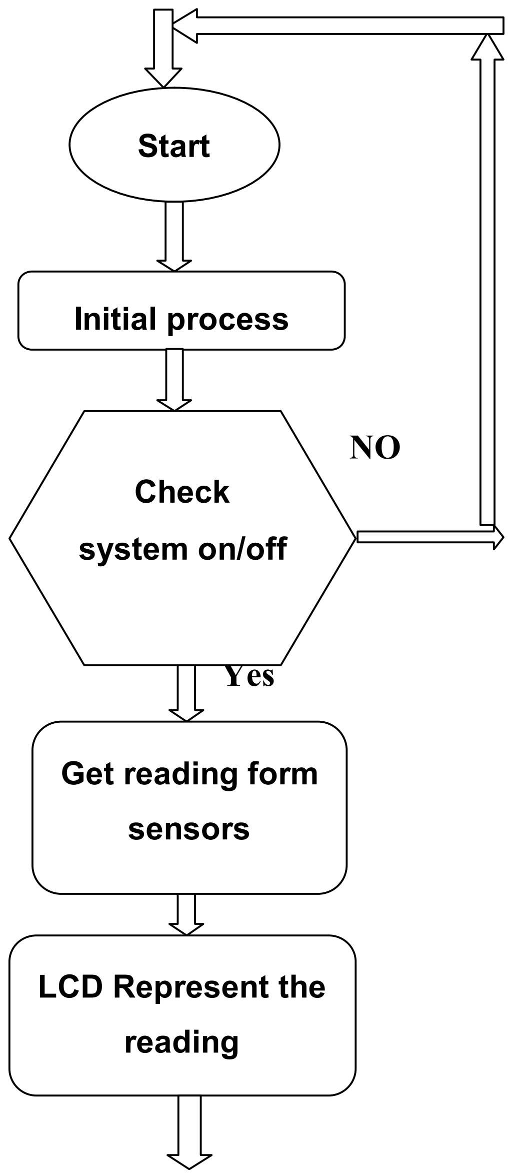
In this section the step – to- step procedure to program the ATmega16 using the universal programmer is done .It should be noted that this universal programmer will be used to program the microcontroller which will then be placed in the main circuit.

After loading the programmer software into the host PC, the following instructions are considered:

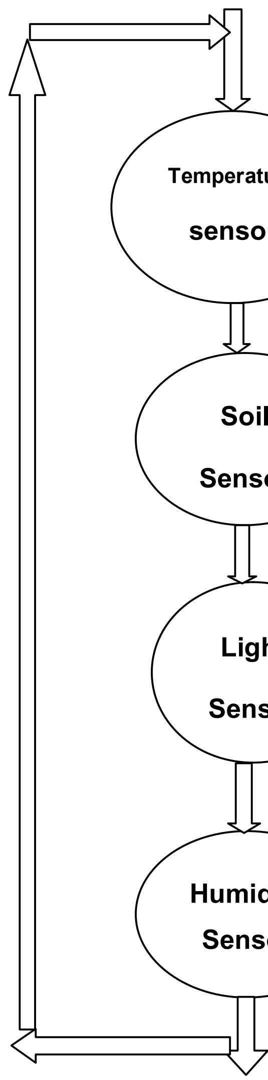
- Ensure that the universal programmer is powered down.
- Insert the ATmega16 into the 40-pin socket.
- Power up the universal programmer.
- Click on the universal programmer software to show the window. The window shows (select, load, configuration, program…etc).
- Select the microcontroller type (ATmega16).
- Load the Hex file, your file name .Hex.
- Configuration: for choosing the frequency.
- Program: Erase the chip before programming and then program .A message is sent at the end of the programming to verify that the programming is completed successfully.
- Power down the universal programmer, remove the programmed chip and place it in the main circuit.

The flowchart is below:

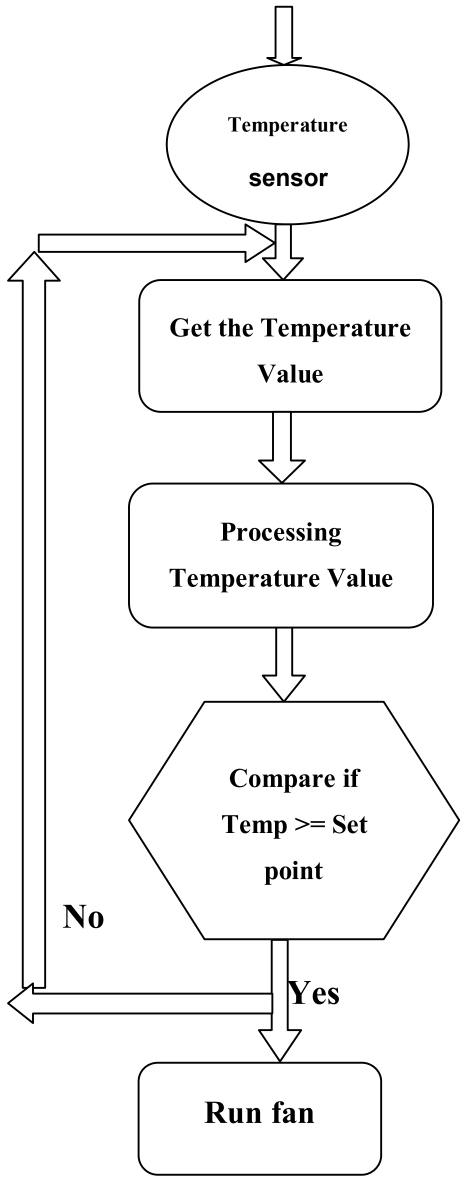
Main Program



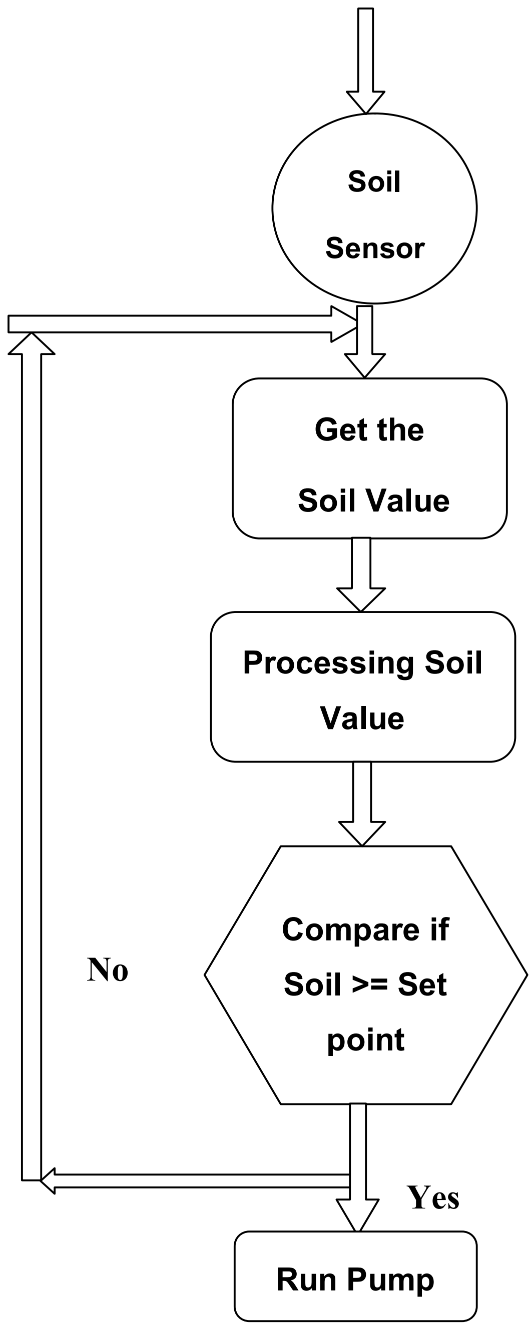
Loop program

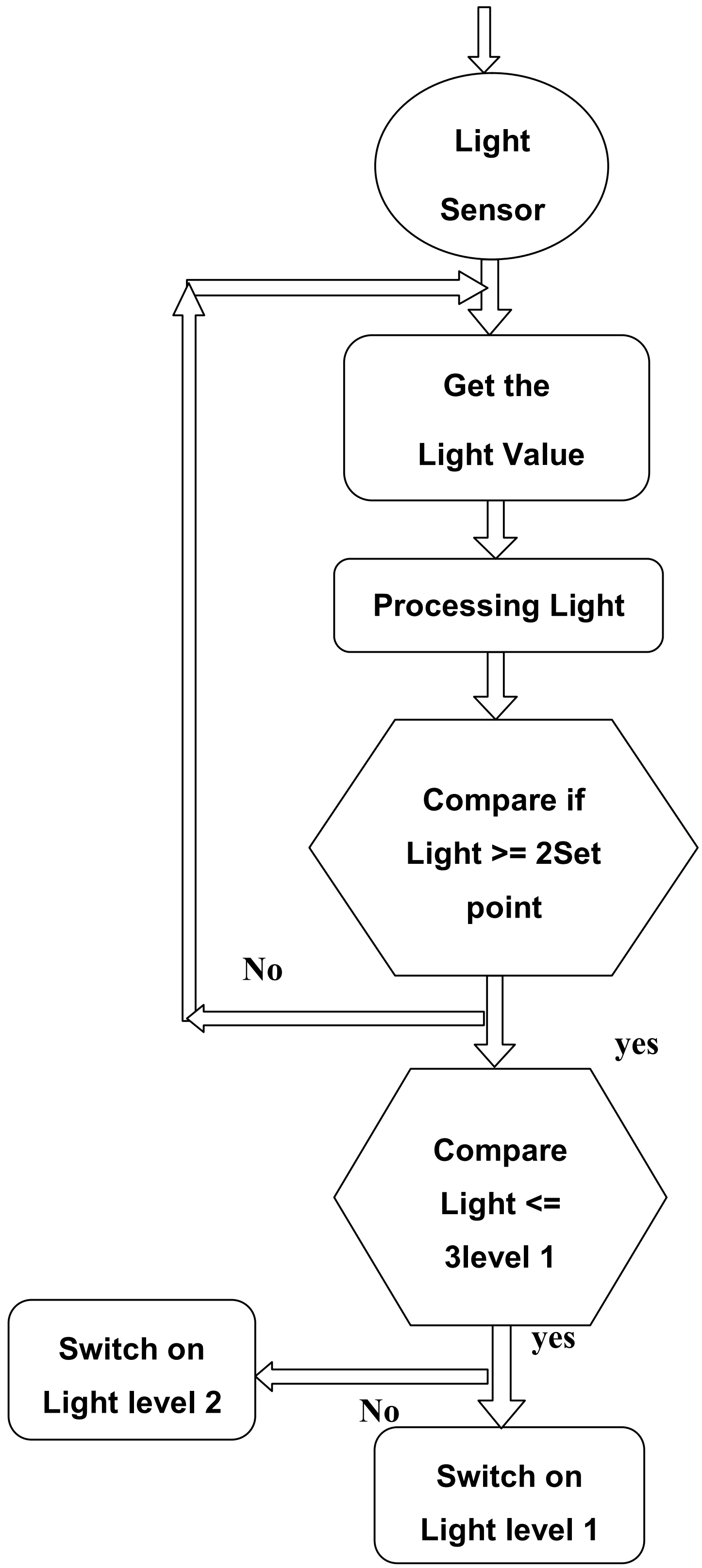


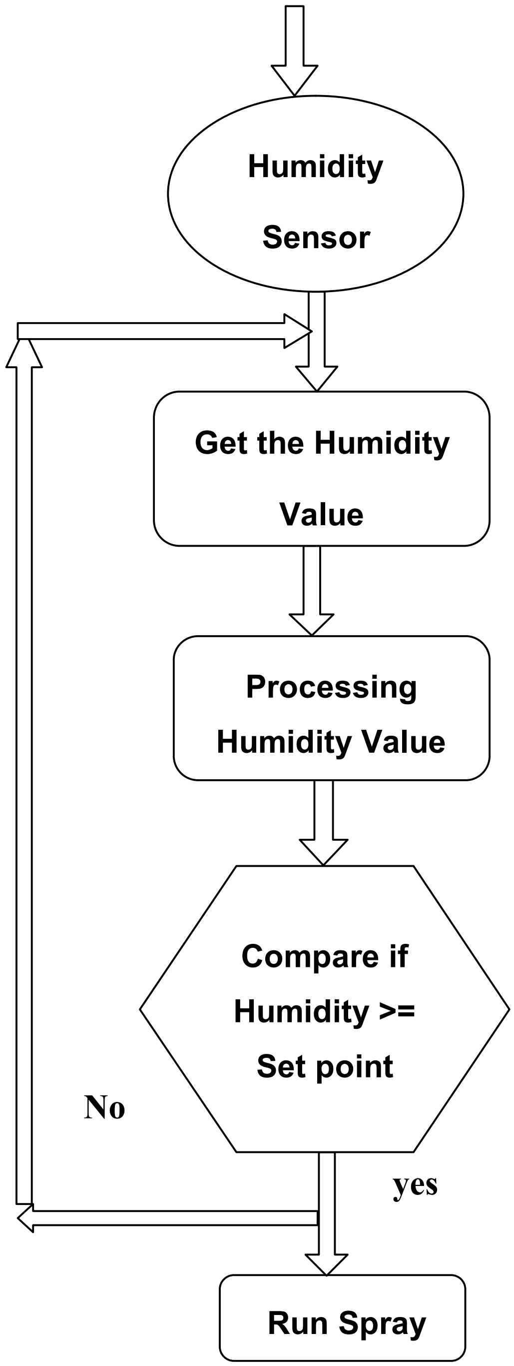
Sub Routine


Temperature
sensor
Get the Temperature Value
Processing Temperature Value
Compare if Temp >= Set point
No
Yes
Run fan

\


Soil
Sensor
Get the
Soil Value
Processing Soil
Value
Compare if
Soil >= Set
point
No
Yes
Run Pump


Light
Sensor
Get the
Light Value
Processing Light
Compare if
Light >= 2Set
point
No
yes
Compare
Light <=
3level 1
yes
Switch on
Light level 2
No
Switch on
Light level 1


Humidity
Sensor
Get the Humidity
Value
Processing
Humidity Value
Compare if
Humidity >=
Set point
No
yes
Run Spray

Chapter Four

SIMULATION RESULTS

4.1 Introduction

Computer simulations have become a useful part of mathematical modeling of many natural systems to observe their behavior. It allows the engineer to test the design before it is built for real. As mentioned earlier, the simulations for this thesis is performed using PROTEUS program. This software a applications is widely used in control engineering, for both simulation and design.

5.2 Procedure of Simulation

Before simulation can be run, the procedure will be illustrated step by step:

- First step: The PROTEUS program is chosen from program menu and PROTEUS program is chosen from ISIS7 professional.

After clicking the ISIS7professional a work area appears as in Figure (4.1).

