DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FEDERAL UNIVERSITY OYE EKITI

DESIGN AND CONSTRUCTION OF A WIRELESS ENVIRONMENTAL MONITORING SYSTEM USING A GSM MODULE

BY

BEJIDE OLUWADAMILARE SAMUEL

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A PROJECT REPORT SUBMITED TO DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING FEDERAL UNIVERSITY OYE EKITI

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN ELECTRICAL AND ELECTRONICS

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CERTIFICATION

This project work titled "Wireless environmental monitoring system" by Bejide Oluwadamilare Samuel, meets the requirements for the award of Bachelor of Engineering (B.Eng.) degree in Electrical and Electronics Engineering Department, Federal University Oye-Ekiti.

28/11/17

ENGR BABARINDE . A.K

PROJECT SUPERVISOR

DATE

27/11/17

DR AKINSANMI . O

HOD ELECTRICAL DEPARTMENT

DATE

EXTERNAL EXAMINER

DATE

DEDICATION

This report is dedicated to the ruler of the universe the custodian of great wisdom and the giver of knowledge Almighty God, for his love, guidance and blessing through my stay at the university, to my dearest Father DR. OLUGBENGA BEJIDE and my mother MRS. MORAYO EROGUNAYE who made my academic succession a reality through their moral inspiration and financial support.

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I acknowledge the love, blessing and guidance of His Excellency Almighty God, for giving me the strength, wisdom and inspiration to complete my course. Sincere gratitude, appreciation and thanks go to my Father Dr. Olugbenga Bejide and my mother Mrs. Morayo Erogunaye for their love, care, moral and financial support. Also appreciation goes to Mr. Sam OLUEMKUN.

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ABSTRACT

This project presents a wireless environmental monitoring system using a DHT-11 sensor for its working operation. The DHT-11 sensor senses agricultural parameters such as temperature and humidity, being that plant requires the proper environmental conditions for optimal growth and health. If the mixture of temperature and humidity are incorrect fruit and vegetable yield can be affected. Hence these agricultural parameters such as temperature and humidity are then displayed on an LCD screen. This project is however programmed in such a way that when a SIM card is been inserted into the SIM 800 GSM module a message of request for the agricultural parameters such as temperature and humidity of the environment can be sent to the mobile number of the SIM card inserted into the module and in return will receive the agricultural parameters such as temperature and humidity on the mobile screen of the device used to send the SMS message provided the device is connected to an AC source supply within the farm area. Thus, the aim and objective of the project is achieved.

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1. LCD – LIQUID CRYSTAL DISPLAY
2. GSM- GLOBAL SYSTEM FOR MOBILE
3. SIM- SUBSCRIBER IDENTITY MODULE
4. DHT- DIGITAL HUMIDITY AND TEMPERATURE SENSOR
5. CCTV- CLOSE CIRCUIT TELEVIOSION
6. GPS- GLOBAL POSITION SYSTEM
7. WSN- WIRELESS SENSOR NETWORK

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CHAPTER ONE

1.0 INTRODUCTION

A wireless environmental monitoring system is an agricultural/electrical project circuit by which agricultural parameters such as temperature and humidity is being monitored and measured by electrical sensors on an environmental farm. By using a DHT-11 sensor, microcontroller, SIM 800 GSM Module and other electrical components this project is been achieved (Joseph, 2016).

1.1 BACKGROUND OF THE PROJECT

In this 21st century agriculture plays a very important role in the life of mankind and various livestock, adding also its impact on the economic state of various Nations around the world, agriculture is defined as —the science or practice of farming, including cultivation of the soil for the growing of crops, and the rearing of animals, to provide food, wool and other productsl. (OxfordDictionary) Agriculture is basically divided into two categories; livestock rearing and Crop production, for which the crop production is where the emphasis of this project lies upon. Providing plants with optimal growing conditions ensure a larger and healthier harvest, plants require proper environmental conditions for effective growth and health. Such conditions include proper climate, nutrients, hydration etc. therefore the ability to monitor these conditions accurately and clearly is very important in determining the right decision to be taken to ensure that the main aim and objectives are achieved. Electronics sensors such as DHT-11, embedded system and a screen such as LCD Screen therefore play a huge role in helping to monitoring process and display the real time conditions of the plants immediate environment and various important parameters.

1.2 STATEMENT OF THE PROBLEM

Recently there is a new revolution that is picking up huge popularity in the world of modern wireless technologies and this is leading to internet of things whereby objects are able to collect and exchange data using embedded sensors and this have led to emergence of smart environment as one aspect of research. Nevertheless, there are so many problems affecting agricultural practice in Nigeria which these project have been introduced to minimize them and these includes.

1. Real time environmental information which in turn help the agro based specialist achieve efficient management and utilization of agro ecological resources.
2. Networking without cable, through the help of GSM module embedded in the system agricultural parameters such as temperature and humidity can be received on a mobile phone based on request SMS sent to the SIM card inserted into the module without human having to be present on the farm area to get the readings on an LCD screen.
3. Continuous check on the environment for any change in temperature.
4. Understanding of environmental conditions affecting crop yield so it can be prevented before happening.

1.3 MOTIVATION

With the increase in world population and more specifically Africa, unstable state of economy it is obvious that there is a serious need for us to start developing technologies to aid agricultural processes and plant growth. This would enhance the quality of harvest, minimizing loses, as the right actions are taken. The quality of life will be improved considerably, and economic activity of countries that adopt such will be boosted. The potentials are enormous, and its value in the world continues to grow profoundly. Being a part of this success story in Nigeria is one of my main motivations for this project.

1.4 AIMS OF PROJECT

1. The aim of this project is to design a monitoring system that will help monitor and display through a wireless system the real-time values of agricultural parameters such as temperature and humidity on an output screen LCD using a GSM Module by the help of a microcontroller which is the brain of the whole system which in turn takes in electrical signals, makes decision on that signal and gives out an electrical signals, the microcontroller also stores the code which describes the sensor output behaviors and serial data output for the GSM module.

OBJECTIVES OF PROJECT

1. To design the Temperature and Humidity of a farm using electronic DHT-11 sensors.
2. To establish a wireless communication for transfer of data between the sensors and the display unit.
3. To display real-time values of the measured parameters on an LCD Screen.
4. To display real-time values of the measured parameters on a mobile phone through an SMS received on request by the help of the SIM 800 GSM Module provided there is a SIM Card inserted into the module for transmitting and receiving data.

1.5 SCOPE OF PROJECT

This project desires to focus on outdoor farming, rather than its conventional application in green houses. The goal is to utilize this technology in the ordinary farm environment. The testing will be done on readily available farms and home gardens, but with a larger vision of applying it on a larger scale. But there are some limitations to the working principle of the project and these limitations include lack of power supply in the farm area to power the monitoring system and lack of GSM Network coverage to receive the agricultural parameters as SMS on a mobile phone.

1.6 PROJECT OUTLINE

This project is divided into five chapters as follows chapter one; chapter one entails the introduction, scope, background, aims and objectives, statement of problems and motivation of the whole project ; chapter two explains the literature review and theoretical background of the process of implementing the project, chapter three shows the analysis of the hardware design of the environmental monitoring system ; chapter four explains the construction and testing of the whole project while chapter five concludes the whole work with limitations and recommendations for future work.

CHAPTER TWO

LITERATURE REVIEW

2.1REVIEW OF RELATED LITERATURES

Recently, there have been great improvements and innovations in information communication technology. These have been a greater convergence between different industries. The combination of and integration of IT with agricultural technology is an area where there's a great expectancy that higher value in produce and productivity can be realized. An agricultural environmental monitoring system enables the monitoring of environmental information and soil information. (Fraunhofer) This system helps in maintaining optimal growing environment for crops while improving the convenience and productivity of users. Wireless sensors networks have become an important tool in helping agricultural innovation. They enable completely new capabilities for measurement and control applications. Some of the areas where it is currently being employed are;

1. Environmental monitoring
2. Precision agriculture
3. Viticulture
4. Greenhouses
5. Livestock monitoring systems

Over the last seven years, the advancement in sensing and communication technologies has significantly brought down the cost of deployment and running of a feasible precision agriculture framework. Emerging wireless technologies with low power needs and low data rate capabilities, which perfectly suites precision agriculture, have been developed. The sensing and communication can now be done on a real-time basis leading to better response times. The wireless sensors are cheap enough for wide spread deployment in the form of a mesh network and offers robust communication through redundant propagation paths. Wireless sensor networks allow faster deployment and installation of various types of sensors because many of these networks provide self-organizing, self-configuring, self-diagnosing and self-healing capabilities to the sensor nodes. In recent years, there has been a growing concern about technology all over the world on how it has provided man with important solutions as well as created other problems for man. In lieu of these problems, man has been responsible and acquainted with exposing themselves to the much needed experience in the handling of equipment and machines with respect to their various fields. However, further exposure to other technologies has helped humanity in battling these problems. The applications using wireless sensor technology for precision agriculture are briefly explored below: (Oke, Awokola, & Amusan, 2017). Various researches has been done in the direction of this project, a very relevant one is discussed below:

1. A study carried out on agricultural environment monitoring server system using wireless sensor networks these researches focused on agricultural monitoring server system for monitoring information concerning outdoors agricultural production environment, utilizing wireless sensor network (WSN) technology. The proposed agricultural environment monitoring server system collects environmental and soil information on the outdoors through WSN-based environmental and soil sensors, collects image information, through CCTV's and collects location information using GPS modules. This collected information is converted into a database through the agricultural environmental monitoring server consisting of a sensor manager, which manages image information collected from CCTV's, and

a GPS manager, which processes location information of the agricultural monitoring server system, and provides it to the producers. In addition, a solar-cell based power supply is implemented for the server system, so that it could be used in agricultural environments with insufficient power infrastructure. This monitoring system could even monitor the environmental information on the outdoors remotely, and it could be expected that the use of such a system could contribute to increasing crop yields and improving quality in the agricultural field by supporting the decision making of crop producers through analysis of collected information. (Jeonghwan Hwang, 2010)

