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WEATHER STATION BASED ON GSM SYSTEM

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Dissertation submitted in partial

fulfilment of the requirements for the award of Advanced Diploma A1 in Electronics and Telecommunication Technology Option.

supervisor: KAYIJAMAYE Patrick

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WEATHER STATION BASED ON GSM SYSTEM

Done by: AMPA BAHATI ROLAND

CERTIFICATION

This is to certify that this project, WEATHER STATION SYSTEM BASED ON GSM SYSTEM by **AMPA BAHATI Roland**, with Roll number **201850044** meets partial fulfillment for the requirement of the degree of **Electronic and Telecommunication Science** and has been approved by the Department of Electrical and Electronic Faculty, **ULK POLYTECHNIC INSTITUTE**, Kigali.

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HEAD OF DEPARTEMENT

DEDICATION

This project is dedicated to God Almighty who has been with us all our life and has provided a way out of every obstacle that has crossed our path. It is also dedicated to my parents, BAHATI CISIRU Simeon & Mrs. BAHANANGA CIREZI Rosette, they are my motivation and source of happiness, without which We wouldn’t have been able to get
to this final stage of our program. We can never be grateful enough.

ACKNOWLEDGEMENTS

We are thankful to God Almighty who has protected us from our fears, guided us with His mercy and brought us to this phase of life. Our gratitude also goes to our supervisor, **Eng. Kayijamahe Patrick**, and all our lecturers who have been our mentors and friends, thank you for letting use come this far.

I would like to appreciate my friends, classmates and many others that can’t be mentioned. For all your love, care, tolerance, and support, I am forever thankful. I truly wish you the best of things in this life and the next.

I would also like to thank my families, sisters, cousins, for all your support and motivation, I could never find the words to show my appreciation. I love you all more than I can ever say.

To my father, thank you for being my sponsor, protector and friend. Thank you for bringing us laughter every time school weighed down on me. I couldn’t have gone this far without you. we love you and God bless you.

Lastly, my appreciation would not be complete without thanking my mother. You mean more than the world to me, my confidant, my strongest motivators and inspiration. Without you, I’d have lost my way and never come this far. I love you more than you could ever know. I am forever indebted to you, thank you for being my friend, thank you for being my mother, and God bless you.

ABSTRACT

Weather Forecast stations are used for the prediction of future weather conditions. These systems require intensive human efforts and are sometimes inaccurate in its prediction. Wireless weather monitoring stations are created to monitor weather virtually or remotely without the requirement of direct human efforts. The system is designed to implement sensors which accurately acquire analog or digital data passed to a microcontroller for the storage and processing of these data. This project is focused on the construction of weather monitoring system bases on GSM able to sense temperature, humidity and light intensity for normal use by regular users, application in agriculture, science laboratories, industries and creation of weather reports through sms.

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LIST OF ABBREVIATIONS

GSM– Global System for Mobile Communications

LCD – Liquid Crystal Display

ADC – Analog-to-digital Converter

SMS– Short Message Service

PC– Personal Computer

USB – Universal Serial Bus

EEPROM– Electrically Erasable Programmable Read-only Memory

IDE– Integrated Development Environment

I/O – Input/output

SIM– Subscriber Identity Module

DC– Direct Current

MO– Mobile Originated

MT – Mobile Terminated

PDU – Protocol Data Unit

HEX – Hexadecimal

GND– System Ground

VCC– Common Collector Voltage

LDR– Light Dependent Resistor

PWM-Pulse width Module

CHAPTER ONE

INTRODUCTION

1.1: BACKGROUND

In our modern world of information and technology, monitoring and predicting weather conditions is essential in planning out human activities; In Agriculture to determine where and when to plant and wait for harvest, in our social lives to determine where and when to hold events, in transportation to determine how safe it is to travel by road, by air, or by water because, all of these have weather as a major factor, whether it's a hindrance or a benefit.

Telecommunication allows for weather conditions to be monitored and analyzed wirelessly without much effort or human interaction from the user with the aid of sensors and the GSM module. Weather monitoring systems allow for certain weather conditions to be detected or predicted before they come in phase.

Wireless weather monitoring systems however, allow users to gain access to these systems virtually or remotely without the necessity of physically being present.
The system senses the climatic conditions with weather sensors by studying its patterns and giving a more accurate prediction unlike weather forecasting. It senses data wirelessly over a given distance where the outcome is shown on an LCD screen, and transmits the results to a GSM module. It is able to detect various weather conditions like temperature, rain, humidity, wind, sunlight intensity and other weather parameters.

The different sensors are able to work together by interfacing them on the microcontroller, thereby, allowing a single weather monitoring station to be able to sense various weather conditions and reducing the cost of constructing a weather monitoring station that is able to analyze only a particular type of weather condition.

1.2: PROBLEM STATEMENT

Uncertainty about weather conditions can be catastrophic in planning out human activities. Monitoring the weather requires critical analysis of different climatic conditions, studying the patterns and processing data obtained to produce results.

Weather Forecasting is based on analysis of data and the use of meteorology to predict future weather conditions. They require very active human interaction to determine weather conditions and are not necessarily reliable since they are sometimes inaccurate.

Weather monitoring station is a solution to this problem, however, the cost of construction is to be considered. They prove to be inefficient if it requires active human interaction to be able to operate and produce results whilst still being able to monitor only a specific weather variable e.g. Rain

1.3: AIM

The aim of this project is to construct a Wireless weather monitoring system that is able to sense multiple weather conditions; temperature, humidity and light, simultaneously, at specific time intervals for a given coverage and eliminate human interaction with the system.

1.4: OBJECTIVES

The objective of this project is to design a weather monitoring system that is able to:

- Acquire data about multiple weather conditions using sensors interfaced on a microcontroller
- Convert analog data to digital data with an ADC (Analog-to-Digital Converter) before being fed to the microcontroller
- Display data on an LCD screen after processing at the microcontroller
- Transmit the results in a simplex form of communication by sending an SMS to a mobile phone with the aid of a GSM module.

1.5: SIGNIFICANCE OF THE STUDY

Wireless weather monitoring system allows for weather conditions to be accurately predicted to allow for proper planning of events or activities which rely on weather as a major factor. It is essentially better than a weather forecasting system which involves extensive analysis, calculations and choosing the right weather forecast models that best predict the weather. Weather forecasting systems are usually unreliable due to the time difference between when the weather is actually predicted and when it comes into phase. The use of a wireless weather monitoring system eradicates the problems of humans having to interact directly with the systems, or having to do all the major work in predicting the weather. Intensive data analysis, processing and calculations are done by the system instead, thereby, removing the problems of human errors and providing a user friendly system that allows users with little skills of operating a technical device, the opportunity to operate the monitoring system.

The weather monitoring system is able to sense different weather conditions and allows the user to receive information about weather conditions through an SMS, allowing the user to have partial control of the system without being in the same location as the system.

