PROJECT

INTELLIGENT BASED GREENHOUSE PLANTATION MONITORING AND CONTROLLING USING GSM

A Thesis

Submitted for partial fulfillment for the bachelor's degree in Electronics (Honor's Degree) to the **Department of ELECTRONICS**

QUAID-I-AZAM UNIVERSITY, Islamabad.

BY

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QUAID-I-AZAM UNIVERSITY

JULY 2019

Declaration by Student

I, **Usama Tahir**, hereby declare that the work presented herein is original work done by me and has not been published or submitted elsewhere for the requirement of a degree program. Any literature date or work done by other and cited within this thesis has given due acknowledgement and listed in the reference section.

Usama Tahir

Quaid-I-Azam University

Islamabad

Date: ________________

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Dr. Arshad Hussain

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CERTIFICATE

Certified that the thesis entitled "Intelligent Based Greenhouse Plantation Monitoring and Controlling using GSM" submitted by **Mr. Usama Tahir** towards partial fulfillment for the bachelor's degree in Electronics is based on the investigation carried out under our guidance. The thesis part therefore has not submitted for the academic award of any other university or institution.

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Abstract:

In this project, an embedded system which is closely monitored and controlled the climate parameters such as temperature, humidity, light and moisture in the soil of a greenhouse based on wireless sensor network on a regular basis around the clock for growth of vegetables or specific plant species which maximize their production was presented. These parameters are monitored and display on an LCD.

The microcontroller used in this project is Arduino UNO with atmega328 IC attached on it. Arduino is the heart of this project because it can communicate between the sensors and the load.

The greenhouse monitoring and controlling project can be done by using wireless technologies. It is a closed loop system, once the temperature and humidity fall or rises above the certain specified range, then an action control the temperature and humidity using relays interface and maintain the functionality of the greenhouse, so no plant is damaged inside the greenhouse. These relays can be attached to fan, a light bulb and sprinkler etc. and at the same time these values of all the parameters transmitted through messages using the GSM module. The GSM module can receive the greenhouse parameters and then convey the data using wireless communication.

The designed system shows the importance of using the wireless sensor network in such application, where the installation, power and running cost can be minimized.

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CHAPTER 1

INTRODUCTION

1.1 Greenhouse Background

The important aspects of all the Greenhouse system present around us are how to control and monitor the Greenhouse. For monitor the Greenhouse stipulations effectively, we should design a control and measurement system. By using different type of sensors, we can measure the present conditions at a given time and take steps if any stimulation present falls or exceed above the pre-decided range. Main idea is implemented of a microcontroller-based application. That application can sense environmental parameters like as humidity, temperature, sunlight and moisture. Increasing of growth of plants and continuously monitoring are the key parameters.

With the use of Wireless Technology, we can transfer information‟s and encloses a wide area of network which cannot be encloses by conventional wire-based system. In this thesis we have proposed a structure that can collect the data which is identified with the Greenhouse environment and provide status and control the Greenhouse frequently. By thoroughly observing the climatic condition, this observation has a reason for making the relationship between the references and sensors, advancement of the provide status and natural variables where they are exhibit. Moreover, the management of programming will give information attainment and control, authentic time graphical shows, dates and time labels the whole information and then save it for present and future utilization.

1.2 What is Greenhouse?

Greenhouse means husbandry of the plants, mainly for materials, comfort, food and beauty. Greenhouse is growing of vegetables, flowers, fruits and plants for decorating, garnishing and fancy. Greenhouse is a structure where plants are grown. These complex ranges are in size from small barn to industrial sized buildings. Communication Greenhouses are high technological producing resources for flowers and vegetables. Glass of Greenhouse is filled up with equipment such as heating, cooling and automatically controlled by a computer to optimize the growth of the plants. Intensively plants are produced for human food, personal and social use by applying skills, knowledge and technologies.

Greenhouse consists of different type of protection ingredients like as plastic roof or artificial walls are heated because of entering observable sunlight is immersed through the glass. The wind is heat up by warm air comes from the internal hot region and is maintained in glass by the covering and barriers. Greenhouse has its own unique requirements for maintaining plants growth. By ventilation regulates the temperature and humidity. By heating and cooling temperature is controlled, by lightening retain the growth and by enrichment of CO_2 (carbon dioxide) protect the plants from dry out.

Greenhouses are usually used for vegetables, flowers, fruits and plants growth. Special Greenhouses contains variety of the crops such as tomatoes are generally used for economical production. Extremities of heat and humidity, diseases and pests must be monitored, and irrigation is required to produce water. Notable input of light and heat may be essential, especially with water productivity of warm-weather vegetables.

Recently, a well-developed country has launched projects on greenhouse monitoring and controlling. The monitoring and controlled system used in greenhouse projects is based on a cable network which is not only a complex but also makes less efficient greenhouse system. By using a low cost, low power sensor and modern communication technologies, the greenhouse systems has become easy to develop and to maintain the growth of plants.

The Greenhouse system is displayed in Diagram.

1.3 Problem Statement

The greenhouse monitoring and control system to develop is not an easy task because it involves various environmental parameters like temperature, humidity, soil moisture and light intensity. Controlling these parameters require special care and proper monitoring. If any one of these parameters is not under control they may harm the crops inside the greenhouse. Also, for a greenhouse system there is a need of large no of cables to divide the sensors and the actuators among greenhouse which is too costly. These are the main problems we can face in any greenhouse system we develop.

1.4 Proposed Solution

The solution proposed for this problem is to design a greenhouse which relies on wireless sensor network. For this purpose, we can use the GSM module to send and receive the data.

The wireless sensor network can be used to monitor greenhouse parameters and sends all the parameters data to a mobile server via a GSM module which can control the greenhouse environment by retransmitting the data to a microcontroller which can take a specific action to control the environment.

1.5 Project Objective

The project objective is to implement a low-cost wireless sensor network system built machinery that monitored and control our Greenhouse. In our country everything can be controlled naturally; nonetheless there are lot of the places where computation has not been received may be of few reasons, one such reason is expense. Among them agricultural is one of the field in every country which are the necessary occupation of man succeeding to right on time development and even today physical interposition in cultivating are convicted. Greenhouse frame is an essential piece of the agriculture areas in our state as by controlling climatic condition they ideally produce to develop plants.

1.6 Methodology

For the achievement of this project objective, there are numerous possibilities which are essential. Project requires to achieve intentional objectives through right way.

The greenhouse design composed of two sections. The first section is monitoring the greenhouse parameters like temperature, humidity, moisture and light intensity. And the other section is controlling the greenhouse environment by activating actuators like heater; fan, light and water pump to irrigate the soil. An LCD is also used which can display the parameters data on a screen. A GSM module can also be used to control the greenhouse environment by sending an SMS to a mobile user. The data from sensors can be sends to GSM in a real time through wireless communication. Test and evaluate the system and its components can be achieved using ISIS Proteus simulations.

1.7 Outline

The thesis is arranged in the following order: the 2nd chapter is about literature review of the greenhouse system and wireless sensor technology. Some of the previous greenhouse models were reviewed in chapter two. In chapter three, the design of the proposed greenhouse system was demonstrated. Chapter four discusses the programming code and simulation results obtained using proteus software. At last in chapter five we can draw the conclusions and give some recommendations about this system in future and also give references.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Today‟s agriculture is changing in response to the requirements of modern society, where ensuring food supply through practices such as water conservation, reduction of agrochemicals and the required planted surface, which guarantees high quality crops are in demand.

It is well known that a greenhouse is a building or complex in which plant are grown. These structures range in size from small sheds to industrial-sized buildings. Greenhouses are often used for growing flowers, vegetables and fruits. Greenhouses are very useful for they provide an optimal temperature around plants, protect them from weather conditions, extends the growing season of plants, allowing us to sow plants earlier and harvest plants later and allow economic crops such as tomatoes, cucumbers, melons and aborigines to crop more successfully. Basic factors affecting plant growth such as sunlight, water content in soil, air humidity, temperature and CO2 concentration. These typical factors are hard to control manually inside a greenhouse and there is a need for automated design arises.

A. Temperature effect

One of the benefits of growing crops in a greenhouse is the ability to control all aspects of the production environment temperature is one of the most important factors to be monitored because it is directly related to the growth and development of plants. Different crop species have different optimum growing temperature and these optimum temperatures can be different for the root and shoot environment and for the different growth stages during the life of a crop. Since we are usually interested in rapid crop growth and development, we need to provide these optimum temperatures throughout the entire cropping cycle. If a greenhouse were like a residence or commercial buildings are insulated so that the impact of outside condition is significantly reduced.

B. Humidity effect

Water vapor inside the greenhouse is one of the most significant variables effecting the plant growth. Humidity is important to plants because it partly controls the moisture loss from the plant. The leaves of plants have tiny pores, co2 enters the plant through these pores, oxygen and water leaves through them. Transpiration rates decrease proportionally to the amount of humidity in the air. This is because water is diffusing from areas of higher concentration to areas of lower concentration. Due to this phenomenon, plants growing in a dry room will most likely lose its moisture overtime. The damage can be even more severs when the difference in humidity is large.

The humidity control is complex because if temperature changes then relative humidity changes inversely. Temperature and humidity are controlled by the same actuator. The main priority is for temperature control because it is the primary factor in the plant growth. Based on the inside relative humidity value the temperature set-point can be adjusted to control the humidity within a determined range. Hence to control the required humidity is very complex task. For proper control of humidity internal air can be exchange with outside air by properly controlling ventilations of the greenhouse.

C. Light effect

All the living things needs energy to grow, human and animals get their energy from food they eat. On the other hand, plants get their energy from sunlight through a process called photosynthesis. This is how light effects the growth of a plant. Without light a plant would not be able to produce the energy it needs to grow. Aside from its effects through photosynthesis, light influences the growth of individual organs or of the entire plant in less direct ways. The most striking effect can be seen between a plant grown in normal light and the same kind of plant grown in total darkness. The plant grown in the dark will have a tall and spindling stem, small leaves, or both leaves and stem are lacking chlorophyll are pale yellow. Plants grown in shades instead of darkness show a different response. Moderate shading tends to reduce transpiration more than it does photosynthesis. Hence shaded plants may be taller and have larger leaves because the water supply within the growing tissues is better. With heavier shading, photosynthesis is reduced to an ever-greater degree and results in weak plants.

D. Soil Moisture effect

Soil water also affects the plant growth. Therefore, the monitoring and controlling of soil condition has a specific interest, because good condition of a soil may produce the proper yield. The proper irrigation and fertilizations of the plants are varying as per the type, age, phase and climate. The PH value, moisture, electric conductivity and the temperature of a soil are some key parameters. The PH values and other parameters will help to monitor the soil condition. The temperature and the moisture can be controlled by the irrigation techniques like drift and sprinkles system in a greenhouse. The temperature of the soil and the inside temperature of the greenhouse are interrelated parameters which can be controlled by proper setting of ventilation. Since the temperature control is depend on direct sun radiation and the screen material used, the proper set point can adjust to control soil temperature. The temperature set-point value can depend on actual temperature of the inside and outside of the greenhouse.

2.2 Previous Research Works On Greenhouse System:

From Roman time the idea of the planting was present. At that time Roman used the artificial method of growing of the plants. Wireless sensor network consists of the base station and the nodes. Node formulated by the processor, sensor, radio battery and the local memory.

In previous embedded network server unit structure created on tiny panel have been proposed by **Darko Stipanicev** and **J. Maracovic** (1) using simple wire local network (WLN) by getting data from the distributed sensors and activity is connected. The webserver is linked with internet through dial network.

For controlling of humidity and air temperature in horticulture is explained by means of **Tαkαgi Sugeno Fuzzý Model** and the parallel scattered recompence concept. This system is proposed by **Meriem Nachidi, Abdellah Benzaouia** and **Fernando Tadeo** (2). Using T.S.F model control design difficulties and constancy inspection is reduced to reach at quite enough state signified as linear matrix inequalities. Use of this measurable system and technology in the field of Agriculture has become a possible. Simulation give outcomes for numerous tests analyzing the valuable stability and performance gotten with planned proposal methodology are present.