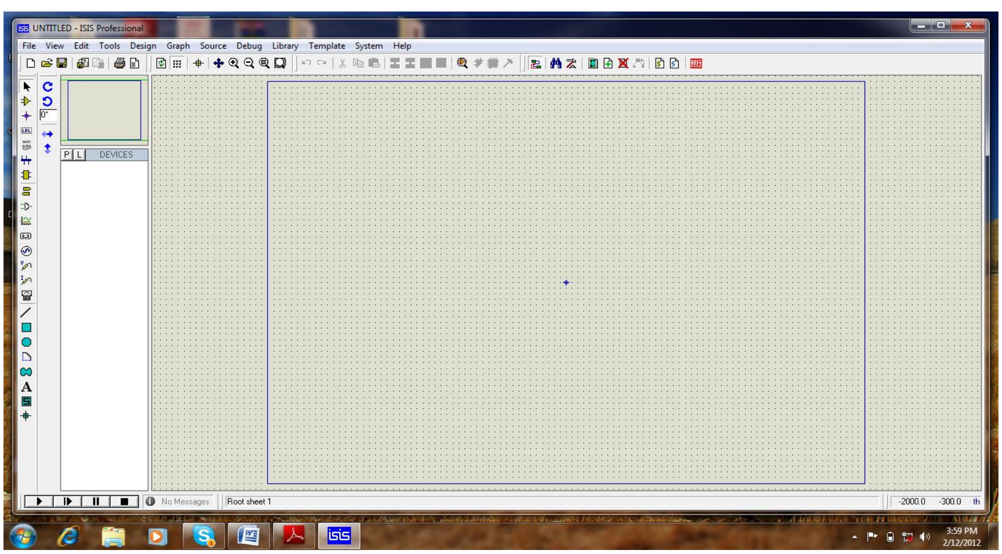


Figure (4.1): The work area.

Second step: The tools needed for the design is chosen as in Figure (4.2).

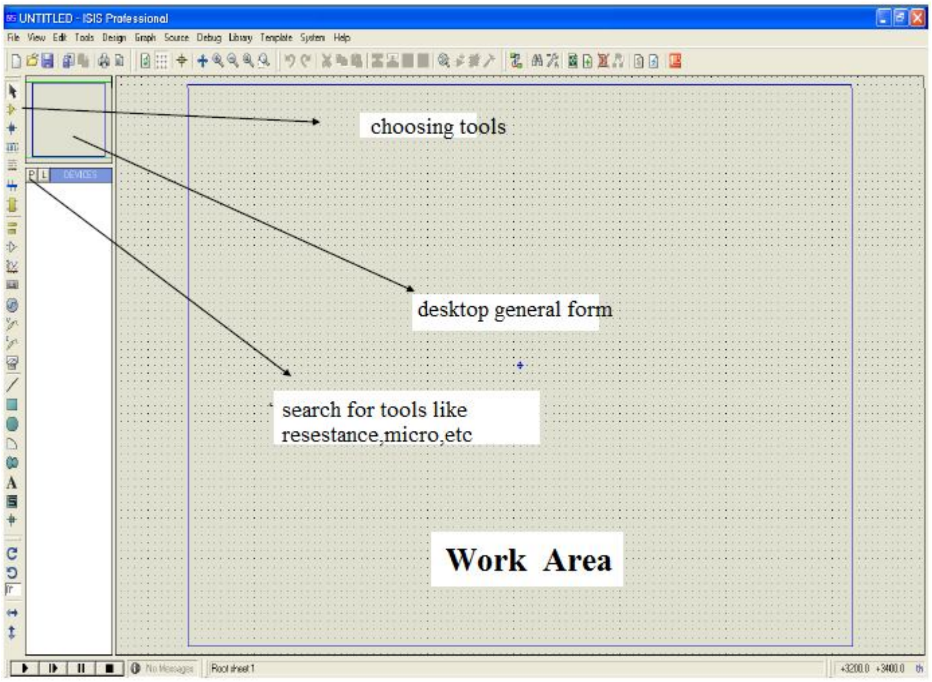


Figure (4.2): tools choosing.

The LCD is choosen as in Figure (4.3) .

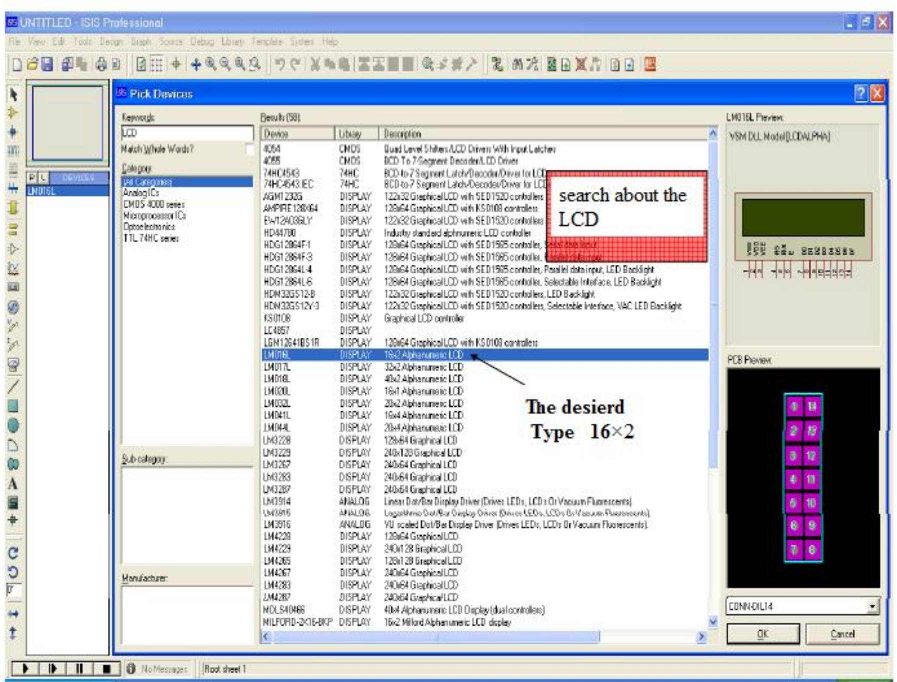


Figure (4.3): Search about the LCD.

ATmega16 is selected from program library as shown in Figure (4.4) .

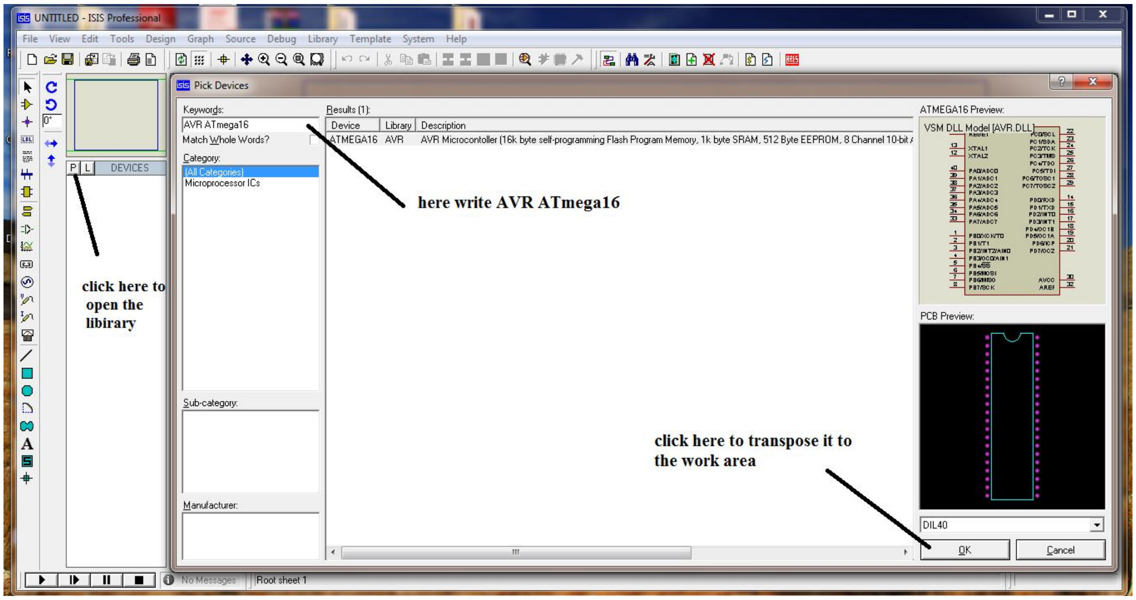


Figure (4.4): Search for the ATmega16.

