Sudan University of Science and Technology

College of Engineering

Electronics EngineeringDepartmen

A project Submitted In Partial fulfillment for the Requirements of the Degree of B.Sc. (Honors) in Electronics Engineering

CONTROLING AND MONITORING GREEN HOUSE USING MICROCONROLLER ARDUINO MAGA BEASE SYSTEM

Prepared by:

1. ALSADIG ISMAIL ALTAHIR IDRISS
2. SAHL ALI ABDSLLAH ALI
3. SAFA MOHAMED ALMAHI ALSADIG

Supervised by:

DR. AHMED ABDALLAH

Oct2016

الإستهلال

بسم الله الرحمن الرحيم

﴿ اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ الْمِصْبَاحُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِنْ شَجَرَةٍ مُبَارَكَةٍ زَيْتُونَةٍ لَا شَرْقِيَّةٍ وَلَا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ نُورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَنْ يَشَاءُ وَيَضْرِبُ اللَّهُ الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ ﴾

صدق الله العظيم

(سورة النور 35)

الإهداء

مع عبق الورود وترانيم الأمل المشرق
ومع شمعه إضاءة المستقبل وعبر زعفران ارض
السودان ومن قلعه المعرفة
جامعه السودان
كانت سحابه الإهداء تمطر البسمات والكلمات
والتحايا
وتبث جذور الإهداء إلى منبع المهد
وإلي حاضنه الأجيال وإلي مقر الرجال إلى يمن
الإيمان إلي بيت الحكمة والآمال.
وإليكم أنتم دون سواكم أبي وأمي
فضلكم يا والداي عمني حتى اللجم إن كل م جنيت
من جهودكم نجم
والدي ي خير عون كان لي عند المحن
أنت يا من تملكين جنه تحت القدم
كل ألفاظي لساني كل شكر قد رهن
اجمعوا كل المعاني من عراب أو عجم لا توافي
شكرهن لاتجاوز العدم.
وإلي كل الأصحاب والأحباب وإلي كل الكوادر التي
ربت هذه الأجيال إلي كل من اعتلى الهمة وزرع
النبتة, شكراً لكم.

Acknowledgment

All favor due to Allah first and foremost, all our thanks to our lord. Thanks to the supervisor **Dr. AHMED ABDALLAH** for any things he gave us his experience in the knowledge and work, helped and motivated, to reach this form. To our families and friends, those who pushed our goals till clarity, supported to the limit for to be, sometimes over pushed it just so we succeed.

ABSTRACT

The needs of a greenhouse structure it is to provide protection and a controlled environment for raising plan indoors. This research we are design and implement an embedded system based on microcontroller (Arduino) system. For automatic and manual monitor and control of greenhouse. Our embedded system is record the parameters such as humidity, temperature, and light that control the environmental conditions in the plant field. The designed system shows the importance of monitoring and controlling via graphical user interface.

المستخلص

الاحتياج للبيوت المحميه يكمن في الحوجه للحمايه والتحكم في المناخ لزراعة النباتات. في هذا المشروع سوف يتم تصميم وتنفيذ نظام مدمج مبني علي المتحكمات الدقيقه(اردويونو) للتحكم والمراقبه يدوي وأوتومتيك في المناخ .ايضا في هذا النظام يتم التحكم في العناصرالمؤثره في المناخ مثل الحراره والرطوبه والضوء . كما يوضح النظام اهميه المراقبه والتحكم عن طريق واجهة تطبيقات المستخدم .

TABLE OF CONTENTS

CHAPTER ONE INTRODUCTION

CHAPTER TWO LITERATURE REVIEW

CHAPTER THREE CIRCUIT DESIGN

CHAPTER FOUR SIMULATION RESULTS

CHAPTER FIVE CONCLUSION AND RECOMMENDATIONS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

ADC	Analog to Digital Converter
API	Application Programming Interface
AVR	Advanced Virtual Risk
DC	Direct Current
DHT	Digital Humidity and Temperature
GND	Ground
GSM	Global System Mobile
GUI	Graphical User Interface
IT	Information Technology
LCD	Liquid Crystal Display
LDR	Light Dependent Resistor
LMI	Linear Matrix Inequalities
MEMS	Micro Electro Mechanical System
NEST	Network Embedded System Technology
PAR	Photo-synthetically Active Radiation
PC	Personnel Computer
PDA	Personal Digital Assistant
PDC	Parallel Distributed Compensation
PGHS	Paprika Green House System
PID	Proportional Integral Derivative
RF	Radio Frequency
RX	Receiver
SMS	Short Message Service
SIM	Subscriber Identification Module
T-S	Takagi – Sugeno
TX	Transmit
WSAN	Wireless Sensor Actor Networks

WSN	Wireless Sensor Network
A	Ampere
°C	Degree Celsius
GHz	Gaga Hertz
V	Voltage
W	Watt

CHAPTER ONE

CHAPTER ONE
INTRODUCTION

1.1 Introduction

There is continuous increase in demand for food production technology. Sudan is a country where the economy is dependent on agricultural produce. Sudan weather conditions are characterized by having predominantly long and hot summers and short and mild winters. Such climatic conditions put a great strain on the types of crops that could be successfully grown. This is very much true with most horticultural vegetables with medium thermal requirements (tomato, pepper, cucumber, watermelon, marrow, green bean, eggplant) [1, 2].

Agricultural means can satisfy the food production demand. But due to isotropic climatic conditions. This ultimately affects the plant growth. Also there are many such problems associated with it. To overcome from this problem. Pests and diseases, and extremes of heat, humidity, light and temperature, and irrigation is necessary to provide water. The farmers have been using different irrigation technique for increasing production. These techniques were done by human intervention. But due to this sometimes either the plants consume more water or the water reaches late up to the plants.

Greenhouses protect crops from too much heat or cold, shield plants from dust storms and help to keep out pests. Light and temperature control allows greenhouses to become suitable place for growing plants. The cultivation exhibition of plants under controlled conditions. Greenhouses also are often used for growing flowers, vegetables and fruits.

In other word, a greenhouse is a structure that provides protection and a controlled environment for raising plan indoors. The primary issue of greenhouse based horticulture is to manage the greenhouse environment optimally in order to comply with the economic and environmental requirements [3, 4].

We can use an automatic or manual microcontroller (Arduino) based system. For automatic monitor and control for greenhouse we are developing an embedded system which will record the temperature, moisture and other parameters that will control the environmental conditions in the plant field. Moreover for effective control, an interface application is used along with embedded system.

1.2 Problem Statement

There is a need to provide suitable environment for the cultivation of plant in all seasons of the year. There are many disadvantages of the conventional systems such as; high effort and cost expended in the old system. Beside, plant productivity is not optimum. The conventional manual controlling of cultivation environments (greenhouse).

1.3 Solution Statement

A climate control system is designed to provide a suitable environment for growing the plant by reading the temperature, humidity, lighting and the amount of irrigation by special sensors. And Control the fans for cooling, heating, humidity, the proportion of lighting and irrigation through an electrical circuit governed by a specific program automatically.

1.4 Objectives

The objectives of this research are to implement, design and realize a low cost the microcontroller (Arduino) based system technology for monitoring and controlling greenhouse climate, and implement prototype hardware in a real time environment.

1.5 Methodology

In order to achieve the objective of the scope few tasks need to be done for the hardware of the system and the GUI application software. For the hardware of the system there are three parts which have to be considered. They are the microcontroller board (Arduino) based system, the transmitted and the received frame and software of the system. First of all, in this system, the microcontroller have to be test and check for it functionality.

Secondly, transmitter and the receiver need to be test for its functionality. It can be done by sending a bit of data from the transmitter to the receiver. The push button and the LED can be used as the representation of data sending and receiving. Or displaying the transition frame in virtual terminal.

Finally the software of the system, for that there are two parts which have to be considered. They are the software for the programming and the Visual studio c# programming for GUI application. The Visual Basic studio software used to make a connection to the remote monitoring using GUI application. Hyper terminal is used to record data that have been received through the serial connection.

The last part in order to achieve the objective is to test the output of the system. The driver circuits which consist of relay and transistor are needed to be tested so that the cooling fan and the irrigation valve are functional. To test the relay is by giving appropriate power supply to its coil.

1.6 Thesis Outline

Chapter two reviews literature of this project based on journals and other references. Chapter three discusses system design of the proposed solution. Details of the implementation steps are also explained in this chapter. Chapter four presents, analyzes and discusses the results of the implemented circuit. Chapter five concludes the research and presents future recommendations.

CHAPTER TWO

CHAPTER TWO

LITERATURE REVIEW

2.1 Background

Today 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.

As it is well known that greenhouse is a building or complex in which plants are grown. These structures range in size from small sheds to industrialized buildings. Greenhouses are often used for growing flowers, vegetables and fruits. Greenhouses are very useful for they provide an optimal growing season, allowing you to sow plants earlier and harvest plants later and allows economic crops such as tomatoes, cucumbers, melons and aborigines to crop more successfully [5]. Basic factors affecting plant growth such as sunlight, water Content in soil, air humidity, temperature, CO2 concentration. These physical factors are hard to control manually inside a greenhouse and there is a need for automated design arises.

2.2 Effect Elements in Greenhouse

One of the benefits of growing crops in a greenhouse is the ability to control all effective elements of the production that important to be monitored because it is directly related to the growth and development of plants.

2.2.1 Temperature effects

Different crop species have different optimum growing temperatures and these optimum temperatures can be different for the root and the shoot environment and for the different growth stages during the life of the 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 residential or commercial building, controlling the temperature would be much easier since these buildings are insulated so that the impact of outside conditions is significantly reduced [6].

2.2.2 Humidity effects

Water vapour inside the greenhouse is one of the most significant variables affecting the crop 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 plants through these pores, and oxygen and water leave through them. Transpiration rates decrease proportionally to the amount of humidity in the air. This is because water diffuses from areas of higher concentration to areas of lower concentration [7]. 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 actuators. The main priority is for temperature control because it is the primary factor in the crop 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 [5].

2.2.3 Light effect

All things need energy to grow, human and animals get energy from food. Plants, on the other hand, get energy from the sun light through a process called photosynthesis. This is how light affects the growth of a plant. Without light, a plant would not be able to produce the energy it needs to grow. Aside from its effect 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, and both leaves and stem, lacking chlorophyll, are pale yellow. Plants grown in shade 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, weak plants result [7].

2.2.4 Water level in soil effects

Soil water also affects the crop growth. Therefore, the monitor & control of soil condition has a specific interest, because good condition of a soil may produce the proper yield. The proper irrigations and fertilizations of the crops are varies as per the type, age, phase and climate. The pH value, moisture contains, electric conductivity and the temp 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, control by proper setting of ventilation. Since the temperature control is depends on direct sun radiation and the screen material used, the proper set point can adjust to control soil temperature. The temperature set-point value depends on actual temperature of the inside and outside of the greenhouse [8].

2.3 Previous Works

There are many previous studies in this area which should be reviewed for helping in proposing a system with solvable problem in greenhouses.

Stipanicev and Marasovic [9] have proposed system is an embedded Web server unit system based on TINI board, by collecting data from distributed sensors and activating connected actuators using simple 1-wire local network. On the other side Web server is connected to the Internet through Ethernet or dial-up network [9]. They have claimed that the developed system shows all advantages of Network Embedded System Technology (NEST), like the possibility of changing physical topology and low dimensions and cost in comparison with PC based system, preserving the full functionality at the same time [9].

Nachidiet al [10] has proposed system to control of air temperature and humidity concentration in greenhouses is described by means of simultaneous Ventilation and heating systems by using Takagi-Sugeno (T-S) fuzzy models and the Parallel Distributed Compensation (PDC) concept**.** And showed that the robust fuzzy controller effectively achieves the desired climate conditions in a greenhouse, using this T-S fuzzy model, the stability analysis and control design problems can be reduced to sufficient conditions expressed as Linear Matrix Inequalities (LMIs) [10].

Qianet al [11] have compared the advantages of ZigBee with other two similar wireless networking protocols, Wi-Fi and Bluetooth, and proposed a wireless solution for greenhouse monitoring and control system based on ZigBee technology. As an explorative application of ZigBee technology in Chinese greenhouse, it may promote Chinese protected agriculture. With the capabilities of self-organizing, self-configuring, self-diagnosing and self-healing, the ZigBee based monitoring and control system provides nearly unlimited installation. Flexibility for transducers, increases network robustness, and consider ably reduces costs. Therefore, they concluded that the ZigBee-based monitoring and control system can be a good solution for greenhouse monitoring and control [11].

Elmusratiet al [12] have suggested a different approach for implementing WSN in greenhouse environment by making use of a commercial wireless sensing platform provided by Sensinode Inc. The hardware design of the system consists of Sensinode's Micro 2420U100 operates as basic measuring node, with four commercial sensors (e.g. humidity, temperature, light and CO2). The idea behind this development is to test the reliability and feasibility of a prototype wireless environment monitoring system in commercial greenhouse. The experimental result showed that the network can detect local difference in the greenhouse climate caused by various disturbances in the environment [12].