A Wireless solution by **Zhang Qian** and **Yang Xiang-long** (3) placed on the Zigbee mechanisam and compare the benefits of Zigbee with Wi-Fi and Bluetooth as both these are also has similar wireless networking protocol. The temperature, humidity, radiations, water and carbon dioxide are the main attributes that are controlled in the greenhouse.

In greenhouse control system the wireless sensor network should be implement, provides real time and spread out sensing, acquiring required values differences in the heart of the greenhouse**. Gilberto A. Pereira** and **Carlos E. Cugnasca in 2005** (4) proposed the applications of Lon Work that divided the greenhouse control technology. A scattered greenhouse control system is presented whose root is Lon-Work technology and at Pereira and Cugnasca the processing and communication joints are spread among the parts of the system known as nodes.

Using commercial wireless sensing network in greenhouse can be done, this approach of implementation is suggested by **Muhammad Elmusrati** (5) and platform is provided by the Sensinode Inc. Hardware design contain Sensinode"s micro 2420U100 which operates as essential calculating nodes. Network can determine the local differences which are present in the greenhouse climate and caused by the various disturbances, like as the direct sunshine which are present near the greenhouse walls.

In 1994, **Simon Blackmore** (6) describes that by properly monitoring soil and environment, a system can be established to grow up quality of agricultural yield and he also notice that farmers were unwilling to establish it in early stage of wireless sensing network, because of huge price. The development of the technologies reduces the price. Satellite sensing system, remote sensing system, geographical information system and global position system for hardware in addition of MEMS technology are also contributing in overall progress.

To bestow a description on microcontroller data for plants and embedded greenhouse monitoring and control system have recommended by **Leong Boon TiK, Chan Toong Khuan** and **Selalppan Palaniappan** (7) within the greenhouse environment with an unconventional technique for increasing temperature crops using micro-climatic condition in a steamy condition. The greenhouse relates to the ordinary wired sensor that gives the reading the light intensity, air temperature and the nourishing explanation of temperature in the compound container. The acidity and nutrients absorption were checked and then adjusted according to normal concentration and using this wireless sensor, they develop a PA model for these crops" growth under Aeroponic conditions. The researchers declare that for star network reliability was relatively high with many nodes and normally it is above 90%.

The growth of the final yield and agriculture are hugely developed from last decades in agricultural field. **Abdul Izzat-din, Muhammad Hilmi Aziz, Muhammad Jimmy, Mazlina** and **Nazleeni Haroon** (8) proposed a system, which measure the level of the temperature. For this they proposed a remote-control monitoring system, which contain SMS technology and wireless sensor. By using this system, the farmers were alert, so they take early precautions steps. It increases the productivity of foods and crops. This system is implemented by artificial intelligent component. This system predicts, self-learn and define the uncertain situation so the whole product is safe.

For productivity of the farmers, the paprika greenhouse system is established by **J.W. Lee** and **C. Shin** (9). In November 2010 paper on Paprika greenhouse management system was proposed by Hyun hoe. This greenhouse system has wire sensing network environmental sensor and have CCTV camera, which is present outside or inside the Paprika greenhouse system. It provides the growth environment monitors services using sensors which measure the temperature, witnesses of the leaf, and conditions of the fruits, artificial light source control, illuminance and humidity.

Lots of the researches determine that in agricultural engineering the greenhouse system is well accepted. In all progress the geographical system also take part. In a very large-scale design and deployment on wireless sensing network the **Christine Jardak, krisakorn Rerkari, Petri Mahonen, Janne Rihijarvi and Aleksandar Kovacevic** (10) works. They positioned a sample of 64 sensors to monitor the profitable vineyard. This provides software components ranging from cleaning raw data to a centralized and a dispersed data storage request. A backend server delivers a user-friendly graphical interface contribution of two main purposes. Logging communication skills of the protocols and delivering end-user provision for on-request and periodic data demands. The used procedures confirm dependable and vigorous statement and weight-balancing energy consumption. In Europe Lofar Agro project the accuracy of the prearranging crops controlling is studied. Using this project, the fertilizers and pesticides application were spread out as per real time changes in environment and control the pests including weeds and supply plants nutrients necessary for the growth of the plans.

Yongnian Song, Juanli ma, Yuan Feng, Chenglong Gong and **Xianjin Zhang** (11) design greenhouse environment monitoring and self-control system based on a wireless sensor Network, adopts At-mega 128L chip and LC2530 RF chip. This system solves the problem of compound cabling whose benefits are short price, decent strength and high dependability. This system based on AVR single chip microcontroller. The CO2 is gathered, the info about concentration of brightness is gathered, and humidity and the temperature of the greenhouse are controlled by the management center. For this purpose, the self-control system is recognized, which has low cost, consume low power and control and monitor the whole greenhouse.

Intelligent transducers and wireless sensors are linked with some micro-controller supplying network and process management. Various automation functions can be done by smart sensors and actuators. Total amount of nodes and sensors are based on the size of greenhouse. For physical area if the greenhouse is 35m x 200m then there should be 200 nodes. Sensor nodes consist of the 3 types. (1) A, (2) B and (3) C. The A and the B is for climate sensor. A is for outside; B is for inside and C is for soil sensors. Water concentration and need of nutrients are certainly managed using automatic machine. Artificial light is used for controlling temperature, humidity and the shading.

A Rahli, M Gurbaou, A. ED Dahak, Y EL AFou, A Tanouche, A LAchab and **B Bouchee k** (12) work on greenhouse control and development of the data attainment, that mingle the remote-control functions rooted in GSM module. The monitoring and control of greenhouse using remote control system and consist of serial cable, microcontroller and GSM module. For receiving signal an active receive card is required. For control and monitoring of the PC and all data storage through PCL812PG card, LAB-VIEW software is used for interface. Advancement of this system has attention on the main constraints, friendly and simply executed.

Pardep KAmar S and **Bregowda B K** (13) have developed a greenhouse monitoring and automation using the GSM modem. This proposed system is embedded system. In these system microclimatic constraints of greenhouse on regular basis is monitor and control, round the clock for crops cultivation and specific plants species that make most the whole crops growth construction and remove the difficulties which are inside the system by decreasing human involvement to best possible extinct.

The **MOHD Fauzi** and **Khairunisa Shazale** (14) for conservational observing system they suggested a wireless sensor network application. This system assists and improves the performance of the work in our daily life and in the field of industry. This research tells how to improve the performance of the system and fulfilled the requirements of the function.

The **Kryzysztof S. Berezowskee** (15) has proposed a landscape of the wireless sensor networking in the application of greenhouse management. This paper defines the research problems, identify the limitations of the design space, and sketch the solutions. Its purpose is to give more awareness about this applications domain to computer engineers, communication infrastructure and give awareness about offence of wireless technology and optimization of their usage in the greenhouse to greenhouse researcher.

Alouisa Dely W.S and **Keshinoo Kaze Kolawoly** (16) have proposed a microcontroller-based glasshouse manage device which are used in auto control and monitoring of tools and amounts like as connection displaying, warming, lightning and other conditions in the greenhouse. It also consists of the alarm circuit for the attention of the supervisor call. This shows the functionality of greenhouse control device.

M. Rubeena and **Vajaya Kumaar** (17) has summarize an idea and proposed a system of using wireless sensor web for management and control of greenhouse gases. A wireless environment monitoring system is projected in which circuit for both the monitoring and vigorous greenhouse gases. Such as C02 and SO2 is designed. This system works on 3 processes: 1st outlet gases, 2nd observing the process and 3rd absorption level of gases mechanism. LAB-VIEW module is used in this project

Jianiman Houu and **Yii GAO** (18) proposed and design a greenhouse network of wireless sensor monitoring arrangement which contains solar energy. Data is conveyed through wireless receiving and sending apparatus without the organized electric wiring. Temperature and humidity of greenhouse can be managed and control by the management center, CO2 is measured and information about the intensity of the enlightenment is gathered. This all is done with any manpower. This system uses less energy, internet capacity is very high and have low price. It adopts MSP430 MCU, network transmitting chip is nRF24L01 and have multi-level energy memory.

Zouu Weii, Zouu Jianjm, Wang xiiafang, Waan XIV and **Caiijichen Taii** (19) recommended a system created on Zigbee network for greenhouse monitoring and control system, based on the greenhouse data procurement control glasshouse remote controller software. Concentration of carbon di-oxide, soil dampness, temperature and moisture are monitored and control. The data could be saved to greenhouse data-base acquiring controller consists of two kinds of control mode which include remote wireless control mode and local manual control mode. For temperature management in glasshouse, PID control method is used. Using low power wireless communication system is designed and installation is so easy.

Chein Chiuing Hing, Chen Guan Yu and Chein Jwuu Jinq (20) proposed a remote control-based greenhouse environment system. By using smart mobiles or PDA, the greenhouse environment system is monitored. For ecological limitations retrieval Nationwide Tool Field ideas are useful in glasshouse on actual period. Wherever user can use keen mobile or PDA to regulate and display the arrangement by using wireless system. The planned system could be more successful in manpower reserves and it unpraised the goods commercial rates.

Miss. Virshl R. Peoore and Professor VM Vmale (21) have given a location on wireless identifying system style for control and display of the greenhouse. By using At-mega microcontroller a control system is confirmed. For extreme harvest agriculturalists in the growth countries can simply usage projects.

Suleymaan Aytkin and Lateef Lavent (22) concentrations on the mechanization of glasshouse using wireless technology, the arrangement is built on MSP430 micro-controller with wireless instrument systems and remote displaying. Microcontrollers detect temperature and moisture level with the help of sensors and the arrangement also prepared the action that is happen within the glasshouse. The planned system power feasting is reduced, short price, operator friendly and 3.3V of Lithium battery-operated is enough to work project necessities.

2.3 Wireless Technology in Greenhouse System:

The Worldwide Progressive Cell telecommunication is Known as GSM. For multipurpose communication GSM suggests worldwide agenda. Quality of GSM in 1989 was projected by ETSI (European Telecommunications Standard Institute). After that primary professional managements were established in 1991 and then its early performance held in Europe. In 1992 the standard was international and from that time the GSM is the most generally involved and speedily developing the progressive quality, and it became the world‟s devastating cell standard. Now GSM is enormously abundant manufacturing and special achievement of the world, with complete qualities over the globe the GSM structure transports protected and brilliant voice and management info. A cell communication system is GSM system. From the first GSM system introduce, it became the global fastest developed transferable standard. The advancement in the GSM standards helps the 80% of global professional transferrable business, which contain more than 500 crore individuals oblique in excess of two hundred and twelve states and provinces and make the GSM the universal guide-liner. GSM system basic purpose is to transmit and receive the data. A cell telecommunication system with adaptable mechanical arrangement which is known as GSM, has following ETSI GSM 900A or GSM 1800 standard.

For project I use GSM SIM 900 A. The SIM 900A most probably like as a mobile phone, which has qualities of receiving and sending calls as well as the qualities of sending and receiving the messages. The GSM modem cooperates with GSM network using computer. Only AT commands are used in the GSM module and answer accordingly. The necessary command for GSM is „AT‟. If answer is OK, then its means working is fine otherwise „ERROR‟.