All tools required for LCD operating as in Figure (4.5).

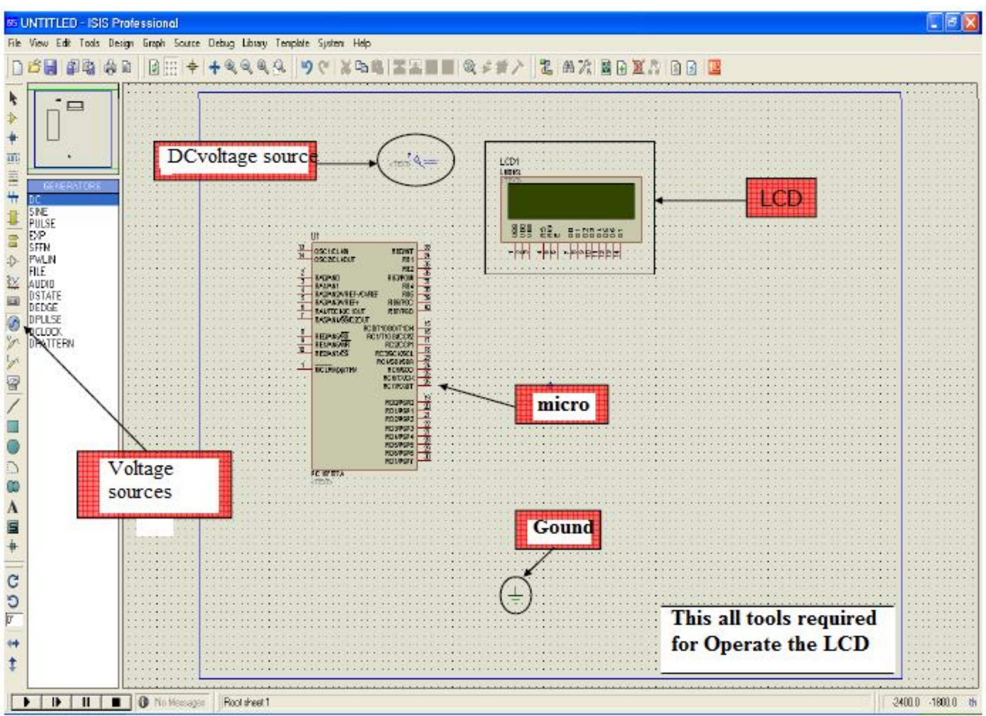


Figure (4.5): Tools required for operating the LCD

Third step: after choosing all tools needed in the design, the tools are assembled as shown in Figure (4.6).

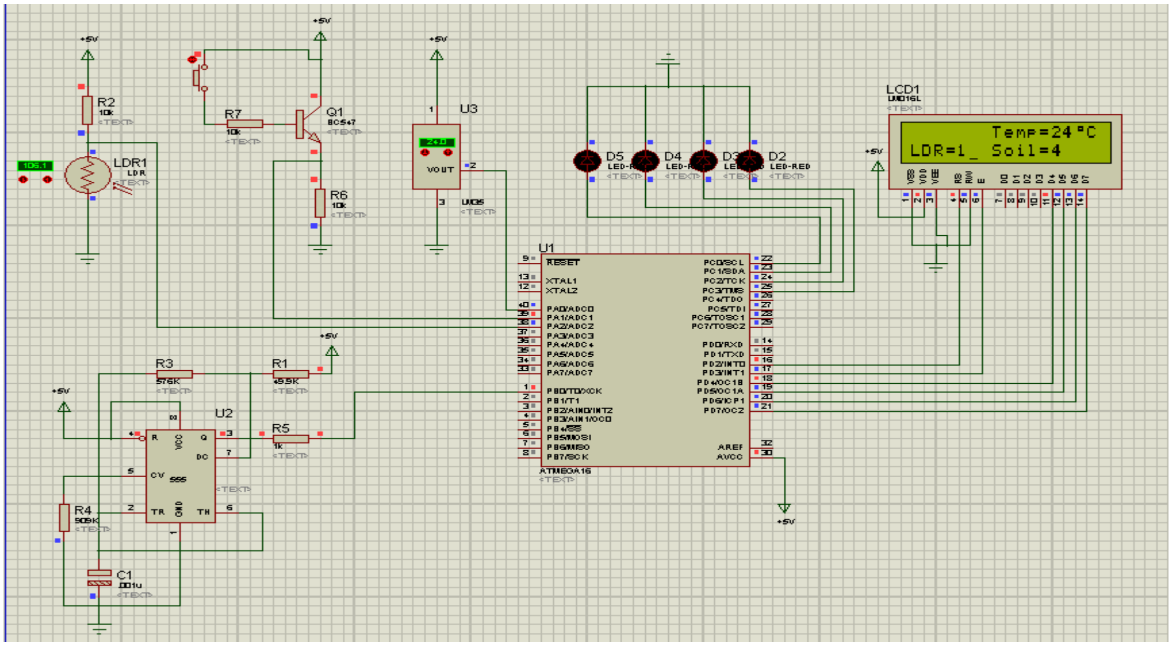
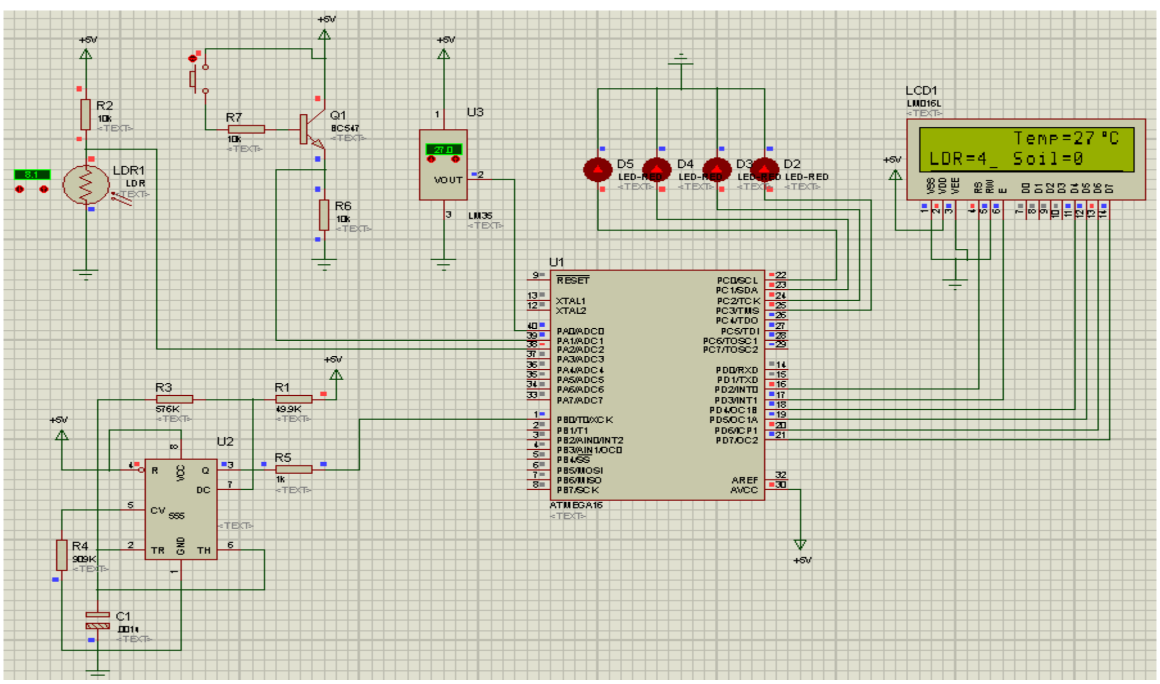


Figure (4.6): The main circuit design.