Palaniappanet al [13] have proposed an embedded greenhouse monitoring and control system to provide a highly detailed micro-climate data for plants within a greenhouse environment with an innovative method of growing temperate crops in a tropical environment using microclimatic conditions. The greenhouse was equipped with conventional wired sensors that provide readings of the air temperature, light intensity and nutrient solution temperature in the mixing tank. The acidity and concentration of the nutrient solution were manually measured ,and adjusted accordingly, and high resolution data, collected with the deployment of a network of wireless sensors to provide sufficient data to develop pa model for the growth of these crops under Aeroponic conditions. The researcher claimed that the reliability of the star network was relatively high, with many nodes performing with a data transmission rate above 90%, where the minimum data transmission rate for all the nodes was 70% [13].

Abdul Aziz et al [14] have proposed system has a measurement which capable of detecting the level of temperature to developed a remote temperature monitoring system using wireless sensor and Short Message Service (SMS) technology. This system also has a mechanism to alert farmers regarding the temperature changes in the greenhouse so that early precaution steps can take and testing several types. This extended to include more environmental variables to be monitored in the agricultural greenhouse which relate to the increment of fruits and vegetables productivity. For example, other than temperature, the soil and water acidity level in the greenhouse also play important role to the quality of fruits, enhanced to produce a system that can trigger automatic actions of related components such as the sprinkler, lighting and air ventilators, rather than just send alert notification message, the proposed system is enhance by implementing artificial intelligent components to enable advanced implementations such as self-learning, predicting, and define ambiguous situation which provide preventive measures [14].

Lee et al [15] have suggested the ‘Paprika Greenhouse System’ (PGHS) which collects paprika growth information and greenhouse information to control the paprika growth at optimum condition. Also controls ventilators, humidifiers, lightings and video-processing through Graphical User Interface (GUI) Application by analyzing the measured data.

The system provides with the 'growth environment monitoring service', which is monitoring the paprika growth environment data using sensors measuring temperature, humidity, illuminance, leaf wetness and fruit condition, the 'artificial light-source control service', which is installed to improve the energy efficiency inside greenhouse, and 'growth environment control service', controlling the greenhouse by analyzing and processing of collected data [15].

Song et al [16] have proposed system based on AVR Single Chip microcontroller and wireless sensor networks. The monitoring and management center can control the temperature and humidity of the greenhouse, measure the carbon dioxide content, and collect the information about intensity of illumination. In addition, the system adopts multilevel energy memory. It combines energy management with energy transfer, which makes the energy collected by solar energy batteries be used reasonably. Therefore, the self-managing energy supply system is established. The system has advantages of low power consumption, low cost, good robustness, extended flexible as well as an effective tool for monitoring and analysis decision-making of the greenhouse environment is provided [16]**.**

Chiung, Guan and Jwu [17] have utilized Field Point of National Instrument to build the greenhouse environment control system, and LABVIEW as programming language for compiling. They have used smart mobile (or PDA) to control the Personnel Computer (PC) server through the wireless network where the Field Point will adjust environment of greenhouse through controlling the device. Moreover, user can master the status of the greenhouse through web cam, and which use the smart mobile to control greenhouse environment system on anywhere. The result of this proposed system showed that the designed system could be more effective in manpower savings and raising the economic value of products i.e. Phalaenopsis [17].

Rahaliet al [18] has designed and development of an electronic system based on a microcontroller that integrates remote control functions rooted in the GSM network. The system allows the acquisition of different climatic parameters in an agricultural greenhouse. In addition, this electronic system achieves the control and remote monitoring of greenhouse solutions, in particular drip irrigation stations, by sending SMS messages. The system, also, includes a serial cable, a GSM, conditional sensors card, power interfaces and microcontroller. An active SIM card is required to receive and send messages. A graphical user interface using LABVIEW software for the acquisition, monitoring with PC and storage of all data through the PCL812PG card have been developed. This interface encompasses at the same time reliability, flexibility of use, interactivity and processing capability in real-time of the whole data. The proposed system presented several advantages: user friendly, easily implemented, focus main parameters, use GSM phones because of theirs availability, low cost of SMS in Morocco, and network coverage [18].

Zagade and Kawitkar [19] designed and implemented of a WSN that can monitor the air temperature, humidity and ambient light intensity in greenhouse. This can help farmers to understand the environmental conditions and they can adopt different methods to increase the crop production. The system is integrated with small size application specific sensors and radio frequency modules. All monitored parameters are transmitted through a wireless link to cellular device for analysis. A cell phone is used instead of computer terminal keeping mind that system will be used by farmers and considering power management [19].

Deore and Umale [20] have given an emphasis on WSN approach f greenhouse monitoring and control. A control system is developed and tested using recent ATmega microcontroller. The farmers in the developing countries can easily use designed for maximizing yield. ATmega microcontrollers are preferred over other microcontrollers due to some important features including10bit ADC, sleep mode, wide input voltage range and higher memory capacity. The design system considered optimization and functional improvement of the system. The system has several advantages in term of its compact size, low cost and high accuracy [20].

Sagar [21] has developed the monitoring and GSM systems for using in greenhouse applications, where real time data of climate conditions and other environmental properties are sensed and control decisions are taken by monitoring system and they are modified by the automation system and sends SMS that what operation is performed by them to user. The architecture of a greenhouse monitoring system comprises of a set of sensor nodes and a control unit that communicate with each sensor node and collects local information to make necessary decisions about the physical environment. The system is little cost with wireless sensors but it works with more effectively [21].

Song et al [22] have proposed system scheme based on wireless sensor network, where they adopted an Atmega128L chip and a low power RF chip from TI i.e. CC2530 to design the sink node and sensor nodes in the WSN. The monitoring and management center can control the temperature and humidity of the greenhouse, measure the carbon dioxide content, and collect the information about intensity of illumination, and so on. And the system adopts multilevel energy memory. It combines energy management with energy transfer, which makes the energy collected by solar energy batteries be used reasonably. Therefore, the self-managing energy supply system is established. In addition, the nodes deployment method and time synchronization problem are analyzed in detail. The system can solve the problem of complex cabling with the advantages of low power consumption, low cost, good robustness, extended flexible and high reliability. An effective tool is provided for monitoring and analysis decision-making of the greenhouse environment [22].

Othman and Shazali [23] have discussed and reviewed wireless sensor network applications for environmental monitoring. Development in the technology of sensor such as Micro Electro Mechanical Systems (MEMS), wireless communications, embedded systems, distributed processing and wireless sensor applications have contributed a large transformation in WSN recently. It assists and improves work performance both in the field of industry and our daily life Wireless sensor network has been widely used in many areas especially for surveillance and monitoring in agriculture and habitat monitoring. Environment monitoring has become an important field of control and protection, providing real-time system and control communication with the physical world. An intelligent and smart Wireless Sensor Network system can gather and process a large amount of data from the beginning of the monitoring and manage air quality, the conditions of traffic, to weather situations in the monitoring system [23].

Mittal et al [24] have designed hardware for green house monitoring various sensors are used to control the environment parameters such as temperature, humidity, and light intensity for green house and soil wetness for crop growth. The system comprises of sensor, ADC, microcontroller and actuators. When any of the above mentioned climatic parameters cross a safety threshold which has to be maintained to protect the crops, the sensors sense the change and the microcontroller reads this from the data at its input ports after being converted to a digital form by the ADC. The system has successfully overcome quite a few shortcomings of the existing systems by reducing the power consumption, maintenance and complexity, at the same time providing a flexible and precise form of maintaining the environment.

The continuously decreasing costs of hardware and software, the wider acceptance of electronic systems in agriculture, and an emerging agricultural control system industry in several areas of agricultural production, will result in reliable control systems that will address several aspects of quality and quantity of production [24].

Berezowski [25] has reviewed the landscape of the application of wireless sensor networking in greenhouse management to make computer engineer more aware about this specific application domain and the space it offers for applying IT and communication infrastructure, as well as to make horticulture researchers more aware of what wireless technologies have to offer and how to optimize their usage in the greenhouse. Also identified, formulated and discussed the design space of a few in opinion most important problems in developing efficient and cost effective WSN deployments for greenhouses. The reasons to propose such an analysis have come from the gap have observed between the results observations coming from preliminary field experimentation in the greenhouse [25].

Hwang and Yu [26] have proposed design and implementation of a remote monitoring and controlling system using ZigBee networks. This system is targeting the home network. Web service and a smart phone are used for the client system to monitor and control the home. This system can be applied in many areas such as elderly protecting systems, cultural heritage or forest fire monitoring systems, managing systems for agricultural cultivation and so on [26].

Sahu and Mazumdar [27] have designed a simple, easy to install, microcontroller-based (Atmel) circuit to monitor and record the values of temperature, humidity, soil moisture and sunlight of the natural environment that are continuously modified and controlled in order optimize them to achieve maximum plant growth and yield. The microcontroller communicates with the various sensor modules in real-time in order to control the light, aeration and drainage process efficiently inside a greenhouse by actuating a cooler, fogger, dripper and lights respectively according to the necessary condition of the crops. An integrated Liquid Crystal Display (LCD) is also used for real time display of data acquired from the various sensors and the status of the various devices [27].

Alausa Dele and Kolawole [28] have proposed microcontroller based greenhouse control device is used in the automatic control and monitoring of Equipments and quantities such as screening installations, heating, cooling, lighting, temperature, soil Moisture level and other quantities/conditions in a greenhouse, with effective monitoring of all quantities therein, hence eliminating need for Human monitoring. With an enhanceable feature it integrates and automates by turning ON or OFF all monitoring devices in the house as well as provides suggestions for remedies when the need arises. The system has successfully overcome quite a few short comings of the existing systems by reducing the power consumption, maintenance and complexity, at a reduced cost and at the same time providing a flexible and precise form of maintaining the environment [28].

Mohanty and Patil [29] have proposed some important parameters that should be monitored at a greenhouse in order to achieve good results at the end of the agricultural production such as temperature, light and humidity. And have presented a wireless sensor network having several sensor nodes with these commercial sensors to measure the above parameters. The system can efficiently capture greenhouse environmental parameters and it shows normal communication between source and sink node and fine network stability. It also obtains strong adaptability, good confidentiality and high reliability. So will developed greenhouse wireless sensor network monitoring system design based on solar energy. The sensor nodes receive the solar energy and supply it to the wireless sensor network. The design will consume less energy and cost effective [29].

Nikhade and Nalbalwar [30] have summarized an idea that can carry out to provide an efficient control mechanism of microclimate into greenhouses through the implementation of an infrastructure of wireless sensors network to control environmental parameters. This enables a real time action process that aims to atomies the network tasks. Based on the advantage gained from the small size of the network, low cost distributed sensing network that can be employed anywhere and even with harsh environments greenhouse crops are in essential neediness for WSAN system which achieve better monitoring-controlling and hence avoiding damage of the crops due to unstable inside parameters like temperature, humidity, soil moisture, leaf temperature and many other parameters which affects crops growth and may cause of diseases. The design is more focusing on automation jobs, optimizing the response time, and providing instant solution [30].

Gaoet al [31] have designed a wireless greenhouse monitoring system based on ZigBee and GSM technology to resolve the problems of complicated cabling and costly wired network in the current system. The system consists of two parts: a wireless sensor network and remote control terminal. According to parameter distribution in the monitoring regional, a wireless transmission network was formed, all of the nodes in the network using solar power. In the remote control terminal, the study developed a simplified expert decision system, in which the part of greenhouse control decision adopts the fuzzy decoupling control algorithm to realize the temperature and humidity decoupling control and increase the accuracy of decision-making according to the experimental test. It can realize real-time, accurate monitoring and collecting of parameters data in the greenhouse environment; the remote control terminal can give effective decision management solutions. The system achieves automatic real-time monitoring of environmental parameters and gives correct decision plans, which is of a broad application prospect [31].

Jianjunet al [32] has presented system that consists of a data acquisition controller and greenhouse remote monitoring and control software. The system, monitor temperature ,humidity, soil water content and concentration of carbon dioxide inside the greenhouse which then saved to a database. According to the current indoor temperature, the target temperature and the offset temperature, Proportional Integral and Derivative (PID) control method is used to control temperature control in greenhouse. The system is implemented using low power wireless components, and easy to be installed [32].

In addition, Lambebo and Haghani [33] provided a detailed study and implementation of a WSN for real time and continuous environmental monitoring of greenhouse gases. A tree-topology WSN consisting of two sensor nodes and a base station was successfully built and tested using open source and inexpensive hardware to measure the concentration level of several greenhouse gases. The captured data is made available to the user through a graphing Application Programming Interface (API). The network works within the range of 100 meters for optimum performance [33].

CHAPTER THREE

CHAPTER THREE

CIRCUIT DESIGN

3.1 An Overview of the Greenhouse Design

The proposed greenhouse system is presented in Figure 3.1, as can be grasped, the system has the following units: sensing unit, processing unit, displaying unit, communication unit, and derivers and actuators unit. In the following, the units of the proposed greenhouse system were designed, simulated, implemented, tuned and integrated. A Proteus ISIS environment simulator was utilized to simulate the proposed system as shown in Figure 3.2, where the implemented system was achieved by using the Breadboard.