CHAPTER 3

SYSTEM DESIGN

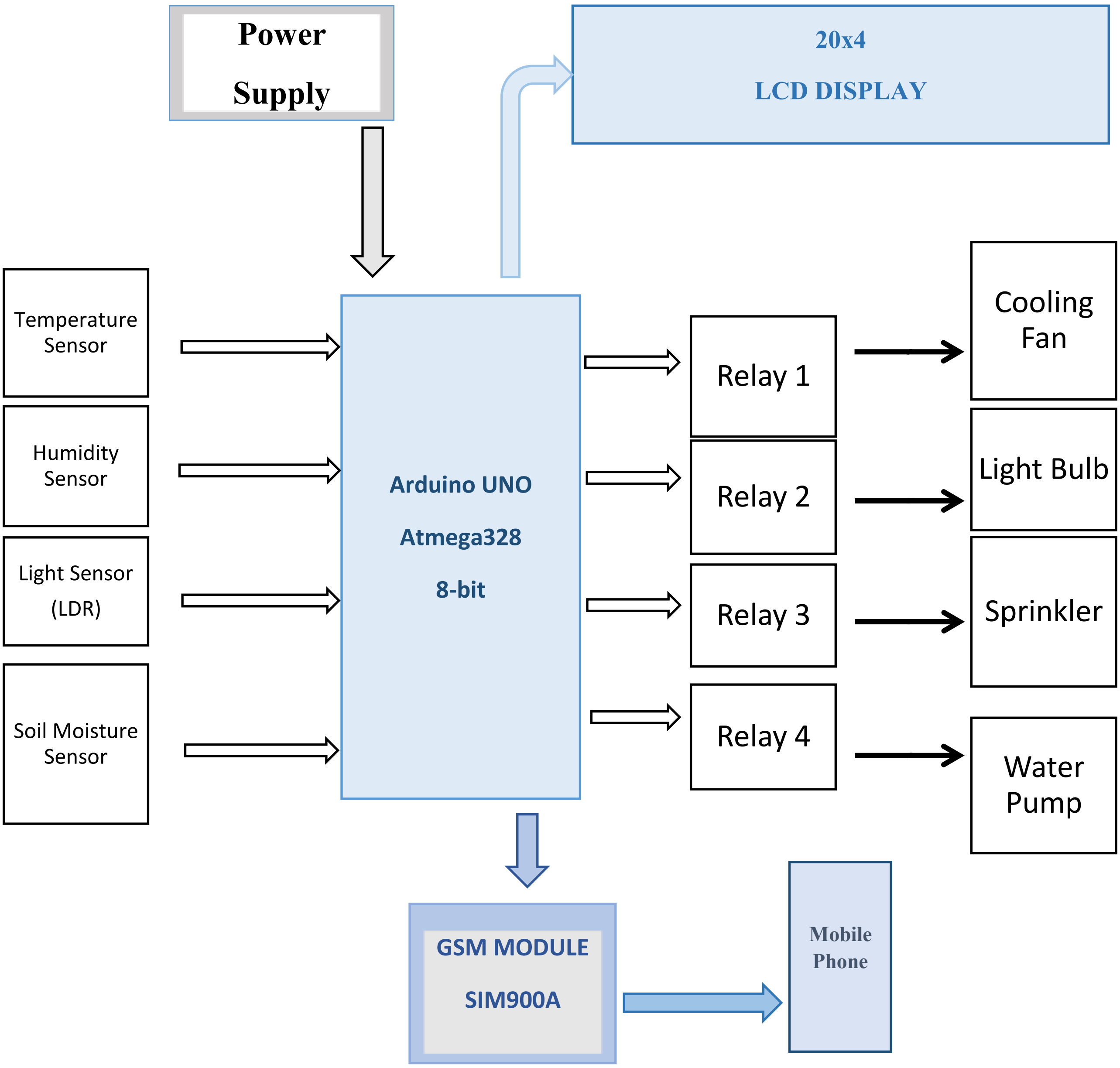
3.1 Overview of the Greenhouse Design

The proposed greenhouse system is shown in figure. The greenhouse system we use has the following units:

1. Sensing Unit
2. Processing Unit
3. Wireless communication Unit
4. Display Unit
5. Controlling Unit
6. Power Supply Unit

The block diagram of the complete system is shown in the Figure.

Block Diagram:



A proteus ISIS environment simulator was utilized to simulate the proposed system as shown in the following Figure, where the implemented system was achieved by using the Vero Board.

Proteus schematic:

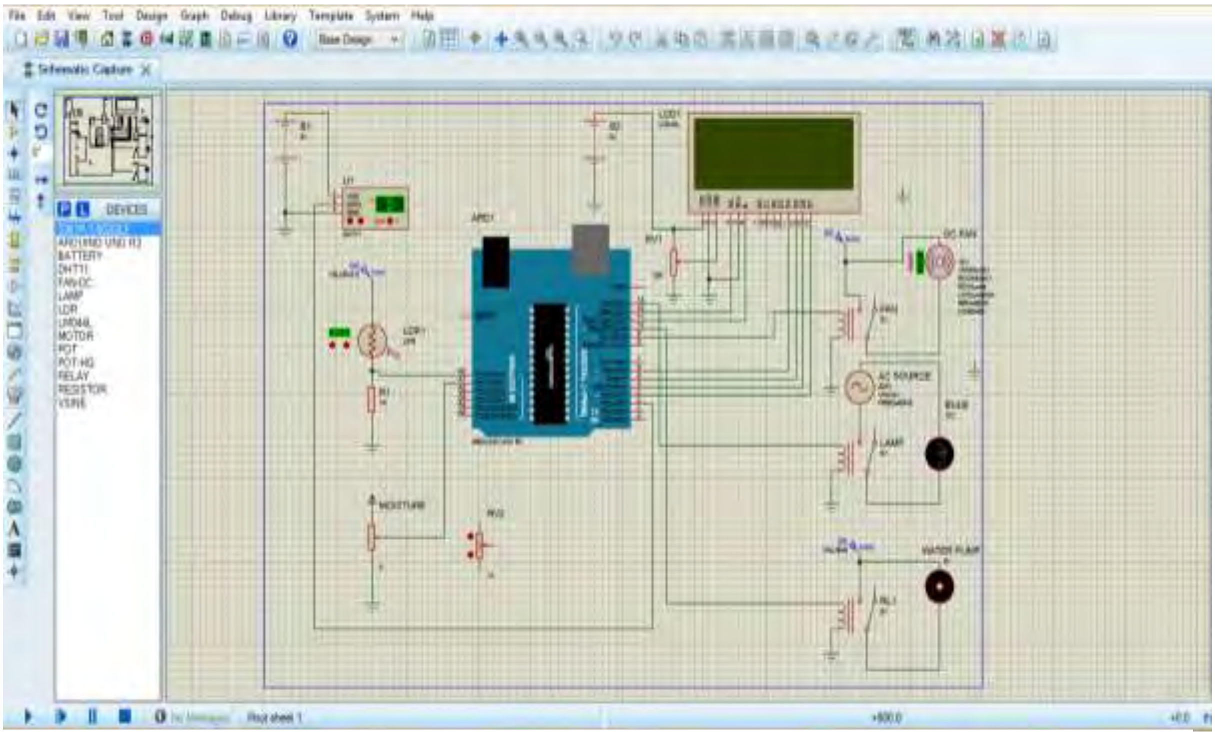


Figure 3.1 Schematic Diagram of Greenhouse System

3.2 Greenhouse System Units:

3.2.1 Sensing Unit:

Sensor is a device for sensing a physical variable of a physical system or an environment. It senses the environmental phenomenon and output an electrical signal. An actuator may be described as opposite to a sensor. It converts electrical signal into generally nonelectrical energy. For example, an electric motor is an actuator it converts electrical energy into mechanical action.

The following factors must be considered when choosing sensors:

- Range and span: This represents the range of a sensor for which the input can vary. The span is the maximum value of the input minus the minimum value.
- Errors: The error is the difference between the result of a measurement and the free value of the quantity being measured where (Error = measured value-free value)
- Accuracy: It is the relationship showing how much output you get from per unit input.
- Stability: It is the ability to give the same output when used to measure a constant input over a period.
- Resolution: When input varies continuously over the range of output signal for the sometime may change in serial steps.

In this thesis the sensors we can use to measure the environmental factors are following:

i. Temperature and Humidity Sensor DHT11
ii. Light Sensor (LDR)
iii. Soil moisture Sensor Module

3.2.1.1 Temperature and Humidity Sensor (DHT11)

The temperature sensing technology is the most popular technology in today‟s world. It allows for the detection of temperature in various applications and provides protection from excessive temperature excursions. DHT11 Temperature and humidity sensor features a temperature and humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component and connect to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. It‟s very easy to use but require careful timing to sense the data. The only real downside of this sensor is that you can only get data from it every 2 seconds. The operating voltage for DHT11 sensor is from 3V to 5.5V. DHT11 sensor consists of 4 pins, 2 for power supply and 3rd for Data Communication and Last pin is not connected. DHT11 provides data in two parts. No 1 is Decimal part and no 2 is Integral part. Total 80 bits are used for complete data and DHT11 sensor uses the higher bits first. Micro-controller which linked with DHT11 sensor firstly sends the start signal to DHT11 sensor to activate it. After activation sensor respond in the form of 40 bits data which contain information about temperature and humidity. Micro-controller first when send the start signal then DHT11 sensor can ensure detection, drag up voltage and hold for 20µs to 40µs for DHT11 sensor response.

The DHT11 sensor is shown in the figure

Figure 3.2 Dht11 sensor

3.2.1.1.1 Technical Specifications:

Overview:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

Table 3.1 Technical specifications of DHT11

Detailed Specifications:

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

Table 3.2 Detailed Specification of DHT11

Typical Application:

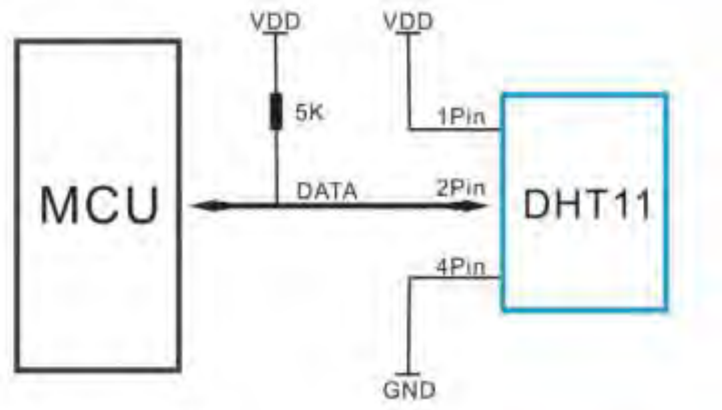


Figure 3.3 Typical Application

3.2.1.1.2 Communication Process:

Single bus data format is used for communication and synchronization b/w MCU and DHT11 sensor. One communication process is about 4ms.

A complete data transmission is 40bit, and it sends higher data bit first.

When microcontroller sends a start signal, it changes from the low power consumption mode to a running mode, waiting for MCU completing the start signal. Once it is completed, it sends a response signal of 40-bit data that include the relative humidity and temperature information to MCU. Users can choose to read some data. Without the start signal from MCU, dht11 will not give any response signal to MCU. When data is collected, dht11 will change to the low power consumption mode until it receives a start signal from MCU again.

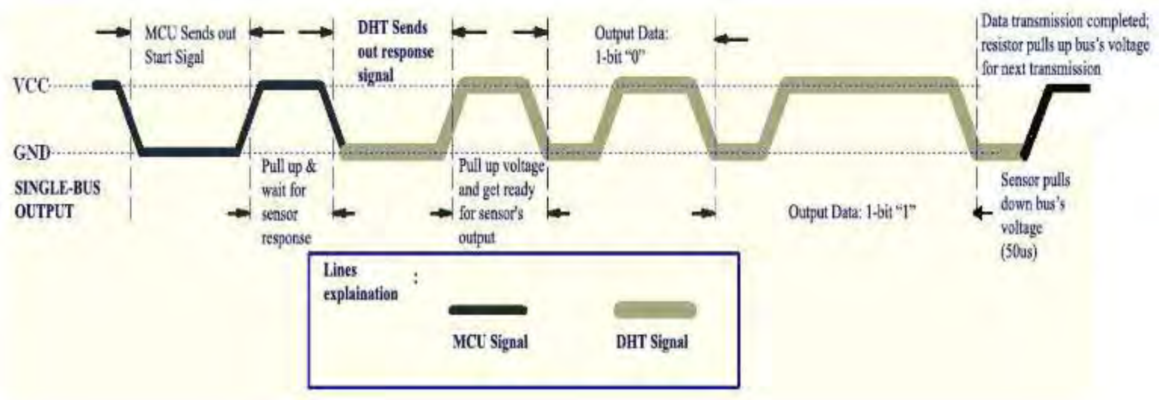


Figure 3.4 Communication Process

3.2.1.1.3 Electrical Characteristics:

	Conditions	Minimum	Typical	Maximum
Power Supply	DC	3V	5V	5.5V
Current Supply	Measuring	0.5mA		2.5mA
	Average	0.2mA		1mA
	Standby	100uA		150uA
Sampling period	Second	1		

