INTELLIGENT GREENHOUSE

Dissertation submitted in fulfilment of requirements for the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

Under the supervision of

Mr. Munish Sood

By:

121068- Dixita Gupta

121076- Udbhav Sharma

121077- Tavishi Dutt

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,

WAKNAGHAT-173234 ,MAY 2016

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled **"INTELLIGENT GREENHOUSE"**, submitted by **Dixita Gupta , Udbhav Sharma & Tavishi Dutt** at **Jaypee University of Information Technology, Waknaghat** is a bonafide record of their original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

The above statement made is correct to the best of my knowledge.

Mr.Munish Sood

Assistant Professor Department of ECE ,JUIT

Date: 24-05-2016

ACKNOWLEDGEMENT

We are very grateful and highly acknowledge the continuous encouragement, invaluable supervision, timely suggestions and inspired guidance offered by our supervisor **Mr. Munish Sood** , Department of electronics and Communication Engineering, Jaypee University of InformationTechnology Waknaghat, during the project.

We are grateful to **Dr.(Prof). Sunil Bhooshan**, Head of the Department of Electronics and Communication Engineering, for permitting us to make the use of the facilities available in the department to carry out the project successfully.

Finally the acknowledgement would be incomplete without thanking **Mr. Pramod Kumar** and **Mr. Manoj Kumar Pandey**, lab technicians, Department of Electronics and Communication Engineering, JUIT , who spent their precious time to help us with the laboratory works performed during the project.

ABSTRACT

In today's day and age, it seems unnatural to be living in a world that is not solving our problems and making our lives simpler. The motivation for our project came precisely from this notion.

'Intelligent Greenhouse' is an arduino -based project wherein we will automate its working to a great extent, if not fully, in order to reduce manual labor. A greenhouse is a controlled-area-environment for the growth of plants. It is a structural building with different types of covering materials such as glass or plastic. It heats up because the transparent glass traps the incoming solar radiation , and is absorbed by the plants inside.

Automatic greenhouse involves the automatic monitoring and controlling the climatic parameters like light ,temperature, humidity and moisture in the soil, which directly or indirectly govern the plant growth. The heart of this project is the Atmega328p.

Analog signals from different sensors used to measure physical quantities will be fed into the microcontroller and according to the set threshold values different output device will be switched ON/OFF to maintain the climatic parameters.

Keywords : Embedded systems, automatic monitoring, microcontroller, arduino ,sensor, analog signal, digital signal.

LIST OF ABBREVATIONS

AC - Alternating Current

ADC -Analog to Digital Converter

BJT -Bipolar Junction Transistor

DC- Direct Current

LDR -Light Dimming Resistor

LED -Light Emitting Diode

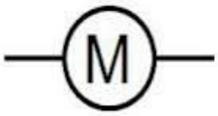
SMS-Soil Moisture Sensor

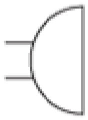
SPDT-Single Pole Double Throw

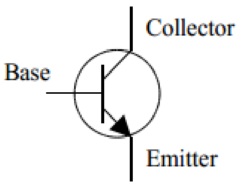
SPST-Single Pole Single Throw

LIST OF SYMBOLS

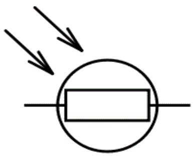
 Resistance

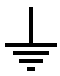
 DC Motor

 Buzzer



npn transistor

 Light Dependent Resistor

 Ground

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 GREENHOUSE BASICS

A greenhouse is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheds to industrial-sized buildings. A miniature greenhouse is known as a cold frame. The interior of a greenhouse exposed to sunlight becomes significantly warmer than the external ambient temperature, protecting its contents in cold weather.

Many commercial glass greenhouses or hothouses are high tech production facilities for vegetables or flowers. The glass greenhouses are filled with equipment including screening installations, heating, cooling, lighting, and may be controlled by a computer to optimize conditions for plant growth.

1.2 AUTOMATED GREENHOUSE

Automated greenhouse involves automatic monitoring and controlling of parameters which directly or indirectly govern the plant growth and hence their production.

In order to control the climatic parameters and environment autonomously, a software equipment is required.

1.3 MOTIVATION FOR THE PROJECT

The idea for this project came from automation in an agricultural field, for people who are lacking technologically. Instead of a field, we tried to implement it in a greenhouse so that it could be easily demonstrated.

1.4 OBJECTIVE OF THE PROJECT

The aim is to build a miniature greenhouse fully equipped with automatic monitoring and controlling system in order to eliminate manual labor to a significant extent.

1.5 APPLICATIONS

- The project can be extended on a large scale to be implemented in an actual agricultural field.
- It will prove helpful to those who are technologically backward, as it reduces human dependency.
- It can be interlinked with mobile communication or the internet to make it wireless and remotely controlled.

CHAPTER 2

EMBEDDED SYSTEMS

2.1 EMBEDDED SYSTEM

- An embedded system is a combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular function.
- Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys (as well as the more obvious cellular phone and PDA) are the possible hosts of an embedded system.
- Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.
- Embedded systems that are programmable are provided with programming interfaces and embedded programming is a specialized occupation.
- It is embedded as part of a complete device often including hardware and mechanical parts.
- The key characteristic is being dedicated to handle a particular task.
- The embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.
- Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

2.2 PARTS OF EMBEDDED SYSTEM

- An embedded system consists of three parts:
    1. Input
    2. Processing Unit
    3. Output

- The INPUT devices are responsible for providing input to the embedded system which is then processed by the processing unit to produce a desired output.
- In general, we use sensors as input devices while dealing with microcontrollers.
- A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.
- PROCESSING UNIT process the input provided by the input devices and produces the output.
- All the decisions are taken by this devices depending upon the algorithm provided by the user.
- OUTPUT devices show the result of our algorithm. A number of devices can be used. Some of them include LEDs, Motors (DC, Stepper, Servo) etc.
- All the decisions are taken by this devices depending upon the algorithm provided by the user.
- OUTPUT devices show the result of our algorithm. A number of devices can be used. Some of them include LEDs, Motors (DC, Stepper, Servo) etc.

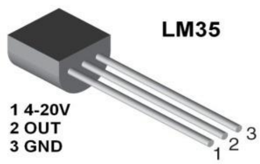


Fig 2.1: Input units

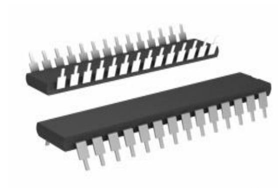
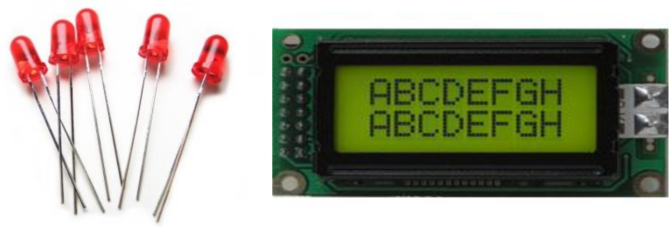


Fig 2.2: Processing unit



LEDs LCD

Fig 2.3: Output units

PROCESSING UNIT

- Microprocessor
- Microcontroller

2.3 MICROPROCESSOR

- A microprocessor incorporates the functions of computer's central processing unit (CPU) on a single integrated circuit (IC or microchip).
- It is a multipurpose, programmable, clock-driven, register-based electronic device that accepts digital data as input, processes it according to instructions stored in its memory, and provides results as output.
- It is an example of sequential digital logic, as it has internal memory, i.e. its registers.

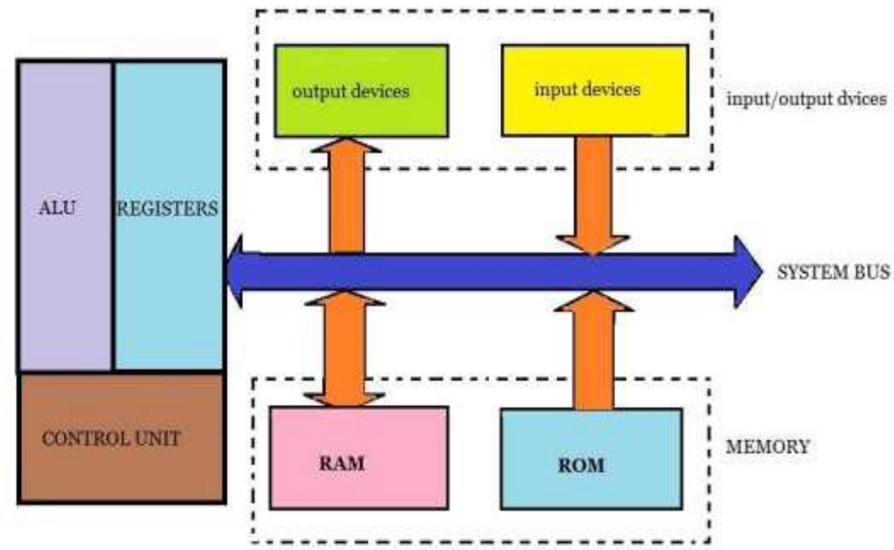


Fig 2.4:Block diagram of a microprocessor

2.4 MICROCONTROLLER

- A digital computer having microprocessor as the CPU along with I/O devices and memory is known as microcomputer.
- The microcontroller could be called a “one-chip solution”.
- It typically includes:
  I. CPU (Central Processing Unit),
  II. RAM (Random Access Memory),
  III. EPROM/ PROM/ROM
  IV. I/O (Input/Output)

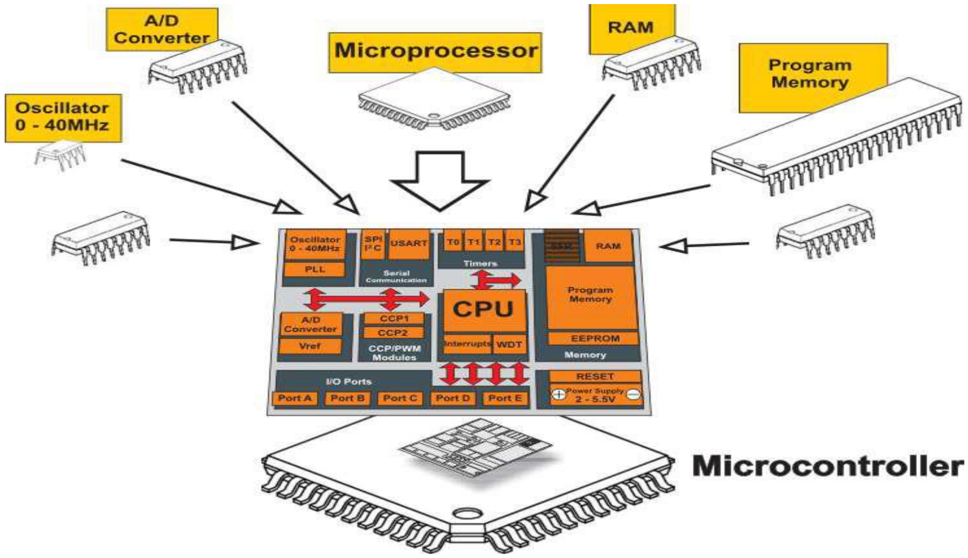


Fig 2.5: Basic microcontroller

2.4.1 DIFFERENT FAMILIES OF MICROCONTROLLERS

- There are number of popular families of microcontrollers which are used in different applications as per their capability and feasibility to perform the desired task.
- Most common of these are:
  - 8051 microcontroller family
  - AVR microcontroller family
  - PIC microcontrollers family

Table 2.1: Comparison of Different Microcontroller families

FEATURES	**8051**	**PIC**	**AVR**
Speed	Slow	Moderate	Fast
Memory	Small	Large	Large
Architecture	CISC	RISC	RISC
ADC	Not present	Inbuilt	Inbuilt
Timers	Inbuilt	Inbuilt	Inbuilt
PWM channels	Not present	Inbuilt	Inbuilt

2.5 MICROPROCESSOR VS MICROCONTROLLER

Table 2.2 :Comparison between Microprocessor and Microcontroller

MICROPROCESSOR	MICROCONTROLLER
• CPU is stand-alone, RAM, ROM, I/O, timer are separate. • Designer can decide on the amount of ROM, RAM and I/O ports. • Expensive • Versatility • General-purpose	• CPU, RAM, ROM, I/O and timer are all on a single chip. • Fix amount of on-chip ROM, RAM, I/O ports. • For applications in which cost, power and space are critical. • Not versatile • Single-purpose

2.6 INTRODUCTION TO AVR

- AVR was developed in the year 1996 by Atmel Corporation.
- AVR derives its name from its developers and stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller.
- They are also known as Advanced Virtual RISC.
- The AT90S8515 was the first microcontroller which was based on AVR architecture.
- AVR microcontrollers are available in three different categories:
    - Tiny AVR – Less memory, small size, suitable only for simpler applications.