In cases where a weather forecasting system will predict rainfall in the whole of a metropolis or city, whereas, it rains in only a certain percentage of the location, contributes to the unreliability of the system. The weather monitoring system will, however, predict the weather, covering a smaller distance which will provide better accurate results than that of a weather forecast.

The weather monitoring system is designed to be inexpensive, small in size, giving it portability with a memory capacity enabling it to compare previous weather conditions with current weather conditions, and accurately predict future ones. They can work as an outdoor unit to sense environmental weather conditions or as an indoor unit to give information about the real feel of the weather or temperature feel of equipment.

1.6: SCOPE AND LIMITATIONS OF THE STUDY

The scope of this study covers a limited range depending on the location of the weather monitoring system. The wireless weather monitoring station can only sense weather within a given coverage based on the concentration of the weather on the sensors. The system designed is only able to sense three weather conditions; temperature, humidity and light. Although, the major benefit of the wireless monitoring station is being able to receive information about the weather of a particular environment without being there in a cost-effective manner by making use of the GSM technology, the system requires an uninterrupted power supply to effectively perform its functions.

1.7: OVERVIEW OF CHAPTERS

The insight of the chapters are highlighted below:

Chapter 2- Literature Review: This chapter gives an entailed literature review of the wireless weather monitoring system.

System Chapter 3- Design & Methodology: the third chapter discusses the hardware components and software implemented in the construction of the system, the block diagram design of the system and the process of the design.

Chapter 4- Results: Results obtained from the system is discussed in this chapter.

Chapter 5- Summary and Conclusion: Summarizes the report and suggests future recommendations that could improve the project.

CHAPTER TWO

LITERATURE REVIEW

Monitoring the weather did not begin from modern times. Our ancestors and their immediate descendants learned to monitor the weather because of its impact on our daily activities especially our outdoor activities like travelling, agriculture and events. Different instruments like the rain gauge, barometer, anemometer etc., have been use dover the centuries to predict the weather. Unfortunately, these will never be enough and the need for a device that can interpret the atmospheric condition without the intervention of human effort was required.

In modern times, sensors brought about the creation of automated weather monitoring stations because of its ability to sense the conditions and real feel of the atmosphere and record the data obtained more accurately without the problem of human errors.

The design of a wireless monitoring weather station in this project has been researched on, and is based on different literature focused on the implementation of weather monitoring stations with the justification for the need to survive in our environment by predicting future weather conditions.

In the journal, “Cost Effective Automated Weather Station– A Review” A low cost automated weather station is designed wirelessly with the aid of GSM technology to monitor its immediate environment with the use of sensors for specific weather parameters; rain, temperature, wind speed, wind direction and humidity functioning with a power supply sourced from a solar panel. This journal describes an automated weather station that can be monitored wirelessly and also emphasizes on the elimination of human effort in the monitoring process.

The sensors used are interfaced on an ARM-7 microcontroller where it reads digital data converted by the ADC (Analog-to-digital Converter). Data is analyzed and processed by the microcontroller and is displayed on the LCD (Liquid Crystal Display) screen.

The microcontroller also stores data which is transmitted to the GSM module and received by the PC (Personal Computer) via a serial interface. The PC is connected to thedatabase containing the maximum and minimum values for weather parameters being monitored by the sensors.

In another literature, “A Low-Cost Microcontroller-based Weather Monitoring System”, the weather station is designed to monitor temperature, relative humidity and pressure with their corresponding sensors for applications in the industry, agriculture, and weather monitoring in our daily lives. It is designed to be affordable, portable and small sized with a large memory capacity. The components are sectioned into 4different circuits; the sensor circuit comprising of the sensors, the data-logging circuit housing the microcontroller, the time-keeping circuit and the USB interfacing circuit connecting the station to the PC. The sensor used for temperature, relative humidity, and pressure respectively are: LM35, HSP15A and MPX4115A. Analog data obtained by the sensors are converted into digital signals by the ADC in-built on the microcontroller, PIC16F877A which processes and analyzes data transmitted to the PC via USB (Universal Serial Bus) interface.

N. Ghalot et al, in the “Zigbee based Weather monitoring System” journal, researched in the agricultural field emphasizing the reality of agriculture decreasing in yielding its products and reveals the necessity of technology to support farmers in the process of planting and harvesting the products of the soil. This journal depicts the implementation of a Wireless weather monitoring system that requires no human effort in its operation. It is targeted towards the reliability of pollution monitoring system using wireless sensor networks allowing it to sense; rain, temperature, wind, humidity, sunlight intensity and humidity over a larger area than a manual weather station might cover, and displays the results on an LCD screen in real time on an hourly basis.

The literature on the “Wireless Weather Monitoring System using Arduino DUE and GSM Technology”, uses an Arduino due microcontroller, the core of the system connected to the major components and the sensors via the ADC c. It measures temperature, humidity, rain, light intensity, carbon dioxide, pressure and wind with their corresponding sensors. It allows the user to gain control over the system remotely with the implementation of the GSM module in the system. The user is able to call the weather station which the GSM module receives as a notification and further retrieves the data on weather based parameters and transmits to the user as an SMS.

The journal, “Low Cost Weather Monitoring System with Online Logging and Data Visualization” describes a weather station comprising an outdoor and indoor unit, where the outdoor unit comprises the sensors; temperature, wind, rain, humidity and pressure, all connected to the indoor unit comprising of two Arduino Uno boards with an Ethernet shield. Data obtained from the sensors is stored in the memory and sent to the internet cloud for monitoring the weather remotely.

“Design and Implementation of Weather Monitoring and Controlling System” by **P.Susmitha** and **G. Sowmyabala** implements a weather station with temperature, gas, humidity and accelerator sensors interfaced on the microcontroller and giving the user remote access to it by uploading weather parameter results in the form of an excel sheet via serial cable on Lab view and transmitting the results to a mobile via SMS with the aid of a GSM module.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1: INTRODUCTION

This chapter aims to explain to the reader, the components used in the construction of the system and the integration of the hardware components and software module. It describes the interfacing of the sensors on the microcontroller on the Arduino board, and the connection of the LCD and GSM module. The block diagram of the proposed system design and a flowchart is also depicted to show the construction process of the weather monitoring station.