2. In this project the author was able to design a wireless monitoring of soil moisture, temperature and humidity using ZigBee wireless network to transmit data in remote monitoring system for precision agriculture, the merits of embedded system into monitoring and control system was utilized for agricultural parameters. The design has the advantage of ZigBee technology WSN comprised of Radio frequency transceivers, sensors, microcontroller and power source. (prof Chavan C. H, 2014)
3. This project was able to design Sensor Data Collection and Irrigation Control on Vegetable Crop using Smart Phone". The main purpose of the project was to find a better way controlling an irrigation system with automatic system manual control by smart phone and provide long term sustainable solution for automation of agriculture. Agricultural automation has several methods to getting data from vegetable crop like sensor for environmental measurement and developed portable measurement technology which includes sensors like soil

moisture, humidity sensor and air temperature sensors, for collecting different environmental data. (Kaewmard, 2014)

4. This project designed a GSM Based Environmental monitoring system using a temperature sensor since the instability in temperature of an environment can cause damage and also reduce the efficiency and lifespan of equipment found in the area. An alert subsystem and a global system for mobile communications GSM module was incorporated into the design to make it more effective. This environmental monitoring system is was designed to monitor the temperature at certain range (increase or decrease) and it is powered by an external source of power supply via an AC to DC power adapter. (Oke, Awokola, & Amusan, 2017)
5. This project is designed to help monitor and maintain conditions for plant growth using wireless temperature sensors, humidity sensors and light sensors, with the design of this project you can have 24/7 monitoring of your agricultural green house and still have the ability to track environmental changes, allowing the farmer to maximize his energy efficiency and grow healthier crops with higher yield. The Monnit remote monitoring system allows the farmers to track the temperature, humidity, light, and CO around the plants, the automated system of this design will then alert the farmer if any conditions fall out of optimal ranges, so they can maximize their fruit and vegetable yield (Monnit, 2013)

2.2 REVIEW OF FUNDAMENTAL CONCEPTS

The design and construction of a wireless environmental monitoring system can be implemented using so many techniques, based on so many related designs that has been carried out on this project it can be deduced that not only a GSM module can be used to transmit and receive data as imbibed in this project but ZigBee, Bluetooth module and different kind of sensors can be used to achieve related goals. The readings can be read on an LCD Screen or an android mobile app. Comparing different author with the project been worked on, their major aims are to monitor environmental system be it temperature, humidity, soil moisture etc. But different approach has been applied to getting the desired goal.

2.3 SENSORS

The American National Standards Institute defines a sensor as a device which provides a usable output in response to a specified measured (input). A sensor acquires a physical quantity and converts it into a signal suitable for processing (e.g. optical, electrical, mechanical). Recently, common sensors convert measurements of physical phenomena into an electrical signal. The active element of a sensor is called a transducer (device which converts one form of energy to another). There are various physical phenomena that can be detected, such as; biological, chemical, electric, electromagnetic, motion, radioactivity, optical, etc. These various sensors have their conversions achieved, based on readily available physical principles, some of which are;

- Ampere's Law: A current carrying conductor in a magnetic field experiences a force (e.g. galvanometer)

- Curie-Weiss Law: There is a transition temperature at which ferromagnetic materials exhibit paramagnetic behavior

- Faraday's Law of Induction: A coil resists a change in magnetic field by generating an opposing voltage/current (e.g. transformer)

- Photoconductive Effect: When light strikes certain semiconductor materials, the resistance of the material decreases (e.g. photo resistor).

In choosing a suitable sensor, to meet the desired specifications, some key factors must be considered such as; environmental factors, economic factors, and the sensors intrinsic characteristics.

2.3.1 THE DHT-11 SENSOR

The DHT11 Temperature & Humidity Sensor features a temperature & 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 (Negative temperature coefficient) temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programs in the OTP (One time programmable) memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20-meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request. DHT11's power supply is between 3.5-5V DC. (micropikcom)

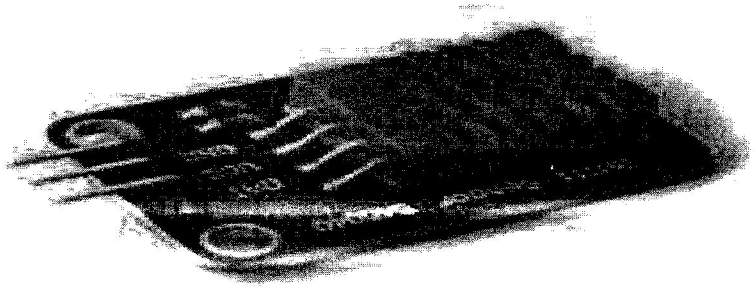

Figure 2.1 DHT-11 Sensors. Micropik.com

Table 2.1 DHT-11 Pin Description

PIN	DEFINITION
VCC	5V
GND	GROUND(0V)
DO	DIGITAL OUTPUT

Table 2.2 Overview and Detailed Description of DHT-11 Sensor (Micropik.com, 2016)

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

Table 2.3 DHT-11 Sensor Performance Description (Micropik.com, 2016)

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

2.4 MICROCONTROLLERS

The microcontroller is simply a computer on a chip. It is one of the most important developments in electronics since the invention of the microprocessor itself. It is essential for the operation of devices such as mobile phones, DVD players, video cameras, and most self-contained electronic systems. The small LCD screen is a good clue to the presence of a Microcontroller Unit (MCU). It needs a programmed device to control it. It works sometimes with other chips, but often on its own. The MCU provides the key element in the vast range of small programmed devices which are now commonplace. However, the ATMEGA8 has a good range of features and allows most of the essential techniques. It has a set of serial ports built in, which are used to transfer data to and from other devices, as well as analogue inputs which allow measurement of inputs such as temperature. All standard types of microcontrollers work in a similar way, so analysis of one will make it possible to understand all the others. The ATMEGA8 is also a good choice for learning about micro-controllers because the programming language is relatively simple compared to a microprocessor such as the Intel Pentium which is used in the PC. This has a powerful but complex instruction set to support advanced multimedia applications. The supporting documentation for the PIC MCU is well designed. The mobile phone can support a microcontroller application in addition to the sophisticated digital communications subsystem which provides its main function. It can also have a full-color, medium resolution liquid crystal display (LCD) screen, camera, sound system and so on. (Oke, Awokola, & Amusan, 2017)

Microcontrollers are very prominent in our modern society. They are found in automobiles, airplanes, toys, kitchen appliances, computers, TVs and VCDs, mobile phones space telescopes, and practically every electronic digital device that incorporate an independent functionality to its user. A microcontroller (sometimes called an MCU) is actually a computer on a chip. (Julio2007)

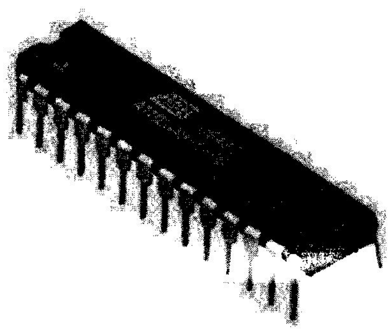

Figure 2.2 ATMEGA8 Microcontroller

2.4.1 THE ARDUINO MICROCONTROLLER BOARD

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable publicity recently. The Arduino is open-source, which means hardware is reasonably priced and development software is free. Arduino is essentially a tiny computer that can connect to electrical circuits. The Arduino Uno is powered by an ATmega8 chip which can easily be programmed and reprogrammed through a computer, with the simplified C-programming language. The top row of the Arduino has 14 digital pins, labeled 0-13. These pins can act as either inputs or outputs, which can be connected to circuits to turn them on or off. It has an input for 5v Vcc (input voltage) and ground, another input and output labeled Tx and Rx for data transmission and reception respectively. (aduino.cc)

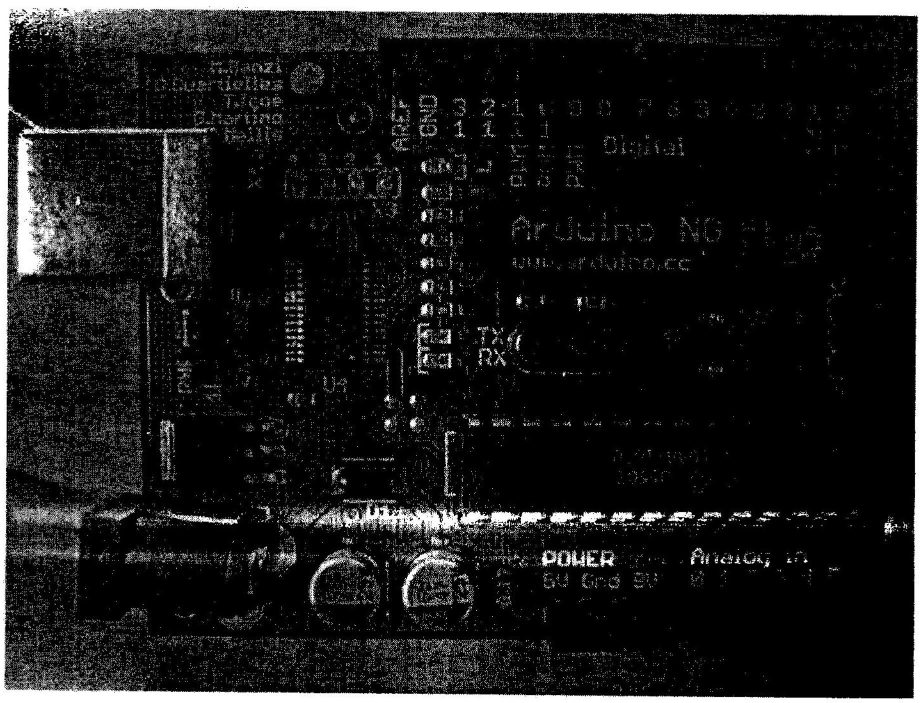

Figure 2.3 Arduino Uno Microcontroller Board

2.5 GSM TECHNOLOGY OVERVIEW

SIM 800 GSM Module is a complete Quad-band GSM/GPRS solution in a SMT type which can be embedded in the customer applications. SIM800 support Quad band 900 MHz or 1800 MHz, it can transmit voice, SMS, and data information with low power consumption. The SIM 800 modules are upgraded version of its previous successful GSM/GPRS Module series SIM 900. (Pujar, 2015). The GSM module (SIM-800) shown in Figure below is a GSM RF chip, a basebands processor chips, memory, power amplifier other device in an integrated circuit board, which has an independent operating system, GSM RF processing function and provides a standard interface module, the module is a wireless technology standard for exchanging data over long distances (using long-wavelength UHF radio waves in the industrial, scientific and medical (ISM) radio band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). The GSM module serially communicates with the microcontroller, and then transmits the data received to the paired device