- Mega AVR – These are the most popular ones having good amount of memory (up to 256 KB), higher number of inbuilt peripherals and suitable for moderate to complex applications.
- Xmega AVR – Used commercially for complex applications, which require large program memory and high speed.

Table 2.3 : Comparison of major AVRs Series

Series	**Pins**	**Flash Memory**
Tiny AVR	6-32	0.5-8 KB
Mega AVR	28-100	4-256 KB
Xmega AVR	44-100	16-384 KB

.

CHAPTER 3

SYSTEM OVERVIEW

3.1 SYSTEM OVERVIEW

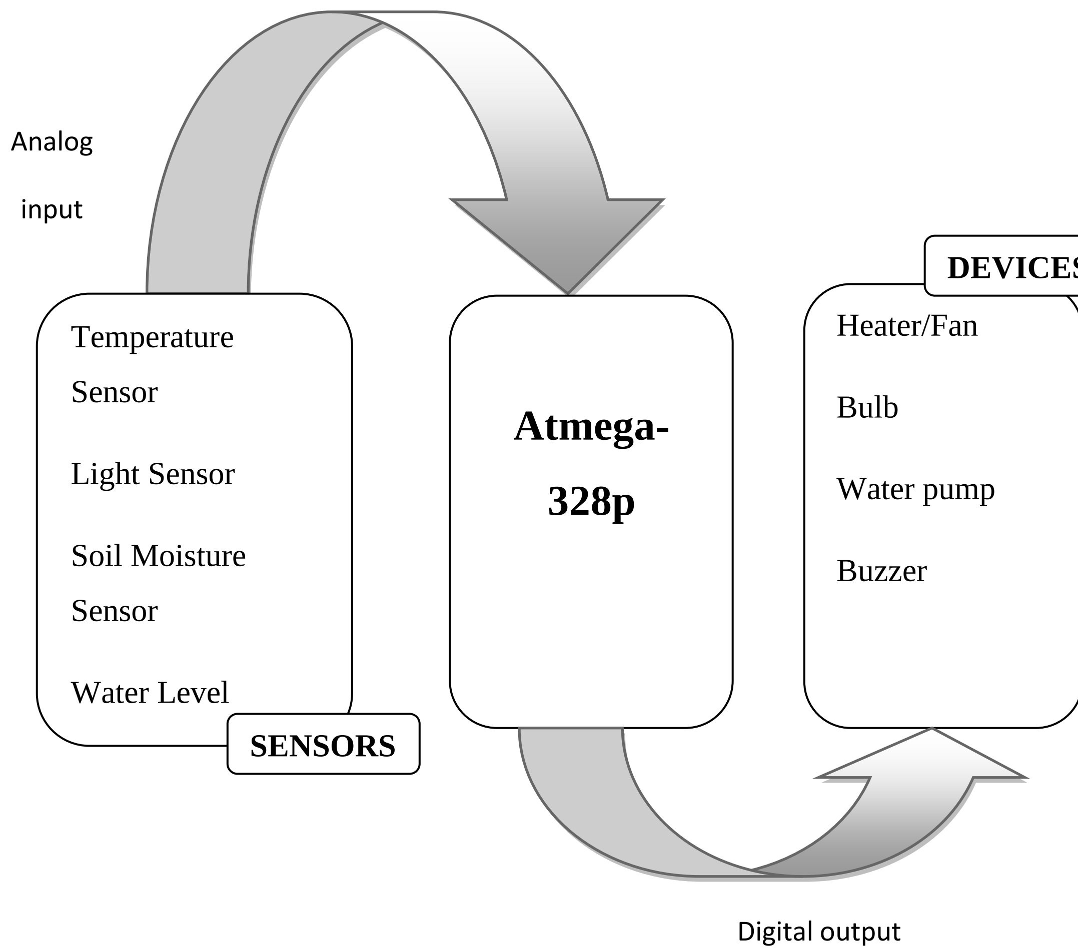


Fig 3.1:System Overview

3.2 SYSTEM DESCRIPTION

Analog voltage values from sensors will be fed into microcontroller(Analog pins) and an Analog to Digital Converter (ADC) converts analog values into a digital approximation based on the some mathematical formulations.

Each sensor will have corresponding devices attached to it ,which will be turned ON/OFF according to the set threshold value of the physical parameters (temperature, moisture, light and water level) in order to maintain optimum plant growth.

3.3 BLOCK DIAGRAM

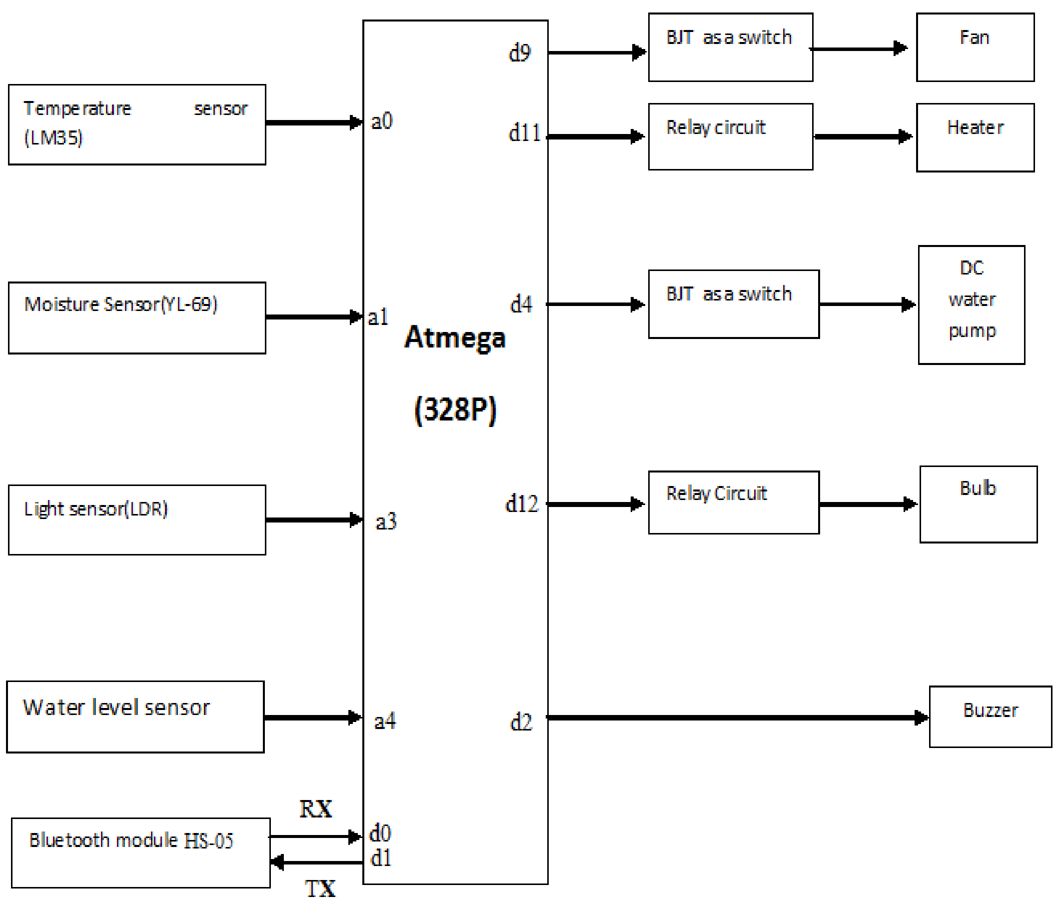


Fig3.2 : Block Diagram of system

3.4 FLOW CHART

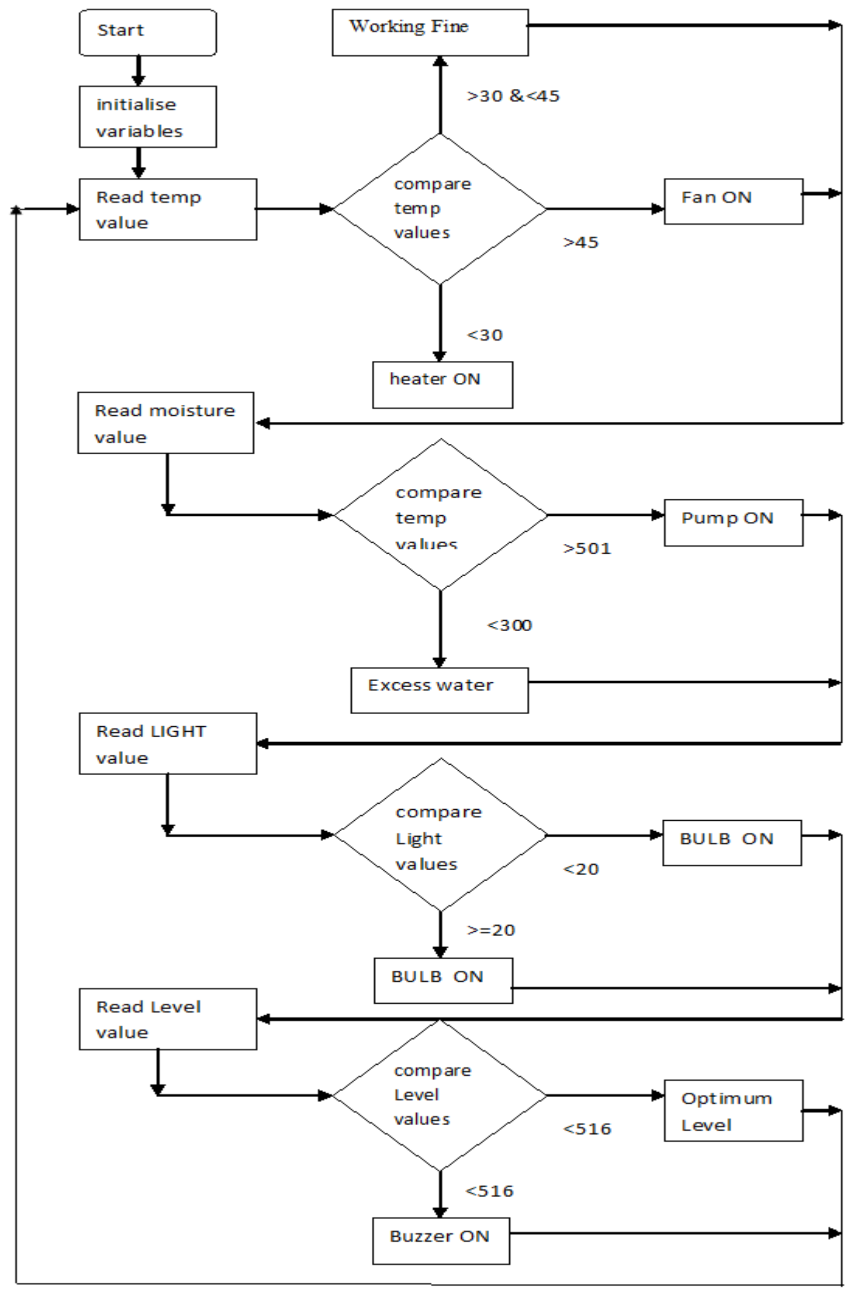


Fig 3.3:Flow Chart

CHAPTER 4

HARDWARE DESCRIPTION

The task has been divided into 5 parts consisting of five module to make it simple and to avoid errors and complexity.