3.2: HARDWARE COMPONENTS

The hardware components required to implement this project are:

- Arduino nano Microcontroller
- Temperature sensor; DS18B20
- Humidity Sensor; DHT11
- Light Intensity Sensor; Light Dependent Resistor
- Liquid Crystal Display; 20* 4
- GSM Module; SIM800

3.2.1: ARDUINO NANO MICROCONTROLLER

The Arduino nano microcontroller board is in-built with ATmega328p microcontroller in a plastic quad pack with consisting of 32 pins with 2 of them being used for the ADC [10]. It comes with 8 ADC ports and a mini-USB port used
for programming and serial monitoring. It selects the strongest power source using the potential dif

ference. It has 14 digital I/O pins working with a maximum of 5Vand a low of 0V, produces and receives current values of up to 50 mA with a pull-up resistance of 20-50 kΩ.

figure 1: arduino nano microcontroller

3.2.1.1: NANOMICROCONTROLLERSPECIFICATIONS

The specifications of the Arduino nano microcontroller are :

- Microcontroller: ATmega328
- Architecture: AVR
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V

- Flash Memory: 32 KB with 0.5 KB used for bootloader
- SRAM: 2 KB
- Clock Speed: 16 MHz
- EEPROM: 1 KB
- Analog I/O Pins: 8
- Digital I/O Pins: 14
- DC per I/O Pins: 40 Ma
- DC Current for 3.3V pin: 50mA
- Input Voltage(limits): 6-20V

3.2.2: DS18B20 TEMPERATURE SENSOR

The temperature sensor is a digital thermometer that outputs 9– 12 bits measurement values in Celsius. It connects with the microcontroller with single wire bus and possesses the ability to source power from this line without the need for external power supply. It has an alarm function which is user programmable. A number of DS18B20 sensors can be multiplexed on a single wire bus due to its unique 64-bitserial code, giving the microcontroller the ability to control all the DS18B20 sensors connected to the single wire bus.

3.2.2.1: DS18B20 SPECIFICATIONS

The specifications of the temperature sensor are:

- Programmable digital temperature sensor
- Uses unique 1-wire method
- Operating voltage: 3V – 5V
- Temperature range: -55°C to +125°C
- Accuracy: ±0.5°C

- Output resolution: 9-bit to 12-bit
- Unique 64-bit addressing
- Conversion Time: 750ms at 12-bit
- Programmable alarm options

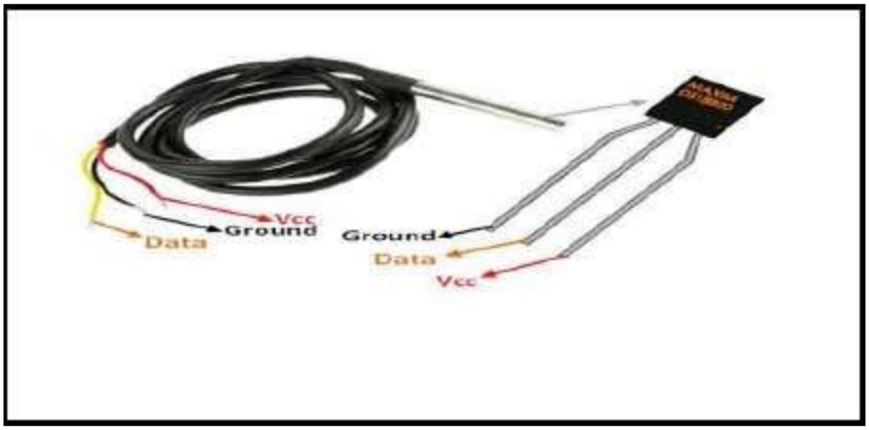

figure 2: ds18b20 temperature sensor

3.2.3: DHT11 HUMIDITY SENSOR

The DHT11 humidity and temperature sensor is used only for the monitoring of humidity in this project. It is a reliable, inexpensive and low power consuming device. It acquires digital signal values making it highly reliable and giving it long term stability. The sensor has 4 pins and makes use of resistive type humidity component with an 8-bit microcontroller to output values of humidity data serially. Itis able to measure humidity in the range of 20-90% precisely with ±1% accuracy.

3.2.3.1: DHT11 SPECIFICATIONS

The specifications of the DHT11 are as follows:

- Operating voltage: 3.5 – 5.5V
- Operating Current: 0.3 mA (measuring) 60 µA

- Output: serial data
- Temperature range: 0° - 50° C
- Humidity range: 20– 90%, 2-5% accurancy
- Resolution: 16-bit
- Accuracy: ±1% and ±1°C

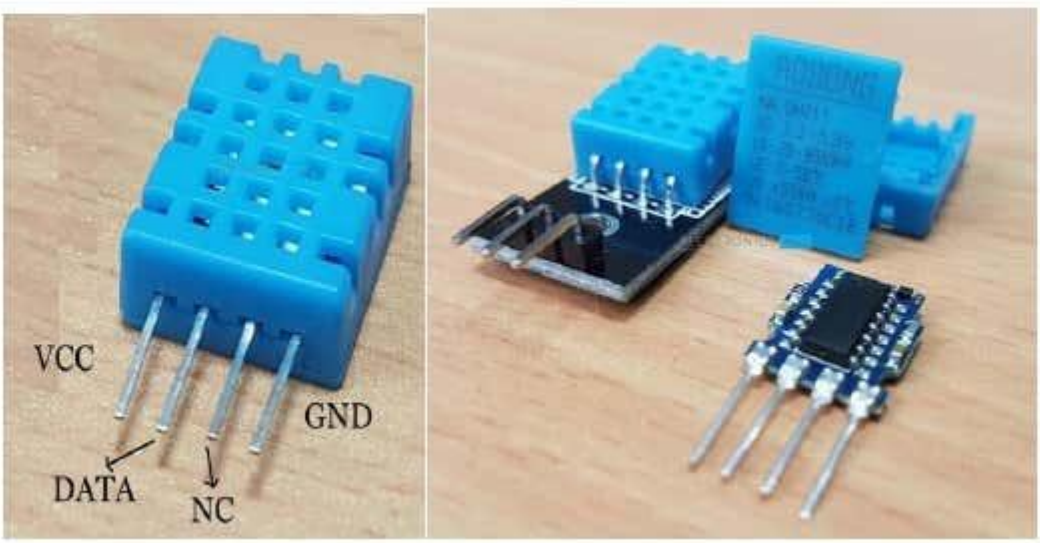

figure 3: dht11 humidity sensor

3.2.4: LIGHT DEPENDENT RESISTOR SENSOR

The light sensor has a variable resistance that changes with the level of light it receives. The resistance is decreased when light falls on it and increased in the dark. They operate based on the principle of photo conductivity where the conductivity increases with the fall of light on the material and decreases in the absence of light. They are generally inexpensive and easy to use. It is applied in weather monitoring stations to measure the intensity of sunlight, and can be applied in other technologies such as alarm locks and street lights. The figure below shows the image of a light dependent resistor.