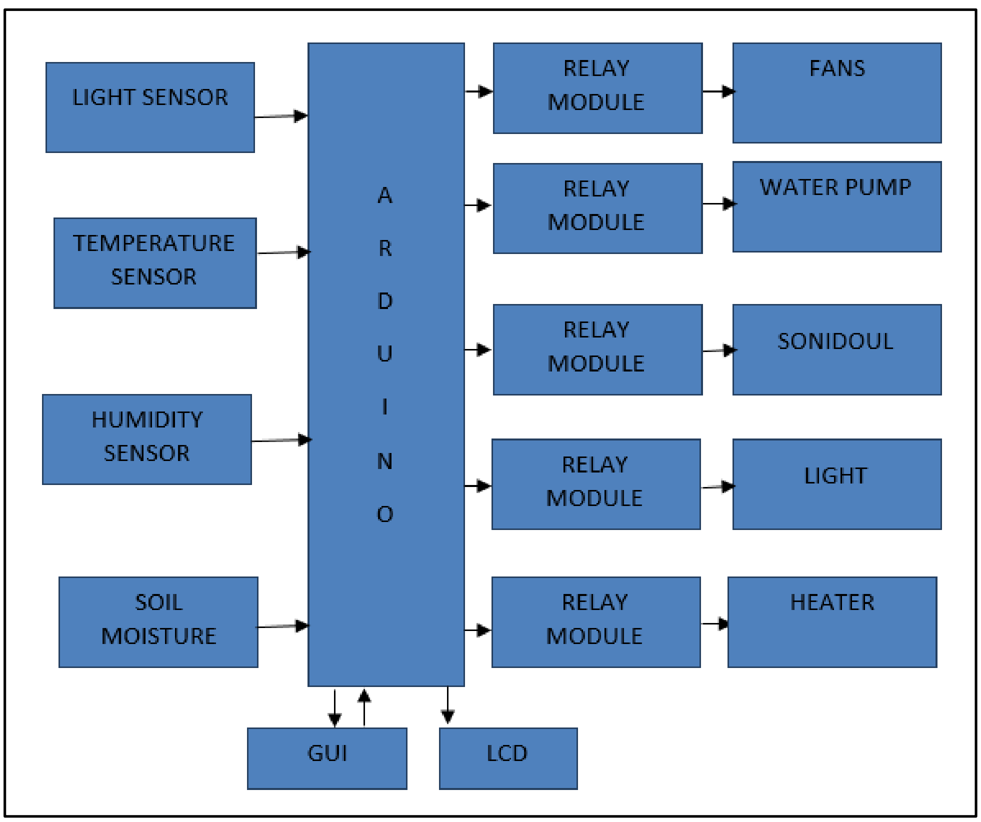

Figure 3.1: The Proposed Greenhouse Block Diagram

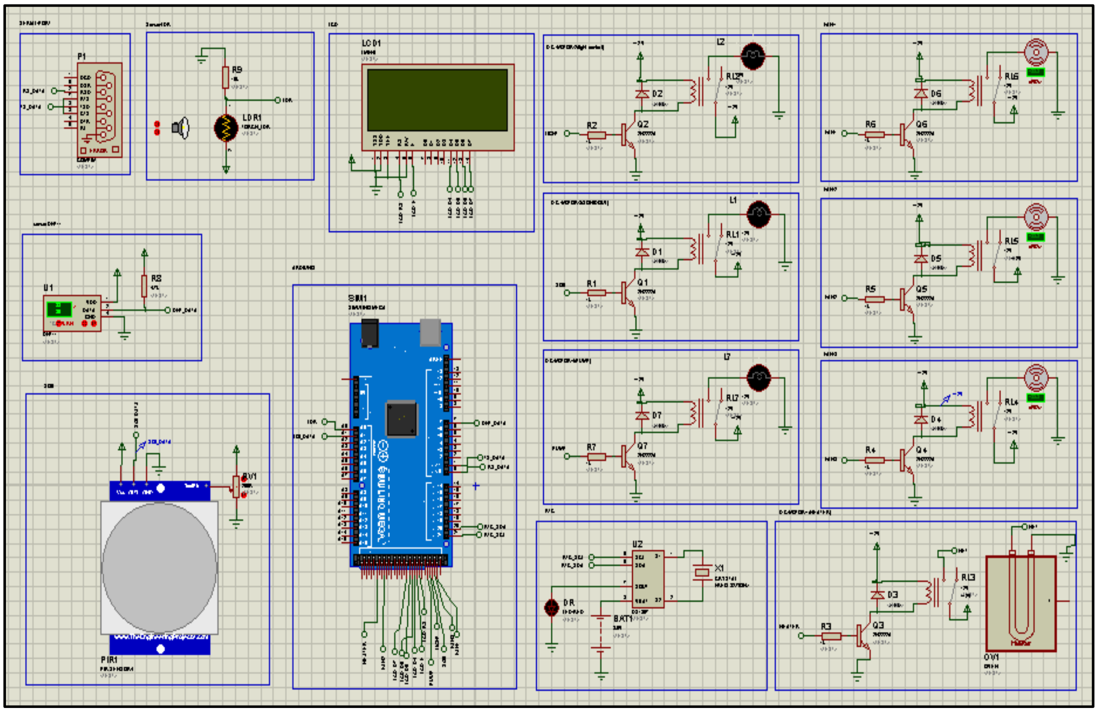

Figure 3.2: The complete schematic diagram of the proposed greenhouse system

3.2 Sensing Unit

Transducer is a device which transforms energy from one type to another, even if both energy types are in the same domain. Typical energy domains are mechanical, electrical, chemical, magnetic, optical and thermal. Transducer can be further divided into sensors –which monitors a system– and actuators –which impose an action on the system.

Sensor is a device for sensing a physical variable of a physical system or an environment. It senses the environmental phenomena 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 electric energy into mechanical action.

The following factors must be considered when choosing sensor:

- **Rang and span:** This represent the range a limits heater which the input can vary. The span is the maximum value of the input minus the minimum value.
- **Errors:** Is the different between the result of the measurement and the free value of the quantity being measured where (Error = measured value – free value)
- **Accuracy:** is the extent to which the value indicated by measurement system might be varying. It is the summation all possible error that to accuracy.
- **Sensitivity:** it is relationship indicating how much output you get per unit input.
- **Stability:** it is the ability to give the same output when used to measure a constant input over a period of time.
- **Resolution:** when input varies continuously over the range the output signals for the some seasons may change in serial steps.

In this thesis the sensors used to measure environmental parameters are: Temperature and Humidity sensor (i.e.DHT11), light sensor (i.e. LDR) and Soil Moisture Sensor (i.eYL-69).

3.2.1 Temperature and humidity sensor

Temperature sensing technology is one of the most widely used sensing technologies in the modern world. It allows for the detection of temperature in various applications and provides protection from excessive temperature excursions. The DHT11 shown in Figure 3.3 was selected in this application. DHT11 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. The only real down side of this sensor is you can only get new data from it once every 2 seconds. Table 3.1 shows technical specification of DHT 11.

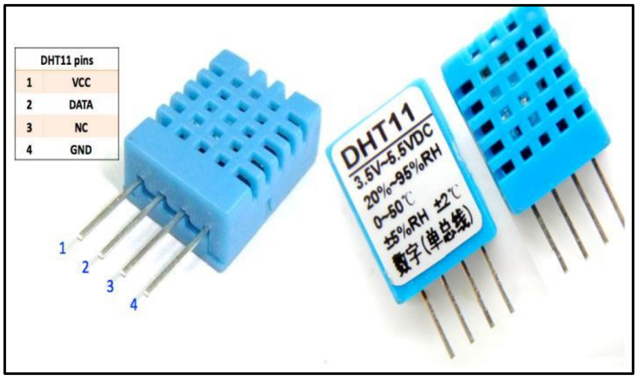

Figure 3.3: The DHT11 sensor

Table 3.1: Technical specification of DHT11

Specification	Value
Resolution	1
Response time Temperature /Humidity	30 S /10 S
Accuracy Temperature /Humidity	±2℃/±5%RH
Range Temperature/ Humidity	0-50 ℃/ 20-90%RH
Power supply	DC 3.5～5.5V
Sampling period	more than 2 seconds

3.2.2 Light sensor

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

Light Dependent Resistors (LDR) shown in Figure 3.4 was selected in this application. LDR is basically a resistor that has internal resistance increases or decreases dependent on the level of light intensity impinging on the surface of the sensor where it measures visible light as seen by the human eye with fast response, and small in size. Table 3.2 shows technical specification of LDR.

Figure 3.4: The light dependent resistor

Table 3.2: Technical specification of LDR

Specification	Value
Voltage ,AC or DC peak	320V
Current	75Ma
Power Dissipation at 30°C	250Mw
Operating temperature range	-60°C to 75°C

Because LDR give variable resistor it must connected to voltage divider circuit as shown in Figure 3.5, where the equation of Vout from the voltage divider is:

$$\mathrm{Vout} = \frac{\mathrm{LDR} \times \mathrm{Vin}}{\mathrm{LDR} + \mathrm{R1}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.1)$$

Then,

$$\mathrm{LDR} = \frac{\mathrm{Vout} \times \mathrm{R1}}{\mathrm{Vin} - \mathrm{Vovt}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

To calculate the intensity of light uses this equation:

$$\mathrm{R1} = \frac{500}{\mathrm{LUX}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

$$\mathrm{LUX} = \frac{500}{\mathrm{R1}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.4)$$

$Vout = Output\ voltage$

$Vin = Input\ voltage$

$R1 = Resistor\ of\ voltage\ divider$

LUX =Light intensity

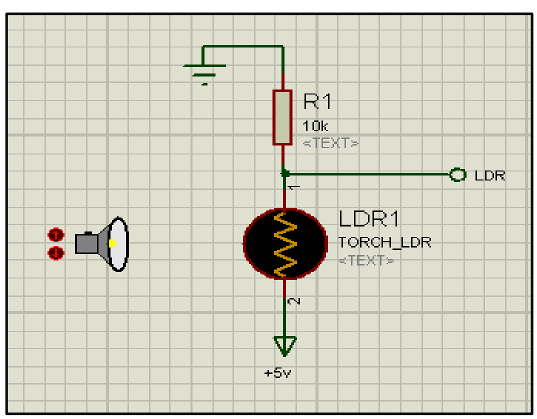

Figure 3.5: Schematic of signal conditioning circuit for LDR sensor

3.2.3 Soil Moisture Sensor

The Soil Moisture Sensor is used to measure the volumetric water content based on the dielectric constant of soil. The sensor is inserted in the soil to sense the existence of water. An electric current can easily pass through if there is moisture and due to the fact that the level of moisture is hard to determine and to make sure that the moisture sensor is very accurate and efficient. Figure 3.6 shows the Soil Moisture Sensor YL-69, and Figure 3.7 show the Equivalent Circuit of Soil Moisture Sensor.

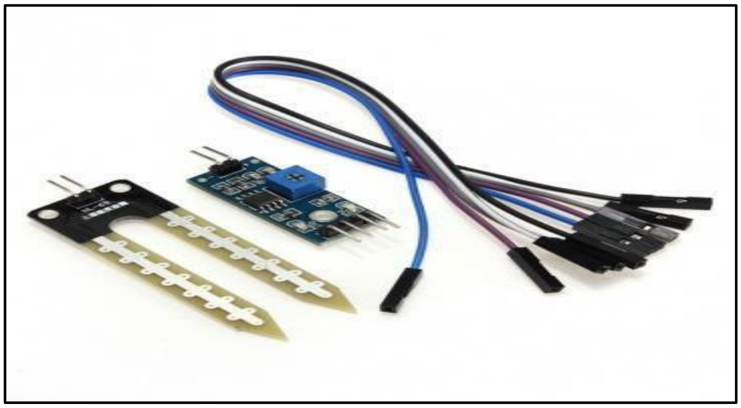

Figure 3.6: Soil moisture sensor YL-69

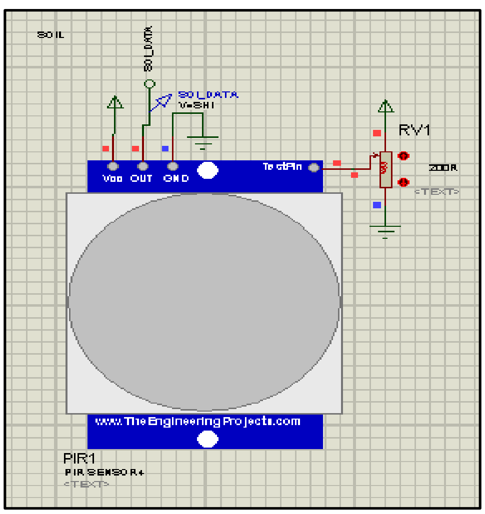

Figure 3.7: Equivalent circuit of soil moisture sensor

3.3 Processing Unit (Arduino)

Arduino is a situated of advancement sheets that accompany pretested equipment and programming libraries. That is to say, easy to Arduino board and begin adding to your task immediately. The Arduino is open-source electronics prototyping platform environment built for designers and artist's people with little technical expertise.

3.3.1 Advantages of Arduino

- Huge documentation and support.
- Larger library collection and Low power consumption.
- Open source and Low power consumption.
- Simplified and user-friendly programming language.
- No additional programmer/burner hardware required for programming board and highly customizable.

3.3.2 Arduino in the greenhouse

Arduino is the heart of The Intelligent Greenhouse. Its boards are able to receive, analyze and send data in order to maximize plant growth and health. Figure 3.8 shows the basic Arduino board (Mega 2560), and Figure 3.9 show the Block diagram of Arduino Mega 2560.