First module will be temperature control module consisting of following components:

- Arduino Uno Board
- Temperature Sensor LM-35
- 9V DC Battery
- BJT
- 6V Relay
- Cooling device (9-12V dc fan used for demonstration)
- Heating device (led used for demonstration)

Second module will be soil moisture control module consisting of following components

- Arduino Uno Board
- Soil moisture sensor/Hygrometer YL-69
- 3-6V dc water pump
- BJT

Third module will be light control module consisting of following components

- Arduino Uno Board
- Light Dependent Resistor (LDR)
- 3W Bulb

- 6V relay
- BJT

Fourth module will be water level detection module consisting of following components

- Water level detection and droplet depth sensor
- 3-6V Buzzer

Fifth module will be Bluetooth module to get data on the phone using an android application names as *ardudroid*. This module will contain following components

- Arduino UNO
- Bluetooth Module HS-05

4.1 ARDUINO UNO

Arduino is based on a microcontroller board design, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. The Uno is a microcontroller board based on the ATmega328P .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; we simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

4.1.1 TECHNICAL SPECIFICATIONS

Table 4.1: Specifications of arduino board.

Microcontroller	**328p**
Operating Voltage	5V
Input Voltage(recommended)	7-12V
Input Voltage(limit)	6-20V
Digital Inputs/Outputs pins	14(out of which 6 provide PWM)
PWM digital I/O pins	6
Analog Inputs	6
DC current per I/O pin	20mA
DC current for 3.3V pin	50mA
Flash memory	32 KB (out of which 0.5 KB used by boot loader)
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

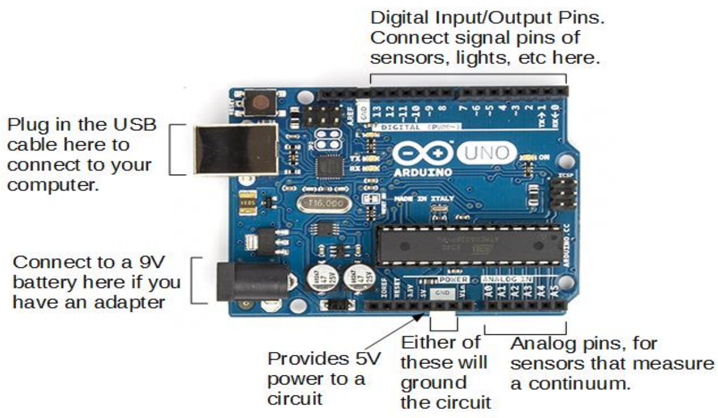


Fig 4.1: Basic arduino Uno Board

4.1.2 ATMEGA 328P

The ATmega328 is a single chip microcontroller created by Atmel and belongs to mega AVR series The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes.

Table 4.2:Technical specifications of ATMEGA-328P

Parameter	Value
CPU type	8-bit AVR
Performance	20 MIPS at 20 MHz
Flash memory	32 kB

SRAM	2 kB
EEPROM	1 kB
Pin count	28-pin PDIP, MLF, 32-pin TQFP, MLF[2]
Maximum operating frequency	20 MHz
Maximum I/O pins	26
External interrupts	24

4.1.3 PIN DESCRIPTION OF ATMEGA328P

The Atmega328 has 28 pins. It has 14 digital I/O pins, of which 6 can be used as PWM outputs and 6 analog input pins. These I/O pins account for 20 of the pins.

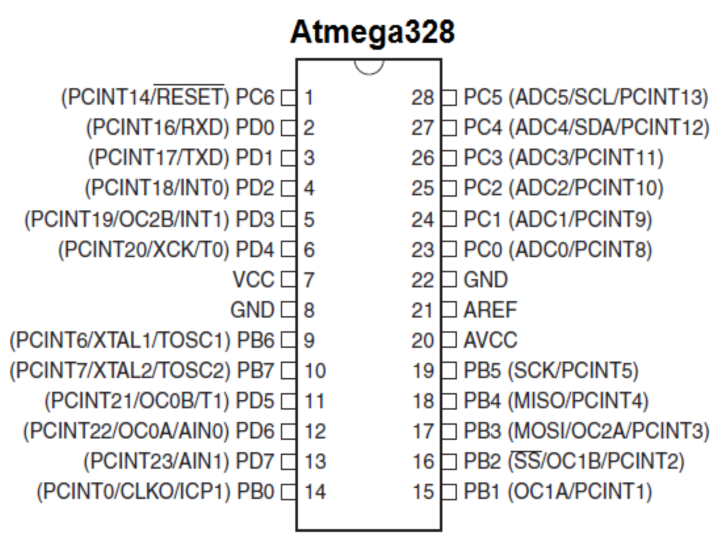


Fig 4.2:Pin diagram of Atmega328P

The table below gives a description for each of the pins, along with their function

Table 4.3-Pin Description of Atnega-328P

Pin Number	**Description**	**Function**
1	PC6	Reset
2	PD0	Digital Pin (RX)
3	PD1	Digital Pin (TX)
4	PD2	Digital Pin
5	PD3	Digital Pin (PWM)
6	PD4	Digital Pin
7	Vcc	Positive Voltage (Power)
8	GND	Ground
9	XTAL 1	Crystal Oscillator
10	XTAL 2	Crystal Oscillator
11	PD5	Digital Pin (PWM)
12	PD6	Digital Pin (PWM)
13	PD7	Digital Pin
14	PB0	Digital Pin
15	PB1	Digital Pin (PWM)
16	PB2	Digital Pin (PWM)
17	PB3	Digital Pin (PWM)
18	PB4	Digital Pin
19	PB5	Digital Pin
20	AVCC	Positive voltage for ADC (power)
21	AREF	Reference Voltage
22	GND	Ground
23	PC0	Analog Input
24	PC1	Analog Input
25	PC2	Analog Input
26	PC3	Analog Input
27	PC4	Analog Input
28	PC5	Analog Input

As stated , 20 of the pins function as I/O ports. This means they can function as an input to the circuit or as output. Whether they are input or output is set in the software. 14 of the pins are digital pins, of which 6 can function to give PWM output. 6 of the pins are for analog input/output.

Two of the pins are for the crystal oscillator. This is to provide a clock pulse for the Atmega chip. A clock pulse is needed for synchronization so that communication can occur in synchrony between the Atmega chip and a device that it is connected to.

The chip needs power so 2 of the pins, Vcc and GND, provide it power so that it can operate. The Atmega328 is a low-power chip, so it only needs between 1.8-5.5V of power to operate.

The Atmega328 chip has an analog-to-digital converter (ADC) inside of it. This must be or else the Atmega328 wouldn't be capable of interpreting analog signals. Because there is an ADC, the chip can interpret analog input, which is why the chip has 6 pins for analog input. The ADC has 3 pins set aside for it to function- AVCC, AREF, and GND. AVCC is the power supply, positive voltage, that for the ADC. The ADC needs its own power supply in order to work. GND is the power supply ground.

AREF is the reference voltage that the ADC uses to convert an analog signal to its corresponding digital value. Analog voltages higher than the reference voltage will be assigned to a digital value of 1, while analog voltages below the reference voltage will be assigned the digital value of 0. Since the ADC for the Atmega328 is a 10-bit ADC, meaning it produces a 10-bit digital value, it converts an analog signal to its digital value, with the AREF value being a reference for which digital values are high or low. Thus, a portrait of an analog signal is shown by this digital value; thus, it is its digital correspondent value.

The last pin is the RESET pin. This allows a program to be rerun and start over.

4.2 LM35 TEMPERATURE SENSOR

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device does not require any external calibration or trimming to provide accuracies of ±¼°C at room temperature.

The low-output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 draws only 60 µA from the supply, it very low self-heating of less than 0.1°C in still air.

4.2.1 FEATURES OF LM35

- LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C)
- The operating temperature range is from -55°C to 150°C.
- Linear + 10-mV/°C Scale Factor
- Operates from 4 V to 30 V
- Less than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Non-Linearity Only ±¼°C

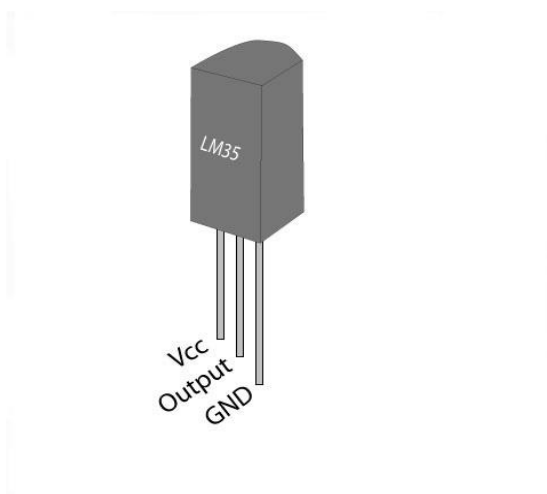


Fig 4.3: LM35 Temperature Sensor

4.2.2 PIN DESCRIPTION OF LM35

Table 4.4 : Pin description of LM35

Pin No	Function	Name
1	Supply voltage; 5V (+35V to -2V)	Vcc
2	Output voltage (+6V to -1V)	Output
3	Ground (0V)	Ground

4.3 DC MOTOR

A DC motor is a class of electrical machines that converts direct current electrical power into mechanical power.

This DC or direct current motor operation is based on the principle when a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. This is known as motoring action. If the direction of current in the wire is reversed, the direction of rotation also reverses. When magnetic field and electric field interact they produce a mechanical force, and based on that the working principle of dc motor established.

A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances.

4.4 RELAY SWITCH

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. Solid-state relays control power circuits with no moving parts.

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two contacts in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open.

Fig 4.4 a: A solid state relay

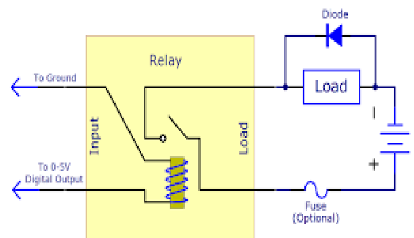


Fig 4.4 b: Basic operation of relay

When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position.