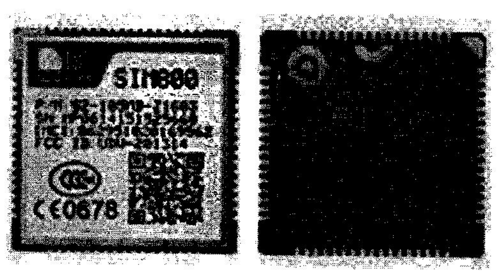

Figure 2.4 SIM 800 GSM Module (Pujar, 2015)

ADVANTAGES OF GSM

1. GSM is a cellular technology used for transmitting mobile voice and data services. Out of all cell technologies in use today, GSM is the most widespread.
2. GSM widespread use throughout the world. According to GSM word.com, GSM has a harmonized spectrum, which means even though different countries may operate on different frequency bands; users can transfer seamlessly between networks and keep the same number.
3. GSM is everywhere
4. GSM has low power—with the advent of Bluetooth Smart (BLE or Bluetooth low energy),
5. GSM can cover a wide range

2.6 LCD SCREEN

A liquid crystal display is a flat/ panel display or other electronically modulated optical device that uses the light modulating properties of liquid crystals. Liquid crystal does not emit light directly. (Awokola, 2017) Instead of using a backlight or reflector to produce in color or monochromes. LCDs are available to display arbitrary images (as in general purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as present words, digits and seven segments display, as in digital clock. LCD is used in wide range of applications including computer monitors, televisions, instruments panel and indoor or outdoor signage. Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculator, and mobile phone including smart phone. The display section begins with the receiver wireless data transfer module (GSM) and the received data is transferred to the microcontroller which decodes the information, and gives an output on the LCD display

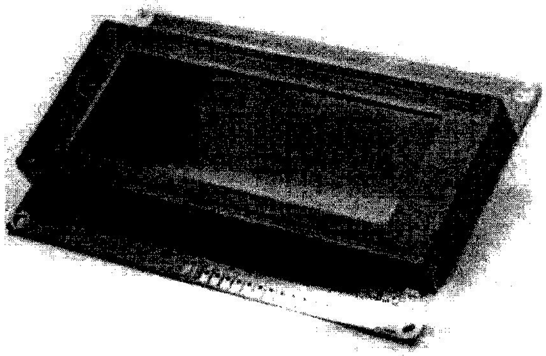

Figure 2.5 LCD Screen Display

2.7 JUMPER CABLES AND CONNECTORS

The jumper cables are selected to interconnect the various sensors, microcontrollers and module. Their size 1mm diameter, which is reasonable for the power demand of the circuit. Below is the jumper cable type used in this project.

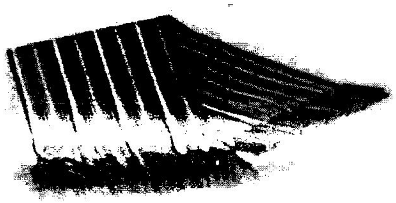

Figure 2.6 Jumper Cables

2.8 POWER SUPPLY

The 230/220V, 50Hz input supply of the device is an AC source which is stepped down by a transformer to deliver a secondary output of 12V, 500 mA. The transformer output is rectified by a full-wave rectifier comprising of diodes, smoothened by capacitor and regulated by a voltage regulator. The Capacitor bypasses the ripples present in the regulated supply. The LED acts as the power indicator and Resistor limits the current through the LED.

CHAPTER THREE

HARDWARE DESIGN AND PROCEDURE

3.1 DESIGN METHODOLOGY

The hardware of this system includes 8 bit AVR ATMEGA 8 Microcontroller, SIM 800 GSM module, Temperature, humidity sensor that is DHT-11, LCD SCREEN. The system is low cost & low power consuming so that anybody can afford it. The data monitored is displayed on an LCD screen. It can be used in precision farming. The system is designed in such a way that even illiterate villagers can operate it. They themselves can check different parameters of the soil like temperature and humidity from time to time.

3.2 FUNDAMENTAL BLOCK DIAGRAM

The block diagram includes blocks of components used in making the circuit functional, the various components involved in the circuit includes the Sensor, microcontroller, GSM module and LCD screen

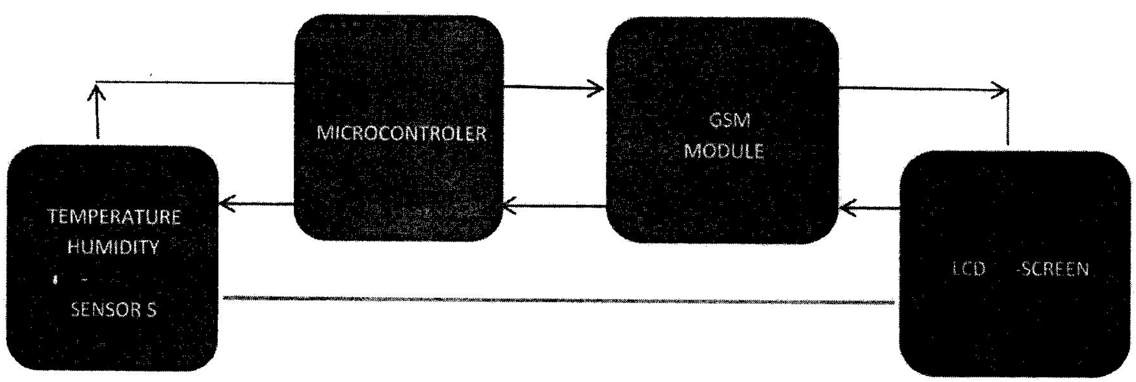

Figure 3.1 Generalized Block Diagram

3.3 FUNDAMENTAL CIRCUIT DIAGRAM

This project required an interconnection of sensors, a microcontroller board, a GSM module and an LCD Screen as illustrated below.

2. The temperature and humidity sensor consists of a single device; the DHT-11 sensor which senses those parameters, and gives a digital output.

3. The microcontroller board utilized is the Arduino-Uno R-3 board, which contains primarily the atmega8 chip, and serial input and output terminals. The microcontroller primarily functions as an analog to digital converter; it also stores the code which describes the sensor output behaviors and serial data output for the GSM module.

4. The GSM module – This is connected to the microcontroller; reading or outputting the data contained, and wirelessly transmits this data via the GSM to the display paired with it.

5. The mobile screen here is an LCD Screen interphase that enables the user to view readings.

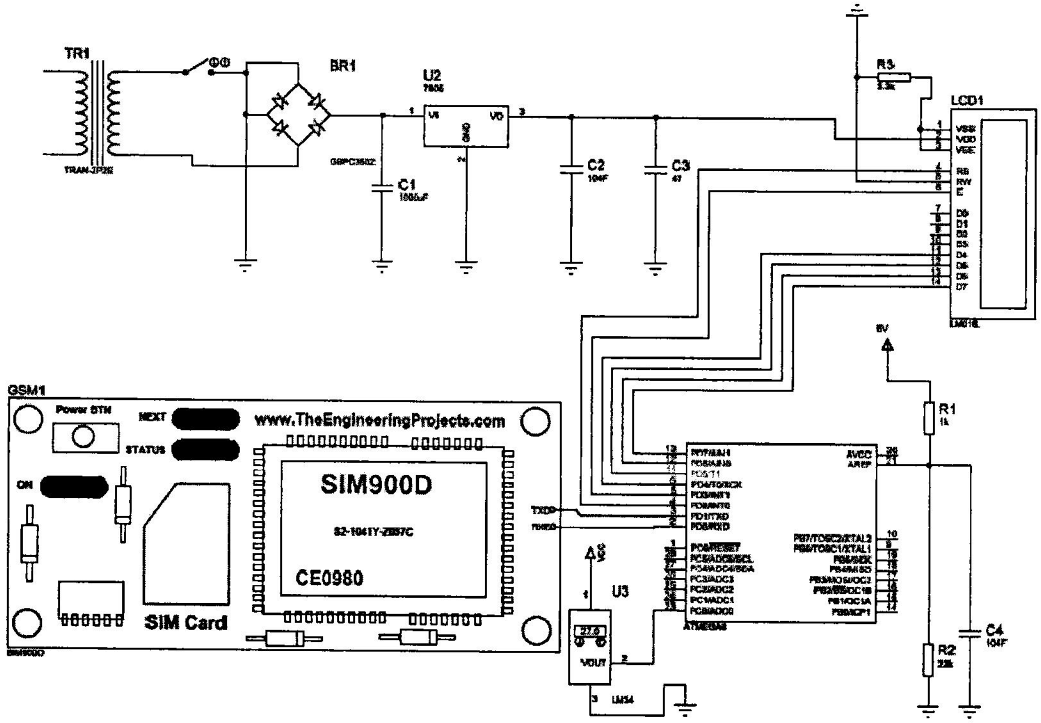

Figure 3.2 Circuit Diagram of the Design Hardware

3.4 PRINCIPLE OF DESIGN AND OPERATION

This project is all about sensing agricultural parameters on an environment and displaying the parameters on an LCD screen and it is powered by an external source of power supply. The 230/220V, 50Hz input supply of the device is an AC source which is stepped down by a transformer to deliver a secondary output of 12V, 500 mA. The System consists of the Hardware and software. The Hardware is divided into five sections: Power supply, Temperature and humidity sensor, Microcontroller, Liquid crystal display (LCD), GSM module while the software program was written in C language. The code was written in such a way that it embeds the High and Low sensitivity of the sensor, Light emitting diode (LED), LCD and the programmed GSM module

3.5 TOOLS USED

1. MULTIMETER- for taking measurements of voltage and others
2. LAPTOP COMPUTER- for designing software application and programming microcontroller
3. MOBILE PHONE- for receiving SMS when requested
4. SET OF SCREW DRIVERS
5. SOLDERING IRON- for heat joining wires and circuit hardware.