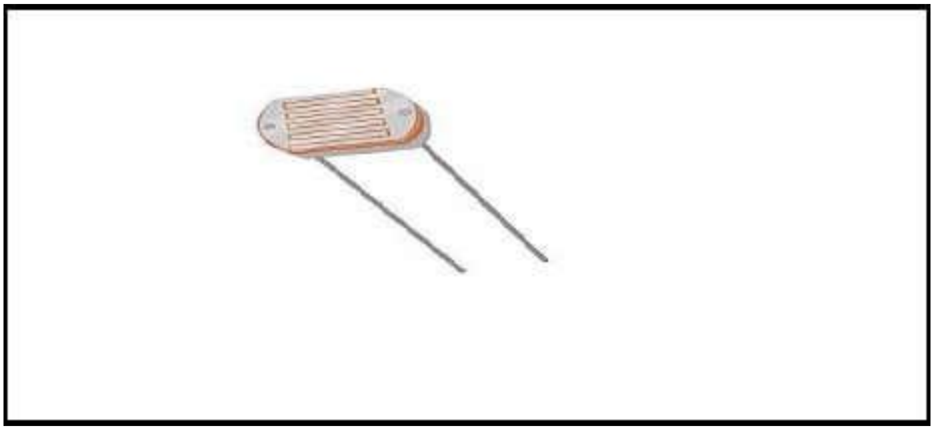

figure 4: light dependent resistor

3.2.5: LIQUID CRYSTAL DISPLAY (LCD) SCREEN

An LCD is a flat panel electronic screen display device that works based on the principle of light modulation properties. It operates by applying varying electric voltage to a layer of liquid crystals causing changes in its light properties. It contains a matrix of pixels that display the graphical images on the screen. The polarized backlight shines through the liquid crystal layer which is able to block the light when off and reflect red, blue and green when on, giving it the ability to consume less power than a light emitting diode.

3.2.5.1: SPECIFICATION

- 20 characters wide, 4 rows
- Black text on the yellow background
- The module can easily interface with an MCU
- The module is a low-power consumption character LCD Module with a built-in controller
- Single LED backlight included can be dimmed easily with a resistor or PWM.
- Can be fully controlled with only 6 digital lines! (Any analog/digital pins can be used)

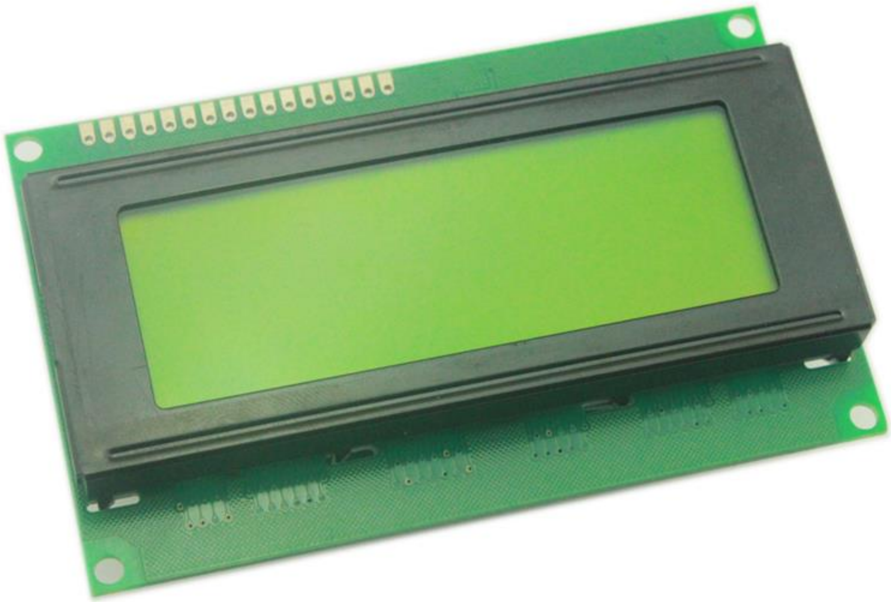

figure 5: 20*4 lcd display screen

3.2.6: SIM 800

The SIM 800 module is a Quad-band GSM technology that supports the transmission of voice, data and SMS. It is the core of the wireless communication, as it allows receiver a certain level of control over the weather monitoring station. It is the most inexpensive, efficient wireless technology and is suitable for cost effective build of the weather stations.

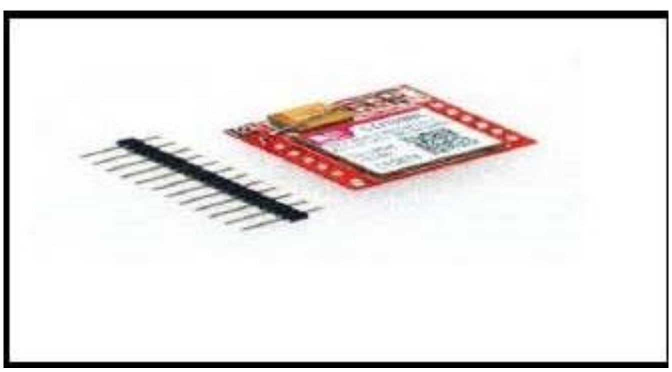

figure 6: sim 800 module

3.2.6.1: SMS SPECIFICATIONS

The SMS specifications for SIM 800 are:

- Point to point MO and MT
- SMS cell broadcast
- Text and PDU mode

3.3: SOFTWARE IMPLEMENTED

3.3.1: ARDUINO SOFTWARE

The software used in this project is the ARDUINO software. Arduino IDE software is written in Java programming language and operates on Windows, macOS and Linux. It supports C and C++ languages and is the platform for writing and editing program codes which are interpreted to HEX files which the Arduino hardware supports [19]. Sketch is the program code written on the Arduino IDE and are stored as text files on the computer memory with extension ino. The two required functions of the programs are:
setup() and **loop()**.
setup(): This function is called once at the startup of the device and runs throughout he program. It initializes the variables and I/O pin modes.
loop(): This function allows the program to change, respond and control the Arduino hardware and is executed continuously throughout the program .

3.3.2: PROTEUS PCB DESIGN AND SIMULATION SOFTWARE

Proteus is a design and simulation software used in the circuit design of the system. It was developed by Lab center Electronics for the design of electrical circuits. It provides real time simulation of circuits by allowing human access during run time. Its features are:

- It has a wide range of components in its library
- It has sources, signal generators and analysis tools.
- It probes for real time monitoring of the parameters of the circuit

3.4: SYSTEM DESIGN

The system is built on the Arduino nano board with in-built microcontroller. The sensors are interfaced on the pins of the microcontroller. The LCD screen is connected to the microcontroller to receive data and display it in real time. SIM 800 module is placed on the board to allow wireless transmission via SMS to the mobile phone.

3.5: HARDWARE CONNECTIONS

3.5.1: ARDUINO UNO

The Arduino Uno is the main processor of the system. It stores data received from sensors and converts it to digital signals which are processed before outputting it on the LCD screen. The Arduino software program lies embedded within the processor

and the program code written is synced to the microcontroller to perform the main function of the system. The GSM module which is responsible for wireless connectivity of the user to the system, is connected to the microcontroller where the phone numbers are configured in the program code to receive text messages about the weather parameters. The microcontroller processes SMS before sending it to the mobile user.