A relay switches one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways.

- NO contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive.
- NC contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive.

- CO or double-throw (DT), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal

4.5 SOIL MOISTURE SENSOR(YL-69) / HYGROMETER

This is an Electrical resistance Sensor. The sensor is made up of two electrodes. This soil moisture sensor reads the moisture content around it. A current is passed across the electrodes through the soil and the resistance to the current in the soil determines the soil moisture. If the soil has more water resistance will be low and thus more current will pass through. On the other hand when the soil moisture is low the sensor module outputs a high level of resistance. This sensor has both digital and analogue outputs. Digital output is simple to use but is not as accurate as the analogue output.

This module sensor module package consists of has 2 parts- a Sensor part, and a PCB for output and sensitivity control. This module sensor module package consists of has 2 parts- a Sensor part, and a PCB for output and sensitivity control.

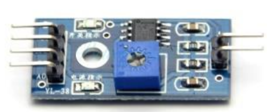


Fig 4.5(a):PCB module for YL-69

Fig 4.5(b) :YL-69 Sensor

The sensitivity control PCB has 4 pins (VCC, GND, D0, A0) on one side, and 2 pins on the other where the sensor will be connected. The Sensor (YL-69) has only 2 pins. The sensor side with ‘YL-69’ written on it will be considered ‘top side’.

YL-69 soil moisture sensor has the following specifications

Table 4.5: Specifications for YL-69 Moisuture sensor

Vcc power supply	3.3V or 5V
Current	35mA
Signal output voltage	0-4.2V
Digital Outputs	0 or 1
Analog	Resistance (Ω)
Panel Dimension	3.0cm by 1.6cm
Probe Dimension	6.0cm by 3.0cm
GND	Connected to ground

4.6 DC WATER PUMP

DC water pump works on Bernoulli's principle which states; as fluid speed increases pressure decreases. Air is a fluid along with water, and inside the pump there is an impeller. That impeller starts to move the air fast causing a pressure drop. The low pressure inside causes water to be drawn up the bottom tube and shot out the side.

Fig 4.6:DC water pump

4.7 LIGHT DEPENDENT RESISTOR (LDR)/PHOTORESISTOR

A photoresistor is a light controlled variable resistor. It follows the principle of photoconductivity i.e. resistance of photoresistor decreases with increasing light intensity.

A photoresistor is made of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several mega ohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands.

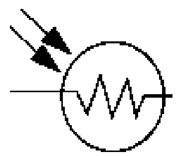


Fig 4.7 a:Circuit symbol of LDR

Fig 4.7b:LDR

4.8 WATER LEVEL DEPTH DETECTION SENSOR

Water level depth detction sensor is based on the principle of conductance method. The conductance method of liquid level measurement is based on the electrical conductance of the measured material, which is usually a liquid that can conduct a current with a low-voltage source (normally <20 V). Hence the method is also referred to as a conductivity system. Conductance is a relatively low-cost, simple method to detect and control level in a vessel.One common way to set up an electrical circuit is to use a dual-tip probe that eliminates the need for grounding a metal tank. Such probes are generally used for point level detection, and the detected point can be the interface between a conductive and nonconductive liquid.

Fig 4.8 : Water level depth detection sensor

4.9 BUZZER

A buzzer or beeper. It works on the principle of generating electricity when mechanical pressure is applied to certain materials and the vice versa is also true. Such materials are called piezo electric materials.

.

Fig 4.9:An electronic buzzer

CHAPTER 5

SWITCHING CIRCUITS

5.1 BJT AS A SWITCH

Solid state switches are one of the main applications for the use of transistor to switch a DC output “ON” or “OFF”. the circuit uses the Bipolar Transistor as a Switch, then the biasing of the transistor, either NPN or PNP is arranged to operate the transistor at both sides of the “ I-V ” characteristics curves. The areas of operation for a transistor switch are known as the Saturation Region and the Cut-off Region**.** We use the transistor as a switch by driving it back and forth between its “fully-OFF” (cut-off) and “fully-ON” (saturation) regions.

5.1.1 OPERATING REGIONS OF BJT

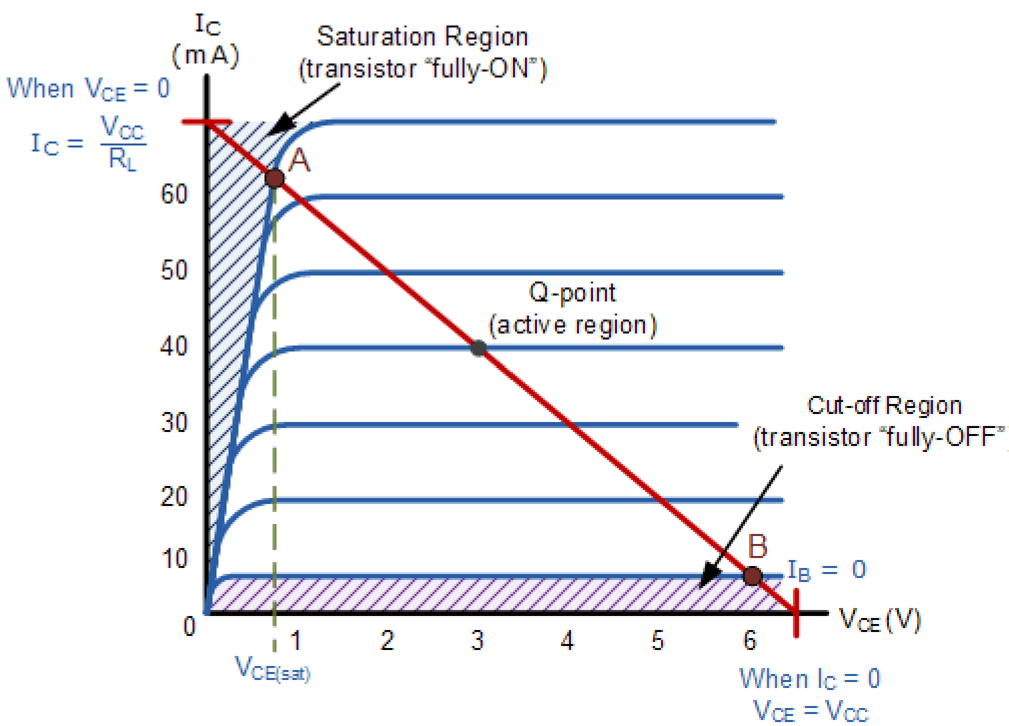


Fig 5.1 : Operating regions for BJT

1. Cut-off Region

Here the operating conditions of the transistor are zero input base current (I_B), zero output collector current (I_C) and maximum collector voltage (V_{CE}) which results in a large depletion layer and no current flowing through the device. Therefore the transistor is switched "Fully-OFF".

Cut-off Characteristics

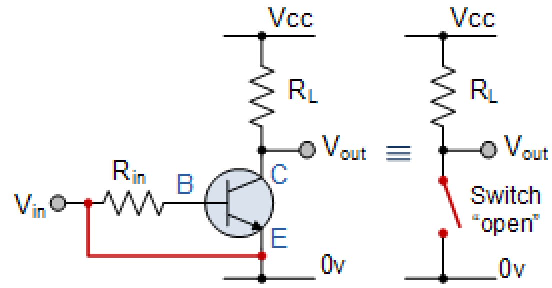


Fig 5.2 : BJT as an Open Switch

- The input and Base are grounded (0v)
- Base-Emitter voltage $V_{BE} < 0.7v$
- Base-Emitter junction is reverse biased
- Base-Collector junction is reverse biased
- Transistor is "fully-OFF" (Cut-off region)
- No Collector current flows ($I_C = 0$)
- $V_{OUT} = V_{CE} = V_{CC} =$ "1"
- Transistor operates as an "open switch"

Thus we can define the "cut-off region" or "OFF mode" when using a bipolar transistor as a switch as being, both junctions reverse biased, $V_B < 0.7v$ and $I_C = 0$.

2. Saturation Region

Here the transistor will be biased so that the maximum amount of base current is applied, resulting in maximum collector current resulting in the minimum collector emitter voltage drop which results in the depletion layer being as small as possible and maximum current flowing through the transistor. Therefore the transistor is switched "Fully-ON"

Saturation Characteristics:

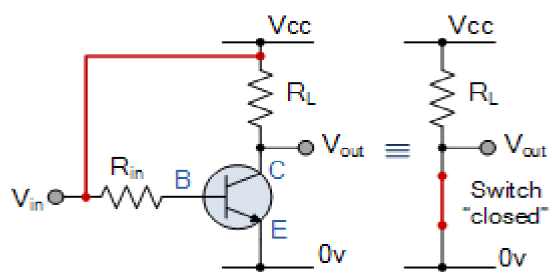


Fig 5.3: BJT as a closed switch

- The input and Base are connected to V_{CC}
- Base-Emitter voltage $V_{BE} > 0.7v$
- Base-Emitter junction is forward biased
- Base-Collector junction is forward biased
- Transistor is "fully-ON" (saturation region)

- Max Collector current flows ($I_C = Vcc/R_L$)
- $V_{CE} = 0$ (ideal saturation)
- $V_{OUT} = V_{CE}$ = ”0″
- Transistor operates as a “closed switch”

Thus we can define the “saturation region” or “ON mode” when using a bipolar transistor as a switch as being, both junctions forward biased, $V_B > 0.7v$ and I_C = maximum.

5.2 RELAY AS A SWITCH

Relays are electromechanical devices that use an electromagnet to operate a pair of movable contacts from an open position to a closed position. The design and types of relay switching circuits is huge, but many small electronic projects use transistors and MOSFETs as their main switching device as the transistor can provide fast DC switching (ON-OFF) control of the relay coil from a variety of input sources so here is a small collection of some of the more common ways of switching relays.

A typical relay switch circuit has the coil driven by a NPN transistor switch, TR1 as shown depending on the input voltage level. When the Base voltage of the transistor is zero (or negative), the transistor is cut-off and acts as an open switch. In this condition no Collector current flows and the relay coil is de-energized because being current devices, if no current flows into the Base, then no current will flow through the relay coil.

If a large enough positive current is now driven into the Base to saturate the NPN transistor, the current flowing from Base to Emitter (B to E) controls the larger relay coil current flowing through the transistor from the Collector to Emitter.

For most bipolar switching transistors, the amount of relay coil current flowing into the Collector would be somewhere between 50 to 800 times that of the required Base current to drive the transistor into saturation.

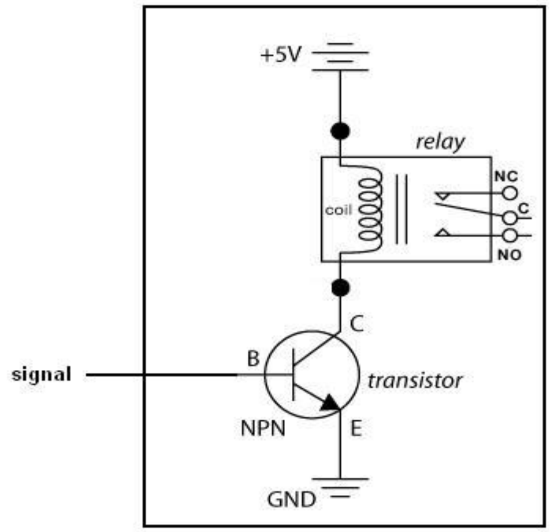


Fig 5.4: NPN Relay Switch Circuit

When power is applied to the coil due to the switching action of the transistor, a maximum current will flow as a result of the DC resistance of the coil as defined by Ohms Law, (I = V/R). Some of this electrical energy is stored within the relay coil's magnetic field.