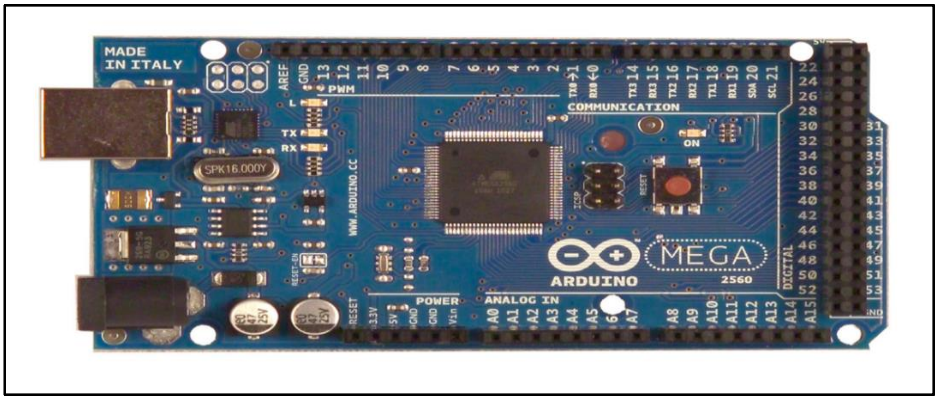

Figure 3.8: The basic Arduino board (Mega 2560)

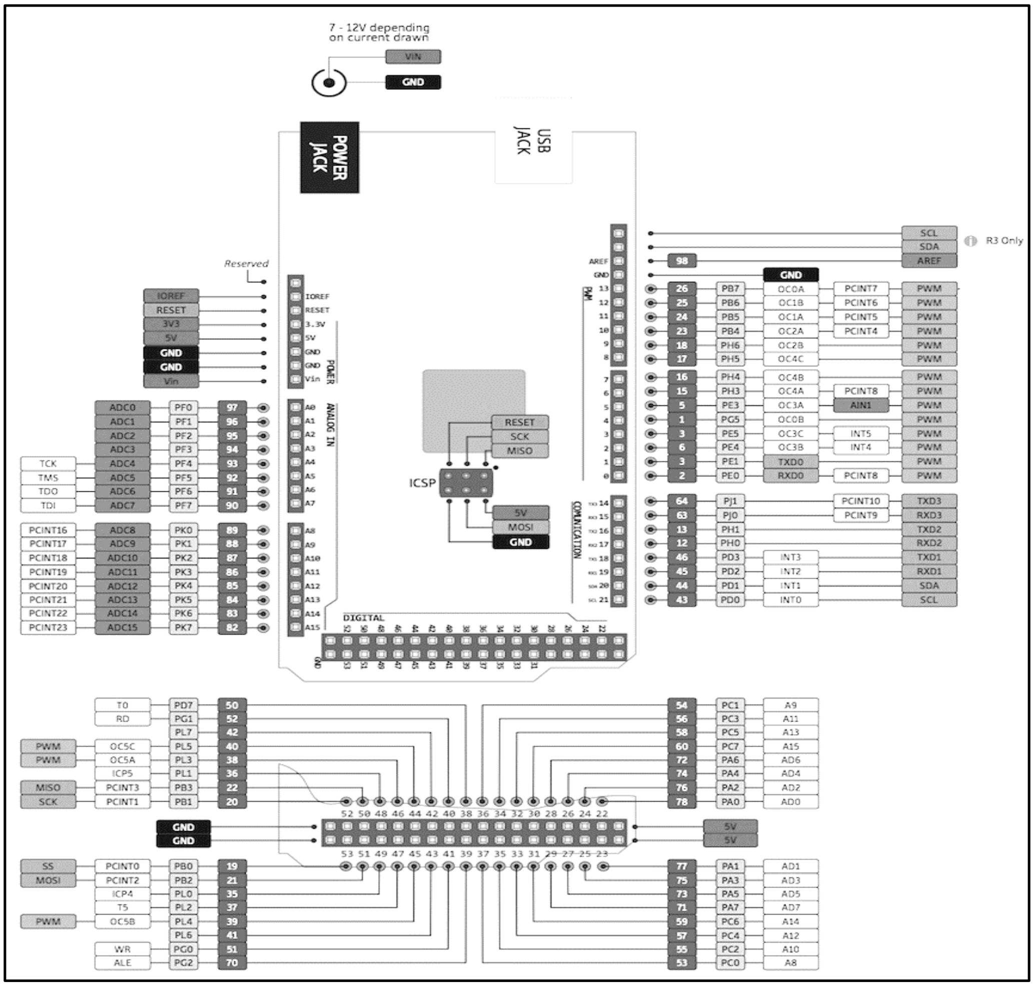

Figure 3.9: Block diagram of Arduino Mega 2560

3.4 Display Unit

The collected and processed data may need to be displayed. A LCD is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. For this purpose an LCD 20×4 shown in Figure 3.10 and Table 3.3 was used for simplicity and cost efficient.

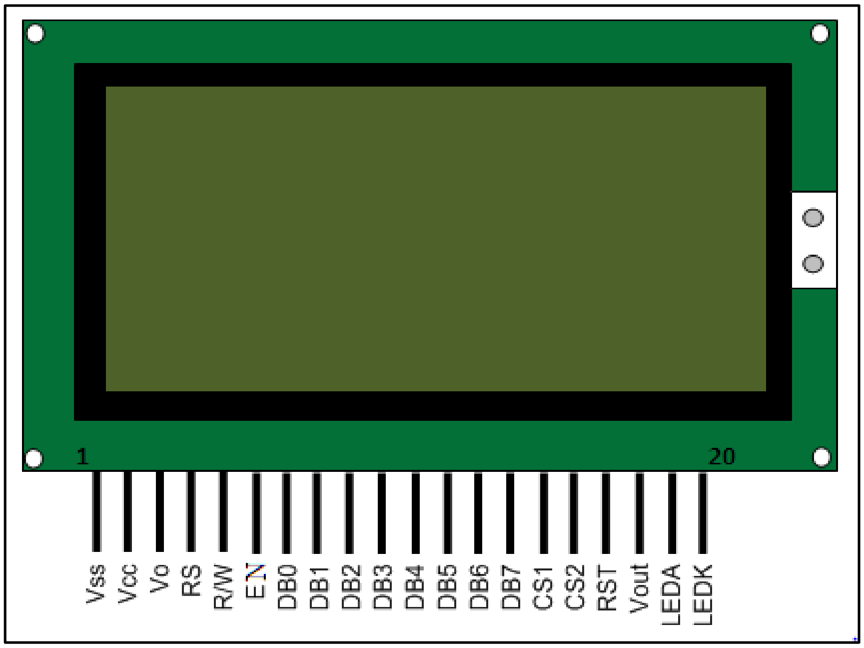

Figure 3.10: LCD and its pin out

Table 3.3: Technical specifications of the LCD

Specification	**Value**
Number of characters	20 characters*4 lines.
Module dimension	NO
Area	76.00mm*25.20mm
Active area	70.40(W)mm *20.80(H)mm
Dot size	0.55 mm *0.55mm
Dot pitch	0.60 mm *0.60mm
Character size	2.95 mm *4.75mm
Character pitch	0.60 mm *0.60mm
LCD Type	STN-LCD Yellow Green.

3.5 Actuation Unit

An actuator is a piece of equipment which will produce a movement when signal is given. Actuators are used in the computer control of an environment, industrial automation and in robotics or, more generally, actuators are the machines used for output in control applications. For the situation in a computer controlled greenhouse, the actuators receive their control signal from the Arduino to control the inside climate variables of the greenhouse. The designed unit includes the following actuators:

i. A ventilation fan: its speed determines the exchange between inside and outside air, thus causing natural ventilation.

ii. Heating system: consists of heater is distributed in the greenhouse.

- **DC Fan**: have developed for applications with demanding environmental requirements, signal speed, alarm with limit speed, external temperature sensor, analogue control input, and moisture protection. Table 3.4 shows the technical specification of this model.

Table 3.4: Technical specification of DC fan

Specification	**Value**
DC Voltage	5 V
Current Input	0.23 A

- **Water Pump:** Pumps provide the means for moving water through the system at usable working pressures. The operation and maintenance of these pumps are some of the most important duties for many water utility operators. There are two basic types of pumps used in water and waste water systems. The most common type of pump is the centrifugal pump. The other type is the positive displacement pump.

- **Heater:** Each plant species has an optimum temperature range.

Heating devices will maintain the temperature within that range during periods of cold weather. Important do not undersize the heating capacity. You may not need all your heaters much of the year, but if you undersize your system you may lose your entire crop during the coldest nights of winter.

3.6 Sensing And Response Unit

The receiving unit connected as shown in Figure 3.11 It contains several electronic elements as follows:

- Microcontroller (Arduino), DHT11 temperature and humidity sensor, YL-69 soil measure sensor, LDR light sensor, DC fans, DC motor, heater ,valve and lamp (which replaced by LEDs),the L7805 regulator, and serial interface for receive or transmit .
- **DHT11 sensor:** Have needed for reading the temperature and humidity in the Greenhouse.
- **LDR sensor:** Have needed for reading the light density in the Greenhouse.
- **YL-69 sensor:** Have needed for reading water level in soil.
- **DC fan:** Have needed for ventilation in greenhouse if the temperature is increase above and humidity is increase the needed of the plant.
- **Water pump:** Have needed for pumping water (which replaced by green LED) in Greenhouse if the relative humidity is decrease the needed of the plant.
- **Heater:** Have needed for heating in greenhouse if the temperature decreasing and humidity decreasing the needed of the plant.

- **Relay:** The relay driver is used to isolate both the controlling and the controlled device. The relay is an electromagnetic device, which consist of solenoid, moving contacts (switch) and restoring spring and consumes comparatively large amount of power. Hence it is possible for the interface IC to drive the relay satisfactorily. To enable this, a driver circuitry, which will act as a buffer circuit, is to be incorporated between them. The driver circuitry senses the presence of a "high" level at the input and drives the relay from another voltage source. Hence the relay is used to switch the electrical supply to the appliances.
- **The L7805 Regulator:** is the basic L7805 voltage regulator, a three-terminal positive regulator with a 5V fixed output voltage. This fixed regulator provides a local regulation, internal current limiting, thermal shut-down control, and safe area protection for your project. Each one of these voltage regulators can output a max current of 1.5A.

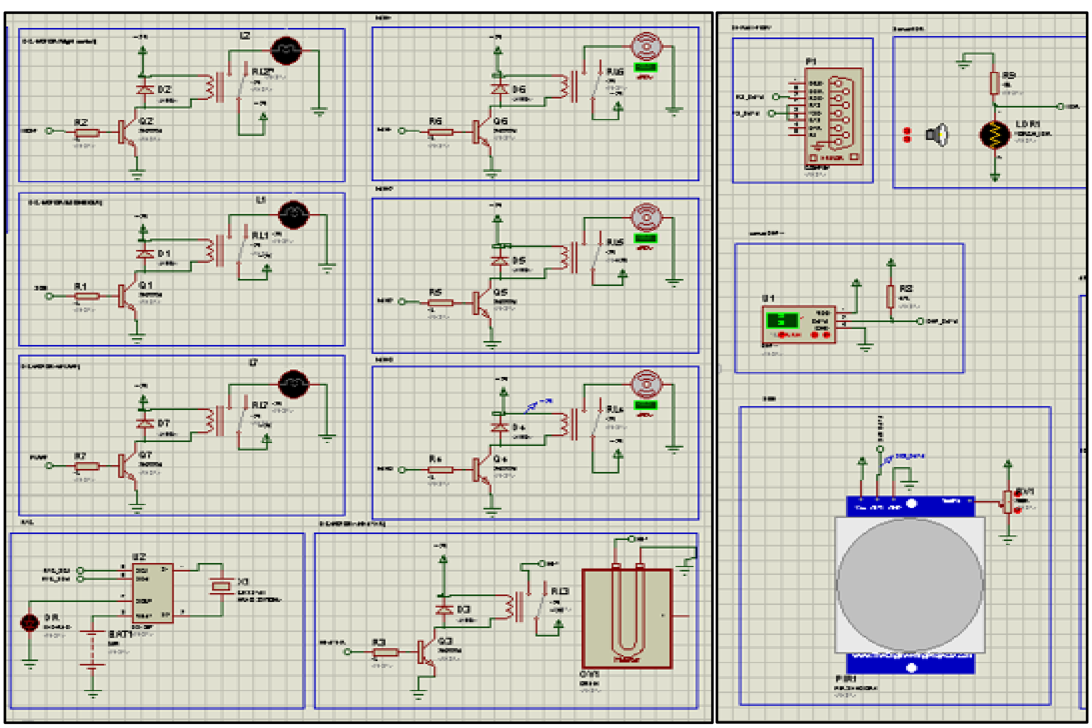

Figure 3.11: Sensing and response unit

3.7 Graphical User Interface

A graphical user interface is a type of user interface that allows users to interact through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation as shown in Figure 3.12, Application interface can send and receive data between device and PC by serial interface.