Table 3.3 Electrical Characteristics

3.2.1.1.4 Schematic Diagram

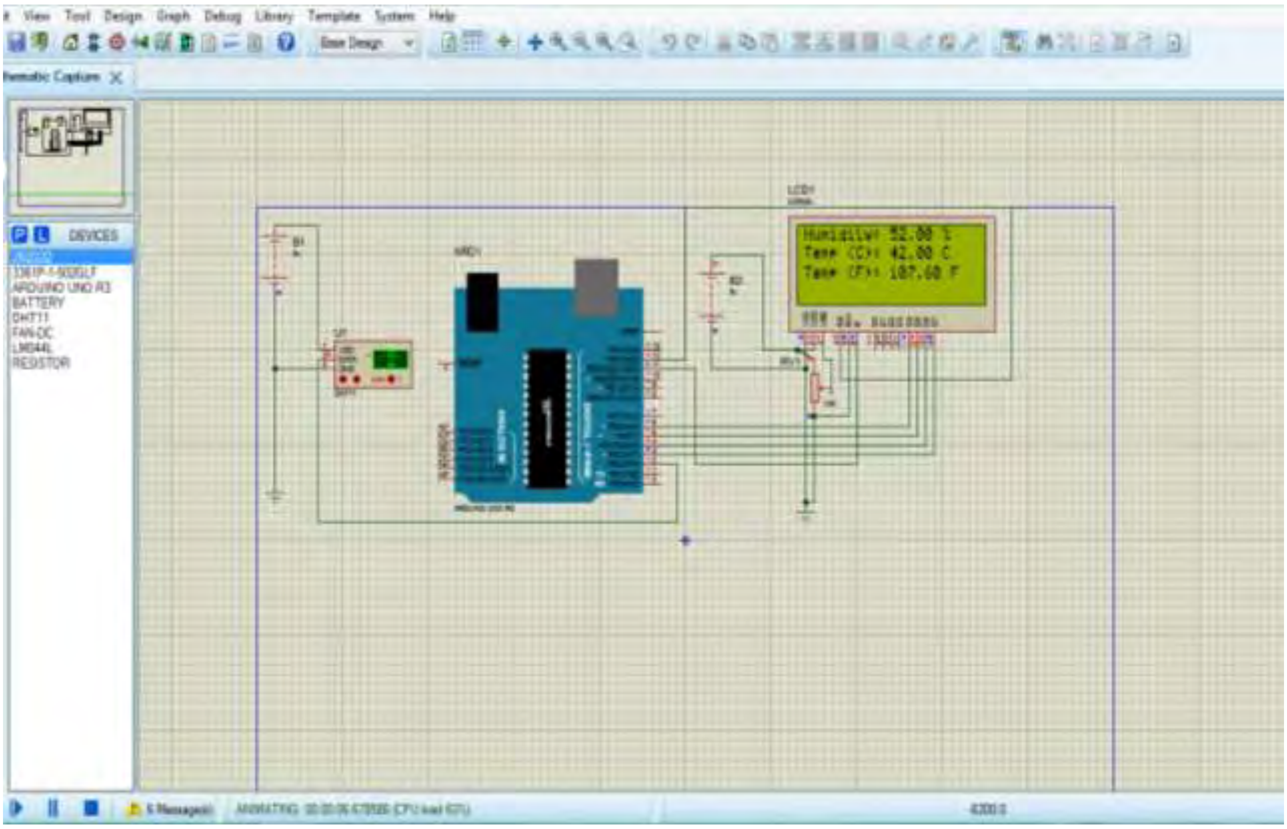


Figure 3.5 Schematic for DHT11

3.2.1.2 Light Sensor (LDR):

Plants use light which is approx. in the range of 400-700 nm referred to as PAR (Photo-synthetically Active Radiation). Monitoring PAR is important to ensure their plants are receiving proper light for photosynthesis.

We can use a Light Dependent Resistor (LDR) a light sensor which is basically a resistor that has an internal resistance increases or decreases depends on the level of a light intensity hitting on the surface of the sensor where it measures visible light as seen by the human eye with fast response, and small in size.

The LDR is shown in the Figure.

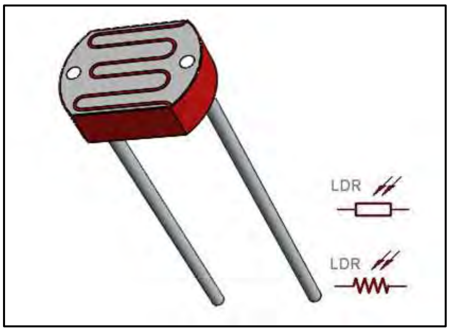


Figure 3.6 Light Dependent Resistor

The LDR sensor module which I can use in the project is shown in the Figure.

Figure 3.7 LDR Sensor Module

Pin details

- VCC = 3.3V to 5V DC
- GND = Ground
- DO = Digital Output
- AO = Analog Output

LDR don‟t produce any electrical energy and are passive with the change in daylight intensity the resistor of the LDR changes. LDR are made up of from semiconductor material so they follow light sensitive property and by controlling a flow of electrons current flow in them. LDR changes high value of electrical resistance from several thousand ohms in dark to only few hundreds of ohms when by creating electrons light is incident on them. Cadmium sulfide (CdS) used to make light dependent resistor because of its similarity of spectral response to that of the human eye. It is simply control by light source like flashlight.

Cadmium sulfide is placed on an insulator as a string pattern. The reason behind this string pattern. The reason behind this string path is to increase the dark resistance, as the resistance increase then current is decrease. To protect this cell from contamination this cell is condense in a glass.

3.2.1.2.1 Technical Specifications:

Specification	Value
Voltage, AC/DC Peak	**320V**
Current	**75mA**
Power Dissipation at 30°C	**250mW**
Operating temperature range	**60-70 C**

Table 3.4 Technical Specification of LDR

The schematic of LDR sensor is shown in the following Figure.

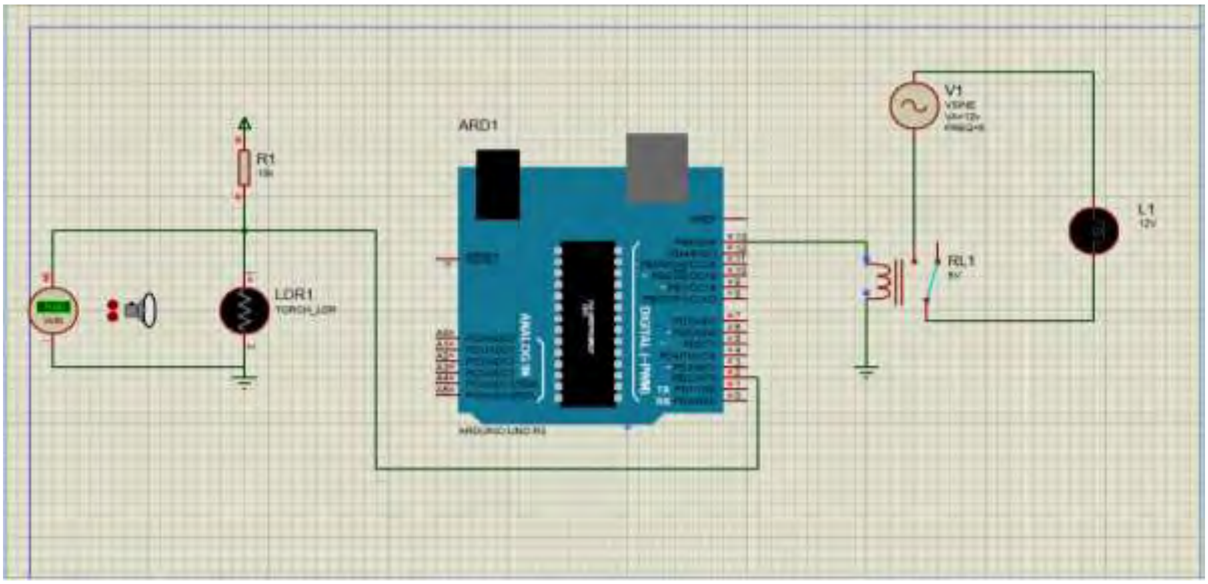


Figure 3.8 Schematic LDR

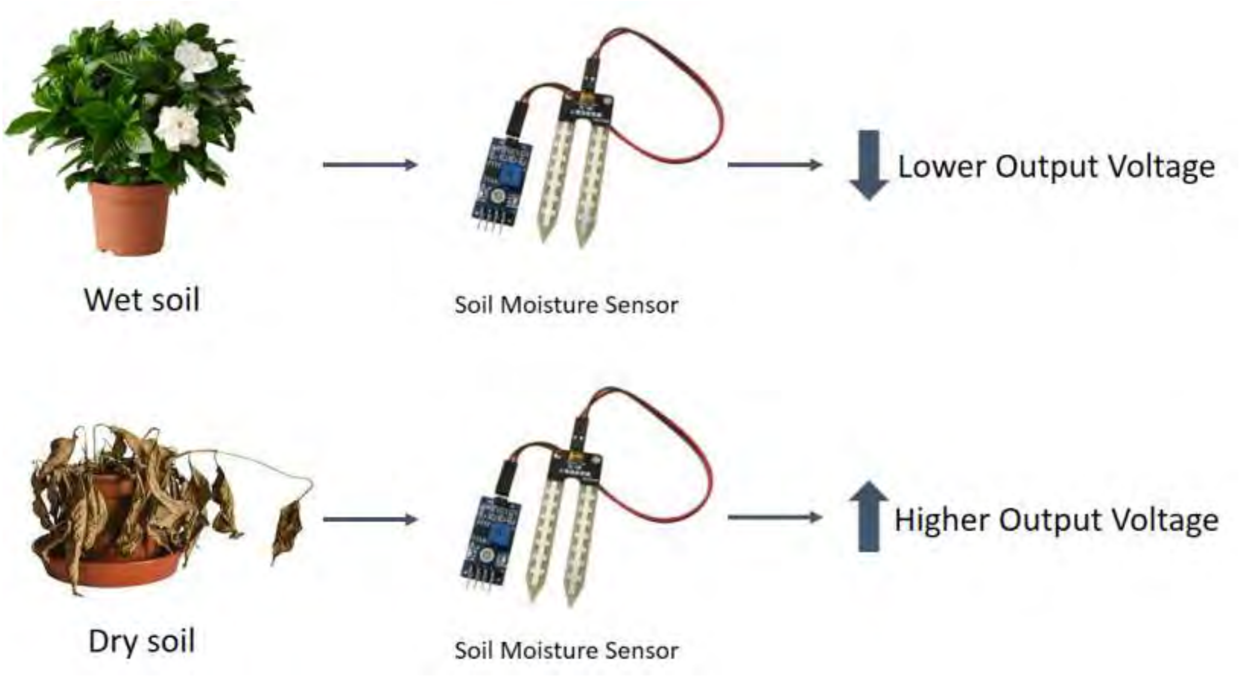
3.2.1.3 Soil Moisture Sensor

To measure the content of water in the soil we can use the soil moisture sensor, which can measure the volume of water present in the soil based on the dielectric constant of soil. Soil moisture sensor is inserted inside the soil to sense the existence of water present in soil. When the soil having water shortage, the module output is HIGH, else the output is LOW. By using this sensor, we can water the greenhouse automatically. Module has three output modes, digital o/p is simple, analog o/p is more accurate, while serial o/p gives exact reading. The soil moisture sensor YL-69 is used in our project is shown in Figure.

Figure 3.9 Soil Moisture Sensor YL-69

Applications

- Agriculture
- Landscape irrigation system



Specifications

Parameter	Value
Operating Voltage	+5v DC Regulated
Soil Moisture	Digital value is indicated by output pin

Table 3.5 Pin Specification of Soil Moisture Sensor

Pin Details

Pin	Name	Details
1	Out	Active high output
2	+5v	Power supply
3	GND	Power supply gnd
4	RX	Receiver
5	TX	Transmitter
6	GND	Power supply gnd

Table 3.6 Pin Details of Soil Moisture Sensor

How to Use

- A0 pin is connected to analog pin of Arduino.
- D0 pin is connected to digital pin of Arduino.
- GND is connected to ground terminal of power supply.
- VCC is connected to +5v of Arduino.