When the transistor switches "OFF", the current flowing through the relay coil decreases and the magnetic field collapses. However the stored energy within the magnetic field has to go some- where and a reverse voltage is developed across the coil as it tries to maintain the current in the relay coil. This action produces a high voltage spike across the relays coil that can damage the switching NPN transistor if allowed to build up. So in order to prevent damage to the semiconductor transistor, a "flywheel diode", also known as a freewheeling diode, is connected across the relay coil. This flywheel diode clamps the reverse voltage across the coil to about 0.7V dissipating the stored energy and protecting the switching transistor.

5.3 COMPARISON OF TRANSISTOR AND RELAY AS A SWITCH

Table 5.1:Comaprison of transistor as a switch and relay as a switch

Transistor	**Relay**
• Transistors can have their voltage drop varied.	• Relays are on-off devices.
• Relays are far slower than transistors; typically 50ms to switch.	• Some types of transistors can switch in picoseconds.
• Relays are electromagnetic and bring problems like interference with other relays in the circuit.	• Transistors are not very EM sensitive. They do not emit much electromagnetic interference.
• Relays also have a much lower internal resistance.	• BJT will have some resistance and drop some voltage.
• Relays have infinite open resistance.	• BJT have leakage that can affect attached electronics.
• Semiconductors can amplify analog signals.	• Relays can only open and close.

5.4 CHOICE OF APPLICATION OF RELAY AND TRANSISTOR AS A SWITCH

Relays are an acceptable choice when the load that needs to be controlled draws more than a couple of amps, and when the switching will not be that frequent.

When we need to break (shut off) a current of several amps, load inductance can cause voltage spikes that will damage a transistor. Relay contacts, being basically large pieces of metal, have much greater tolerance to this application, but even so, breaking large load currents will eventually burn out relay contacts.

When DC load draws low current (<400 mA) and switching if frequent ,transistor as a switch can be suitable option.

CHAPTER 6

DESIGN AND IMPLEMENTATION

In the design of the system analog pins were selected as the arduino input and digital pin was selected as the arduino output pins.

The important pins on the arduino board are shown in the table below.

Table 6.1:Important pins in arduino

AREF	Analog Reference pin
GND(Digital side)	Digital Ground
Vin	Input voltage (external power source)
5V	Regulated power to the microcontroller
3.3V	3.3V generated by the on-board FTDI chip
GND	Ground

Table 6.2-Pins selected on arduino

Pin	Connections
Analog pin 0 (a0)	Connection to temperature sensor
Analog pin 1 (a0)	Connection to soil moisture sensor
Analog pin 3 (a0)	Connection to LDR
Analog pin 4 (a0)	Connection to water level sensor
Digital pin 2	Buzzer
Digital pin 4	Water Pump
Digtal pin 9	Fan
Digtal pin 11	Heater
Digtal pin 12	Bulb
VCC (5V DC)	5V DC
GND	GROUND

6.1 WORKING OF TEMPERATURE MODULE

The temperature sensor records the temperature and outputs constant Analog voltage levels. These voltages are fed to the internal ADC (Analog to Digital Converter) of microcontroller Atmega328P.Here we have used analog pin 0 to take output from the temperature sensor.

Threshold Conditions: if temperature>=28 :FAN ON

if temrerature<=15 :Heater ON

else :NONE

If the temperature exceeds the temperature value of 28ºC microcontroller will output 5V to a switching circuit which will turn on a cooling device (a dc fan used for the demonstration purpose).

If temperature is below 15ºC, a 5V signal from microcontroller will turn on a relay circuit which will turn on the heating device(bulb used for demonstration purpose) by completing the current path.

Switching Circuits used:

- BJT as a switch for 9V DC fan
- BJT as a switch to trigger relay to turn ON heater.

6.1.1 CIRCUIT IMPLEMENTATION OF TEMPERATURE MODULE

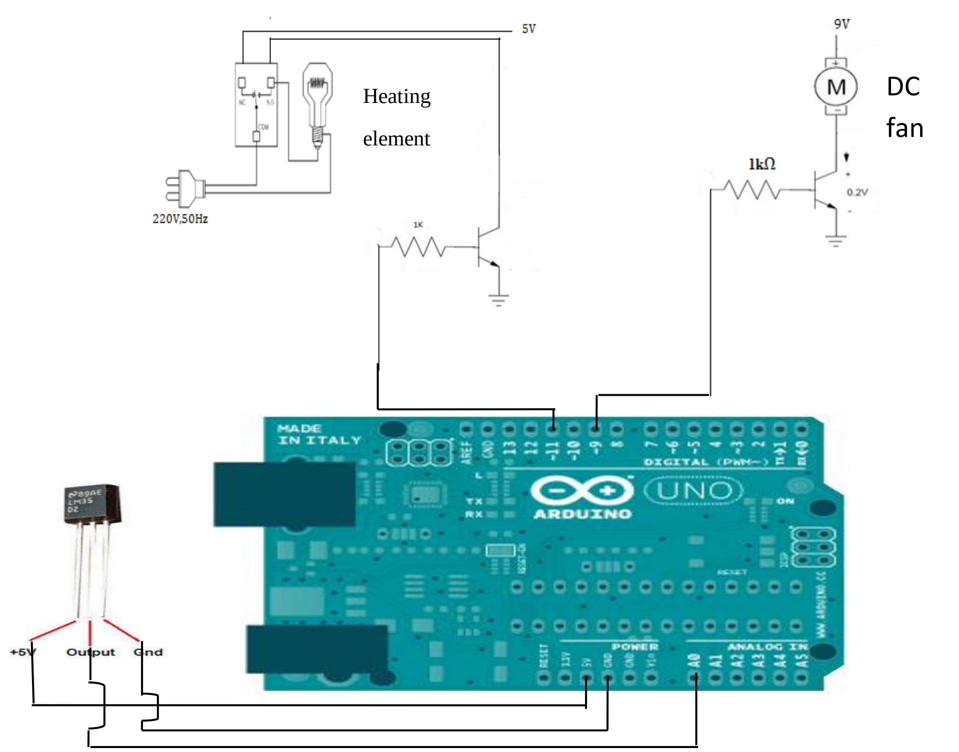


Fig 6.1: Circuit implementation of temperature module.

6.2 WORKING OF MOISTURE MODULE

Analog signal from YL-69 was fed to the analog pin. For dry soils the sensor will indicate higher resistance portrayed by the low current reading. Whenever a dry condition in soil is encountered i.e. value displayed on serial monitor >500, the digital pin 4 outputs a 5V signal to switch , for switching ON the dc water pump used for water supply. When the moisture content in the soil is high more current will be allowed to flow thus indicating low resistance and message "*ALERT !!!Excess amount of water"* will be displayed on serial monitor.

Switching Circuit : BJT as a switch.

6.2.1 CIRCUIT IMPLEMENTATION OF MOISTURE MODULE

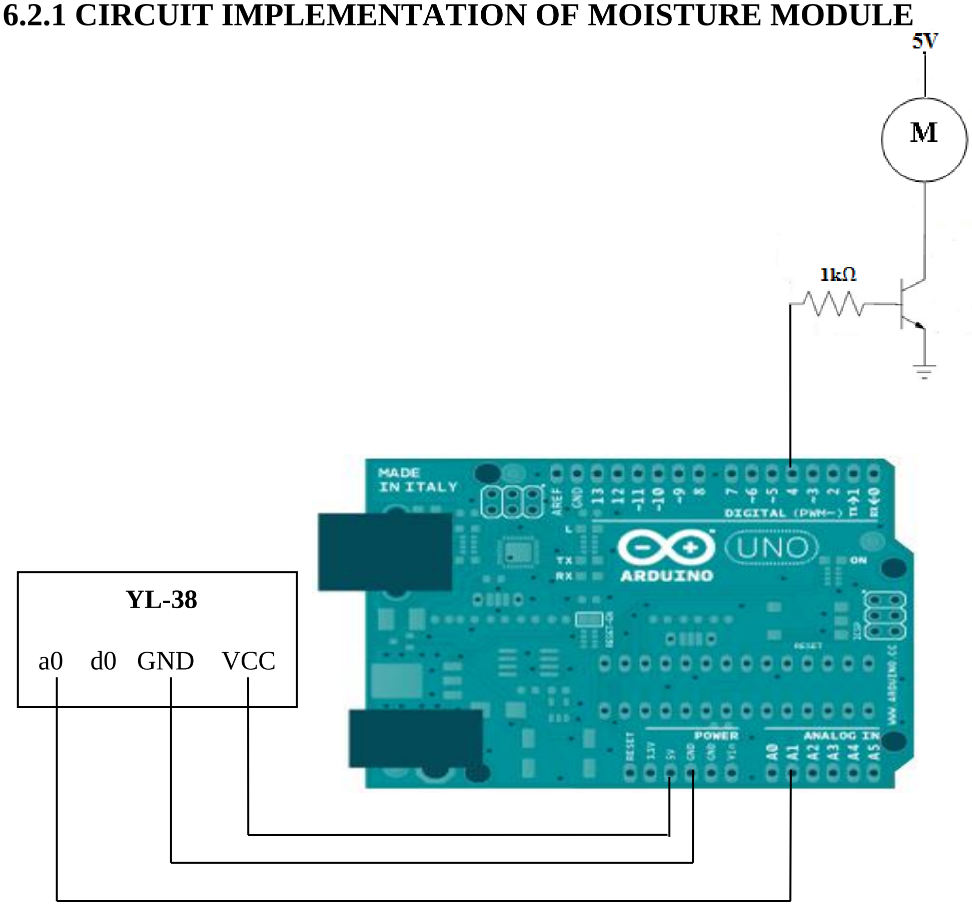


Fig 6.2 :Circuit implementation of moisture module

6.3 WORKING OF LIGHT MODULE

An LDR (LIGHT dimming resistor) gives a high value of resistance(in M Ω) i.e low value of voltage drop across an LDR in dark and as we keep on increasing light intensity resistance goes on decreasing and a large amount of current is passed giving large voltage drop.

Voltage signal from potential divider circuit of an LDR and 1(kΩ) resistor is fed into analog pin 3 of an arduinoUNO board and an ADC will convert this into some digital value.