3.5.2: TEMPERATURE SENSOR

The DSB1820 sensor calculates the current temperature of a given body or environment and acquires digital measurements which is transmitted to the Uno microcontroller. The connections between the sensor and the microcontroller are given as follows:

- The DATA pin is connected to the resistor and the digital pin 4 of the Arduino
- The GND wire connects to the ground of the circuit
- The VCC pin is connected to the 5 Volts output to power up the sensor

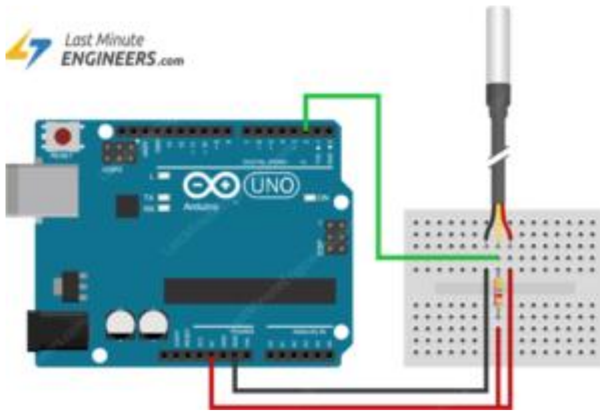

figure 7: ds18b20 pin configuration

3.5.3: HUMIDITY SENSOR

The humidity sensor is responsible for acquiring measurements to determine the humidity of its environment. The DHT11 sensor measures the relative humidity around it and connects to the Uno microcontroller as follows:

- The VCC pin on the sensor connects to the 5 volts output on the Arduino
- The DATA pin connects to the digital pin 8 on the microcontroller
- The GND pin connects to the GND on the Arduino

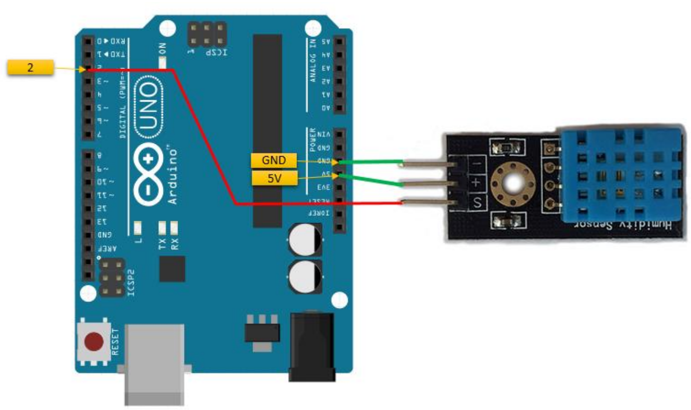

figure 8: dht11 pin configuration

3.5.4: LIGHT INTENSITY SENSOR

The light sensor acquires analog values that determine the current concentration off light or sunlight in its environment. Light dependent resistor measures the exponential values of light concentration making it more variable than that of temperature and humidity measurements. Data is passed to the microcontroller for further processing and conversion to digital data. It connects to the microcontroller as follows:

- The LDR is connected to the VCC 5 volts output and analog pin 0 on the microcontroller
- It is also connected to the resistor and grounded

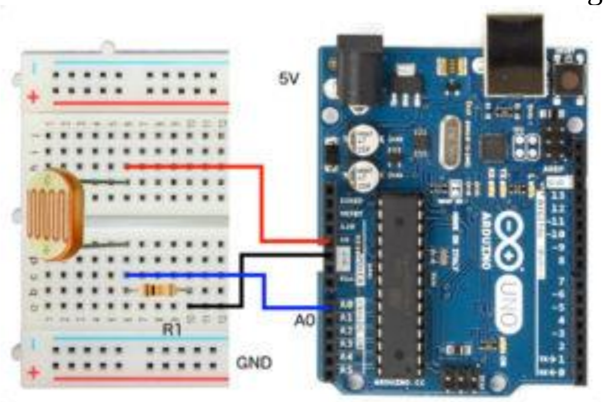

figure 9: ldr pin configuration

3.5.5: LIQUID CRYSTAL DISPLAY

The LCD displays readings for weather values directly viewed from the system. It is connected to the Uno microcontroller as follows:

- The GND wire is connected to the GND pin on the microcontroller
- The Power wire is connected to the 5 volts power pin
- RS wire is connected to digital pin 2
- E wire is connected to digital pin 3
- D4 wire is connected to digital pin 4
- D5 wire is connected to digital pin 5
- D6 wire is connected to digital pin 6
- D7 wire is connected to digital pin 7

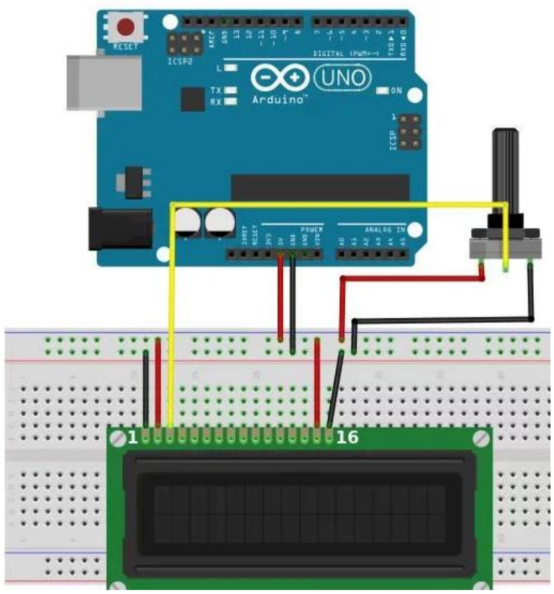

figure 10: lcd pin configuration

3.5.6: GSM MODULE

The GSM module transmits SMS to the mobile user. SIM 800 module is implemented and connected to the microcontroller with the transmit and receive pins wired to 2digital pins on the Arduino processor. It is connected as follows:

- SIM 800 5 volts is connected to the 5 volts pin on Arduino
- GND pin connects to the GND pin on Arduino
- Transmit pin is connected to digital pin 9
- Receive pin is connected to digital pin 10
- VCC pin connected to 5 volts output

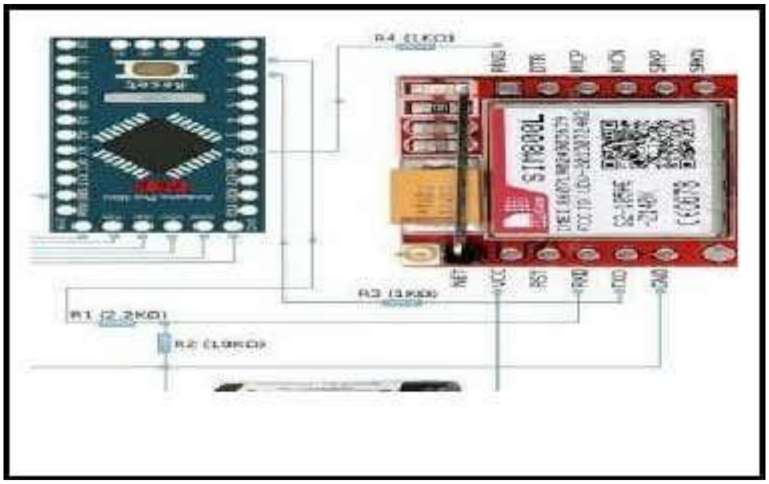

figure 11: sim 800 pin configuration

3.6: ARDUINO SOFTWARE

The main functions implemented in the software are setup() and loop().