3.6 DESIGN CALCULATIONS

3.6.1 SELECTION OF TRANSFORMER

In order to get a reliable DC power supply from the 220/230 V, a step down transformer of primary winding voltage of 240v and secondary winding voltage of 12v is used.

Transformer turn ratio calculations

Vp = voltage induced at the primary winding

Vs= Voltage induced at the secondary winding

Ns= Number of turn induced in the secondary winding

Np= Number of turn induced in the primary winding

$$\frac{240}{12} = \frac{NP}{NS}\ Therefore\ \frac{NP}{NS} = 20$$

Therefore the transformer has rated turn ratio of 20:1

3.6.2 VOLTAGE DIVIDER RULE

A voltage divider involves applying a voltage source across a series of two resistors. This is usually very useful, when a lower voltage is required than the reference voltage in a circuit. The voltage divider equation assumes that the three values of the circuit below: the input voltage (VIN), and both resistor values (R1 and R2). Given those values, we can use this equation to find the output voltage (Vout):

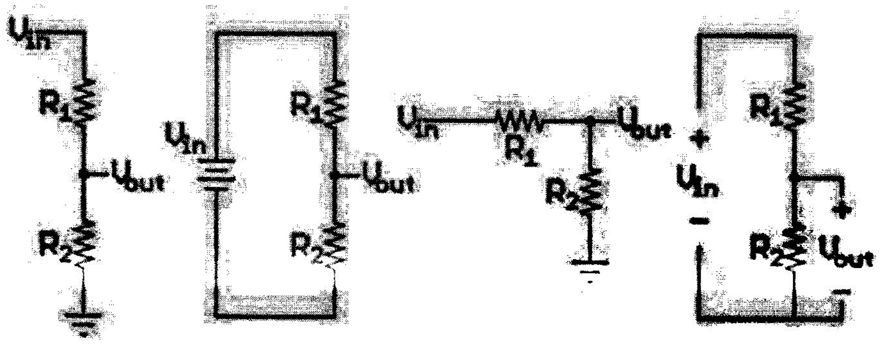

Figure 3.3 Voltage Divider Circuits

$$Vout = Vin \cdot \frac{R2}{R1 + R2}$$

Given R1= 2.2K

Given R2= 3.3K

VIN= 35v

Fixed output voltage =12v

Using the voltage divider rules calculated voltage output= 21v

3.6.3 OVERALL SELECTIONS

All the sensors, module and microcontroller used are low power type sensors, requiring between 3.3V and 5V. Below is an overall selection of the components.

1. Temperature & Humidity sensor=> 5v
2. Microcontroller=> 5-12v
3. GSM module=> 5v
4. Resistors=> 2.2k, 1k, 3.3k
5. Input voltage=> 240VAC
6. Output voltage => 9VAC
7. Supply voltage=> 5VDC/12VDC
8. Current 500Ma
9. Frequency 50Hz
10. Capacitor 1000μf

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 CONSTRUCTION

In implementing any electronics circuit there are some step to step procedures which needed to be put into consideration before achieving the desired result. Steps taken during design includes

1. Circuit design
2. Simulation of circuit
3. Hardware implementation
4. Microcontroller code design
5. Interconnection of 3 and 4
6. Coupling of parts
7. Casing of the project

4.1.1 SIMULATION OF CIRCUIT

The required components were picked and dropped, then interconnected as shown in the Figure below. Afterwards, the design code was uploaded, and the design runs. Below is the detailed Proteus design.

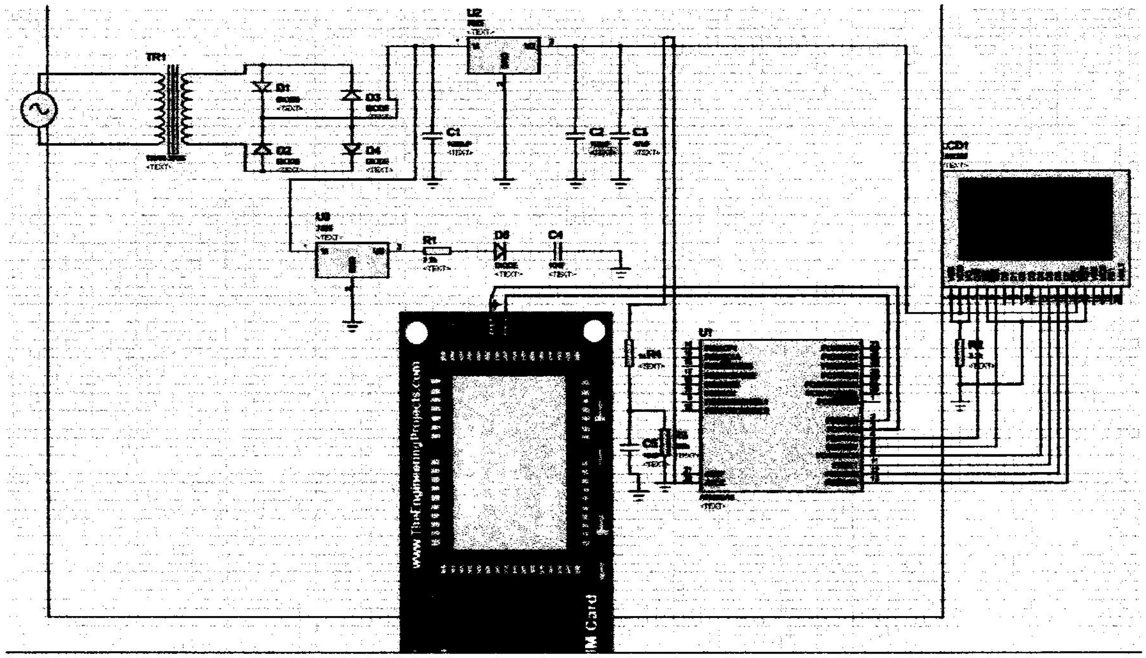

Figure 4.1 Simulations on Proteus

4.1.2 HARDWARE IMPLEMENTATION

The circuit outlined in step one (1) above was first demonstrated on a solder-less board (bread board).

The circuit was connected thus:

1. .THE SENSORS WERE CONNECTED

The temperature and humidity sensor (DHT 11) - The DHT-11 sensor is used as a digital sensor which reads temperature and humidity values, and outputs a corresponding electrical digital value. This sensor was selected, because its range of operation (0-50 degrees Celsius) is reasonable for the scope of the work it will do in this project. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. The sensor has three terminals namely;

VCC- Positive (+ve) voltage terminal

GND- Negative (-ve) voltage terminal

DAT- Digital output

2. SIM – 800 GSM MODULE

   The module (SIM 800) was connected into the existing circuit. It serially communicates with the microcontroller through the transmitter and receiver pin on the PWM terminal of the Arduino board. The GSM module (SIM 800) has four terminals namely;

   TX-Transmitter; it sends or transmits data to the micro controller from an external device.

   RX- Receiver; it receives data from the micro controller serially. The RX pin on the SIM 800 module requires an input of 3.3V, whereas the Arduino output feed in 5V. As such a voltage divider was used to reduce the TX output of the Arduino to 3.3V.

   VCC- Positive (+ve) voltage terminal

   GND- Negative (-ve) voltage terminal

3. TRANSFORMER

   The power terminal was connected to a 220/230V transformer which was stepped down to a 12v output voltage

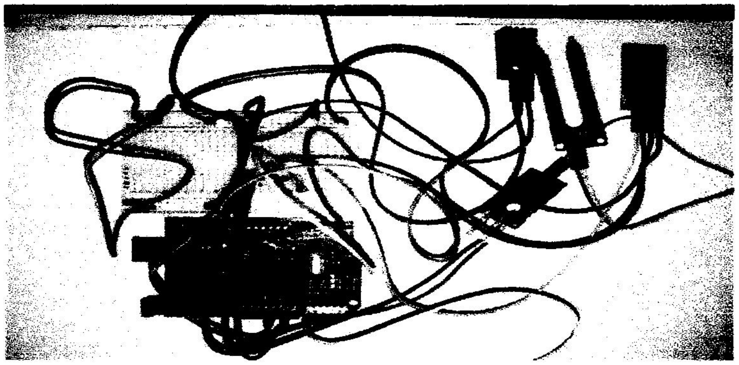

Figure 4.2 Interconnection of Sensors and Module

4.1.3 MICROCONTROLLER CODE DESIGN

The microcontroller used on the Arduino UNO R3 is atmega8. The coding language used on the Arduino platform is simplified C.

4.1.4 INTERCONNECTING THE HARDWARE, CODE AND LCD SCREEN ON A VERO BOARD

1. The hardware was combined with the code for the microcontroller.
2. The hardware was powered by an Alternating Current
3. A connection was established with the LCD Screen as the SIM-800 module was paired with the screen.
4. Sensor values were read from the LCD Screen as shown below.