Threshold values: if value on monitor<=20: Bulb ON

if value on monitor>21 BULB OFF**.**

Switching circuit : BJT as a switch to trigger relay to complete circuit path

6.3.1 CIRCUIT IMPLEMENTATION OF LIGHT MODULE

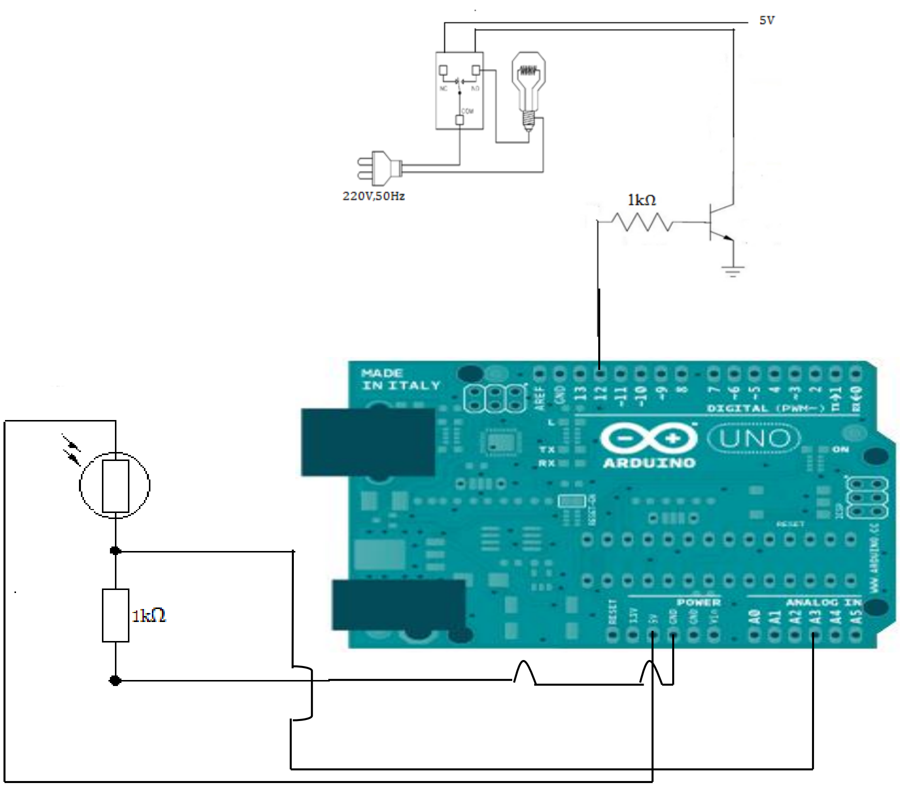


Fig 6.3 : Circuit implementation of Light Module

6.4 WORKING OF WATER LEVEL MODULE

Analog value from water level sensor will be fed into analog pin 4 and ADC will convert it into digital value. Different value of voltages will be noted for different water levels. When water level <=2cm (value displayed on serial monitor <516) an electronic buzzer connected to digital pin 2 will be turned ON to inform user about decreased water level.

No switching circuit is required to trigger buzzer as its current rating wa 15mA which is less than maximum rating of digital pin i.e. <20mA.

6.4.1 CIRCUIT IMPLEMENTATION OF WATER LEVEL MODULE

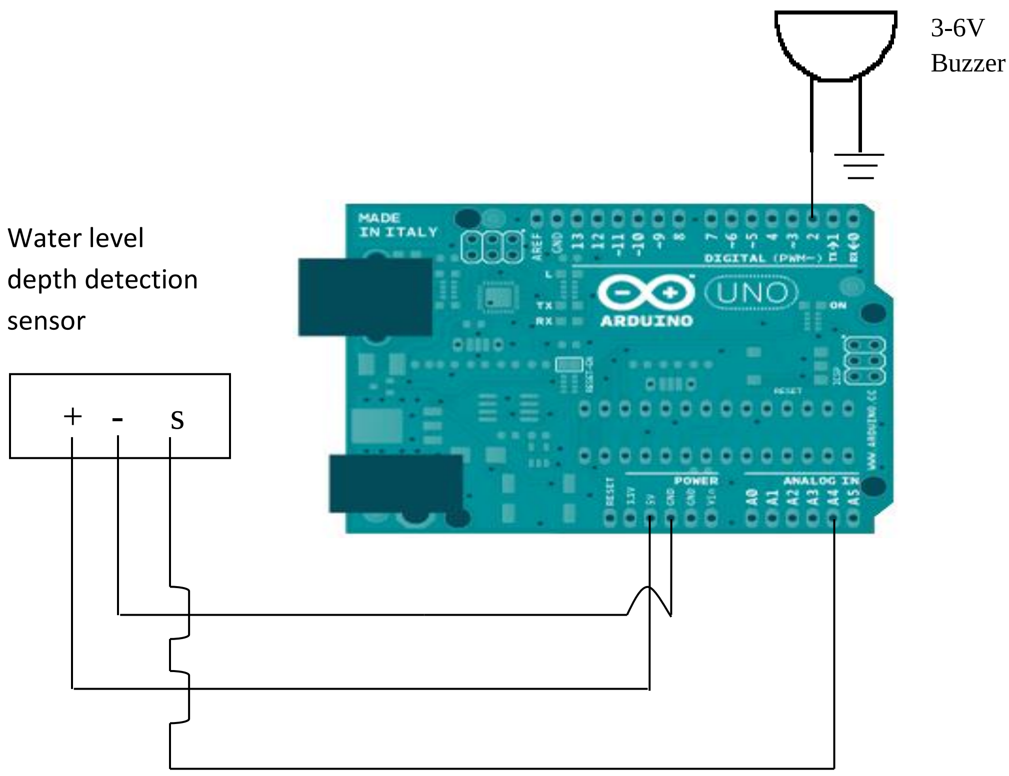


Fig 6.4 : Circuit implementation of Water level module

CHAPTER 7

SOFTWARE DESCRIPTION

7.1 EMBEDDED C

Embedded C is language for programming the microcontroller for embedded applications. There is a large and growing international demand for programmers with embedded skills and many desktop developers are starting to move in this developed area.

The reasons for writing programs in C are

- It is easier and less time consuming to write in C than assembly.
- C is easier to modify and update.
- We can use code available in function libraries.
- C is portable to other microcontrollers also

7.2 ARDUINO IDE

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers. The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in Java. The Arduino IDE supports the C and C++ programming languages using special rules of code organization. The Arduino IDE supplies a software library called "Wiring" from the Wiring project, which provides many common input and output procedures.

A typical Arduino C/C++ sketch consist of two functions that are compiled and linked with a program stub main() into an executable cyclic executive program

- setup(): a function that runs once at the start of a program and that can initialize settings.
- loop(): a function called repeatedly until the board powers off.

7.2.1 SERIAL MONITOR

Serial monitor is the part of arduino IDE software. Its job is to allow you to both send messages from your computer to an arduino board (over USB) and also to receive messages from the arduino . All arduino boards have at least one serial port (also known as a UART or USART).

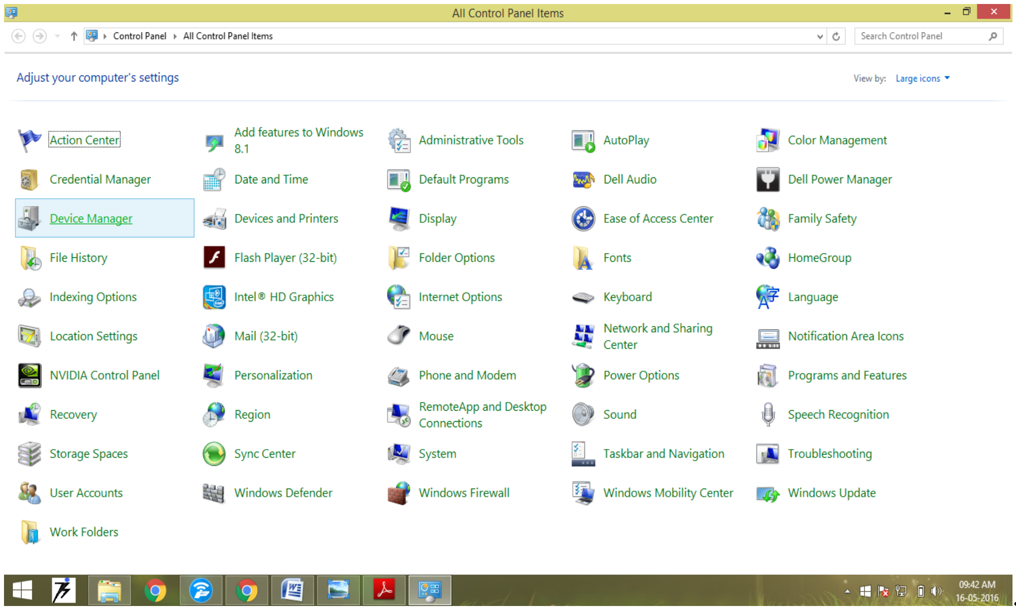
7.2.2 USB A/B

To connect microcontroller with PC for programming we need an USB A/B. THE USB cable is used to connect arduino board with PC.

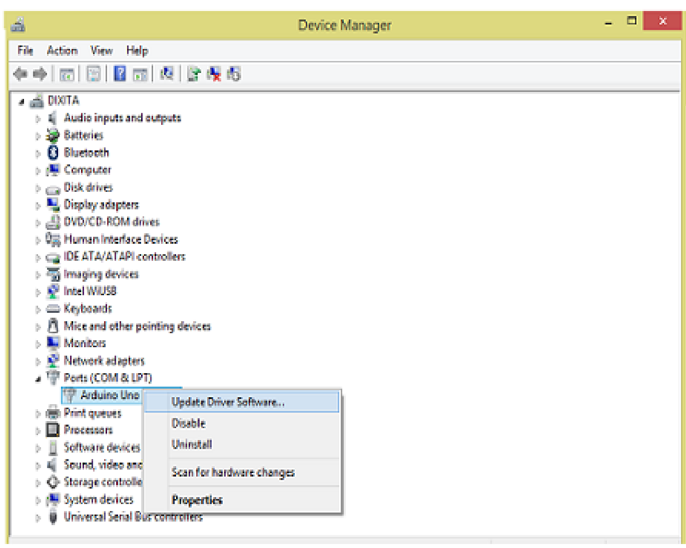
Fig 7.1 : A USB A/B cable

7.2.3 STEPS TO INTSTALL DRIVER SOFTWARE

- Insert USBasp programmer, then open Device Manager. There you will find USBasp in yellow mark



- Right click on the yellow marked USBasp, and then click on Update DriverFig



- Update the driver using “Browse my computer for Driver Software”
- After installation close the window.

7.3 WRITING THE PROGRAM

- Open the installed AVR Studio.
- Select port and board name in tools.
- Name the project you are working in. This will create your .ino file with the same name as your project name inside the project folder.
- Now start writing your code in the editor window.
- After writing your code, click on “Verify” button and after compiling click on "Upload" button.
- After the code is uploaded , check for your results on Serial Monitor.