How it works

Soil moisture sensor is measuring the quantity of water in the soil. Soil moisture probe is made up of multiple soil moisture sensors. One commonly used sensor commercially is a frequency domain sensor e.g. capacitance sensor. Another sensor, the neutron moisture gauge, utilize the moderator properties of water for neutrons.

Soil moisture content is determined via its effect on dielectric constant by measuring the capacitance between the two electrodes inserted in the soil. Where soil moisture is predominantly in the form of free water, the dielectric constant is directly proportional to the moisture present in soil.

The proteus schematic of soil moisture sensor is shown in figure.

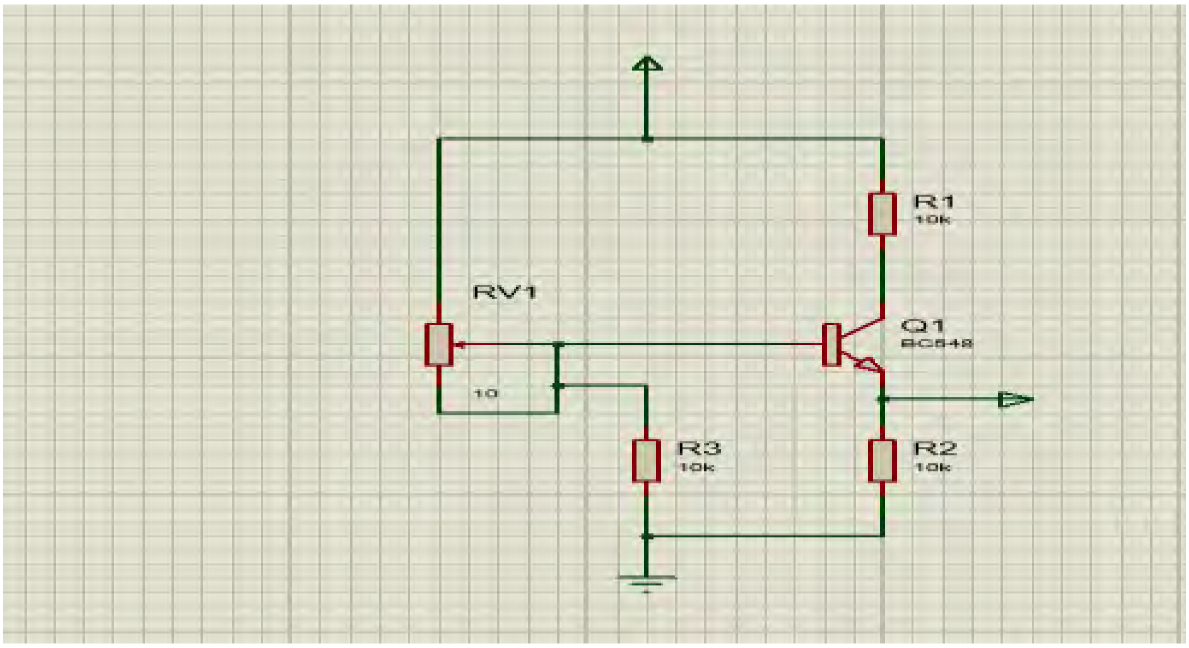


Figure 3.10 Proteus Schematic for Soil Moisture Sensor

3.2.2 Processing Unit

Arduino Uno is the heart of this project with an Atmel microcontroller IC on its board which is the central processing unit (CPU) and performs various tasks as data acquisition, and data processing. It is the integrated chip that has a CPU, random access memory (RAM), read only memory (ROM), Timers, and Digital to Analog converter (DAC). We can use Atmega328 microcontroller which is a product of Atmel microcontroller series. The AVR ATmega328 pu is shown in Figure.

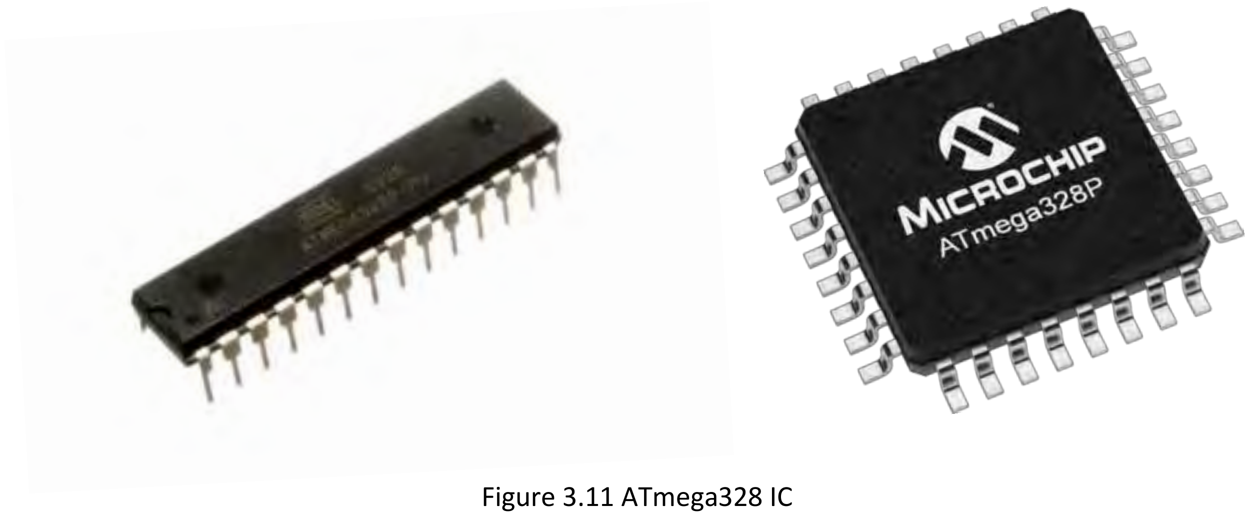


Figure 3.11 ATmega328 IC

Pin Configuration

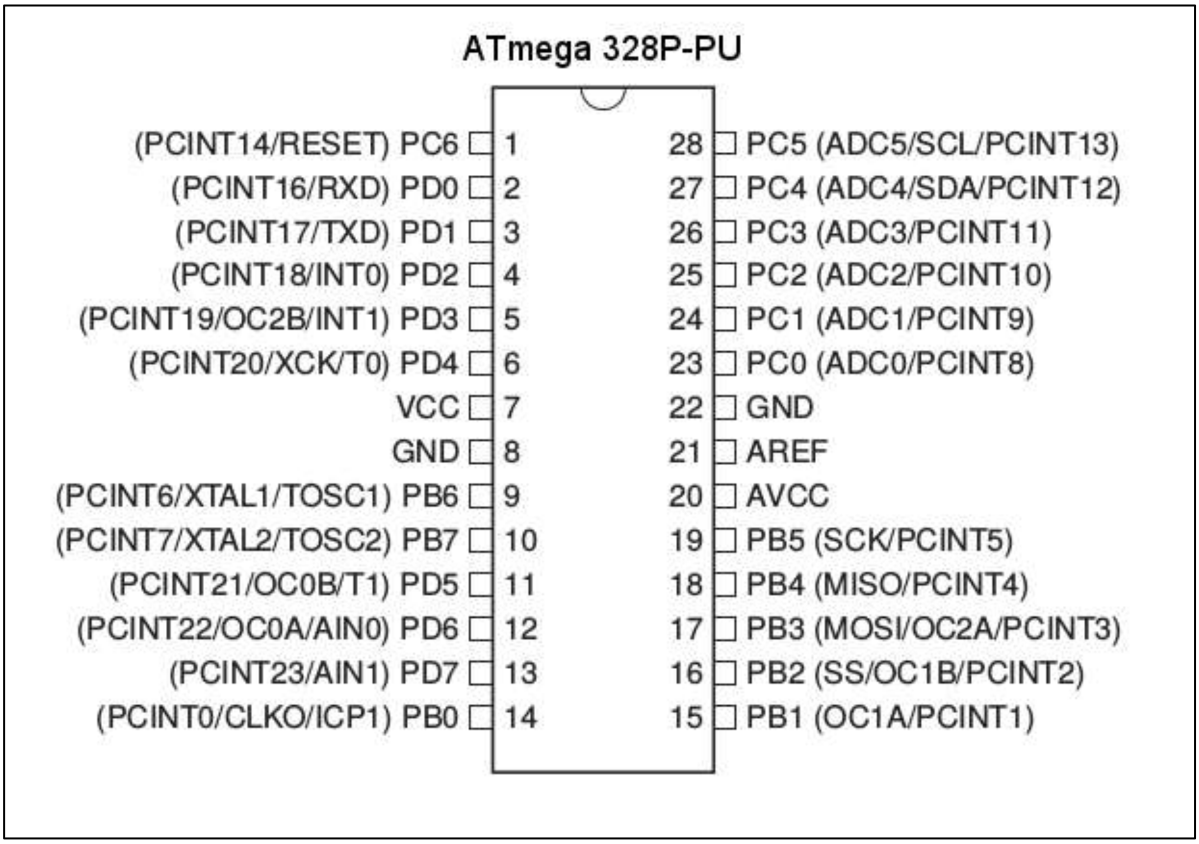


Figure 3.12 ATmega328 Pin Configurations

ATmega328 PU

Overview

Atmega328 is a low power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. It can execute powerful instructions in a single clock cycle. It has 32K bytes Flash memory, 1K bytes EEPROM, 2K bytes RAM, and 2 instructions words/vector.

Block diagram

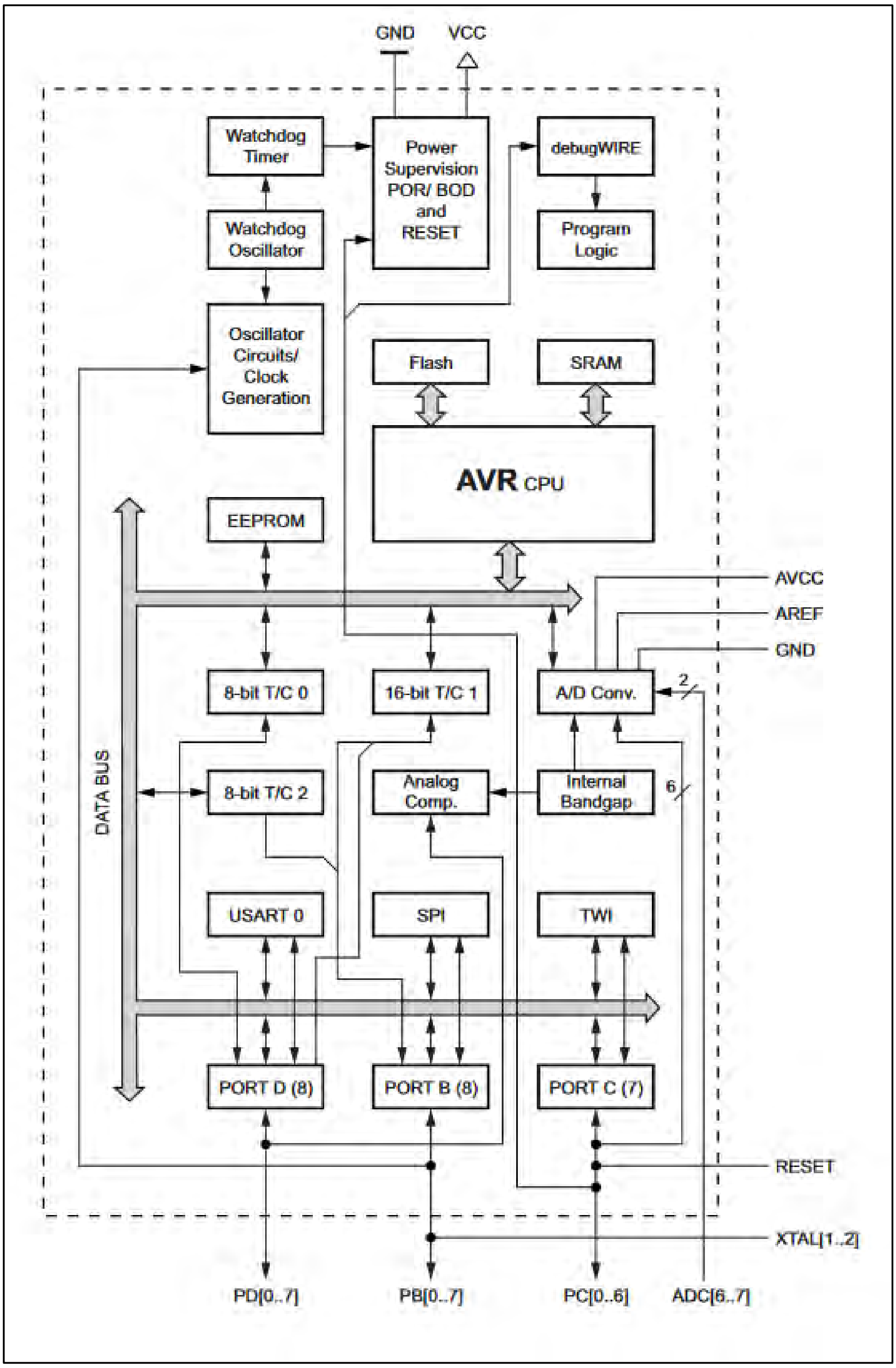


Figure 3.13 Block Diagram of Atmega328

3.2.3 Wireless Communication Unit

The data is collected from sensing unit and monitored in the control unit to provide the specific conditions for the plants is through wireless communication technology. GSM (Global System for Mobile) Module can be used as a wireless communication. GSM is based on 2G Cellular mobile phone technology and is a worldwide progressive cell telecommunication.