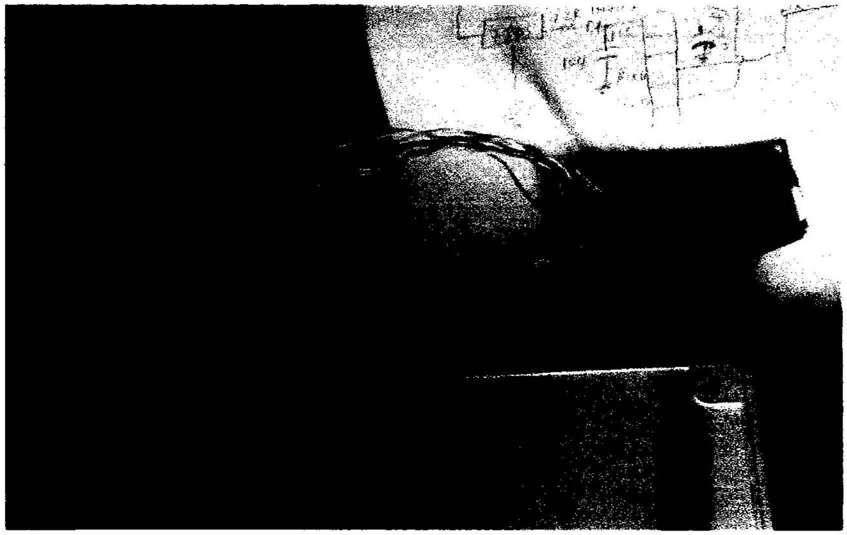

Figure 4.3 Interconnecting the Hardware

4.1.5 CASING

The casing was constructed putting the size of the circuit board, transformer and ventilation for the circuit into consideration. The Figure below shows the typical casing used

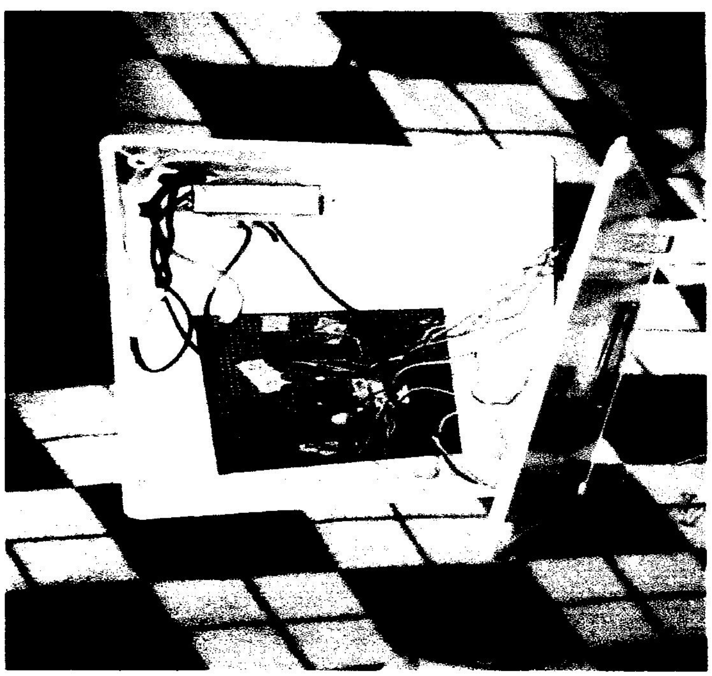

Figure 4.4 Casing of the Project

4.2 TESTING

The testing of the design was carried out and the result for the humidity and temperature sensors were compared with that of standard applications that utilize global satellite values.

4.1.1 TESTING WITH THRESHOLD VALUE IN AIR

The hardware and software was tested for minimum value i.e. low threshold in air. The results were noted and used to calibrate the microcontroller values for low value output from the DHT-11 sensor.

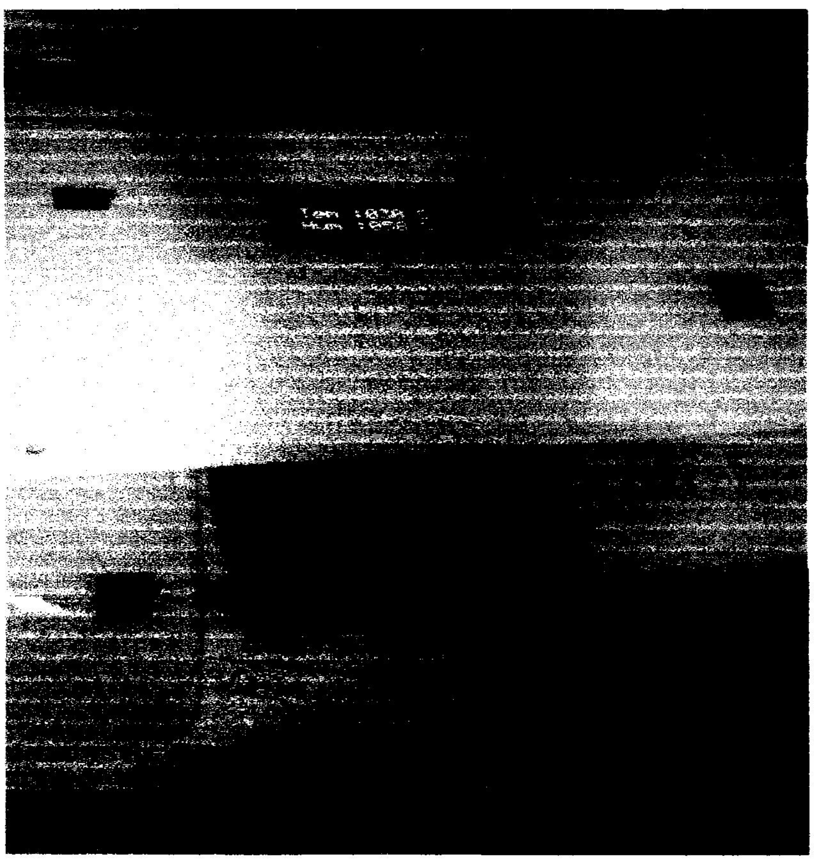

Figure 4.5 Testing the DHT-11 Sensor in Air

4.1.2 TESTING GSM MODULE FOR VARIOUS DISTANCES

The GSM module was tested for relative distances with the LCD screen of more than 300Kilometers within a GSM network coverage, because from any part of the world where there is GSM network coverage the agricultural parameters can be received i.e. temperature and humidity as an SMS on a mobile phone on request. The response was noted, and the performance was observed. After testing the hardware in the air for low threshold value in air, the response was observed on the LCD screen, and the response is displayed below.

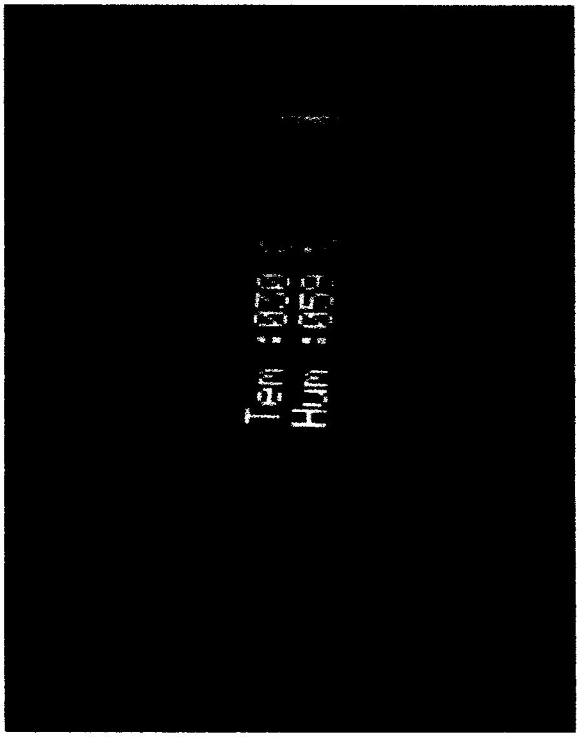

Figure 4.6 Results on an LCD SCREEN when Testing in Air.

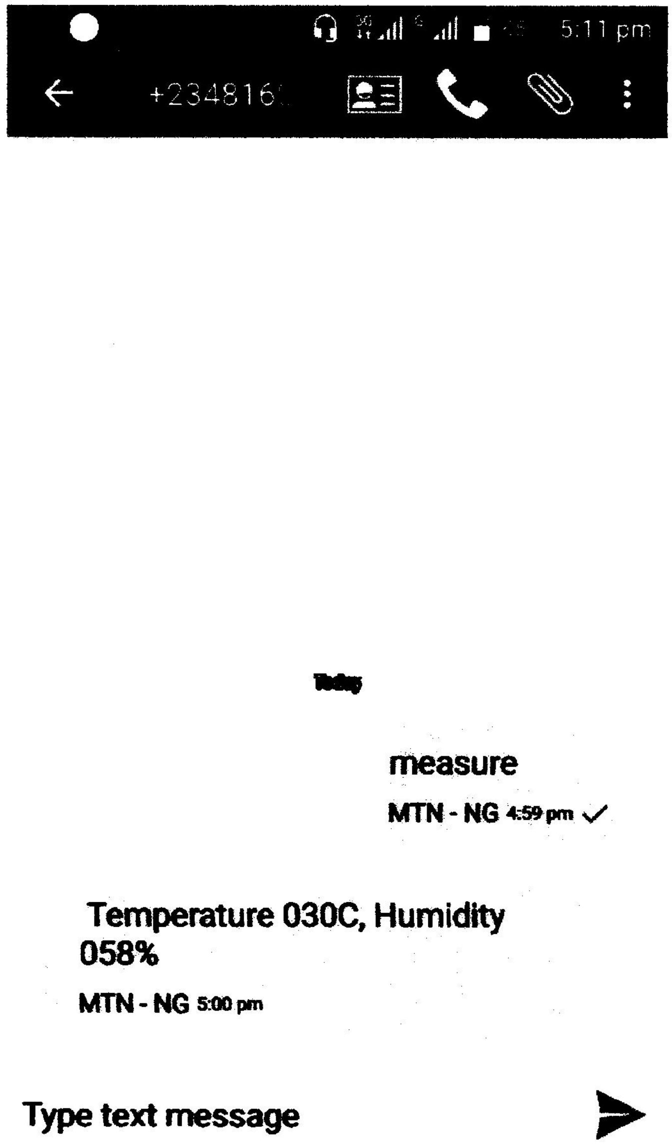

Figure 4.7 Result on a Mobile Phone received as an SMS on request when testing in Air.