The open status of circuit design as shown in Figure (4.7)



Figure(4.7): Open status

The temperature value less than set point and stop fan as shown in Figure (4.8)

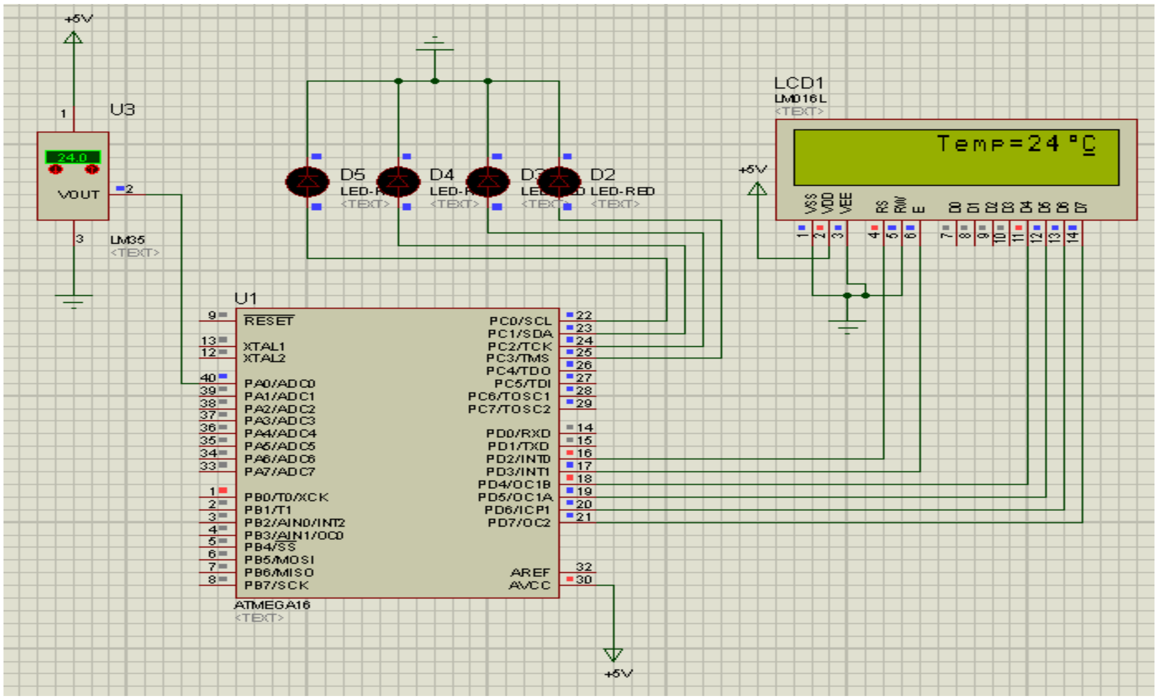


Figure (4.8): Temperature value less than set point and Stop fan

The temperature value equal set point and open fan as shown in Figure (4.9).

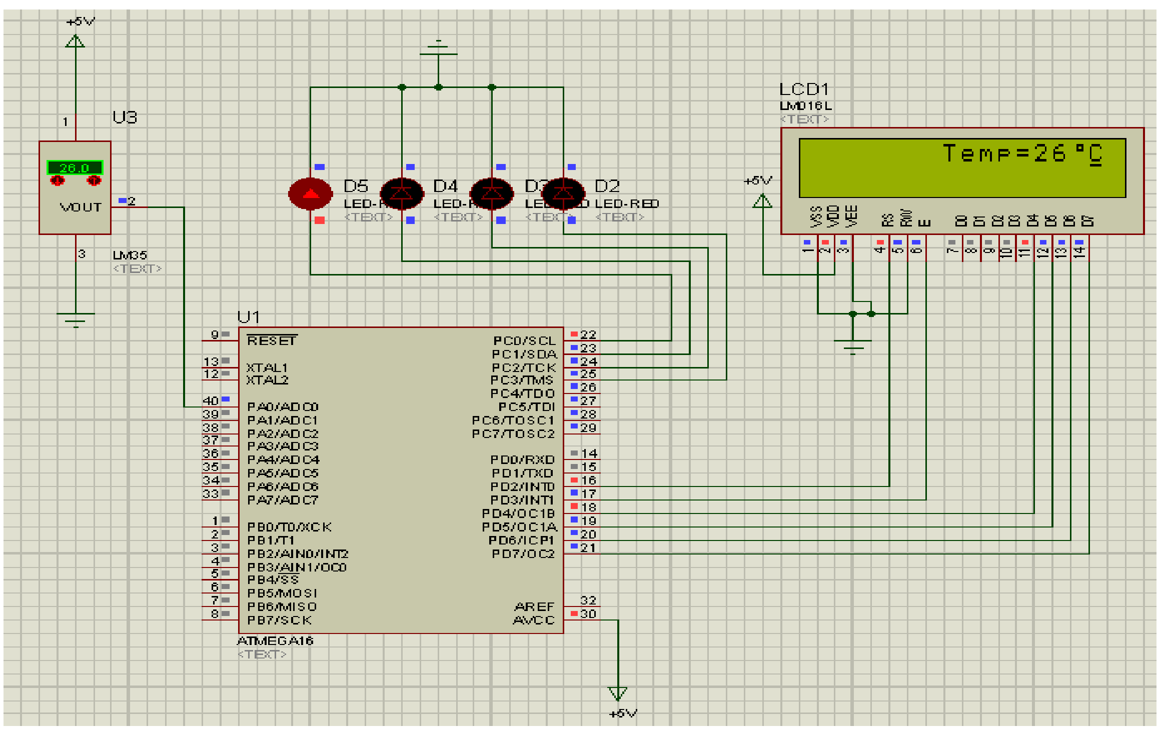


Figure (4.9): Temperature value equal set point and open fan

The soil value less than set point and stop pump as shown in Figure (4.10).