3.2.3.1 GSM

Overview

The Worldwide Progressive Cell telecommunication is Known as GSM. For multipurpose communication GSM suggests worldwide agenda. Quality of GSM in 1989 was projected by ETSI (European Telecommunications Standard Institute). After that primary professional managements were established in 1991 and then its early performance held in Europe. In 1992 the standard was international and from that time the GSM is the most generally involved and speedily developing the progressive quality, and it became the world‟s devastating cell standard. Now GSM is enormously abundant manufacturing and special achievement of the world, with complete qualities over the globe the GSM structure transports protected and brilliant voice and management info. A cell communication system is GSM system. From the first GSM system introduce, it became the global fastest developed transferable standard. The advancement in the GSM standards helps the 80% of global professional transferrable business, which contain more than 500 crore individuals oblique in excess of two hundred and twelve states and provinces and make the GSM the universal guide-liner. GSM system basic purpose is to transmit and receive the data. A cell telecommunication system with adaptable mechanical arrangement which is known as GSM, has following ETSI GSM 900A or GSM 1800 standard.

We can use the GSM SIM900A Module in this project. The SIM 900A most probably like as a mobile phone, which has qualities of receiving and sending calls as well as the qualities of sending and receiving the messages. The GSM modem cooperates with GSM network using computer. Only AT commands are used in the GSM module and answer accordingly. The necessary command for GSM is „AT‟. If answer is OK, then its means working is fine otherwise „ERROR‟.

The GSM SIM900A is shown in Figure.

Figure 3.14 SIM900A

3.2.3.1.1 Key Features

Feature	Implementation
Power supply	Single supply voltage 3.4V – 4.5V
Power saving	Typical power consumption in SLEEP mode is 1.5mA (BS-PA-MFRMS=5)
Frequency Bands	• SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the 2 frequency bands automatically. The frequency bands also can be set by AT command. • Compliant to GSM Phase 2/2+
GSM class	Small MS
Transmitting power	• Class 4 (2W) at EGSM 900 • Class 1 (1W) at DCS 1800
GPRS connectivity	• GPRS multi-slot class 10 （default） • GPRS multi-slot class 8 (option) • GPRS mobile station class B
Temperature range	• Normal operation: -30°C to +80°C • Restricted operation: -40°C to -30°C and +80 °C to +85°C(1) • Storage temperature -45°C to +90°C
DATA *GPRS:* *CSD:*	• GPRS data downlink transfer: max. 85.6 kbps • GPRS data uplink transfer: max. 42.8 kbps • Coding scheme: CS-1, CS-2, CS-3 and CS-4 • Supports the protocols PAP (Password Authentication Protocol) usually used for PPP connections. • Integrates the TCP/IP protocol. • Support Packet Switched Broadcast Control Channel (PBCCH) • CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent • Unstructured Supplementary Services Data (USSD) support
SMS	• MT, MO, CB, Text and PDU mode • SMS storage: SIM card
FAX	Group 3 Class 1
SIM interface	Support SIM card: 1.8V, 3V
External antenna	Antenna pad
Audio features	Speech codec modes: • Half Rate (ETS 06.20) • Full Rate (ETS 06.10) • Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) • Adaptive multi rate (AMR) • Echo Cancellation • Noise Suppression
Serial port and Debug port	Serial Port: • 8-wire modem interface with status and control lines, unbalanced, asynchronous. • 1.2kbps to 115.2kbps. • Serial Port can be used for AT commands or data stream. • Supports RTS/CTS hardware handshake and software ON/OFF flow control. • Multiplex ability according to GSM 07.10 Multiplexer Protocol. • Autobauding supports baud rate from 1200 bps to 115200bps. Debug port: • 2-wire null modem interface DBG_TXD and DBG_RXD. • Can be used for debugging and upgrading firmware.
Phonebook management	Support phonebook types: SM, FD, LD, RC, ON, MC.
SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real time clock	Implemented
Timer function	Programmable via AT command
Physical characteristics	Size: 24mm x 24mm x 3mm Weight: 3.4g
Firmware upgrade	Firmware upgrade by debug port.

Table 3.7 Key Features SIM900A

3.2.4 Display Unit

The Greenhouse parameters are monitored and are displayed on a 20x4 LCD (Liquid Crystal Display). The parameters like Temperature, humidity, light intensity and soil moisture values continuously monitored and displaying on LCD. The LCD we can use in this project is shown in Figure.

Figure 3.15 20X4 LCD DISPLAY

3.2.4.1 Pin Configuration

PIN NO.	SYMBOL	FUNCTION
1	V_{SS}	Ground
2	V_{DD}	+ 3 V or + 5 V
3	V_0	Contrast adjustment
4	RS	H/L register select signal
5	R/W	H/L read/write signal
6	E	H → L enable signal
7	DB0	H/L data bus line
8	DB1	H/L data bus line
9	DB2	H/L data bus line
10	DB3	H/L data bus line
11	DB4	H/L data bus line
12	DB5	H/L data bus line
13	DB6	H/L data bus line
14	DB7	H/L data bus line
15	A	Power supply for LED (4.2 V)
16	K	Power supply for B/L (0 V)
17	NC/V_{EE}	NC or negative voltage output
18	NC	NC connection

Table 3.8 Pin configurations of LCD

3.2.4.2 Electrical Characteristics

ITEM	SYMBOL	CONDITION	STANDARD VALUE			UNIT
			MIN.	TYP.	MAX.	
Input Voltage	V_{DD}	V_{DD} = + 5 V	4.7	5.0	5.3	V
		V_{DD} = + 3 V	2.7	3.0	5.3	
Supply Current	I_{DD}	V_{DD} = + 5 V	-	8.0	10.0	mA
Recommended LC Driving Voltage for Normal Temperature Version Module	V_{DD} to V_0	- 20 °C	5.0	5.1	5.7	V
		0 °C	4.6	4.8	5.2	
		25 °C	4.1	4.5	4.7	
		50 °C	3.9	4.2	4.5	
		70 °C	3.7	3.9	4.3	
LED Forward Voltage	V_F	25 °C	-	4.2	4.6	V
LED Forward Current	I_F	25 °C	-	540	1080	mA
EL Power Supply Current	I_{EL}	V_{EL} = 110 V_{AC}, 400 Hz	-	-	5.0	mA

Table 3.9 Electrical characteristics of LCD

3.2.5 Controlling Unit

The control unit controls the environment of a greenhouse system by controlling the parameters like temperature, humidity, light intensity and soil moisture by taking a specific action against each environmental parameter. The control unit consists of Relays, Cooling Fan, a light bulb used to control light intensity and a water pump for irrigation purpose inside the greenhouse. When any one of the parameters changes its value beyond limits the control system takes an action and turns ON its respective load like Fan, bulb or a water pump.

The loads included in the control unit are as follows:

1) DC Fan
   DC fan can be used for applications with demanding environmental requirements, signal speed, alarm with limit speed, external temperature sensor, analog control input, and moisture protection. It can have a voltage of 12v. The DC fan used in our project is shown in the Figure.

Figure 3.16 DC FAN

2) Light Bulb
   The LED bulb is an energy-efficient greenhouse lighting alternative to incandescent or HPS fixtures for day length extension. The led bulb can reduce energy cost up to 80% over traditional light bulbs. It is ideal for photoperiod-sensitive plants. The light bulb used in our project is shown in Figure.

Figure 3.17 LED Bulb

3) Water Pump
The water pump can be used for irrigation purpose inside the Greenhouse. When there is not enough volume of water in the soil the soil moisture sensor sends a HIGH output signal to its data pin which will turn ON the pump. It can operate at 6v. The current rating is 0.05A. The water flow rate is 100 L/H. The operating power is 3W. The water temperature is approx. -20℃-50℃. Its weight is about 42g. The pump used in our project is shown in the Figure.

Figure 3.18 Mini Water Pump

4) Relay
Relay are used in this project as a switch that opens and close circuits electromagnetically or electronically. Relay can control one electrical circuit by opening and closing contacts in another circuit. Relay can be used as a time delay function, and it can control high voltage circuits with the help of low voltage signals. The relay module is used as an interface between Arduino and the load. The relay module used in our project is shown in the Figure. It is a 5v single channel relay.

Figure 3.19 Relay Module

Pin Connection

Pin	Connection
IN	Connected to Arduino digital pin
GND	Connected to ground terminal
VCC	Connected to 5v of Arduino

Table 3.10 Relay pin connections

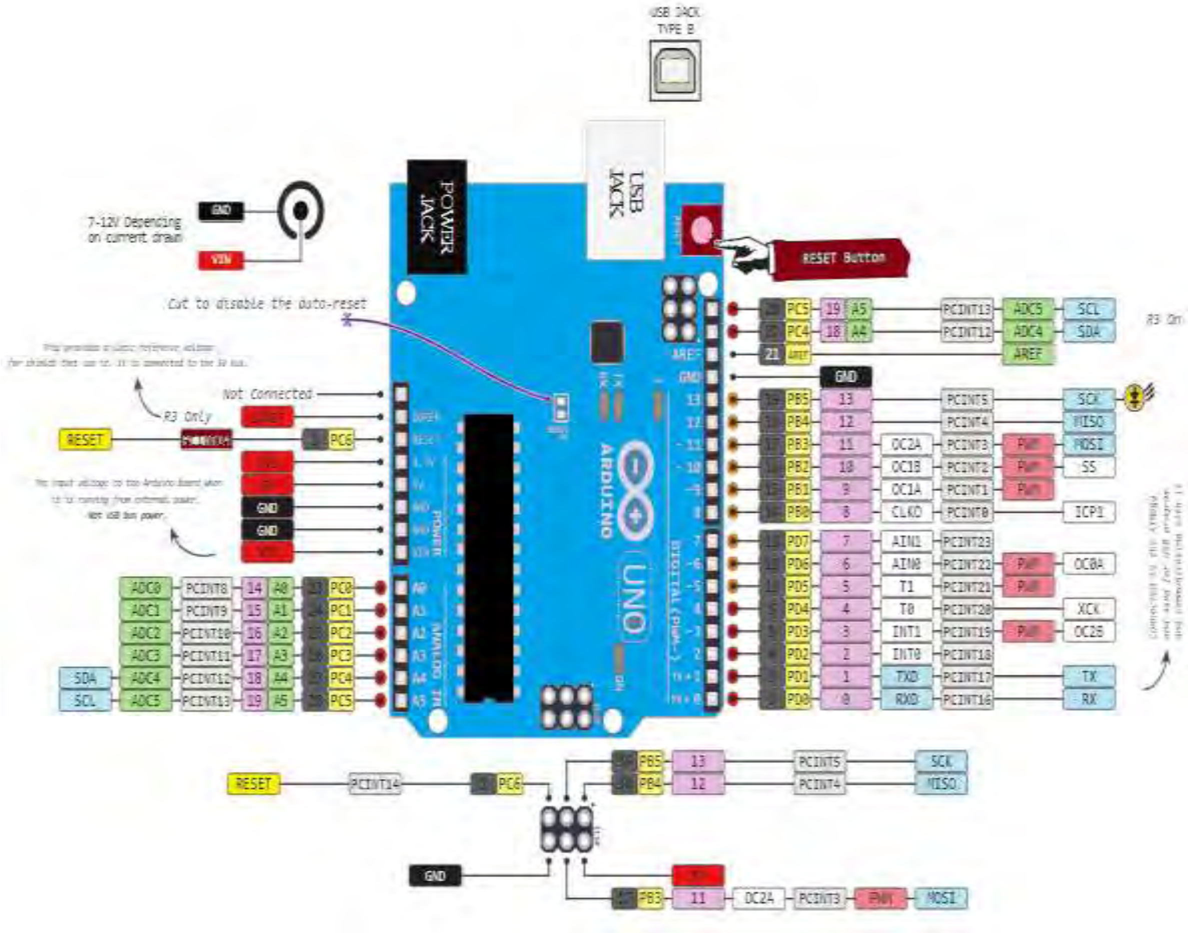
3.2.6 Power Supply Unit

An external power supply is used to power up the Arduino board. The maximum power at which Arduino board can operate is between 6-20volts. Also, batteries of 9v can be used to power the sensors and the load connected in the system. The maximum current rating of Arduino is 1A. so we have a power supply of 12v to be used in our project which is shown in Figure.