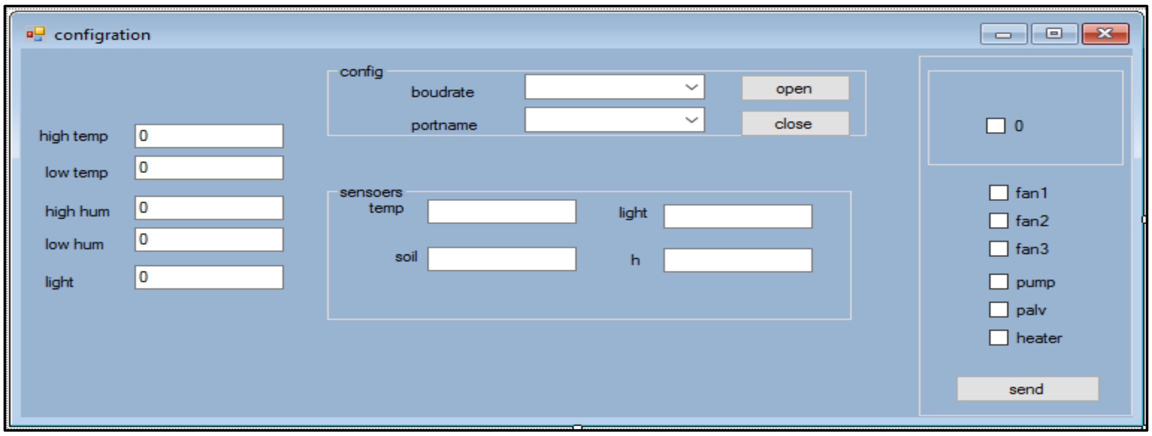

Figure 3.12: Application interface using GUI

3.8 System Operation Flow Chart

The system is clarified using the flowchart; it is illustrate comparing the set values with the acquiring values as shown in Figure 3.13.

Firstly enter the values of the greenhouse parameters and upload these values into sensing and response unit to comparing with acquiring values. If the set temperature greater than the acquired temperature the Arduino send signal to run the fan and the pump, else run the fan. If the set humidity greater than the acquired humidity the Arduino send signal to run the pump, heater and fan, else run the fan. If the set light greater than the acquired light the Arduino send signal to ON the lamp, else OFF the lamp. If the set of soil measure greater than the acquired soil measure the Arduino send signal to open the valve, else close the valve.

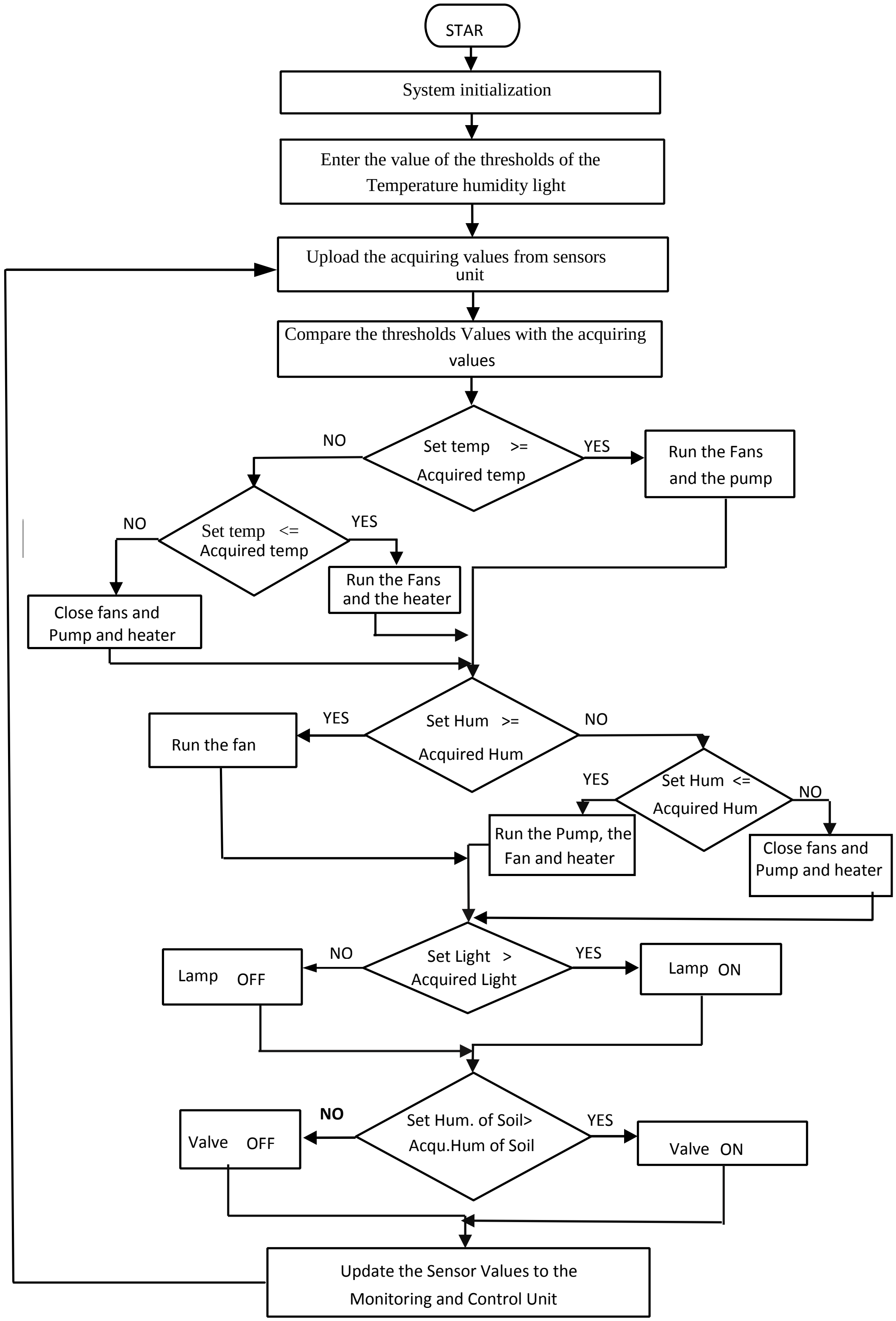

Figure 3.13: The flow chart

CHAPTER FOUR

CHAPTER FOUR

SIMULATION RESULTS

4.1 Introduction

As mentioned in chapter three, the monitoring and controlling unit and sensing and response unit, which can be there got different result based on effective management of greenhouse environment. In this chapter, these different responses were discussed based on the greenhouse management.

4.2 The Monitoring and Control Unit

After safe system booting, the value of the sensors will displaying in the LCD as shown in Figure 4.1.And in GUI as shown in Figure 4.2.

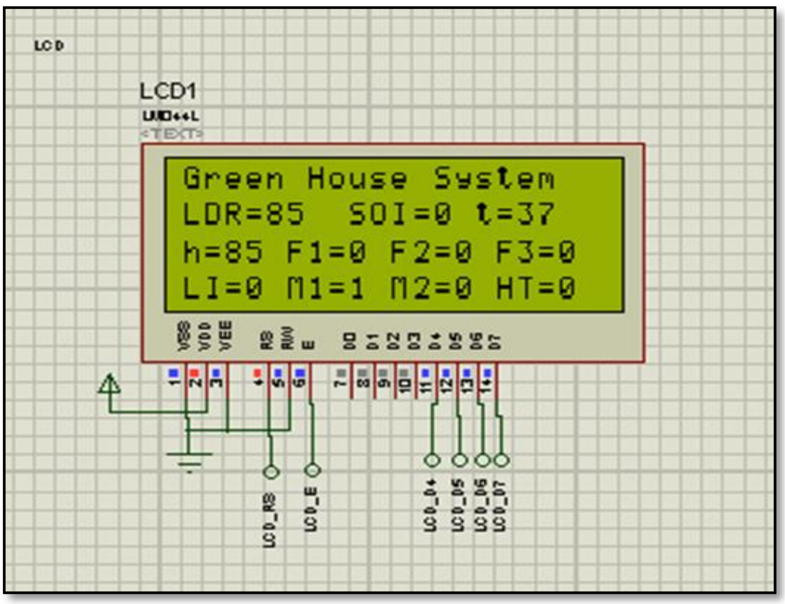

Figure 4.1: Displaying the sensor value in LCD

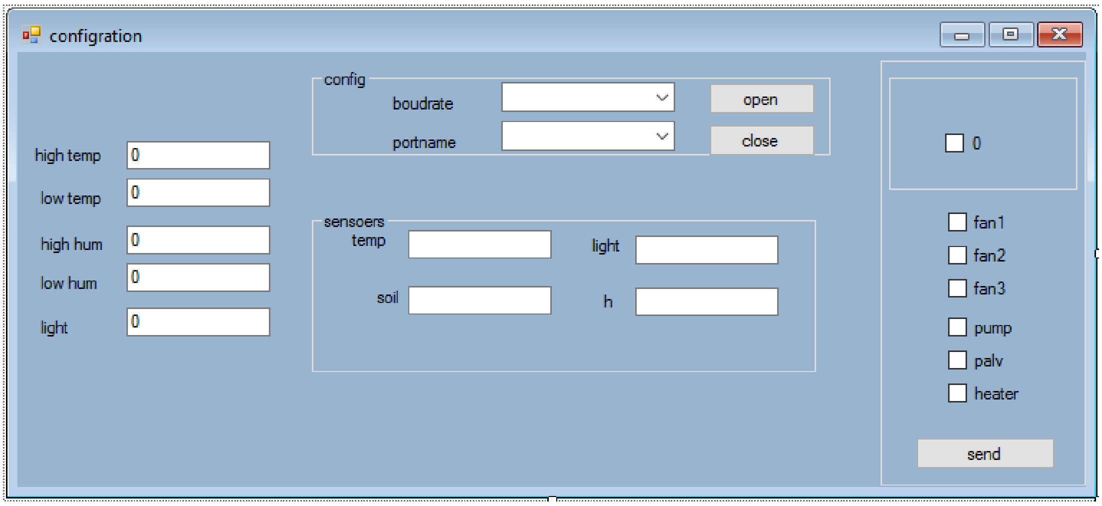

Figure 4.2: Displaying value in GUI

4.3 The Sensing and Response Unit

The sensing and response unit receives the preset sensor values at the monitoring and control unit. Then these values were stored at the Arduino memory to maintain the environmental conditions of the greenhouse accordingly. Four environmental conditions can be maintained temperature, humidity, light and level of water in the soil. In the following, the associated response to the change of each parameter can be explored.

4.3.1 Temperature control

To decrease the acquired temperature in the green house to meet the required one, a ventilating fan can be turned on as in Figure 4.3. A continuous tracking to the temperature can be achieved. In addition, while the acquired temperature in the green house was decreasing comparable to the set one, the fan will stop. And when the acquired temperature goes less than the required value a heater with the circulation fan will turned on as shown in Figure 4.4. To increase the temperature to achieve the suitable one.

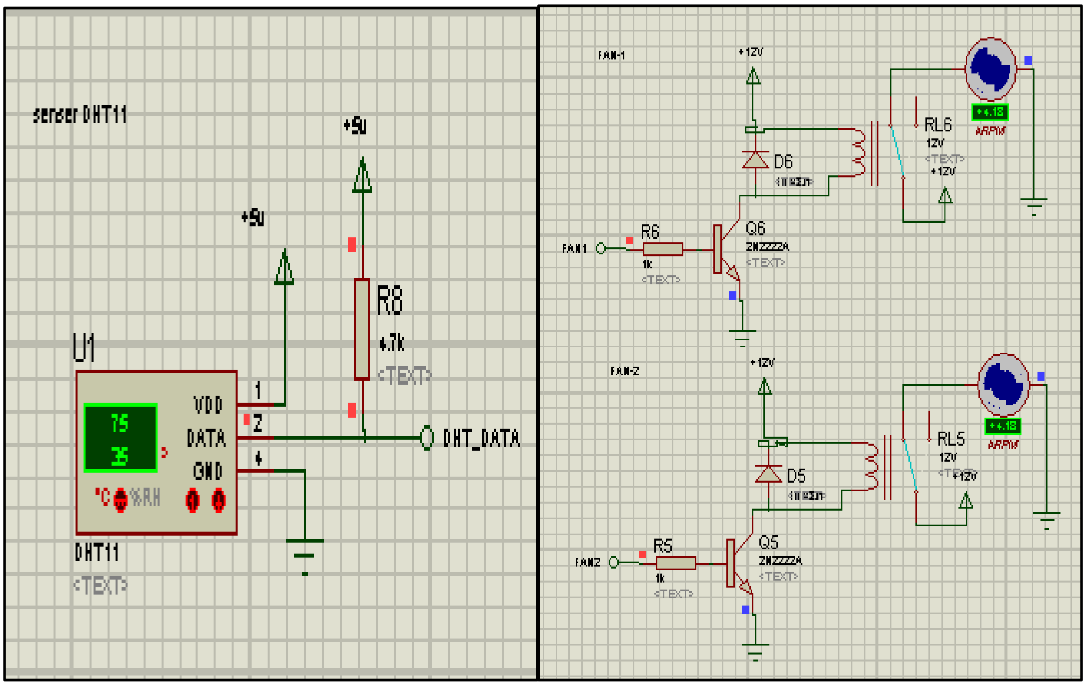

Figure 4.3: The decreasing temperature

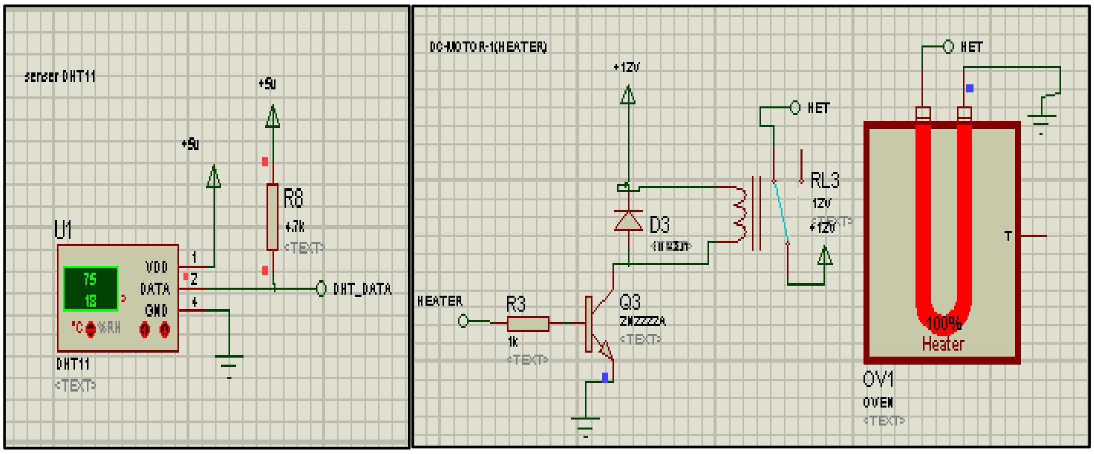

Figure 4.4: The increasing temperature

4.3.2 Humidity control

The DHT 11 humidity sensor can track the percentage of the humidity at the greenhouse atmosphere. While the humidity recorded a higher percentage than the set one, the sucker fan can be turned on to evacuate the excessive percentage of humidity as shown in Figure 4.5.And when the acquired humidity recorded a less percentage than the set one a heater with water pump and the fan will turned on. To increase the humidity to achieve the suitable one as shown in Figure 4.6.