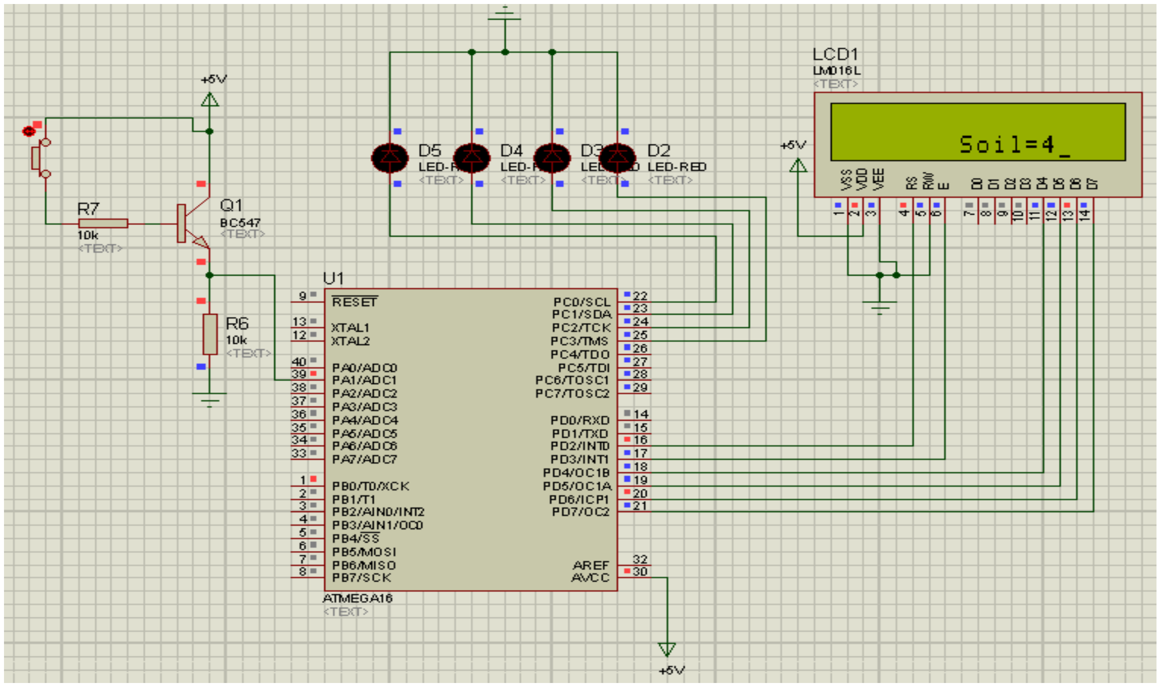


Figure (4.10): Soil value less than set point and stop pump

The soil value equal set point and open pump as shown in Figure (4.11).

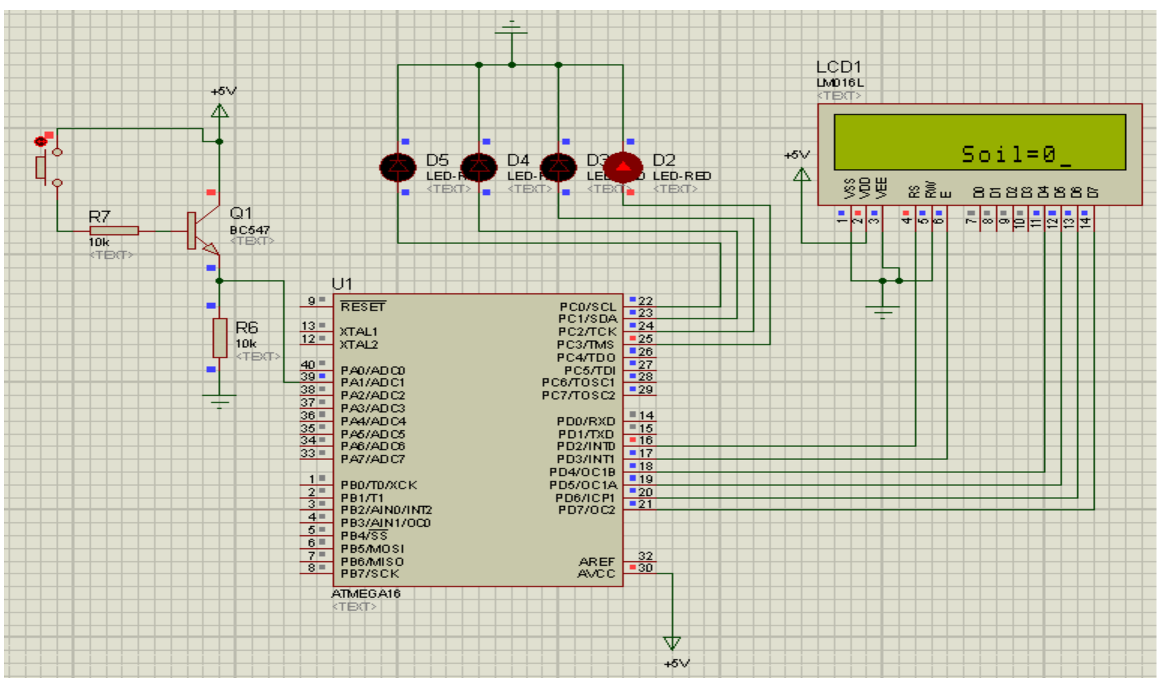


Figure (4.11): Soil value equal set point and open pump

The light value less than set point and stop lamp1 and lamp2 as in Figure (4.12).

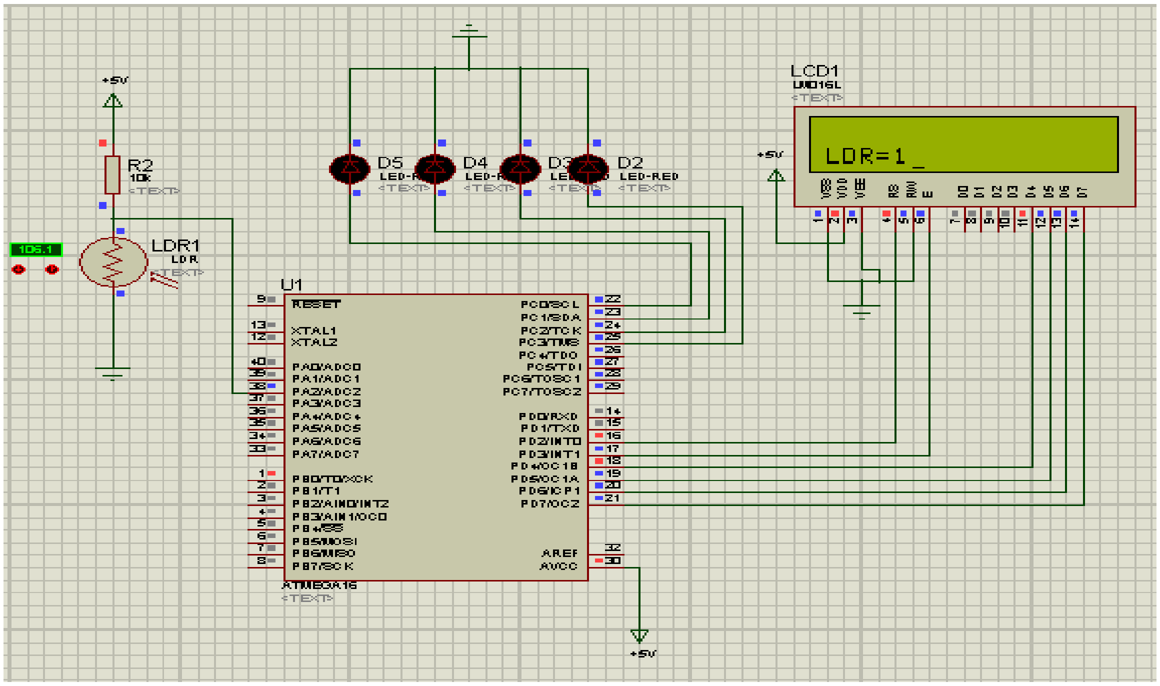


Figure (4.12): Light value less than set point and stop lamp1 and lamp2

The light value equal point and open lamp1as shown in Figure (4.13)