CHAPTER 8

OBSERVATIONS AND RESULTS

8.1 TEMPERATURE MODULE

The following values were observed for LM35 temperature sensor

Table 8.1: Data for LM35 temperature sensor

Temperature(ºC)	Voltage(mV)
16	159mV
24	240mV
28	277mV
29	290mV

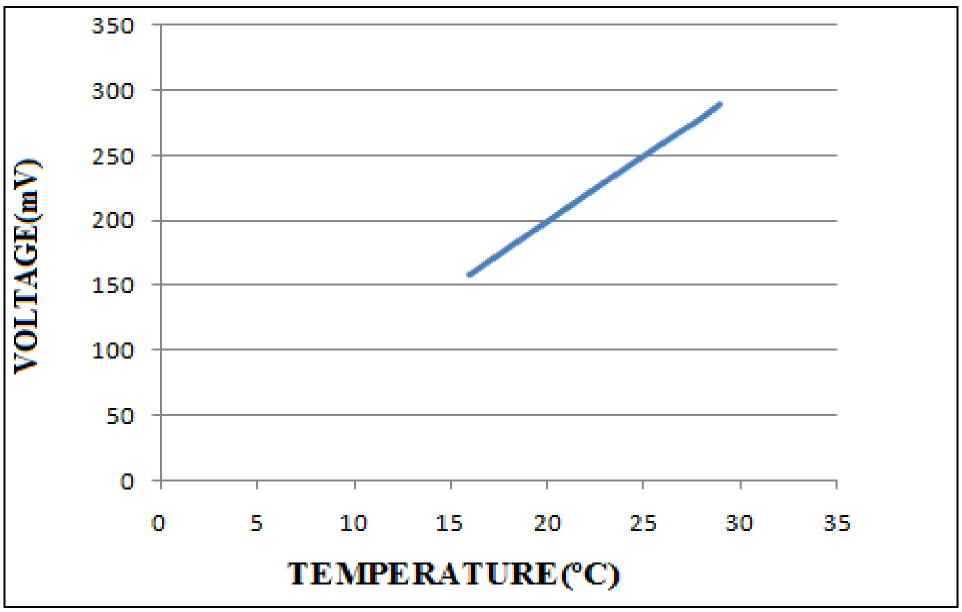


Fig 8.1:Temperature vs Voltage graph

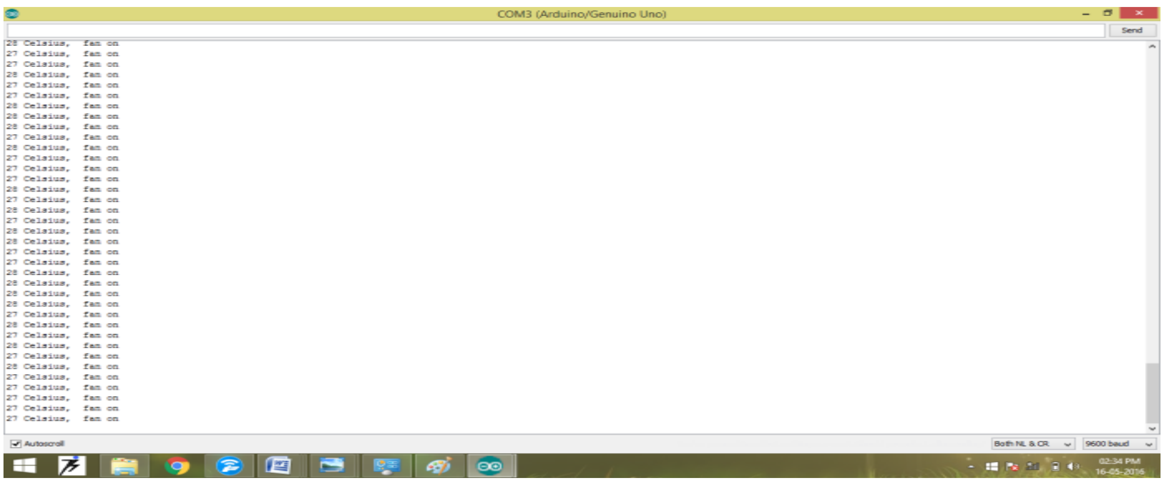
Temperature sensor sensitivity factor came out to be 10mV/ºC(increase).

RESULT: When temperature conditions were set for turning ON the fan ,DC fan triggered accurately according to the set condition.

Condition 1: if temp>25:FAN ON

if temp<15 heater ON

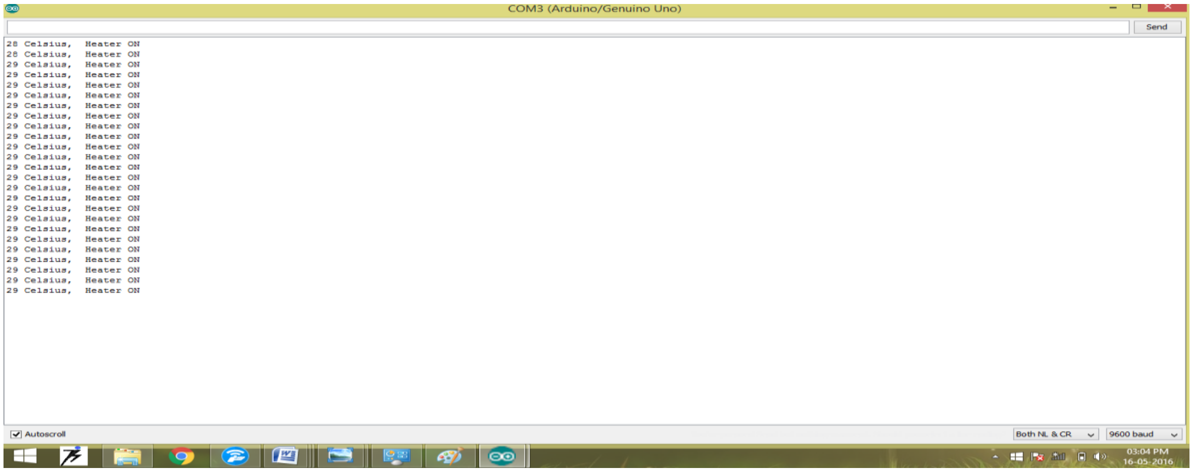
else None



Condition 2:if temperature<30:Heater ON

if temperature>50:Fan ON

else NONE



8.2 MOISTURE MODULE

Table 8.2: Data for YL-69 soil moisture sensor

Soil water content	Sensor reading(Ω)
Extreme dry soil	1023-570
Dry soil	570-400
Moderate water content	400-195
EXCESS WATER CONTENT	<195

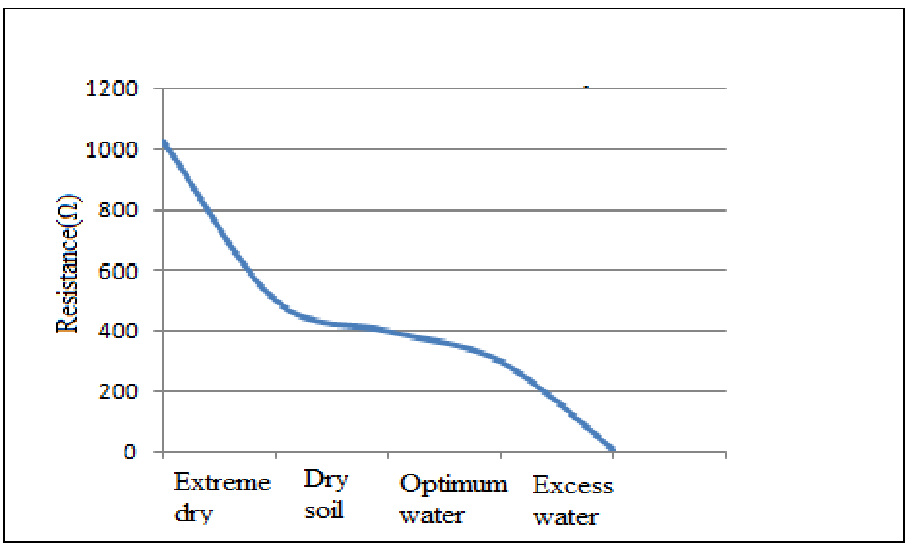


Fig 8.2 : Soil moisture Vs Resistance graph

The obtained graph is an exponential one. The value of the soil resistance decreases with increase in water content to a certain point.

On reaching the dry condition i.e. resistance>=570, a dc water pup was correctly triggered.

8.3 LIGHT MODULE

The following values of voltage and resistance of LDR were observed

Table 8.3: Data for LDR

Light Intensity	Voltage(mV)	LDR Resistance
Natural light	88	343 Ω
Room light	68	364 Ω
Large light intensity	103	328 Ω
Dark	3.5	5.7kΩ
Extreme dark	1.23	12MΩ

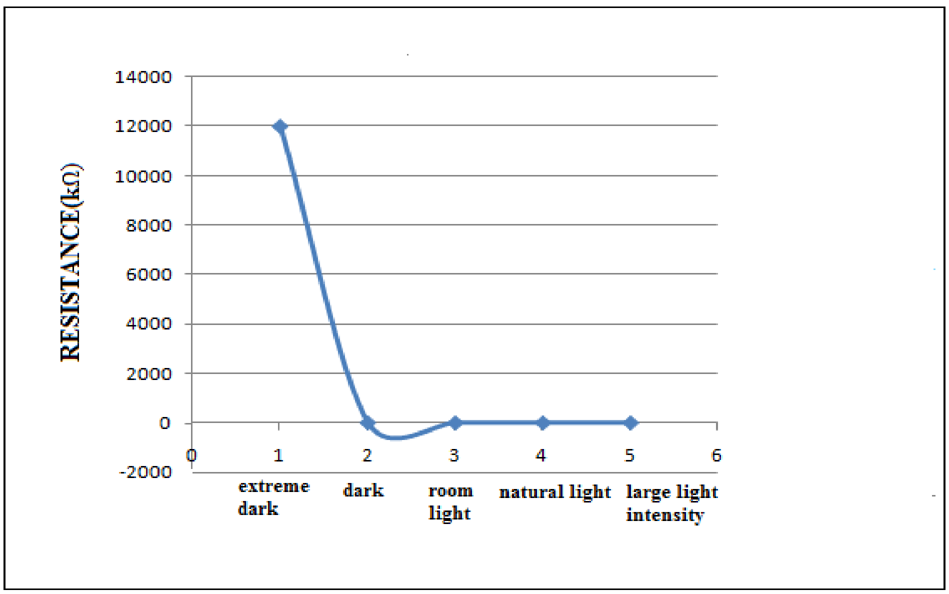


Fig 8.3 :Light Intensity vs Resistance graph

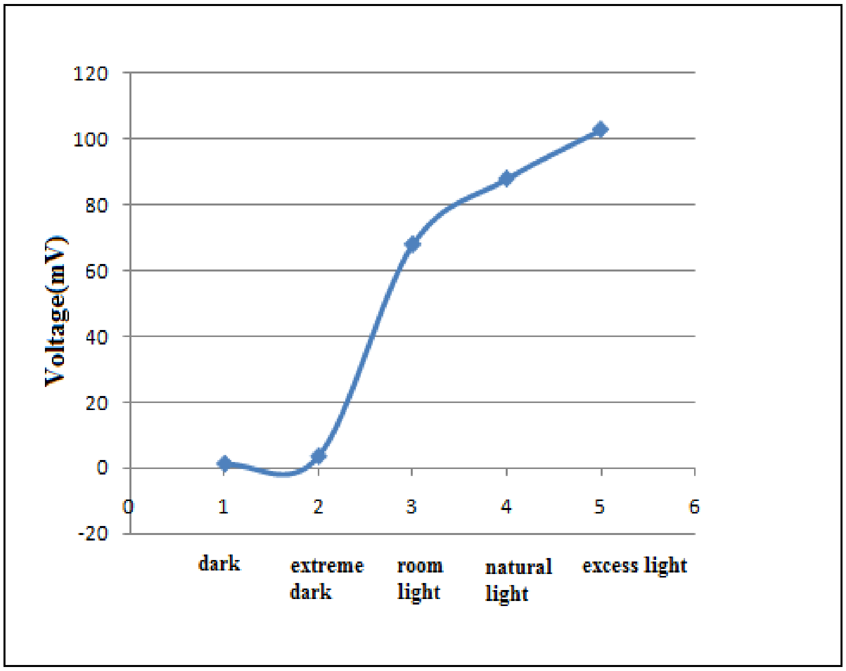


Fig8.4: Light intensity Vs Voltage graph

Resistance of an LDR showed a declining trend with increasing light intensity as per the photoconductivity principle.

Voltage across an LDR increased with increasing light intensity.