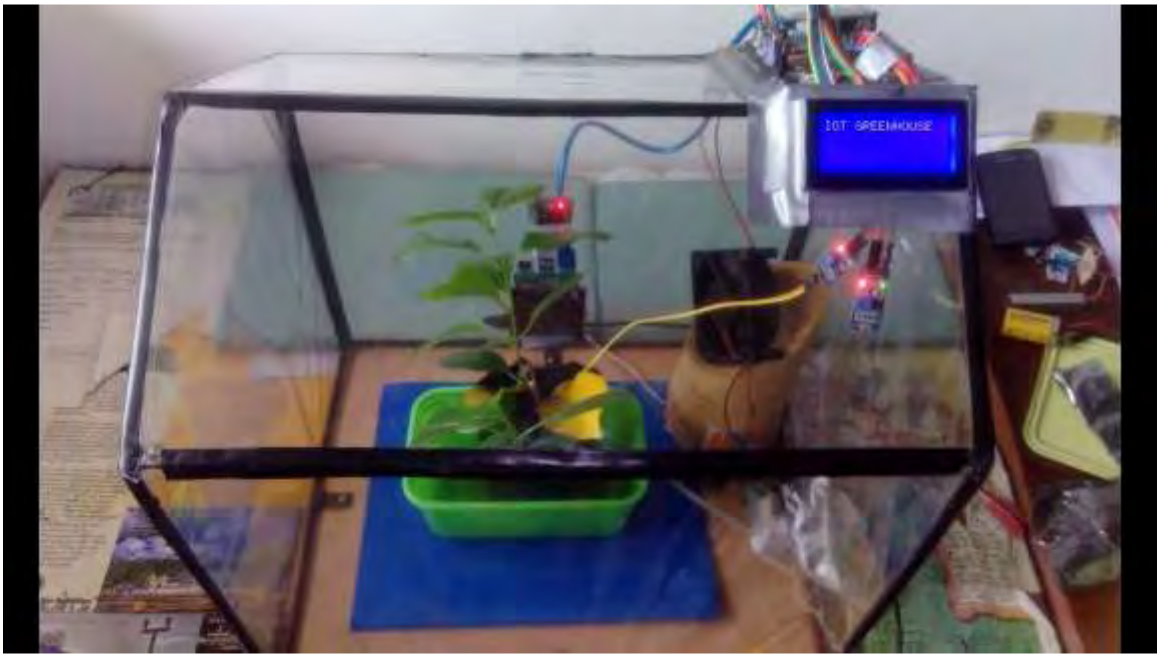
Figure 3.20 DC Power Supply

3.3 ARDUINO

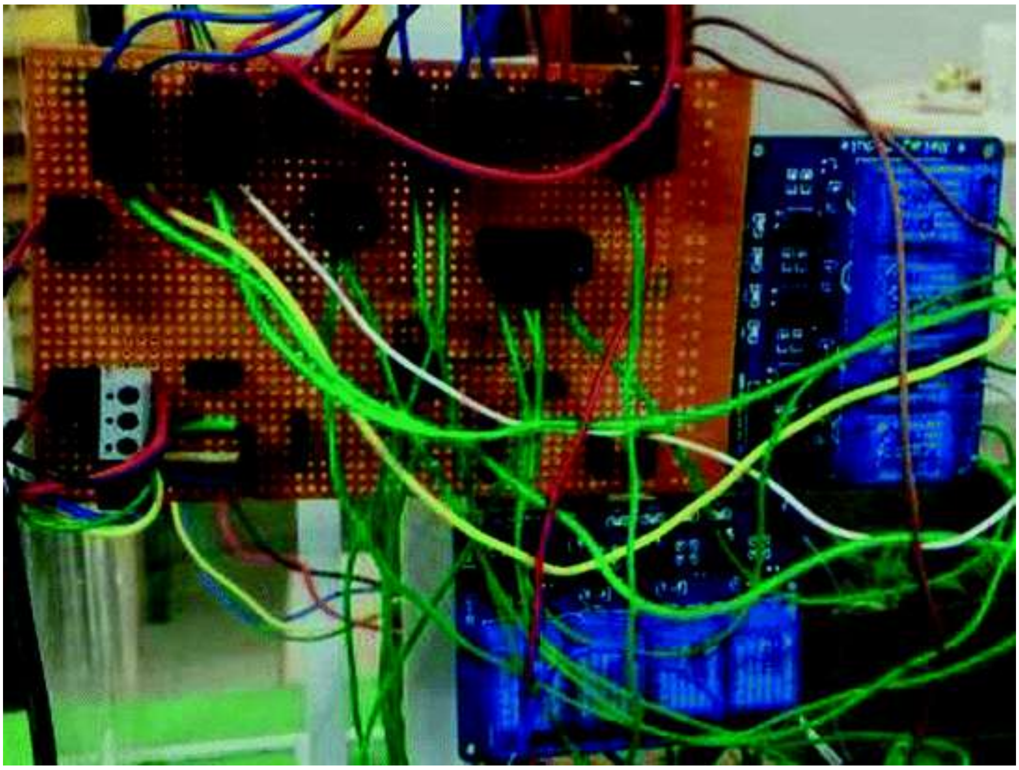
Figure 3.21 Arduino Board



Hardware Prototype I



Hardware Prototype II



3.4 Greenhouse System Flow Chart

Now we can clarify our system by using the flow chart; it is illustrated by comparing the set values with the acquiring values as shown in the Figure 20.

First the sensing unit can sense the values of the parameters and after sensing it can compare the values sensing unit with the set values. If the acquired temperature is greater than the set temperature the microcontroller will send a signal to run the fan and a bulb, else run the fan. If the acquired light intensity is greater than the set value then the microcontroller will send a signal to turn ON the light, else turn OFF the light. If the acquired soil moisture is greater than the set value than the microcontroller will send a signal to drive a pump, else pump will not be driven. Now all the values of the parameters will send to a mobile network through GSM and the user will respond according to that message.

The Flowchart Diagram is shown in the Figure.

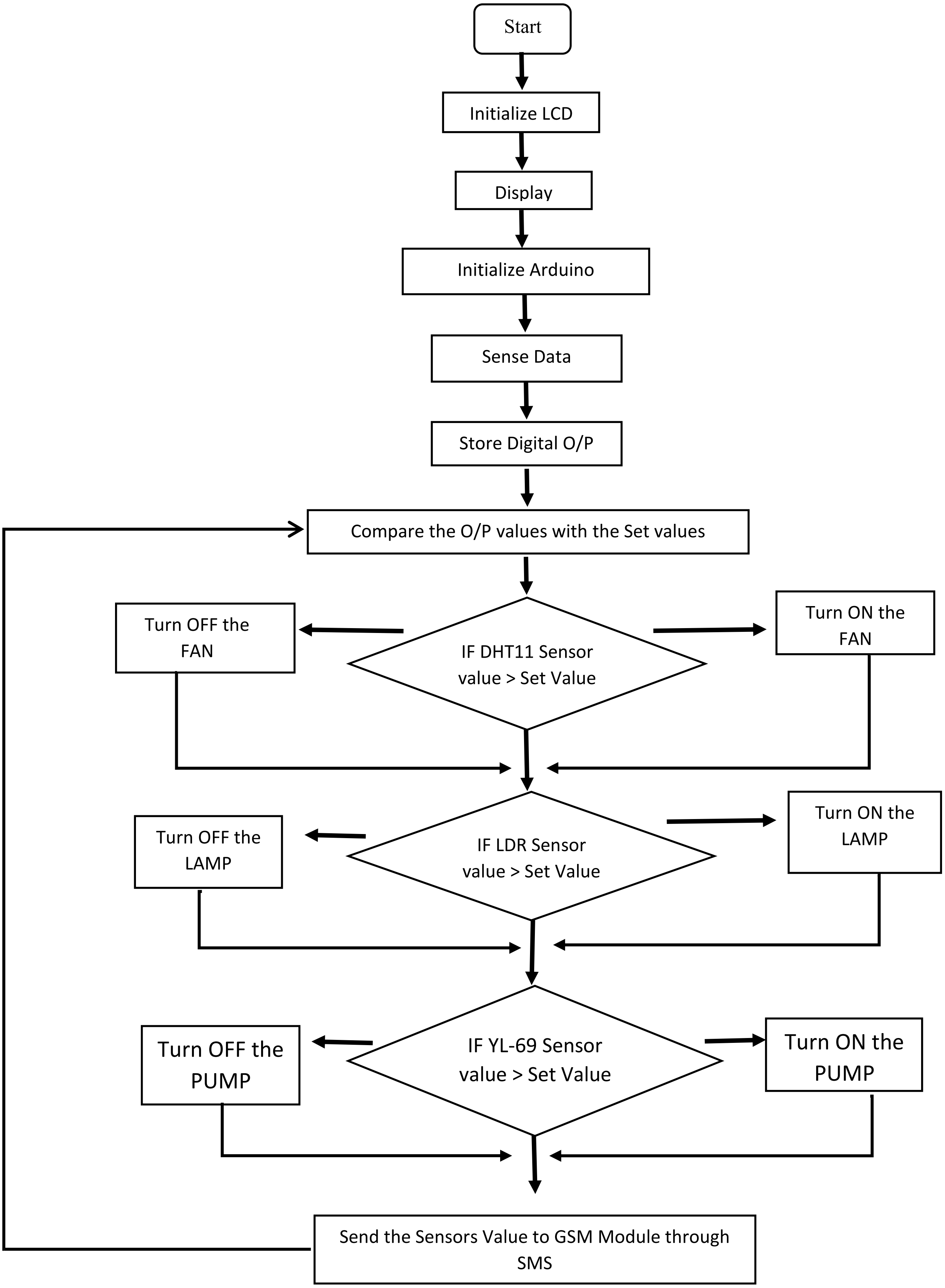


Figure 3.21 the Flow Chart

Chapter 4

Programming Code and Simulations

4.1 Introduction

In this chapter we can do programming for different sensors network and simulate our result by using a simulation software proteus ISIS. The following two software are used in this chapter are as:

- Arduino IDE
- Proteus ISIS

So, we can explain different programming codes for sensors and their simulations in this chapter.