-The results above show the outcomes on the LCD Screen, when the sensor was tested in air.

-The humidity level is measured in percentage and also.

-The Temperature is measured in degrees Celsius.

- The GSM module blinks continuously, until a connection is established with another device. This connection however remains active.

-The LCD Screen is initiated, and a connection is established with the GSM module, and then the data's are displayed.

4.3 DISCUSION AND RESULT

The work deals with assembling, soldering, casing etc. The circuit components used was locally sourced. Once they were gotten, the components were then assembled and soldered on a Vero board according to the specifications of the circuit diagram. After soldering, the testing of the circuit design took place across the nodes of the circuit. A side of the casing had to be drilled in order for the power jack to fit in and for ventilation. After drilling, the parts were positioned in such a way that they were exposed to the external environment and they were held solidly to the case with the use of an adhesive. (Oke, Awokola, & Amusan, 2017)

4.3.1 Operation of the System

The designed device signals when powered initializes the system and display the temperature and humidity from the LCD screen at that particular point in time and it reports by sending a message from the device to the programmed GSM. The detailed operation of the system is stated in the following steps as follows; (Oke, Awokola, & Amusan, 2017)

STAGE 1:

The environmental monitoring device operates in such a way that when the power is supplied to the designed system, the sensor senses the temperature and humidity of the environment in an analogue form. The programmed microcontroller converts the analogue input to a digital form to be used by the control unit for necessary data flow. The liquid crystal display (LCD) helps in displaying the measured temperature in degree centigrade and humidity in percentage. (Oke, Awokola, & Amusan, 2017)

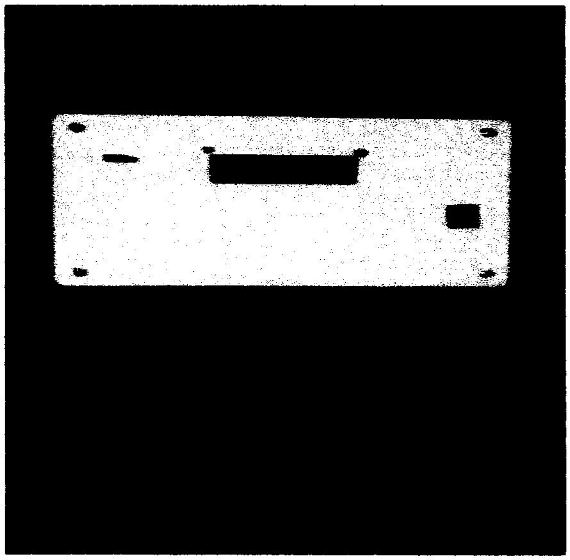

Figure 4.8 Power not supplied to Environmental Monitoring Device

Figure 4.9 Power supplied to the Environmental Monitoring device

STAGE 2:

At the end of the experiment, the designed system has been tested at different time of the day (afternoon and night) and the system was found to be capable of measuring the changes in temperature and humidity of the environment. The Figures below shows the temperature and humidity readings in the afternoon, and in the night. The temperature measured by the device is illustrated below:

Temperature measured and humidity (afternoon) =30^{0}c and 59 %

Temperature measured and humidity (night) =28^{0}c and 67%

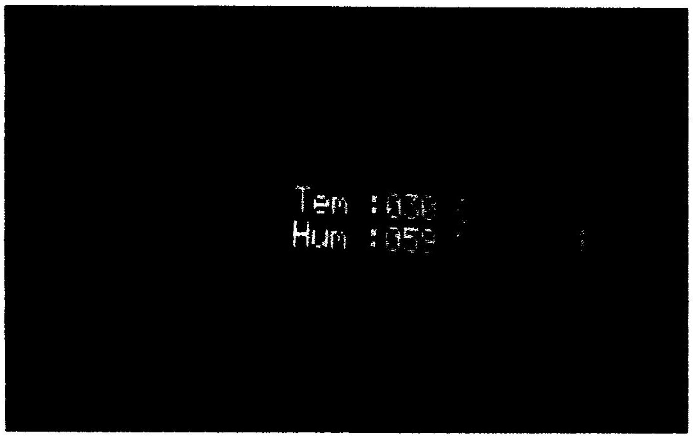

Figure 4.10 Result when Tested in the Afternoon

Figure 4.11 Result when Tested in the Night

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The design and construction of this project was able to successfully measure temperature, humidity thereby displaying the result on an LCD screen and wirelessly transmitting the result on a mobile screen as an SMS on request. Therefore, the major aim and objective of this project was fully achieved. However, it was also observed that the values of humidity and temperature differs a little bit standard values, and that is clearly expected, based on the tolerance given for the sensor (DHT-11), ±2 degrees Celsius for temperature and ± 5% for humidity. This project successfully applies the wireless sensor networks on agro-ecology fields by investigating environmental situations. The real-time environment information is expected to help the agro-based specialists achieve efficient management and utilization of agro-ecological resources.

5.2 LIMITATIONS

Upon the completion of this project I realized some limitations which are discussed below

1. Due to the effect of poor GSM Network coverage, the design of GSM module becomes an issue because this can lead to delay of the expected SMS of the agricultural parameters such as temperature and humidity.
2. Failure of power supply in the farm area will defeat the working principle of this design project as it is being powered by an AC supply
3. Components used in the design of this project cannot be found in Ikole Ekiti. A lot of travelling was done to achieve this project.

5.3 FUTURE WORK

In this project it is suggested that more research can be carried out towards the improvement of the project and a suggested future work are listed below

1. Monitoring and storing more parameters like PH of soil, pressure, and weight by replacing the existing sensors with respective sensor (technologies, 2015).
2. A GSM-Bluetooth based remote monitoring and control system which will eliminate the cost of network usage to a great extent by using Bluetooth when in a range of few meters with the device and using GSM when in a range of wider meters. (Purnima, 2012)

5.3 RECOMMENDATIONS

a. MORE SENSITIVE SENSORS

This project utilized some low-cost, but reliable sensors. However, for better and more accurate results, more sensitive temperature and humidity sensors should be utilized. This will ensure that the results are more dependable, and thus more useful. Also it is suggested that the sensors selected should be more durable, in order to meet real-world, outdoor farming experience.

b. DATA STORAGE AND ANALYSIS

Further improvements could also be made to the hardware and application, in order to make it possible for the system to process the data, log it over a period, and output the results in graphs, charts and other interesting formats. This would make research over a period of time easier, as there is a repository of data which can be utilized whenever the need arises. Also, this can help in the decision making process for farmers, ensuring an overall better use of limited resources to accomplish set goals and more importantly maximize profit.