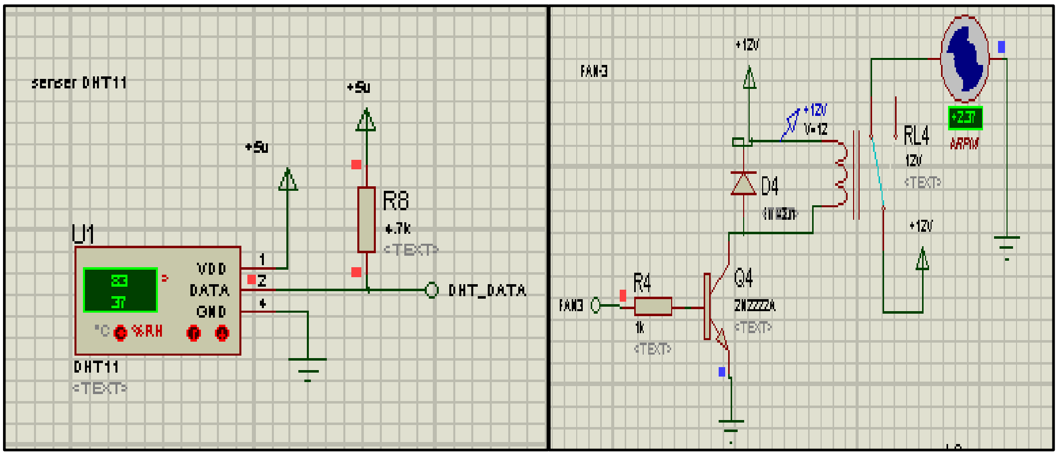

Figure 4.5: The decreasing the humidity

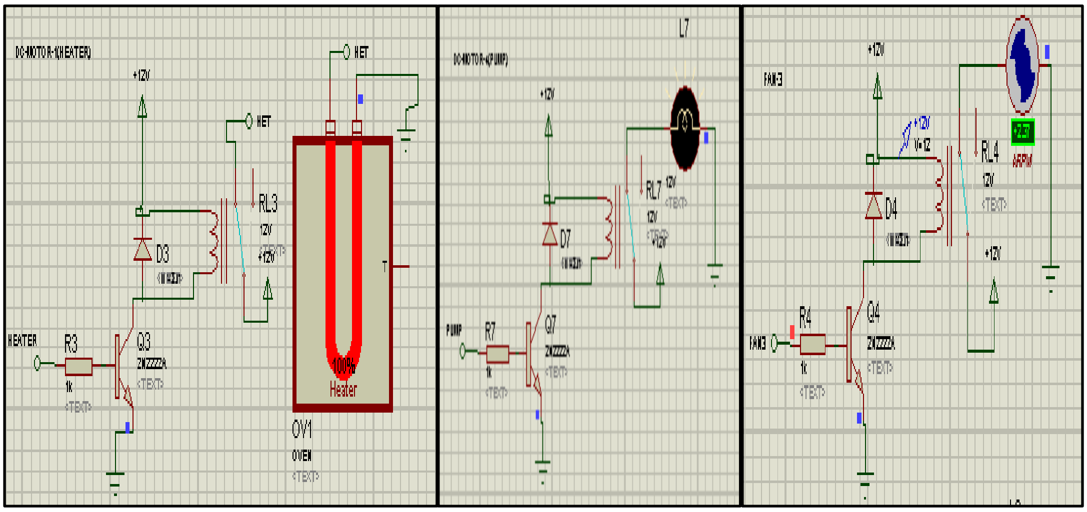

Figure 4.6: The increasing the humidity

4.3.3 Light control

Most of the crop needs a natural sun light to grow. The greenhouse can provide this direct sun light through its transparent roof. After while this transparent roof become darker by the accumulated dust, therefore the light intensity sensor can be used to monitor and note when the received light is less than the required amount. A lamp can be recognized to indicate the low light intensity inside the greenhouse as shown in Figure 4.7.A lamplight in the normal state shown in Figure 4.8.

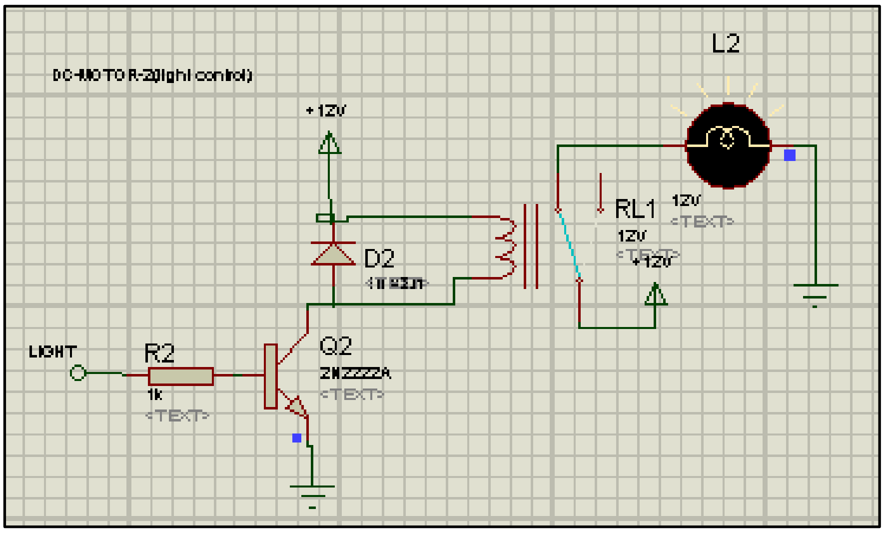

Figure 4.7: The light increase

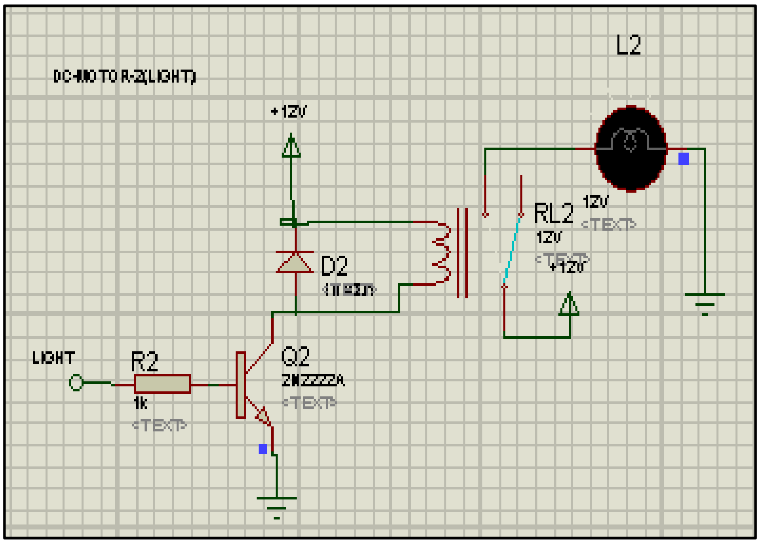

Figure 4.8: Light in the normal state

4.3.4 Soil Control

The YL-69 sensor track the level of water in soil. While the level of water shows decrement percentage, the valve open as can be shown in

Figure 4.9.In contrast, when the water level recorded a higher percentage than the set one, the valve closed as shown in Figure 4.10.

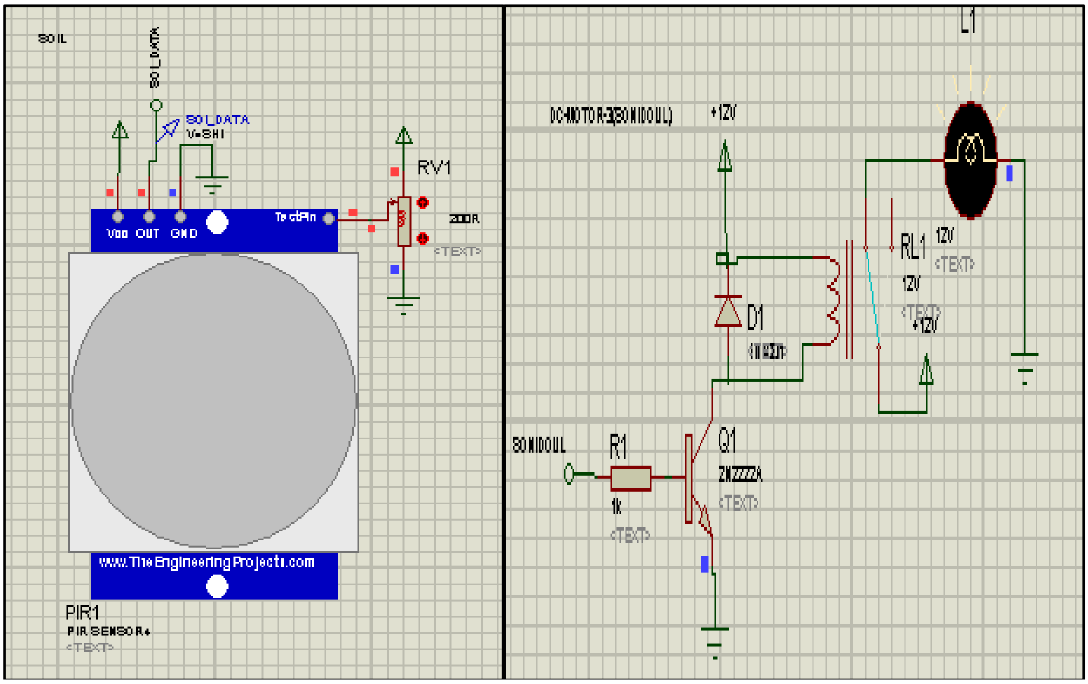

Figure 4.9: The increasing water

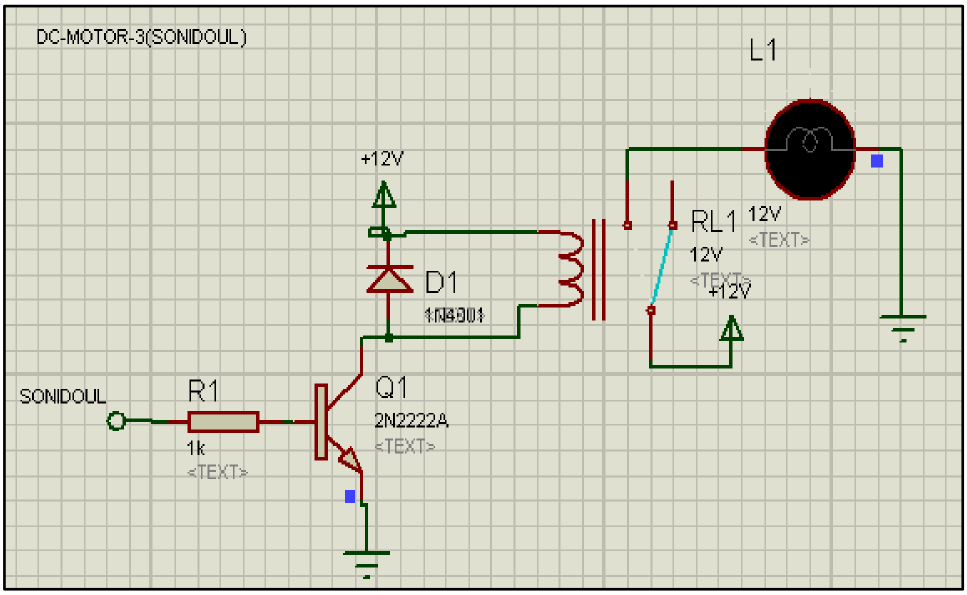

Figure 4.10: The close water

CHAPTER FIVE

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

It is our great pleasure that we have successfully completed our project that presents a design of a simple and low cost monitoring and control greenhouse system based on an Arduino technology. A temperature, humidity and light sensors were integrated with fan, heater and pump to figure out the sensing and responding unit. Arduino mega and serial interface were utilized to be the processing and communication units respectively.