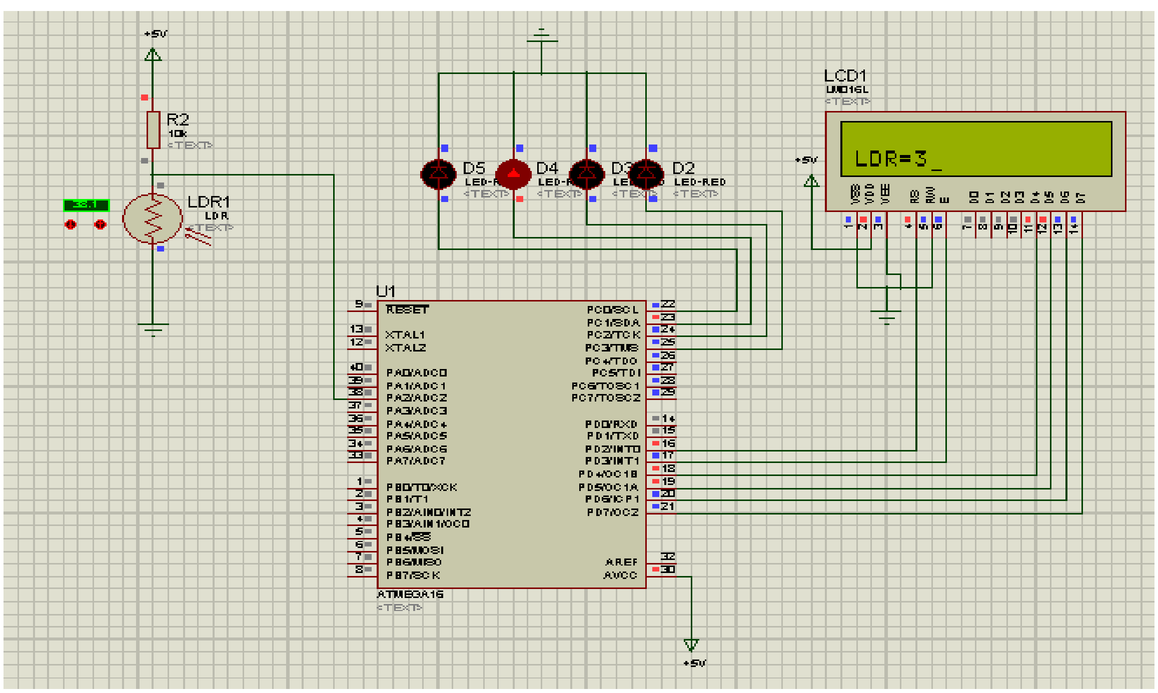


Figure (4.13): Light value equal point and open lamp1

The light value equal set point and open lamp1and lamp2 as shown in Figure (4.14).

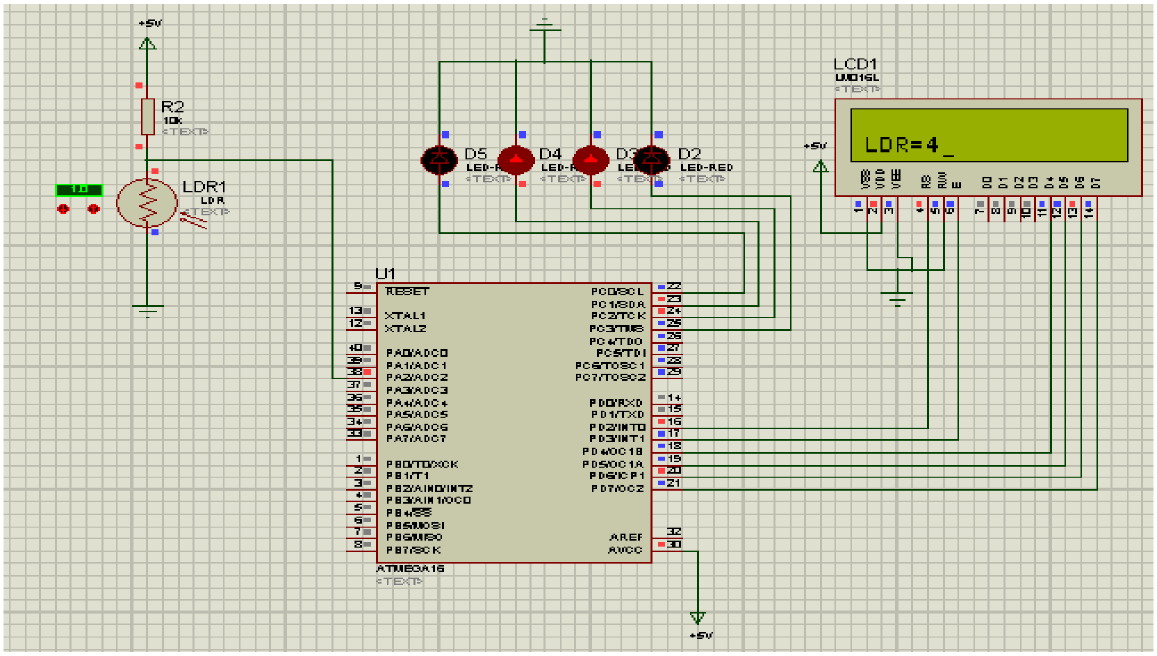


Figure (4.14): Light value equal set point and open lamp1and lamp2

The humidity value less than set point and stop sprayer as shown in Figure (4.15).

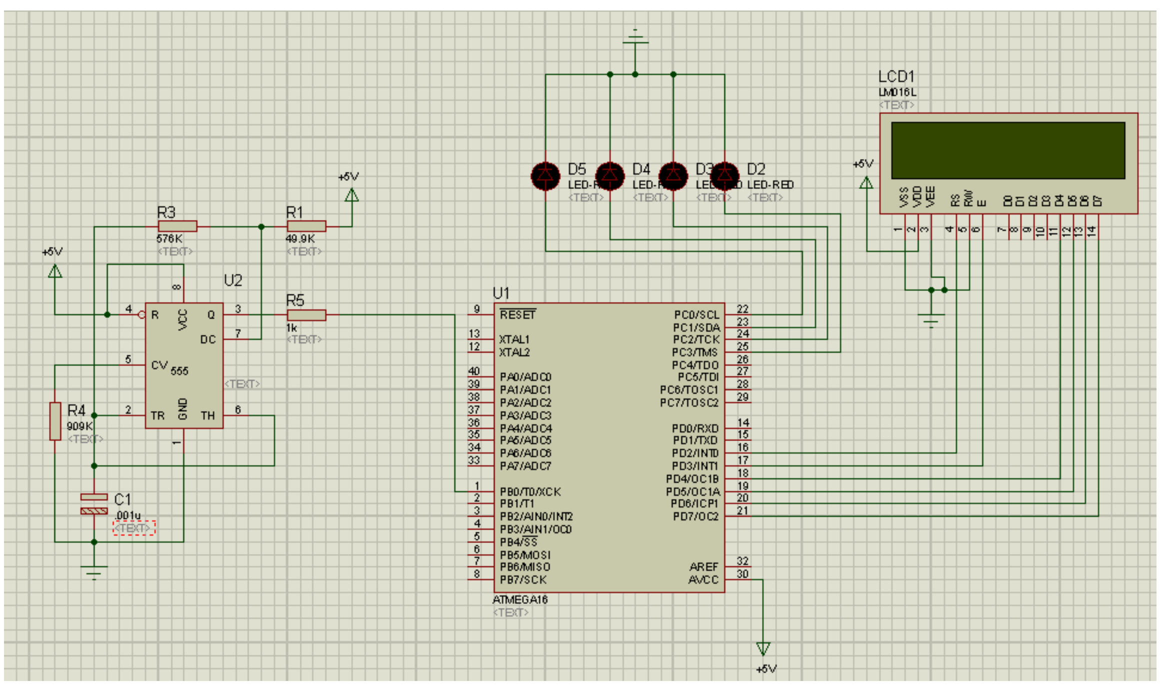


Figure (4.15): Humidity value less than set point and stop sprayer

Chapter Five

IMPLEMENTATION AND TESTING

5.1 Introduction

In this section the proposed system is implemented and tested to ensure that it works proper and meets the desired specification.