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APPENDICES

APPENDIX 1

PROGRAM CODE

The microcontroller used on the Arduino UNO R3 is atmega8. The coding language used on the Arduino platform is simplified C.

```
/*
 * TemHumidityGsmBase.c
 *
 * Created: 10/7/2017 9:46:47 AM
 *  Author: Bejide
 */
#include <avr/io.h>
#include <stdlib.h>
#include <stdio.h>
#include <avr/interrupt.h>
#define  F_CPU 1000000UL
#include "util/delay.h"
#define  Usart_BaudValue 9600
#define  BaudValue (F_CPU / 4UL /
Usart_BaudValue - 1) / 2

#define DHT11_PIN 0
uint8_t
c=0,I_RH,D_RH,I_Temp,D_Temp,Che
ckSum;
#define Input PINC
#define InputDir DDRC
#define InputPort PORTC
```

```
#define LCD_RS       2       //define
MCU pin connected to LCD RS

#define LCD_RW       5       //define
MCU pin connected to LCD R/W

#define LCD_E        3       //define
MCU pin connected to LCD E

#define LCD_D4       4       //define
MCU pin connected to LCD D3

#define LCD_D5       5       //define
MCU pin connected to LCD D4

#define LCD_D6       6       //define
MCU pin connected to LCD D5

#define LCPP PORTC

#define LCDRR DDRC

#define LCD_D7       7       //define
MCU pin connected to LCD D6

#define LDP PORTD //define MCU
port connected to LCD data pins

#define LCP PORTD //define MCU
port connected to LCD control pins

#define LDDR DDRD           //define
MCU direction register for port
connected to LCD data pins

#define LCDR DDRD//define MCU
direction register for port connected to
LCD control pins


#define LCD_CLR             0 //DB0:
clear display

#define LCD_HOME            1
        //DB1: return to home position

#define LCD_ENTRY_MODE      2
        //DB2: set entry mode

#define LCD_ENTRY_INC       1
        //DB1: increment
```

```
#define LCD_ENTRY_SHIFT    0
        //DB2: shift
#define LCD_ON_CTRL        3
        //DB3: turn lcd/cursor on
#define LCD_ON_DISPLAY     2
        //DB2: turn display on
#define LCD_ON_CURSOR      1
        //DB1: turn cursor on
#define LCD_ON_BLINK       0
        //DB0: blinking cursor
#define LCD_MOVE           4
        //DB4: move cursor/display
#define LCD_MOVE_DISP      3
        //DB3: move display (0-> move
cursor)
#define LCD_MOVE_RIGHT     2
        //DB2: move right (0-> left)
#define LCD_FUNCTION       5
        //DB5: function set
#define LCD_FUNCTION_8BIT  4
        //DB4: set 8BIT mode (0->4BIT
mode)
#define LCD_FUNCTION_2LINES 3
        //DB3: two lines (0->one line)
#define LCD_FUNCTION_10DOTS 2
        //DB2: 5x10 font (0->5x7 font)
#define LCD_CGRAM          6
        //DB6: set CG RAM address
#define LCD_DDRAM          7
        //DB7: set DD RAM address


// reading:
#define LCD_BUSY           7//DB7:
LCD is busy
#define LCD_LINES               2
        //visible lines
```

```
#define LCD_LINE_LENGTH
        16      //line length (in
characters)

// cursor position to DDRAM mapping

#define LCD_LINE0_DDRAMADDR
            0x00

#define LCD_LINE1_DDRAMADDR
            0x40

#define LCD_LINE2_DDRAMADDR
            0x14

#define LCD_LINE3_DDRAMADDR
            0x54

// progress bar defines


#define PowerSwitch 0

#define PowerSource         PORTB


#define PowerLine          DDRB


#define cost_per_unit       10//60//unit
charge per time


#define
PROGRESSPIXELS_PER_CHAR   6

#define  NumDigit   16


charMin,Hour,VoltsErro,Alert,PhoneNu
mber[NumDigit];

intRxCount;

int
Ampers,Ampers2,AdcSwap,AdcCount,i
,output_volt_memo,output_volt_memo2
,setP_temp,Ac,input[15],k[10],MgsCou
nt,RecString[200],askey[]={'0','1','2','3','
4','5','6','7','8','9'};
```

```
intj,m,l;

int Time;

float
AmpersMemo,Ampers2Memo,current,t
otal_unit,watt,
kilowattHour,kWhTime,last_kWhTime,
MeterPower1,MeterPower2;

intwatts,unit_place,fract,watts_fract;


voidCheckSms();

void Control();

voidReadSms();

voidWritePhoneNumber();

voidWriteDate();

voidResetGsm();


void serial_init(void)

{

UBRRH=(BaudValue>>8);

UBRRL=BaudValue;

//UCSRA=0x02;  // Communication
Parameters: 8 Data, 1 Stop, No Parity

UCSRA|=(1<<U2X);// Communication
Parameters: 8 Data, 1 Stop, No Parity

UCSRB|=(1<<TXEN);//|(1<<TXCIE);

//UCSRB|=(1<<RXEN);//|(1<<RXCIE);

//UCSRB|=(1<<RXCIE);// ensble serial
interrupt

UCSRC=(1<<URSEL)|(1<<UCSZ0)|(1
<<UCSZ1);

}
```

```
//*******************************
*******************************
*************

//

// ADC conversion complete service
routine

//

//*******************************
*******************************
*************


voidUSART_initialization(void){ //
function to initialize usart. be sure of the
crystal frequency.


UCSRA=0x02; // Communication
Parameters: 8 Data, 1 Stop, No Parity

UCSRB=0x18; // USART Receiver:
On

UCSRC=0x86; // USART
Transmitter: On

    // remove comment mark from the
buadrate and freq u prefer

// for frequency of 1MHz....


UBRRH=0x00; // USART Baud rate:
9600

UBRRL=0x0C;

}


voidUSART_Send(unsigned char
Data){ // function to send a character
through uart
```

```
        while (!(UCSRA &
(1<<UDRE))) {; } /* waits for possible
sending */

   UDR = Data;


}


unsigned char
USART_ReceiveByte(void) { //
function to receive  one byte or char...
remember that the function returns a
char

//    Wait until a byte has been received

while((UCSRA&(1<<RXC)) == 0){;}

return UDR;  // Return received data

}



voidUSART_ReceiveString() { //
function to receive  one byte or char...
remember that the function returns a
char

        j=0;

        do

        {


l=USART_ReceiveByte(); // Wait until
a byte has been received

                RecString[j++]=l;

        }

while(l!='\n'); // Return received data
until enter is press(ASCLL for enter is
13)

        // RecString[j]='\0';

}
```

```
unsigned char UartRecieveString()
{
        do{
                RecString[RxCount]=
USART_ReceiveByte();//SoftUartRecie
veString();
        }
        while(RecString[RxCount++]!='
\n');
        return 0;
}

voidUSART_Send_Str(char*s){
// loop through entire string
  unsigned char i=0;
while(s[i]!=0){
// while(s[i]!='\0'){
USART_Send(s[i]);
i++;
  }
}

voidLCDsendChar(uint8_t ch)
        //Sends Char to LCD
{
        LDP=(ch&0b11110000);
        LCP|=1<<LCD_RS;
        LCP|=1<<LCD_E;
        _delay_ms(1);
        LCP&=~(1<<LCD_E);
        LCP&=~(1<<LCD_RS);
```

```
		_delay_ms(1);
		LDP=((ch&0b00001111)<<4);
		LCP|=1<<LCD_RS;
		LCP|=1<<LCD_E;
		_delay_ms(1);
		LCP&=~(1<<LCD_E);
		LCP&=~(1<<LCD_RS);
		_delay_ms(1);
}
voidLCDsendCommand(uint8_t cmd)
		//Sends Command to LCD
{
		LDP=(cmd&0b11110000);
		LCP|=1<<LCD_E;
		_delay_ms(1);
		LCP&=~(1<<LCD_E);
		_delay_ms(1);
		LDP=((cmd&0b00001111)<<4);

		LCP|=1<<LCD_E;
		_delay_ms(1);
		LCP&=~(1<<LCD_E);
		_delay_ms(1);
}
void LCDinit(void)//Initializes LCD
{
		_delay_ms(15);
		LDP=0x00;
		LCP=0x00;
		LDDR|=1<<LCD_D7|1<<LCD_
D6|1<<LCD_D5|1<<LCD_D4;
```

```
        LCDR|=1<<LCD_E|1<<LCD_R
S;

        LCDRR|=1<<LCD_RW;


  //---------one------

        LDP=0<<LCD_D7|0<<LCD_D
6|1<<LCD_D5|1<<LCD_D4; //4 bit
mode

        LCP|=1<<LCD_E|0<<LCD_RS;

        LCPP|=0<<LCD_RW;

        _delay_ms(1);

        LCP&=~(1<<LCD_E);

        _delay_ms(1);

        //------------two-----------

        LDP=0<<LCD_D7|0<<LCD_D
6|1<<LCD_D5|1<<LCD_D4; //4 bit
mode

        LCP|=1<<LCD_E|0<<LCD_RS;

        LCPP|=0<<LCD_RW;


        _delay_ms(1);

        LCP&=~(1<<LCD_E);

        _delay_ms(1);

        //-------three-------------

        LDP=0<<LCD_D7|0<<LCD_D
6|1<<LCD_D5|0<<LCD_D4; //4 bit
mode

        LCP|=1<<LCD_E|0<<LCD_RS;


        LCPP|=0<<LCD_RW;

        _delay_ms(1);

        LCP&=~(1<<LCD_E);

        _delay_ms(1);
```

```
//--------4 bit--dual line------------
---

LCDsendCommand(0x28);//(0b
00101000);

LCDsendCommand(0x28);

LCDsendCommand(0x28);

//-----increment address, cursor off----
-

LCDsendCommand(0x0c);

}

void LCDclr(void)
//Clears LCD

{

LCDsendCommand(1<<LCD_C
LR);

}

void LCDhome(void)
//LCD cursor home

{

LCDsendCommand(1<<LCD_H
OME);

}

void initLcd(void)

{

LCDinit();//init LCD bit, dual
line, cursor right

LCDclr();//clears LCD

}


voidLCDstring(char *var)

{

while(*var)             //till string
ends
```

```
        LCDsendChar(*var++); //send
characters one by one

}

voidLCDsNumPrint(unsigned
Figure,unsignedintdatas){

        for(i=Figure;i>=0;i--){// load
freq values into k[];

                k[i]=datas%10;

                datas=datas/10;

        }

        for(i=0;i<=Figure;i++)

        LCDsendChar(askey[k[i]]);

}

uint8_t Receive_data()
        /* receive data */

{

        int q;

        for ( q=0; q<8; q++)

        {

                while((Input &
(1<<DHT11_PIN)) == 0);     /* check
received bit 0 or 1 */

                _delay_us(30);

                if(Input &
(1<<DHT11_PIN))     /* if high pulse is
greater than 30ms */

                c = (c<<1)|(0x01);
            /* then its logic HIGH */

                else
              /* otherwise its logic LOW
*/

                c = (c<<1);

                while(Input &
(1<<DHT11_PIN));
```

```
        }
        return c;
}
voidSmsSetup()
{
        UCSRB&=~((1<<RXCIE)|(1<<
RXEN));// disable serial Rx interrupt
        _delay_ms(1000);
        USART_Send_Str("AT+CMGF
=1\r"); //Sending the SMS in text mode
        _delay_ms(1000);
        USART_Send_Str("AT+CNMI=
2,2,0,0,0\r");
        _delay_ms(1000);
        USART_Send_Str("AT\r");
//Sending the SMS in text mode
        _delay_ms(1000);
        USART_Send_Str("AT&W\r");/
/ Save all setting conFigureuration
        _delay_ms(1000);
        UCSRB|=((1<<RXCIE)|(1<<RX
EN));// enable serial Rx interrupt
}
voidTemHumBackSms(){
        UCSRB&=~((1<<RXCIE)|(1<<
RXEN));// disable serial Rx interrupt
        USART_Send_Str("AT+CMGF
=1\r"); //Sending the SMS in text mode
        _delay_ms(1500);
        //USART_Send_Str("AT+CMG
S=\"+2348028426510\"\r"); // default
Number
        WritePhoneNumber();
```

```
        _delay_ms(1500);

        USART_Send_Str("
Temperature ");

        USART_SendStrNum(2,I_Temp
);

        USART_Send_Str("C");

        _delay_ms(1500);

        USART_Send_Str(", Humidity
");

        USART_SendStrNum(2,I_RH);

        USART_Send_Str("%");

        _delay_ms(1500);

        USART_Send(26);//the ASCII
code of the ctrl+z is 26

        _delay_ms(100);

        //UCSRB|=((1<<RXCIE)|(1<<R
XEN));// enable serial Rx interrupt

}


void Control()

{

        if(RecString[0]=='m'
&&RecString[1]=='e'
&&RecString[2]=='a'
&&RecString[3]=='s'
&&RecString[4]=='u'
&&RecString[5]=='r'
&&RecString[6]=='e' )

        {

                TemHumBackSms();

        }

        for
(RxCount=0;RxCount<200;RxCount++
){RecString[0]=0;}
```

```
}

voidReadSms(){
        cli();// disable serial interrupt
        RxCount=0;

        //
        while(USART_ReceiveByte()!='
\n');// Nothing

        if('+'==USART_ReceiveByte())
{ // To Confirm That's Sms

        if('C'==USART_ReceiveByte())
{

        if('M'==USART_ReceiveByte())
{

        if('T'==USART_ReceiveByte())
{

        while('
'!=USART_ReceiveByte());
                                        for
(i=0;i<NumDigit;i++){
PhoneNumber[i]=USART_ReceiveByte
();}// copy Phone Number only to
PhoneNumber Memo
        RxCount=17;
        UartRecieveString();//
Date,Time

        RxCount=0;// Initiallize for
Message
```