RESULT : A 3W bulb corresponding to LDR,was triggered correctly when light intensity was less in order to maintain the artificial light required for optimum plant growth.

8.4 WATER LEVEL DEPTH SETECTION MODULE

For water level module following readings were observed

Table 8.4 : Data for water level sensor

Water level(cm)	Voltage (V)	Integer value
0	0	0
1	2.601	496
2	2.667	516
3	2.734	572
4	2.80	586

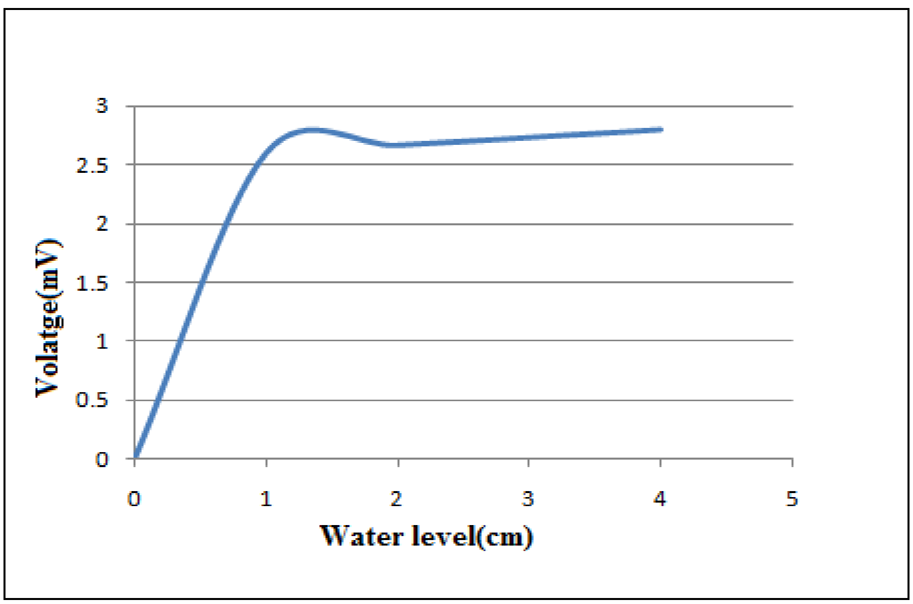


Fig 8.5 : Water Level vs Volatge graph

RESULT: Sensitivity factor : 66mV/cm

The buzzer connected to arduino ,triggered accurately as water level reached <=2cm i.e value displayed on serial monitor <=516.

LIMITATIONS

- The soil moisture sensor in dry sate gave a large current that increased temperature for a very small time and hence sudden hike was observed in temperature .
- The maximum current given by arduino port pin was 20mA and hence was not able to drive the devices.
- Current rating of arduino pin was not sufficient to drive a relay hence an extra switching circuit was used to drive relay circuit.
- Temperature sensor should not be placed in the closed vicinity of heating element , in order to avoid hike in temperature.
- Orientation of bulb should be such that ,LDR do not read its intensity as optimum intensity and bulb gets switched OFF.
- We can't keep YL-38 powered for a long period of time. If we leave it on for a long time it will keep on applying a DC current to YL-69 sensor causing corrosion due to electrolysis and this may reduce the sensor lifetime .In order to keep our sensors in good shape we will have to power on the device before taking the reading and this will somehow hinder the automation.
- Since the proposed model has a small area and hence working of one sensor effects the working of other sensor.

REFERENCES

[1] Diaa Mehdi Faris Mahmood Basil Mahmood *Data Acquisition of Greenhouse Using Arduino* ,Journal of Babylon University/Pure and Applied Sciences/ No.(7)/ Vol.(22): 2014.

[2] Sumit A. Khandelwal *Automated Green House Management Using GSM MODEM*, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 3 (1) , 2012, 3099 - 3102.

[3] S. V. Devika, Sk. Khamuruddeen, Sk. Khamurunnisa, Jayanth Thota, Khalesha Shaik Devika *Arduino based automatic plant watering system,* International Journal of Advanced Research in Computer Science and Software Engineering 4(10), October - 2014, pp. 449-456.

[4] Massimo Banzi, *Getting started with Arduino*, Second Edition, O'Reilly Media, Inc, 2011

[5] Robert L.Boylestad , LouisbNashelsky,*Electronic Devices and Circuit Theory, Tenth Edition*

[6] www.arduino.cc accessed throughout the project

[7] <http://www.alldatasheet.com/datasheet-pdf/pdf/8866/NSC/LM35.html>

[8] <http://store.roboticsbd.com/sensors/145-yl-69-soil-humidity-moisture-sensor-bangladesh.html>

[9]http://eie.uonbi.ac.ke/sites/default/files/cae/engineering/eie/MICROCONTROLLER-BASED%20IRRIGATION%20SYSTEM.pdf

[10] http://microcontrollerslab.com/green-house-intelligent-control-system

[11] <https://www.fairchildsemi.com/datasheets/BC/BC547.pdf>

[12] <www.electrical4u.com/light-dependent-resistor-ldr-working-principle-of-ldr/>

[13] <www.edgefxkits.com/blog/light-dependent-resistor-ldr-with-applications/>

[14] <www.globalw.com/products/levelsensor.html>

[15] ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4659512

[16] http://www.allaboutcircuits.com/textbook/semiconductors/chpt-4/transistor-switch-bjt/

APPENDIX A:CODE FOR ATMEGA 328P

```
#include <math.h>
int temppin = 0; // analog pin a0
int tempc = 0; // temperature variables
int fan=9;      // digital pin 9 will provide input to fan
int heater=11;   // output to heating element

int LDR=3;                          // analog pin a3
int LDR_VALUE=0;
int bulb=12;               //         Output to bulb

int moisture_pin=1;       //analog pin a1;
int moisture_value;        // value given by moisture sensor
int motor=4;                              // output to motor

int level_pin=4; //analog pin a2
int level_value;
int buzzer=4;

void setup()
{
  Serial.begin(9600);
 pinMode(fan,OUTPUT);
 pinMode(heater,OUTPUT);
 pinMode(bulb,OUTPUT);
 pinMode(buzzer,OUTPUT);
 pinMode(motor,OUTPUT);
}
void loop() {
```

```
  //temp();
  //light();
  moisture();
  //level();
}

//*************************************************************************
//*********************TEMPERATURE SENSOR ***************************


void temp()
{
tempc=analogRead(temppin);
 tempc=(5.0*tempc*100.0)/1024.0; //CONVERSION OF ANALOG TO DIGITAL
 Serial.print((byte)tempc);
 Serial.print(" Celsius, ");
    if(tempc>45)                    // EXCESS HEAT switch on cooling device
   {
   Serial.println(" fan on");
   digitalWrite(fan,HIGH);
   digitalWrite(heater,LOW);
   }
    else if(tempc<30)                       //temperature low
    {
   Serial.println(" Heater ON");
    digitalWrite(heater,HIGH);
    digitalWrite(fan,LOW);
   }

   else if(tempc>=30 && tempc<=45)   //optimum temperature  conditions
```

```
    {
     digitalWrite(fan,LOW);
      digitalWrite(heater,LOW);
       Serial.println(" its fine");
    }
  delay(500);
}
//***********************************************************
//***************LIGHT SENSOR ******************************
        void light()
        {
        LDR_VALUE=analogRead(LDR);
 Serial.print(  LDR_VALUE);

 if(LDR_VALUE<15) {
  digitalWrite(bulb,HIGH);
  Serial.println("  Bulb on");
 }
else if(LDR_VALUE>20)
 {
  Serial.println("  Optimim light");
 digitalWrite(bulb,LOW);
        }
        delay(500);

        }
//***********************************************************
//*********MOISTURE SENSOR *********************************
void moisture()
{
  Serial.print("   moisture=");
```

```
 moisture_value=analogRead(moisture_pin);
 Serial.print(moisture_value);
     if(moisture_value>501 && moisture_value<=1023)       // DRY Soil
     {
     Serial.println(" dry!!!! MOTOR ON  ");
     digitalWrite(motor,HIGH);
      }
else if(moisture_value>300 && moisture_value<=500)    //OPTIMUM
      {

       digitalWrite(motor,LOW);
       Serial.println(" working fine!!  ");
      }

    else
     {
    Serial.println(" alert..... excess amount of water!!  ");
      digitalWrite(motor,LOW); //large WATER CONTENT
      }

     delay(500);
}




//************************************************************
//*********LEVEL SENSOR ***********************************

void level()
{
```

```
  level_value=analogRead(level_pin);
  Serial.print(level_pin);
  if(level_value<=516)
  {
    Serial.println("low water level!!!!!!!!!!!!refill the tank");
    digitalWrite(buzzer,HIGH);
    delay(100);
    digitalWrite(buzzer,LOW);
    delay(100);
  }
  else
  {
Serial.print("optimim water level");
digitalWrite(buzzer,LOW);
}
delay(500);
}
```

APPENDIX B :LITERATURE REVIEW

TOPIC : Arduino Based Automatic Plant Watering System
BY : S. V. Devika, Sk. Khamuruddeen, Sk. Khamurunnisa, Jayanth Thota, Khalesha Shaik

ABSTRACT : Watering is the most important cultural practice and most labor intensive task in daily greenhouse operation. Watering systems ease the burden of getting water to plants when they need it. Knowing when and how much to water is two important aspects of watering process. To make the gardener works easily, the automatic plant watering system is created. There have a various type using automatic watering system that are by using sprinkler system, tube, nozzles and other. This project uses watering sprinkler system because it can water the plants located in the pots. This project uses Arduino board, which consists of ATmega328 Microcontroller. It is programmed in such a way that it will sense the moisture level of the plants and supply the water if required. This type of system is often used for general plant care, as part of caring for small and large gardens. Normally, the plants need to be watered twice daily, morning and evening. So, the microcontroller has to be coded to water the plants in the greenhouse about two times per day. People enjoy plants, their benefits and the feeling related to nurturing them. However for most people it becomes challenging to keep them healthy and alive. To accommodate this challenge we have developed a prototype, which makes a plant more self-sufficient, watering itself from a large water tank and providing itself with artificial sunlight. The pro-To type reports status of its current conditions and also reminds the user to refill the water tank. The system automation is designed to be assistive to the user. We hope that through this prototype people will enjoy having plants without the challenges related to absent or forgetfulness.

TOPIC: Automated Green House Management Using GSM Modem
BY : Sumit A. Khandelwal

ABSTRACT : The system proposed in this paper collects 'GreenHouse Effect' is the technology to provide plants and trees the required nourishment from the sunlight and to prevent the same from the harmful rays/effects of sunlight. As well as greenhouse environmental information such as temperature, maintaining light intensity as well as fulfilling water requirements etc. Accordingly, monitoring crop itself is as important as monitoring indoor environments. Using these collected greenhouse environmental data, indoor environments can be more effectively controlled, and monitoring crop itself can contribute to improve productivity and to prevent crops from damages by harmful sun ray.

In addition, it will be possible for farmers to do control plant growth through closely studying relationship between indoor environmental information and monitored information on crop itself. It is made possible to collect information and control effectively and automatically greenhouse in the site or from a remote place through GSM modem. System components are: temperature sensor,humidity sensor, leaf temperature sensor, leaf humidity sensor, Rain Sensor, Transistor switches, relay nodes for automatic control, and data server to store greenhouse information. The system is implemented using low power wireless components, and easy to install.