5.2 System Implementation and Testing

The main circuit board is designed and contains temperature sensor circuit and light sensor circuit and humidity sensor circuit and soil sensor circuit .The output from the sensors output continuously is fed to the microcontroller. Simultaneously the display reading is displayed on liquid crystal display (LCD). Figure (5.1) gives system control circuit.

- **Power Supply**

The voltage regulator circuit is used to produce the required power supply of 5 V when the device is operated from 9 V a adapter.

- **Temperature Sensor**

Temperature sensor is used for the measurement of the temperature inside the greenhouse. The sensor analogue output passes to the microcontroller which converts the signal into a digital from representing the measured temperature. The microcontroller compares the digital signal with temperature degree of reference stored in the program and then run or stops the fan. The output of the microcontroller is indicated by LED1. The fan will turns off when the temperature is normal (equal or less than 25°C) and turns on during temperature is high (greater than 25°C).The temperature sensor readings as in table (5.1).
Table(5.1)Temperature sensor readings

0-----25°C	Turns fan off
26---35°C	Turn fan on

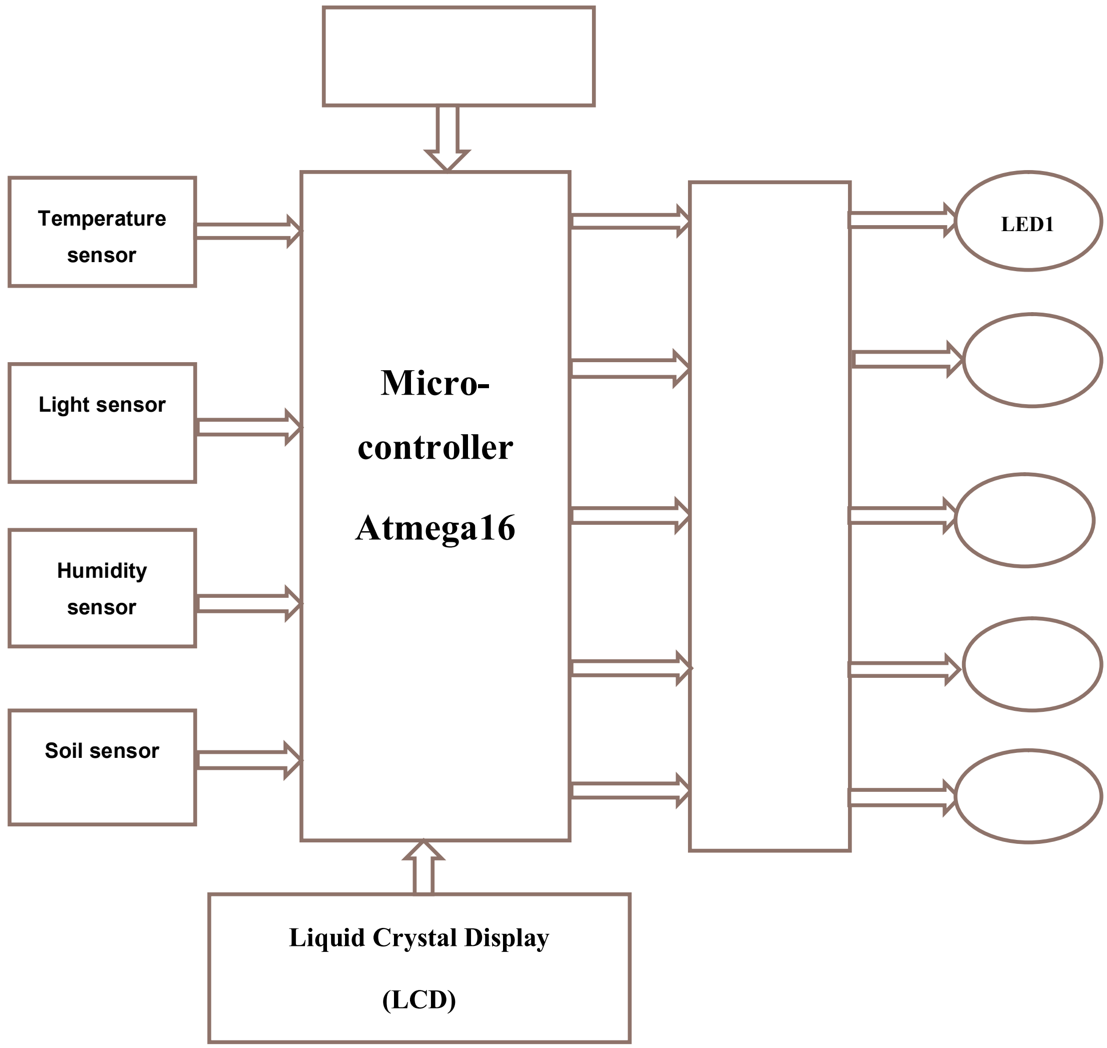


Figure (5.1): system control circuit

- **Light Sensor (LDR)**

The light intensity changes depending on the local weather and during the day. Under normal weather the light increased during the day and decreased during night. During day time when greenhouse light is enough the LDR resistance is low. So its output voltage is low. The lamp1 will turns on during day time and lamp2 will turns on at night when no light and lamp1and lamp2 turn off during sunrise. The LDR sensor readings as in table (5.2).

Table (5. 2): LDR sensor readings

0 --------1 V	Stop lamp
2-------3 V	Open lamp1
4------5 V	Open lamp1&lamp2

- **Humidity Sensor**

The HS1101 humidity sensor is used for sensing the humidity. Relative humidity is measured in percentage of the vapour in the air compared to the total amount of vapour that could be held in the air at a given temperature. The output of humidity varies from 0% to 100%. The output microcontroller is indicated by LED4. The sprayer will turns off when humidity is less than or equal 50% and turns sprayer on when humidity greater than or equal 60%. The humidity sensor readings as in table (5.3).

Table (5.3): Humidity sensor readings

10%------50%	Stop sprayer
60%------100%	Run sprayer

- **Amplifier transistor or Soil moisture sensor**

BC548 transistor gives a voltage output corresponding to the conductivity of the soil .The conductivity of soil depends upon the amount of moisture present in it. It increases with increase in the water content of the soil. The two copper are immersed into the specimen soil whose moisture content is under test. The output microcontroller is indicated by LED5. The pump will turns on when the probes are placed in the soil under dry conditions and there is no conduction path between the two copper leads . The sensor circuit remains open and turns pump off when water is added to the soil .This water increases the moisture content of the soil. This leads to an increase in its conductivity which forms a conductive path between the two sensor probes leading to close path for the current flowing from the supply to the transistor through the sensor probes. The soil sensor readings as in table (5.4).

Table (5.4): Soil sensor readings

0----------2 V	Run Pump
3---------5 V	Stop Pump

Chapter six

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

In this thesis, automatic greenhouse monitoring and control has been designed for the four essential parameters of the plant (temperature, humidity, soil moisture and light intensity). The automatic control of greenhouse reduces the time of using the manual way of watering and lighting and fewer workers are needed to maintain the plants or crops.

6.2 Recommendations

This thesis has been done in order to improve the conditions and cultivation of crops under greenhouse. The performance of the system can be further improved by connecting a wireless sensor networks to communication devices such as modems, cellular phones so as to enable the remote collection of recorded data of parameters.

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