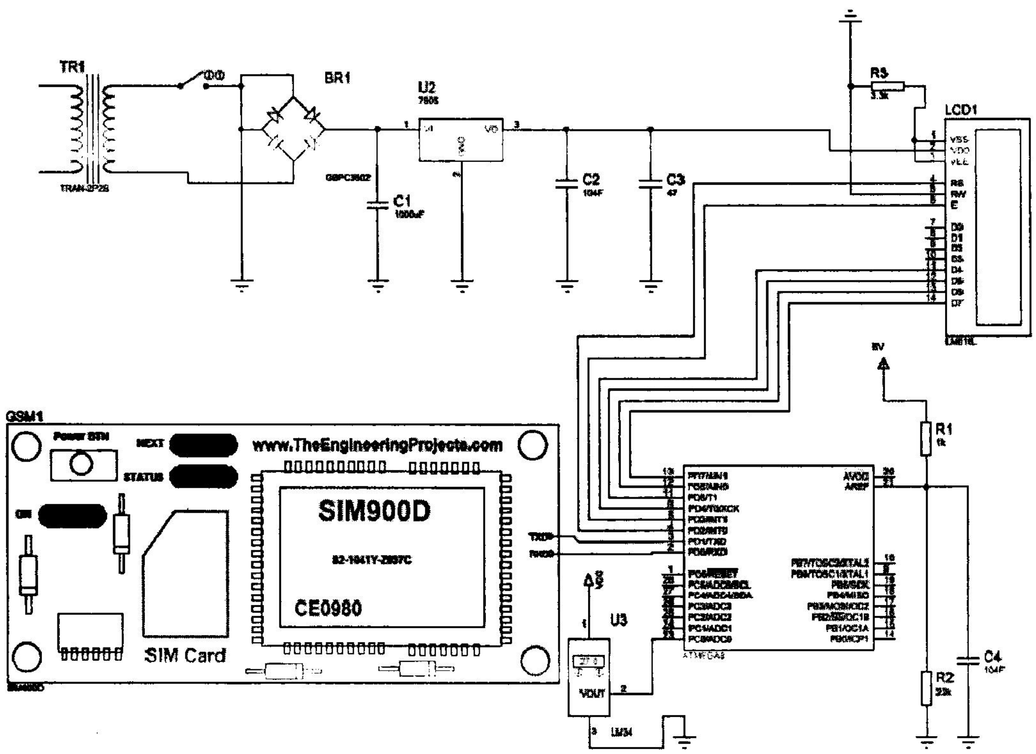
```
        UartRecieveString();//
Messages(Body of Sms)

        Control();// Execute Message
                              } }}}
        UCSRB|=((1<<RXCIE)|(1<<RX
EN));;// enable serial Rx interrupt
                              sei();//
enable  interrupt
                    }
ISR(USART_RXC_vect)//  string datas
from gsm module
 {
        ReadSms();
} // End
int main(void)
{
  LCDR=0b11111110;
PowerLine|=(1<<PowerSwitch); //
Difine as output
PowerSource|=(1<<PowerSwitch);//
pullup pin
sei();
initLcd();
LCDsendCommand(0x080);
LCDstring("Initializing...............");
LCDsendCommand(0x0c0);
LCDstring("    System     ");
serial_init();
  _delay_ms(1000);
SmsSetup(); // just once on a moderm
```

```
//TemHumBackSms();
        while(1)
        {
                I_RH=Receive_data();
                  /* store first eight bit in
I_RH */
                I_Temp=Receive_data();
/* store next eight bit in I_Temp */

        CheckSum=Receive_data();
/* store next eight bit in CheckSum */


                if ((I_RH + D_RH +
I_Temp + D_Temp) != CheckSum)
                {

        LCDsendCommand(0x080);
                        LCDstring("
Error      ");
                }


                else
                {

        LCDsendCommand(0x080);
                        LCDstring("Tem
:");

        LCDsNumPrint(2,I_Temp);
                        LCDstring(" C
");

        LCDsendCommand(0x0c0);
                        LCDstring("Hum
:");
```

```
        LCDsNumPrint(2,I_RH);
                    LCDstring(" %
");
            }

            _delay_ms(10);
        }
}
```

APPENDIXES II

COMPLETE CIRCUIT DIAGRAM



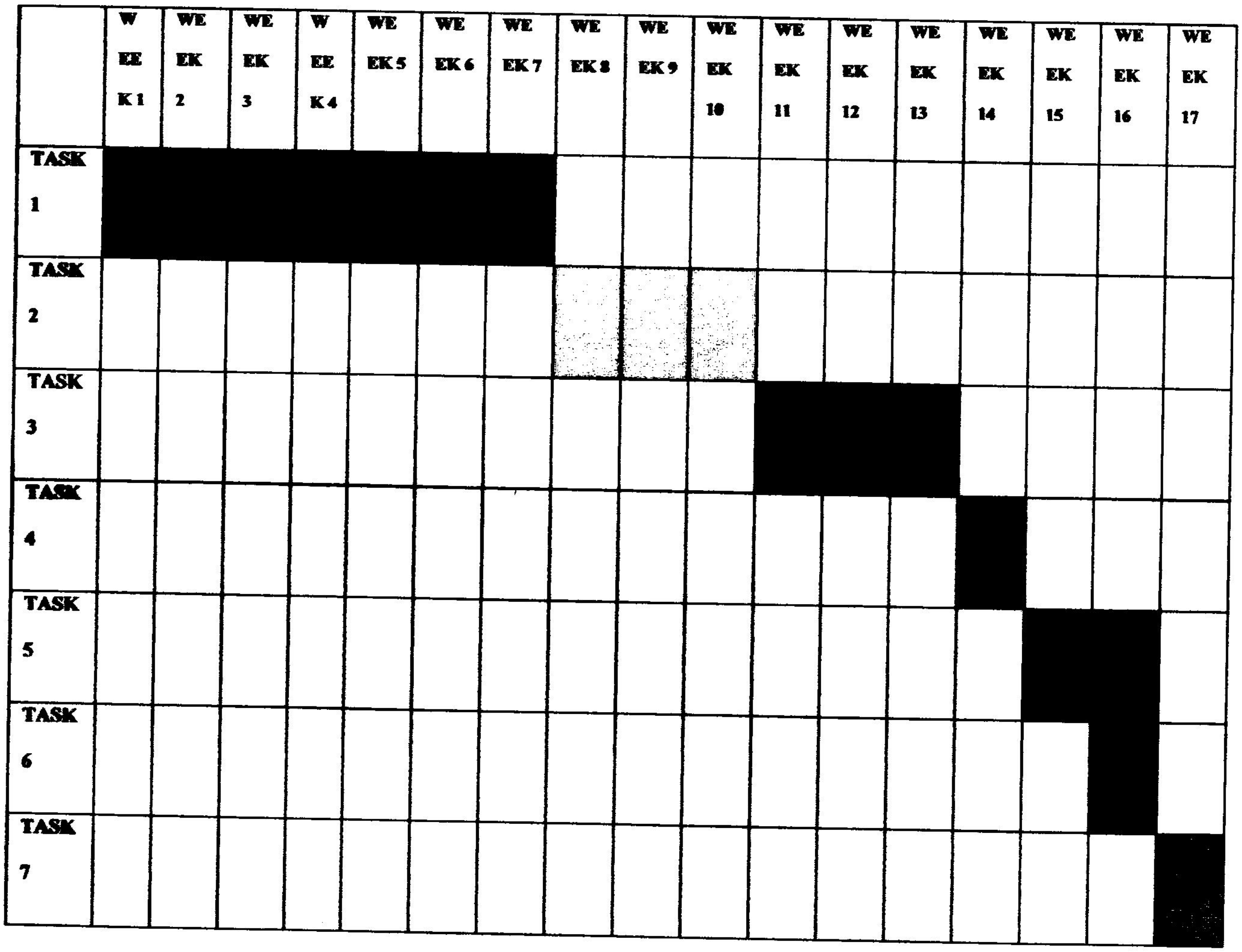
APPENDIX III

COST EVALUATION OF THE WHOLE PROJECT

S/N	COMPONENT/ITEM	QUANTITY	AMOUNT #	TOTAL AMOUNT#
1	Voltage regulator 7812	3	80	240
2	LCD Screen	1	2000	2000
3	Transformer	1	500	500
4	SIM – 800 GSM Module	2	5000	10000
5	DHT-11 Sensor	1	2000	2000
6	Atmega 8 microcontroller	1	1000	1000
7	Vero board	1	100	100
8	Casing	1	3000	3000
9	Connecting wire	1	100	100
10	Mains cable	1	150	150
11	Resistors	10	10	100
12	Capacitors	10	20	200
13	Diode	10	30	300
	GRAND TOTAL			19690

APPENDIX IV

GANTT CHAT



Task 1- Gathering of materials for project.

Task 2- Design of project circuit.

Task 3- Programming of code for the design.

Task 4- Acquisition of components.

Task 5- Construction of circuit on a solder less board.

Task 6- Soldering on a Vero board.

Task 7- Testing and casing of the project.