The proposed displaying and controlling via GUI promising solution lower running costs, and increase flexibility and reliability in a greenhouse management system. Compatibility, compactness, portability and low power consumption is some of important key elements in our design. Therefore a carefully selection of sensing devices and circuitry components is also very important especially when interfaced to the microcontroller. The management scenario of the entire environment of the greenhouse has a crucial importance in utilizing the attached responding elements, where the logical relation between them should be studies firstly. In conclusion, greenhouse climate monitoring and controlling is one attractive application field to create GUI system for monitoring and controlling.

5.2 Recommendations

This research has provided a comprehensive report on the design process and implementation of a GUI for greenhouse management system.

Certainly, there is a need for further study to improve the system reliability and capability. The following improvements can be recommended for possible future work:

- More sensors can be added to the sensing unit to monitor other environmental parameters such as soil pH level, air flow, carbon monoxide and oxygen level.

.

- Global system for mobile communication and SMS can also be integrated into the system. These extra features will allow the system to directly alert the user of any abnormal changes in the greenhouse environment through the transmission of a simple short texts message.
- Design Android application for monitoring and controlling the greenhouse form the smart mobile.
- Using wireless sensor for senescing and transmit the value of the greenhouse parameters to the processing unit.

REFERENCES

REFERENCES

[1]C. Y. Du Xiaoming, "The Realization of Greenhouse Controlling System Based on Wireless Sensor Network [J]," *Journal of Agricultural Mechanization Research,* vol. 6, pp. 141-144, 2009.

[2]S. Speetjens, H. Janssen, G. Van Straten, T. H. Gieling, and J. Stigter, "Methodic design of a measurement and control system for climate control in horticulture," *Computers and Electronics in Agriculture,* vol. 64, pp. 162-172, 2008.

[3]W. Linji, "The Design of Realizing Change Temperature Control in Greenhouse by PLC [J]," Electrical Engineering, vol. 5, pp. 81-83, 2008.

[4]Y. L., L., Shirong, and T., Guanghui,, "The Problem of the Control System for Greenhouse Climate," vol. 23, pp. PP: 154-157,, 2007.

[5]D. Chaudhary, S. Nayse, and L. Waghmare, "Application of wireless sensor networks for greenhouse parameter control in precision agriculture," *International Journal of Wireless & Mobile Networks (IJWMN) Vol,* vol. 3, pp. 140-149, 2011.

[6]A. Both, "Greenhouse temperature management," *New Jersy Agricultural Experiment Station*, 2008.

[7]W. G. Hopkins, *Plant development*: Infobase Publishing, 2006.

[8]F. Rodríguez, "Modeling and hierarchical control of greenhouse crop production (in Spanish)," 2002.

[9]D., Stipanicev, and J., Marasovic, “Networked Embedded Greenhouse Monitoring and Control”, In Proceedings of IEEE Conference on Control Applications (CCA) 23-25 June 2003, Vol. 2, PP. 1350 – 1355, 2003.

[10] A., Benzaouia, F., Tadeo and M., Nachidi, “Temperature and Humidity Control in Greenhouses Using the Takagi-Sugeno Fuzzy Model”, In Proceedings of International Conference on Control Applications, PP 1-5, October 4-6, 2006.

REFERENCES

[11] G., Xi-shan, Y., Xiang-long, W., Li-ren, Z., Qian and Z., Yi-ming, “A Wireless Solution for Greenhouse Monitoring and Control System based on ZigBee Technology” In Proceedings of Journal of Zhejiang University SCIENCE A, 8(10), 2007.

[12] M., Elmusrati, R., Virrankoski, and T., Ahonen, “Greenhouse Monitoring with Wireless Sensor Network”. In Proceedings of the IEEE/ASME International Conference on Mechtronic and Embedded Systems and Applications, Beijing, China, 12–15 October 2008; pp. 403-408, 2008.

[13] C.T., Khuan, L.B., Tik and S., Palaniappan, “Monitoring of an Aeroponic Greenhouse with a Sensor Network”, In Proceedings of International Journal of Computer Science and Network Security, Volume: 9, 2009.

[14] I., Abdul Aziz, M. H., Hasan, M. J., Ismail, M., Mehat and N. S., Haroon, “Remote Monitoring in Agricultural Greenhouse Using Wireless Sensor and Short Message Service (SMS)”, In Proceedings of International Journal of Engineering & Technology IJET-IJENS, Volume 9, No 9, PP 1-9, October2009.

[15] J., Lee, C., Shin, and H., Yoe, “An Implementation of Paprika Greenhouse System Using Wireless Sensor Networks”, In Proceedings of International Journal of Smart Home, Volume 4, No 3, PP 1-12, July 2010.

[16] C., Gong, J., Ma, X., Zhang, Y., Song, and Y. Feng, “Design of Greenhouse Control System Based on Wireless Sensor Networks and AVR Microcontroller”, In Proceedings of Journal of Networks, Volume 6, No 12, December 2011.

[17] C.H., Chiung, C.J., Jwu, and C.Y., Guan, “Greenhouse Environment System Based on Remote Control,” In Proceedings of International Conference on Chemical, Ecology and Environmental Sciences(ICCEES'2011), Thailand, PP. 407-410, 2011.

[18]A., Ed-dahhak, A., Lachhab, A., Rahali, A., Tannouche, B., Bouchikhi, M.,Guerbaoui, and Y., El Afou, “ Development of a data acquisition and greenhouse control system based on GSM” International Journal of Engineering, Science and Technology , No. 8, Vol. 3, PP: 297-306, 2011.

[19]R.S., Kawitkar, and S.U., Zagade, "Wireless Sensor Network for Greenhouse". "In Proceedings of International Journal of Science and Technology" Volume 2 No.3, March 2012.

[20]V. R., Deore .and V.M., Umale , "Wireless Monitoring of the Green House System Using Embedded Controllers" In Proceedings of International Journal of Scientific & Engineering Research, Volume 3, February-2012.

[21]B. V., Sagar , "Green House Monitoring and Automation using GSM" In Proceedings of International Journal of Scientific and Research Publications, Volume 2, Issue 5, ISSN 2250-3153, May 2012.

[22]J., Zhang, X., Ma, Y., Song, and Y., Feng, "Design of Wireless Sensor Network-Based Greenhouse Environment Monitoring and Automatic Control System", In Proceedings of Journal of Networks, Volume 7, May 2012.

[23]K., Shazali, and M. F., Othman, "Wireless Sensor Network Applications: A Study in Environment Monitoring System" In Proceedings of International symposium on robotics and Intelligent sensors, 2012.

[24]A., Agarwal, D. Chauhan, G., Tripathi, and M., Mittal, In Proceedings of VSRD International Journal of Electrical, Electronics & Comm. Engg. Volume 2 No 6, PP 337-345, 2012.

[25]K. S., Berezowski, "The Landscape of Wireless Sensing in Greenhouse Monitoring and Control", In Proceedings of International Journal of Wireless & Mobile Networks (IJWMN), Volume 4 No 4, August 2012.

[26]D., Yu, and S., Hwang, "Remote Monitoring and Controlling System Based on ZigBee Networks", In Proceedings of International Journal of Software Engineering and Its Applications, Volume 6, No 3, July 2012.

[27]K., Sahu, and, S., Mazumdar "Digitally Greenhouse Monitoring and Controlling of System based on Embedded System," In Proceedings of International Journal of Scientific & Engineering Research, Vol. 3, January- 2012.

[28]K. K., Kolawole, and W.S., Alausa Dele, "Microcontroller Based Greenhouses Control Device", In Proceedings of International Journal of Engineering And Science (IJES), Volume 2, Issue 11, PP 129-135, 2013.

[29]C.Y., Patil, and N.R., Mohanty, "Wireless Sensor Networks Design for Greenhouse Automation". In Proceedings of International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, August 2013.

[30]R.K., Nikhade, and S.L., Nalbalwar, "Monitoring Greenhouse using Wireless Sensor Network", In Proceedings of International Journal of Advanced Computer Research, Volume 3, Number 2, Issue 10, June 2013.

[31]J., Tang, L., Gao, and M., Cheng, "A Wireless Greenhouse Monitoring System based on Solar Energy", In Proceedings of TELKOMNIKA, Volume 11, No 9, PP 5448~5454, September 2013.

[32]C., Jichen, W., Xiaofang, W., Xiu1, Z., Jianjun and Z., Wei1, "Greenhouse Monitoring and Control System Based on ZigBee", In Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering (ICCSEE), PP 1-5, 2013.

[33]A, Lambebo, and S., Haghani, "A Wireless Sensor Network for Environmental Monitoring of Greenhouse Gases", In Proceedings of ASEE 2014 Zone I Conference, PP 1-4, 3-5April 2014.

APPINDIX

A.APPENDIX A

CODE OF ARDUINO

```
************************ LAYBARLYS************************
#include <Arduino.h>
#include <HardwareSerial.h>
#include <Wire.h>
#include <inttypes.h>
#include <avr/interrupt.h>
#include "Print.h"
#include "Stream.h"
#include <USBAPI.h>
#include "HardwareSerial.h"
#include "HardwareSerial_private.h"
#include <avr/io.h>
#include <stdio.h> // for size_t
#include <Print.h>
#include "WString.h"
#include <EEPROM.h>
#include <LiquidCrystal.h>
#include "DHT.h"
**********READING TEMPERATURE OR HUMIDITY ************
#define DHTPIN 7
#define DHTTYPE DHT11   // DHT 11
DHT dht(DHTPIN, DHTTYPE);
```

```
float h ; float t;
void DHTT_data (){
h = dht.readHumidity();
t = dht.readTemperature();
float f = dht.readTemperature(true);
if (isnan(h) || isnan(t) || isnan(f)) {
Serial.println("Failed to read from DHT sensor!");
return;
}}
```

************************* **LIQUIDCRYSTAL LCD** ************************

```
LiquidCrystal lcd(30, 31, 32, 33, 34, 35);  // (RS,E,D4,D5,D6,D7)
const int LDR =A0;
const int SOI =A1;
const int FAN1=23;
const int FAN2=44;
const int FAN3=24;
const int motor1=27;
const int motor2=25;
const int heater=47;
const int Light =26;
int
LDR_value,SOI_val,FAN1_ST,FAN2_ST,FAN3_ST,MOTOR1_ST,MOTOR2_ST,HETEAR_ST,LIGHT_ST;
int eer,i;
long HT,LT,HH,LH,LDRH;
```

```
unsigned char form[200],datam[200],bite;
*********SENDING DATA FROM SERIAL INTERFACE**********
void send_data(){    //#   T      H      LDR  SO    FAN1FAN2FAN3
        LIGHT       MOTOR1    MOTOR2    HETEAR_ST       $
Serial.print("#");
Serial.print(",");
Serial.print(t);
Serial.print(",");
Serial.print(h);
Serial.print(",");
Serial.print(LDR_value);
Serial.print(",");
Serial.print(SOI_val);
Serial.print(",");
Serial.print(FAN1_ST);
Serial.print(",");
Serial.print(FAN2_ST);
Serial.print(",");
Serial.print(FAN3_ST);
Serial.print(",");
Serial.print(LIGHT_ST);
Serial.print(",");
Serial.print(MOTOR1_ST);
Serial.print(",");
Serial.print(MOTOR2_ST);
```

```
 Serial.print(",");
 Serial.print(HETEAR_ST);
 Serial.print(",");
 Serial.println("$");
}
void LDR_sensor(){
LDR_value=analogRead(LDR);
LDR_value = map(LDR_value, 0, 1023, 0, 255);
}
void SOI_sensor(){
SOI_val=digitalRead(SOI);
}
void LCD_send(int xx,int yy,int dd){
lcd.setCursor(xx, yy);
lcd.print(dd);
}
******************* ACUATOR_CONTROL *******************
void fan_control(int f1,int f2,int f3,int m1,int m2,int HE,int LIG ){
if(f1==1){ digitalWrite(FAN1, HIGH);FAN1_ST=1;}
if(f1==0){digitalWrite(FAN1, LOW);FAN1_ST=0;}
if(f2==1){ digitalWrite(FAN2, HIGH);FAN2_ST=1;}
if(f2==0){digitalWrite(FAN2, LOW);FAN2_ST=0;}
if(f3==1){ digitalWrite(FAN3, HIGH);FAN3_ST=1;}
if(f3==0){digitalWrite(FAN3, LOW);FAN3_ST=0;}
if(m1==1){ digitalWrite(motor1, HIGH);MOTOR1_ST=1;}
```

```
if(m1==0){digitalWrite(motor1, LOW);MOTOR1_ST=0;}
if(m2==1){ digitalWrite(motor2, HIGH);MOTOR2_ST=1;}
if(m2==0){digitalWrite(motor2, LOW);MOTOR2_ST=0;}
if(HE==1){ digitalWrite(heater, HIGH);HETEAR_ST=1;}
if(HE==0){digitalWrite(heater, LOW);HETEAR_ST=0;}
if(LIG==1){ digitalWrite(Light, HIGH);LIGHT_ST=1;}
if(LIG==0){digitalWrite(Light, LOW);LIGHT_ST=0;}
}
```