4.2 Sensors

4.2.1 Temperature and Humidity Sensor DHT11

Code

```
#include <LiquidCrystal.h>
#include "DHT.h"
#define DHTPIN 2     // what digital pin we're connected to
#define DHTTYPE DHT11   // DHT 11
 LiquidCrystal lcd(12, 11, 6, 5, 4, 3);
DHT dht(DHTPIN, DHTTYPE);
 void setup() {
  Serial.begin(9600);
  //20 x 4-character display
  lcd.begin(20,4);
  delay(200);
  dht.begin();
}
void loop() {
  // Wait a few seconds between measurements.
  delay(1000);
   // Reading temperature or humidity takes about 250 milliseconds!
  float h = dht.readHumidity();
  // Read temperature as Celsius (the default)
```

```
  float t = dht.readTemperature();
  // Read temperature as Fahrenheit (isFahrenheit = true)
  float f = dht.readTemperature(true);
  }
  dht.read(h);
  dht.read(t);
  dht.read(f);
  //dht.read(hic);
  lcd.setCursor(0,0);
  lcd.print("Humidity: ");
  lcd.print(h);
  lcd.print(" %");
  lcd.setCursor(0,1);
  lcd.print("Temp (C): ");
  lcd.print(t);
  lcd.print(" C");
  lcd.setCursor(0,2);
  lcd.print("Temp (F): ");
  lcd.print(f);
  lcd.print(" F");
}
```

Proteus Schematic:

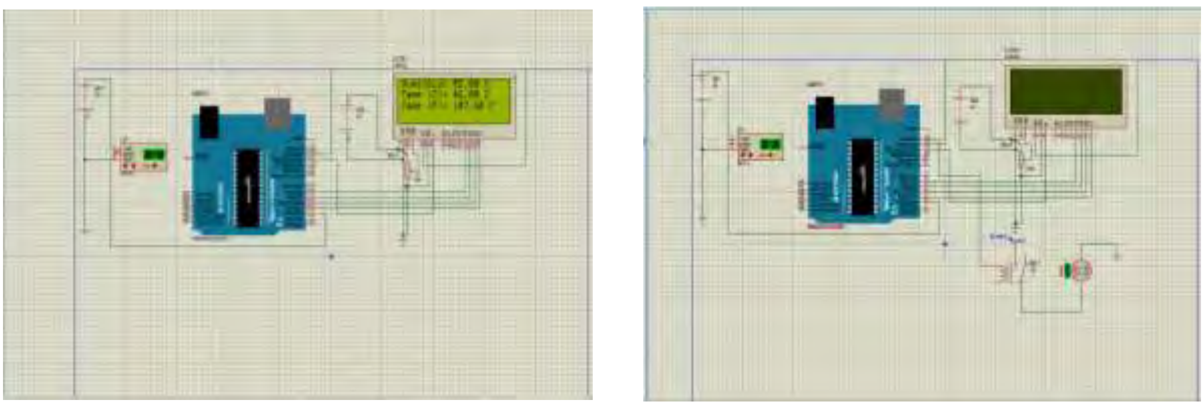


Figure 3.22 Proteus Schematic of DHT11

4.2.2 Light Sensor

Code

```
#define LAMP  9  // choose the pin for the RELAY
void setup() {
Serial.begin(9600);
 pinMode(LAMP, OUTPUT); // declare lamp as output
 //pinMode(PIR,INPUT); // declare sensor as input
}
 void loop()
 {
 int value_ldr = analogRead(A0); // read LDR value
  delay(1000);
  Serial.print("AnalogValue       ");
  Serial.println(value_ldr);
  //Serial.println(value_pir)
 if(value_ldr<250)
 {
       digitalWrite(LAMP,HIGH);  // Turn OFF the light
       //delay(6000);
}
else {
    digitalWrite(LAMP,LOW); // Turn ON the light
 }
 }
```

Proteus Schematic

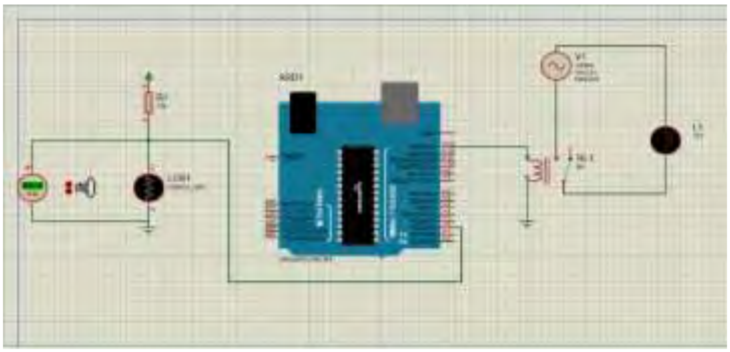


Figure 3.23 Proteus schematic Ldr

4.2.3 Soil Moisture Sensor

Code

```
int Relay = 13;
int sensorPin = A0;
int sensorValue = 0;
int percentValue = 0;
void setup () {
 Serial.begin(9600);
  pinMode(13,OUTPUT); //Set pin 13 as OUTPUT pin, to send signal to relay
  pinMode(A0,INPUT); //Set pin 8 as input pin, to receive data from Soil moisture sensor.
}
void loop() {
  sensorValue = analogRead(sensorPin);
   Serial.print("\n\nAnalog Value: ");
  Serial.print(sensorValue);
   percentValue = map(sensorValue, 1023, 200, 0, 100);
  Serial.print("\nPercentValue: ");
  Serial.print(percentValue);
  Serial.print("%");
  delay(1000);
  if(sensorValue == LOW)
  {
```

```
  digitalWrite(13,LOW); //if soil moisture sensor provides LOW value send LOW value to relay
  }
  else
  {
  digitalWrite(13,HIGH); //if soil moisture sensor provides HIGH value send HIGH value to relay
  }
  delay(400);
}
```

Proteus Schematic

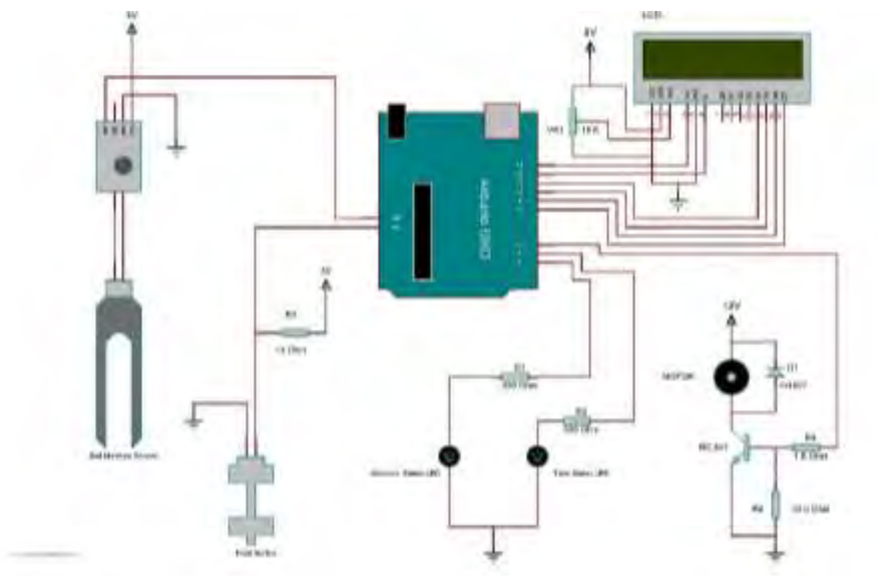


Figure 3.24 Proteus Soil Moisture Sensor

4.3 LCD

Code

```
// include the library code:
#include <LiquidCrystal.h>
// initialize the library by associating any needed LCD interface pin
// with the Arduino pin number it is connected to
const int rs = 12, en = 11, d4 = 6, d5 = 5, d6 = 4, d7 = 3;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
void setup() {
  // set up the LCD's number of columns and rows:
```

```
  lcd.begin(16, 2);
  // Print a message to the LCD.
  lcd.print("hello,world!");
}
void loop() {
  // Turn off the display:
  lcd.noDisplay();
  delay(500);
  // Turn on the display:
  lcd.display();
  delay(500);}
```

Proteus Schematic Sample

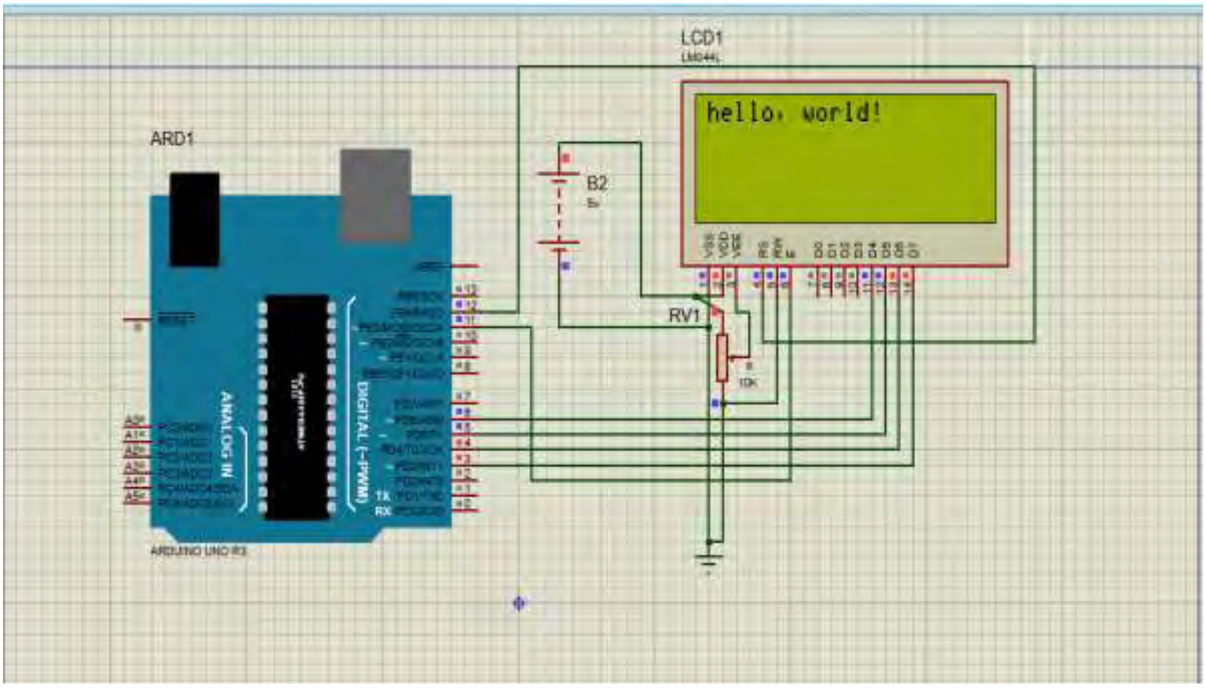


Figure 3.25 Proteus LCD Display

Chapter 5

Conclusion, Recommendations and References

5.1 Conclusions

In this thesis we design a simple low-cost Greenhouse monitoring and controlling system using a GSM Module based wireless cellular technology. A Temperature, humidity, light and soil moisture sensor is used to monitor the Greenhouse parameters and a fan, lamp and a water pump is used to control these parameters. The microcontroller and GSM module were used as a processing and communication unit respectively.

The GSM is a wireless technology used based on a 2G mobile phone cellular technology and is mostly used in wireless applications. Compatibility, portability and low power consumption is some of important key elements in the design of a wireless system. Therefore, a careful selection of sensors and circuit components is also important. The components should be selected so they can easily interface with a microcontroller. LCD is used to display the monitored data which is updated after a few seconds. So, we concluded that Greenhouse is an important and attractive application in the field of agriculture to create a wireless automation system.

5.2 Recommendations

This thesis has provided a comprehensive report on the design process and implementation of a GSM based wireless Greenhouse monitoring and control system. Indeed, there is a need to further study on this system to increase its capacity and reliability. So, we can recommend the following possibilities to improve the system in coming Future:

- We can use four sensors to monitor the environmental parameters, but we could add more sensors to monitor other parameters like PH level of soil, flow of air in Greenhouse, carbon monoxide and oxygen level in the air.
- Using a WIFI Module for wireless communication.
- Using Zigbee based wireless Greenhouse system.
- Developing an android phone mobile app so we can control everything very easily.
- By using IOT (Internet of Things), we can fully control our greenhouse system by sitting in our office or from outside a city.
- Using MAX232 circuit with GUI in controlling unit.

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