**************** **READ_FREAM SERIAL PORT** ****************

```
void Read_fream(){   ///&    ST HT    LT   HH   LH   LDR
        FAN1FAN2FAN3LIGHT    MOTOR1   MOTOR2   HETAR
        *
while (Serial.available()) {
bite= Serial.read();
if(bite=='&'){
i=1;
do{
if(Serial.available()){
bite= Serial.read();
form[i] =bite;
EEPROM.write(0x03+i,form[i]);
Serial.println(form[i],HEX);
i++;
 }
} while (bite!='*');}
```

```
delay(1);
bite=0; }
}
********************** EEPROM.READ ***********************
void READ_eepr(){
datam[1]= EEPROM.read(0x04);
datam[2]= EEPROM.read(0x05);
datam[3]= EEPROM.read(0x06);
datam[4]= EEPROM.read(0x07);
datam[5]= EEPROM.read(0x08);
datam[6]= EEPROM.read(0x09);        //T&H&LDR
datam[7]= EEPROM.read(0x0A);
datam[8]= EEPROM.read(0x0B);
datam[9]= EEPROM.read(0x0C);
datam[10]= EEPROM.read(0x0D);
datam[11]= EEPROM.read(0x0E);
datam[12]= EEPROM.read(0x0F);    // fan1
datam[13]= EEPROM.read(0x010);    //FAN2
datam[14]= EEPROM.read(0x011);     // FAN3
datam[15]= EEPROM.read(0x012);     // LIGHT
datam[16]= EEPROM.read(0x013);      // MOTOR1
datam[17]= EEPROM.read(0x014);      // MOTOR2
datam[18]= EEPROM.read(0x015);       // HETAR
datam[19]= EEPROM.read(0x016);
delay(100);
```

```
HT=(((datam[2])*10)+(datam[3]));
LT=(((datam[4])*10)+(datam[5]));
HH=(((datam[6])*10)+(datam[7]));
LH=(((datam[8])*10)+(datam[9]));
LDRH=(((datam[10])*10)+(datam[11]));
HT=HT;
LT=LT;
LH=LH;
HH=HH;
LDRH=LDRH;
}
void MANU(unsigned char STt){   //
if(STt==0x31){
fan_control(datam[12]-0x30,datam[13]-0x30,datam[14]-0x30,datam[15]-
0x30,datam[16]-0x30,datam[17]-0x30,datam[18]-0x30);
}
}
void MANU(){
fan_control(datam[18]-0x30,datam[20]-0x30,datam[22]-0x30,datam[28]-
0x30,datam[22]-0x30,datam[24]-0x30,datam[26]-0x30);
}
void AUT(){
 if(T>=HT){digitalWrite(FAN1, LOW);FAN1_ST=1;
digitalWrite(FAN2, LOW);FAN2_ST=1;
digitalWrite(motor1, HIGH);MOTOR1_ST=1;
```

```
digitalWrite(heater, LOW);HETEAR_ST=0;
}
if(((T<=LT+6))&&(T>=LT+3))){
digitalWrite(FAN1, LOW);FAN1_ST=1;
digitalWrite(FAN2, HIGH);FAN2_ST=0;
digitalWrite(motor1, LOW);MOTOR1_ST=0;
digitalWrite(heater, LOW);HETEAR_ST=0;}
if(T<=LT){
digitalWrite(heater, HIGH);HETEAR_ST=1;
digitalWrite(FAN1, LOW);FAN1_ST=1;
digitalWrite(FAN2, HIGH);FAN2_ST=0;
digitalWrite(motor1, LOW);MOTOR1_ST=0;
}
if(H>=HH){
digitalWrite(FAN3, LOW);FAN3_ST=1;}
if(H<=LH){
digitalWrite(heater, HIGH);HETEAR_ST=1;
digitalWrite(motor1, HIGH);MOTOR1_ST=1;
digitalWrite(FAN3, LOW);FAN3_ST=1;
}
if((H<=HH)&&(H>=LH)){
digitalWrite(heater, LOW);HETEAR_ST=0;
digitalWrite(FAN3, HIGH);FAN3_ST=0;
digitalWrite(motor1, LOW);MOTOR1_ST=0;
}
```

```
if(LDR_value<=512){digitalWrite(Light, HIGH);LIGHT_ST=1;}
if(LDR_value>=513){digitalWrite(Light, LOW);LIGHT_ST=0;}
if(SOI_val==HIGH){digitalWrite(motor2, HIGH);MOTOR2_ST=1;}
if(SOI_val==LOW){digitalWrite(motor2, LOW);MOTOR2_ST=0;}
}
void setup() {
 pinMode(FAN1,OUTPUT);
 pinMode(FAN2,OUTPUT);
 pinMode(FAN3,OUTPUT);
pinMode(motor1,OUTPUT);
pinMode(motor2,OUTPUT);
pinMode(Light,OUTPUT);
pinMode(heater,OUTPUT);
pinMode(SOI,INPUT);
pinMode(7,INPUT);
lcd.begin(20, 4);
lcd.print("Green House System");
dht.begin();
Serial.begin(9600);
eer=EEPROM.read(0x01);
digitalWrite(9, HIGH);
}
void loop() {
Read_fream();
READ_eepr();
```

```
LDR_sensor();
SOI_sensor();
DHTT_data();
lcd.setCursor(0, 1);
lcd.print("LDR=");
LCD_send(4,1,LDR_value);
lcd.setCursor(8, 1);
lcd.print("SOI=");
LCD_send(12,1,SOI_val);
lcd.setCursor(14, 1);
lcd.print("t=");
LCD_send(16,1,t);
lcd.setCursor(0, 2);
lcd.print("h=");
LCD_send(2,2,h);
lcd.setCursor(5, 2);
lcd.print("F1=");
LCD_send(8,2,FAN1_ST);
lcd.setCursor(10, 2);
lcd.print("F2=");
LCD_send(13,2,FAN2_ST);
lcd.setCursor(15, 2);
lcd.print("F3=");
LCD_send(18,2,FAN3_ST);
lcd.setCursor(0, 3);
```

```
lcd.print("LI=");
LCD_send(3,3,LIGHT_ST);
 lcd.setCursor(5, 3);
 lcd.print("M1=");
LCD_send(8,3,MOTOR1_ST);
lcd.setCursor(10, 3);
lcd.print("M2=");
LCD_send(13,3,MOTOR2_ST);
lcd.setCursor(15, 3);
lcd.print("HT=");
LCD_send(18,3,HETEAR_ST);
MANU(datam[12]);
AUT(datam[1]);
lcd.setCursor(8, 1);
lcd.print(eer);
delay(10);
delay(100);
if(t>=27){fan_control(1,1,1);}
if((t>=24)&&(t<=26)){fan_control(1,1,0);}
if((t>=21)&&(t<=23)){fan_control(1,0,0);}
if(t<=20){fan_control(0,0,0);}
if(LDR_value>=10){}
delay(100);  }
dht.begin();
Serial.begin(9600);
```

```
eer=EEPROM.read(0x01);
}
void loop() {
lcd.setCursor(0, 0);
lcd.print("green,house");
Read_fream();
READ_eepr();
LDR_sensor();
SOI_sensor();
DHTT_data();
if(form[2]=='0'){MANU();
lcd.setCursor(16, 0);
lcd.print("M");}
if(form[2]=='1'){
lcd.setCursor(16, 0);
lcd.print("A");AUT();}
Desp();
ddr++;
if(ddr>=20){
send_data();
ddr=0;}
delay(50);
}
SOI_val = map(SOI_val, 0, 1023, 0, 255);
EEPROM.write(0x01, SOI_val+1);
```

```
LCD_send(3,1,LDR_value);
LCD_send(8,1,SOI_val);
MANU(datam[1]);
lcd.setCursor(8, 1);
lcd.print(eer);
delay(10);
delay(100);
```

A.APPENDIX B

CODE OF APPLICATION INTERFACE

************************ **LAYBARLYS************************

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Windows.Forms;
using System.IO.Ports;
using System.Threading;
namespace GREENHOUSE1
{
public partial class Form1 : Form
{
string[] send;
string Senddata;
```

**************DATA RECEIVE FROM ARDUINO **************

```
string recieveddata;
public Form1()
{
InitializeComponent();
```

```
availapleportname();
send = new string[6] ;
send[0] = "0";
send[1] = "0";
send[2] = "0";
send[3] = "0";
send[4] = "0";
send[5] = "0";
}
void availapleportname()
{
string[] portname = SerialPort.GetPortNames();
comboBox1.Items.AddRange(portname);
string[] send =Senddata.Split(',');

send[6] = "0";
send[7] = "0";
send[8] = "0";
send[9] = "0";
}
private void Form1_Load(object sender, EventArgs e){ }
private void btn_open_Click(object sender, EventArgs e){
if (comboBox1.Text != "" && comboBox2.Text != "")
{
spserial.PortName = comboBox1.Text;
spserial.BaudRate = Convert.ToInt32(comboBox2.Text);
```

```
if (!spserial.IsOpen)
{
spserial.Open();
MessageBox.Show("opend");
}}}
private void button2_Click(object sender, EventArgs e)
{
if (spserial.IsOpen)
{
spserial.Close();
MessageBox.Show("closed");
}}
private void button3_Click(object sender, EventArgs e){
if (spserial.IsOpen)
{
spserial.Write(textBox1.Text);
textBox1.Text = "";
MessageBox.Show("send finshed");
}}
private void spSerial_DataReceived(object sender,
SerialDataReceivedEventArgs e){
Thread.Sleep(50);
recieveddata = spserial.ReadExisting();
this.Invoke(new EventHandler(updateControl));
}
private void updateControl(object o, EventArgs e){
```

```
string[] Tokens = recieveddata.Split(',');
if (Tokens.Count() > 8)
{
textBox3.Text = Tokens[2];
textBox4.Text = Tokens[1];
textBox1.Text = Tokens[9];
textBox2.Text = Tokens[5];
}}
private void button7_Click(object sender, EventArgs e){
send[0] = ("1");
}
private void button3_Click_1(object sender, EventArgs e){ }
private void label3_Click(object sender, EventArgs e){ }
private void groupBox4_Enter(object sender, EventArgs e){ }
private void radioButton1_CheckedChanged(object sender, EventArgs e){ }
private void radioButton2_CheckedChanged(object sender, EventArgs e){ }
private void button8_Click(object sender, EventArgs e){
send[0]=('1');
}
private void checkBox1_CheckedChanged(object sender, EventArgs e){ }
```

***************DATA SEND FROM ARDUINO *****************

```
private void button3_Click_2(object sender, EventArgs e){
Senddata = "";
foreach (var item in send){
Senddata = Senddata+ ","+ item;
```

```
}
string lastdata = "#," + checkBox7.Text + "," + txt_ht.Text + "," +
txt_lt.Text + "," + txt_hh.Text + "," + txt_lh.Text + "," + txt_ldr.Text  +
Senddata + ",*";
if (spserial.IsOpen){
spserial.Write(lastdata);
}}
private void checkBox1_CheckedChanged_1(object sender, EventArgs e){
if (checkBox1.Checked)
send[0] = "1";
else
{
send[0] = "0";
}}
private void checkBox2_CheckedChanged(object sender, EventArgs e){
if (checkBox2.Checked)
send[1] = "1";
else
{
send[1] = "0";
}}
private void checkBox3_CheckedChanged(object sender, EventArgs e){
if (checkBox3.Checked)
send[2] = "1";
else
{
```

```
send[2] = "0";
}}
private void textBox7_TextChanged(object sender, EventArgs e){ }
private void checkBox7_CheckedChanged(object sender, EventArgs e){
if (checkBox7.Checked)
{
checkBox7.Text = " 1";
checkBox1.Enabled = false;
checkBox2.Enabled = false;
checkBox3.Enabled = false;
checkBox4.Enabled = false;
checkBox5.Enabled = false;
checkBox6.Enabled = false;
}
else
{
checkBox7.Text = " 0";
checkBox1.Enabled = true;
checkBox2.Enabled = true;
checkBox3.Enabled = true;
checkBox4.Enabled = true;
checkBox5.Enabled = true;
checkBox6.Enabled = true;
}}
private void checkBox4_CheckedChanged(object sender, EventArgs e){
if (checkBox4.Checked)
```

```
send[3] = "1";
else
{
send[3] = "0";
}}
private void checkBox5_CheckedChanged(object sender, EventArgs e){
if (checkBox5.Checked)
send[4] = "1";
else
{
send[4] = "0";
}}
private void checkBox6_CheckedChanged(object sender, EventArgs e){
if (checkBox6.Checked)
send[5] = "1";
else
{
send[5] = "0";
}}
private void label7_Click(object sender, EventArgs e){ }
private void label10_Click(object sender, EventArgs e){ }
private void label9_Click(object sender, EventArgs e){ }
private void txt_lt_TextChanged(object sender, EventArgs e){ }
private void textBox1_TextChanged(object sender, EventArgs e){
}}}
```