The setup()initializes the whole system, while the loop() runs throughout the working period of the system. The loop() function is used after the setup() function has been run.

The program is written on the software and is synchronized with the microcontroller to function.

CHAPER FOUR

RESULTS AND ANALYSIS

4.1: INTRODUCTION

This chapter produces the results of the project's objectives and discusses the hindrances encountered in achieving them and the limitations of the prototype withrespect to the results achieved. The results of different weather conditions aredisplayed on the LCD screen and sent as text messages to the mobile users aredisplayed as screenshots in this chapter.

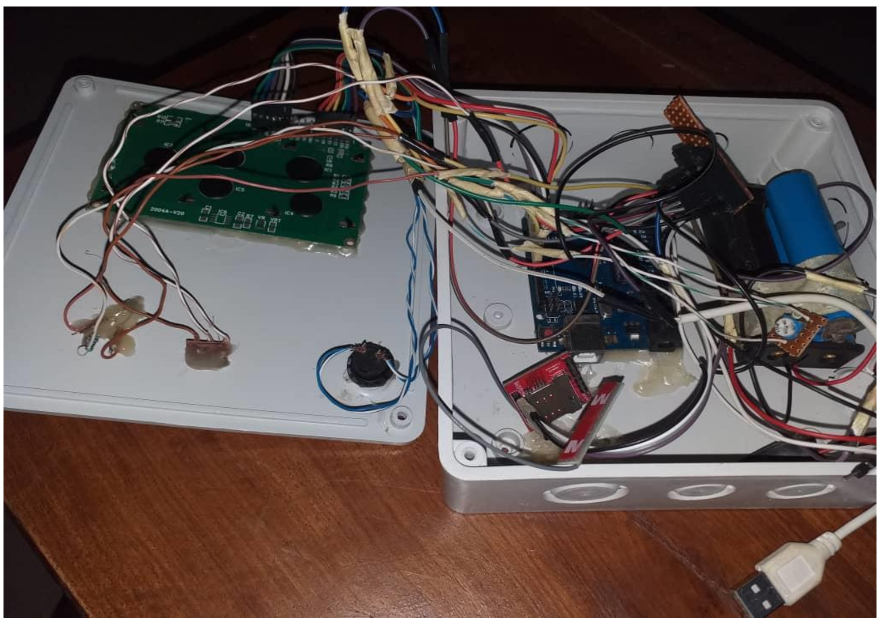

figure 12: developed prototype of weather monitoring system

4.2: BLOCK DIAGRAM OF THE SYSTEM

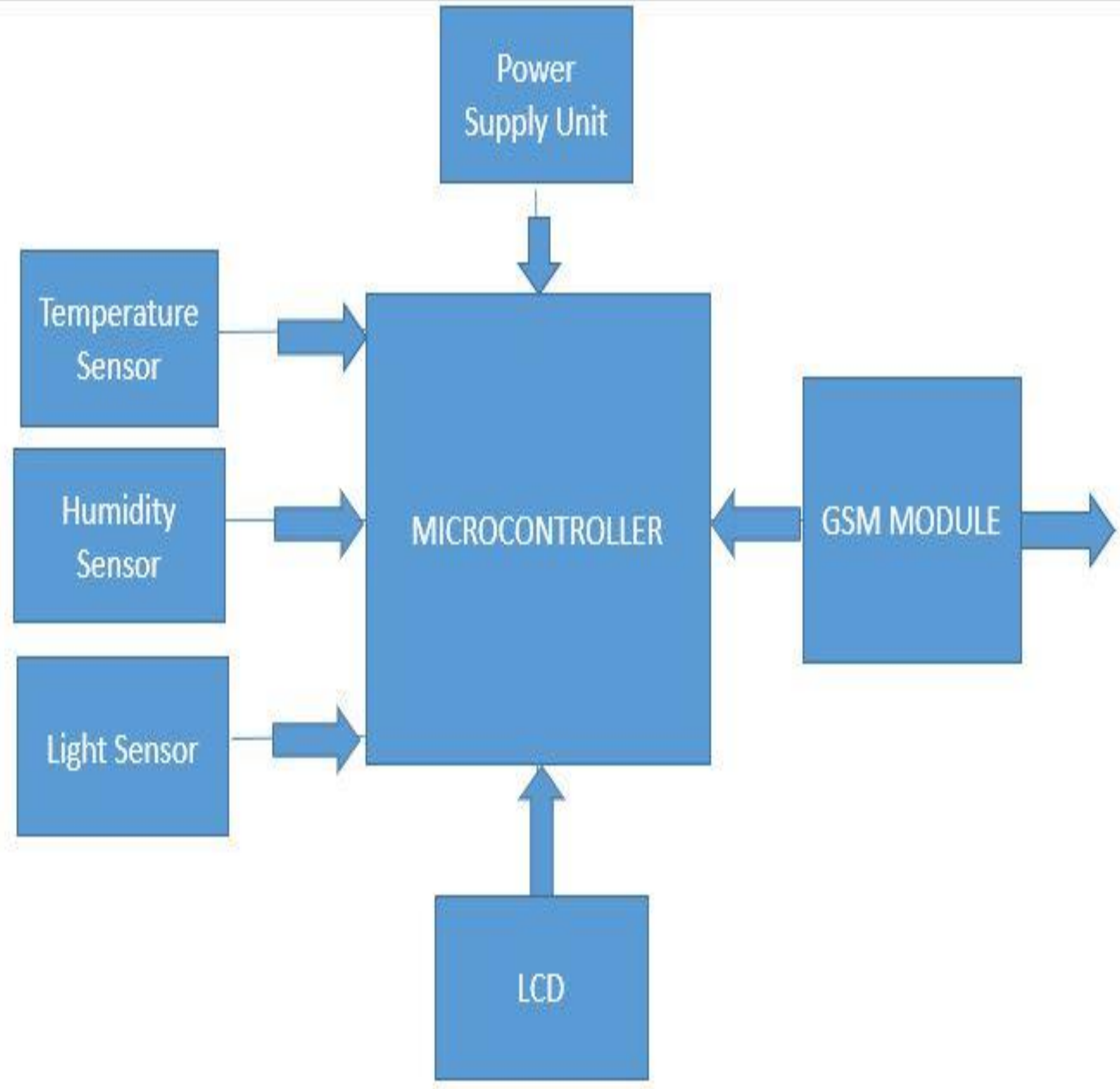

figure 13: system block diagram

4.3: SYSTEM FLOWCHART

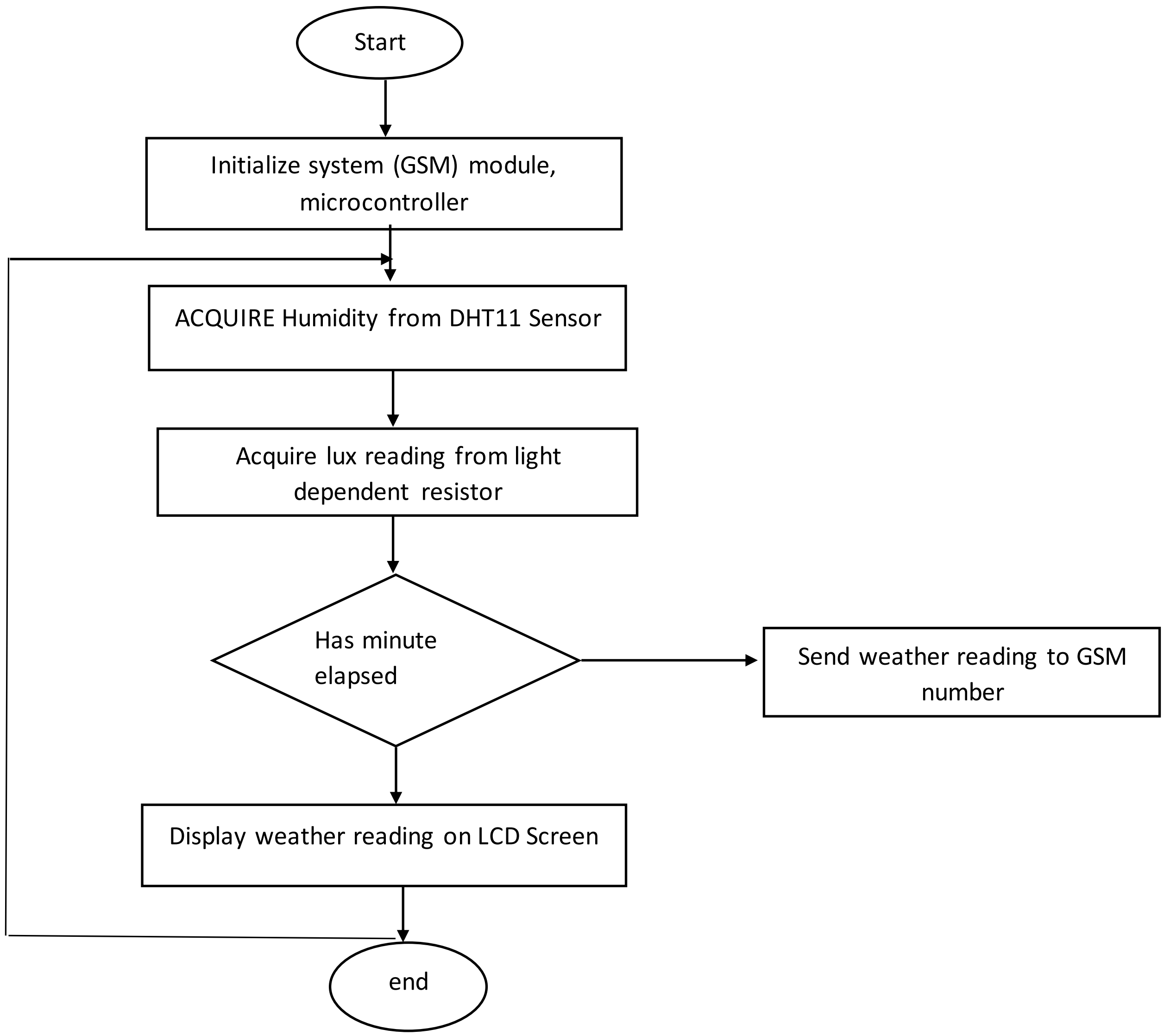

figure 14: system flowchart

4.4: CIRCUIT DIAGRAM

The circuit diagram for the system was created with Proteus software integrating all the components of the system together, with detailed connections showing the wiring of all components to the microcontroller. The diagram of the system is shown below:

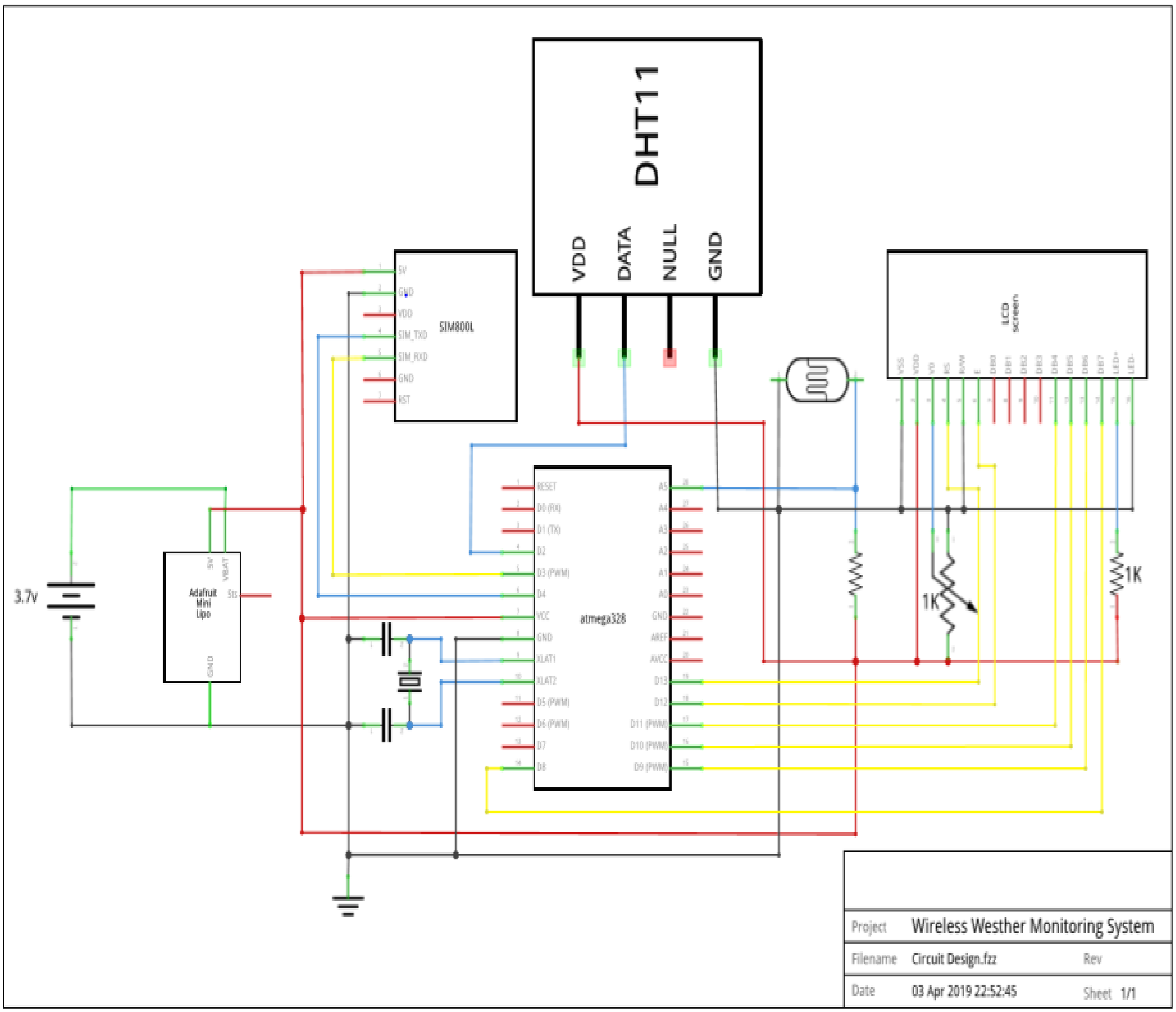

figure 15: circuit diagram of the system

4.5. RESULTS

4.5.1. TEMPERATURE MEASUREMENTS

The results acquired with DHT11 sensor measures in degree Celsius. Throughout the testing period, the values of the measurements taken both indoor and outdoor, were almost constant, varying between 22°C to 29°C. The limit of characters set on the LCD screen allows the results to only be displayed in C, the shorthand version of Celsius with the absence of the degree symbol, and T representing temperature. Results are displayed as T(C) (value) on the LCD screen. The SMS sent to the mobile user displays the result as TEMP= value.

4.5.2. HUMIDITY MEASUREMENTS

The DHT11 sensor is responsible for acquiring the data that displays the result for humidity in percentage. The values, similar to that of the temperature do not often vary in its indoor and outdoor environments. The character limit on the LCD screen is the reason for representing humidity in H character. Results on the LCD screen are displayed as H (%) (Value), and are displayed as HUM= value.

4.5.3. LIGHT INTENSITY MEASUREMENTS

Light constantly varies and is immediately sensed by our eyes. The values therefore, are not constant. They are exponential values that vary greatly in few seconds. The LDR measures the light depending on the focus of light on the sensor. The results are affected by any source of light and not just sunlight. A focus of light sourced from a flashlight or the sun, sets the result to display as infinity on the LCD screen. The values increase in the outdoor environment when there are clear skies during the day, and decreases when the skies are cloudy. In the indoor environment, the values increase when there is a source of light reflecting and decreases when the light decreases or in the absence of light. The amount of light is measured in lux and is displayed on the LCD screen as L(LUX) (Value), with the L character representing Light. The mobile users receive the measurements displayed as LIGHT= value.

4.6. OVERALL MEASUREMENTS

figure 16: results of weather parameters displayed on lcd screen

The message containing the result of weather parameters is sent after a duration of 5 minutes to the user’s mobile. This time period is greatly dependent on the service provider’s network and could take longer than the intended duration.

WEATHER RESULTS ON HOURLY BASIS			
TIME	TEMPERATURE (°C)	HUMIDITY (%)	LIGHT (LUX)
0:00	24.3	82	0.755
1:00	24.3	88	0.821
2:00	24.3	88	0.00
3:00	24.3	90	0.00
4:00	24.3	94	0.00
5:00	24.3	94	0.00
6:00	24.3	94	0.00
7:00	24.3	93	252.74
8:00	25.1	89	1278.5
9:00	25.4	74	593.2
10:00	26.6	69	1196.8
11:00	27.2	63	387.4
12:00	29.6	58	1843.2
13:00	29.6	58	1459.1
14:00	29.6	58	1295.7

15:00	29.6	65	1158.9
16:00	28.5	75	874.6
17:00	27.8	78	294.5
18:00	29.6	75	103
19:00	29.6	78	110.5
20:00	27.8	80	0.755
21:00	26.5	80	0.024
22:00	25.9	81	0.00
23:00	24.2	81	0.00

table 1: overall weather measurement on a 24-hour basis

THERMOMETER	DHT11 SENSOR	DIFFERENCE
28.7	28.5	0.2
29.2	29.6	-0.4
29.9	29.6	0.3
29.9	29.5	0.4
29.5	29.1	0.4
30.1	29.3	0.8
29.4	28.9	0.5
29.8	29.6	0.2
30.5	29.6	0.9
30.7	29.6	1.1

table 2: comparing temperature sensor results with thermometer results

4.7. ANALYSIS

The results obtained from this project were not compared with the results obtained from standard weather measuring equipment because of the scarcity and unavailability of the equipment with the exception of the thermometer used for measuring the temperature. Therefore, the experiments carried out are focused basically on theoretical rather than practical applications. This implies that the accuracy of the results obtained are not certain since they were not compared with other measuring equipment and that the system is not free from errors and imperfection because of electromagnetic interference or noise disrupting the acquirement of data. The wireless technology aspect is also not flawless, as messages may get delayed before being received.

4.8. LIMITATIONS

The project was not practically experimented by comparing results with that obtained from standard weather measuring equipment. The prototype requires a source of power supply that makes it portable. It implements DC batteries which die out quickly because of the high-power consumption of the GSM module and the LCD screen, this makes it impossible to run a 24-hour test of the prototype using these batteries.

Measurements are taken every hour on the clock. It is also unable to take weather measurements for weather conditions that are highly essential for agricultural purposes and regular planning for social activities like rainfall, wind and pressure. The designed prototype has its sensors unprotected from external damage like dirt, water, or a fall.

Measurements cannot be stored online on the internet for archiving data. The results obtained can only be seen on the LCD screen and the user's mobile phone since provisions were not implemented for the prototype to be connected to a PC via a USB cable. There is also the issue of taking into consideration the bills imposed by the service provider for the regular transmission of SMS to the receiver. Communication between the prototype and the mobile user is in a simplex form, preventing the user from disallowing the system to flood the mobile with series of text message.

The system is also unable to send an alarm or a triggered update in the event of a weather condition exceeding a given threshold; messages are only sent after a given period has elapsed. The results obtained also depend on the position of sensors on the prototype and the location of the system.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. CONCLUSIONS

The weather station system based on GSM was constructed and tested practically as shown in the fourth chapter. The system is able to sense the weather parameters; temperature, humidity, and light which is sent as an SMS of the current weather conditions to mobile users at a given period of time. It can be applied in science laboratories, industries and agriculture to monitor weather parameters by providing an accurate analysis of the weather in a cost-effective manner. It also proves to be more useful in a smaller area for effective weather analysis and accurate results. The project is simply a prototype of the intended system. In the actual practical implementation of the weather monitoring system, an uninterrupted power supply from a solar panel is required.

The prototype was designed to be flexible to accommodate multiple sensors to detect different weather conditions. It was also designed to be cost effective by choosing the GSM technology as the cheapest form of wireless technology to support remote access to the system. The prototype was built with three sensors for temperature, humidity and light intensity connected to the microcontroller and was able to produce results of the weather conditions. The objectives for the project were met and the results were found to be reliable

5.2. RECOMMENDATIONS

- The system can be designed to include an alarm that goes off when weather parameters, e.g. temperature, rises or falls to a certain threshold to alert the user, or, send a message as a triggered update without waiting for the default time period to elapse.
- The LCD screen implemented should be bigger to contain measurements of weather parameters and display them simultaneously.
- The system should have an uninterrupted power supply to prevent from having to change batteries frequently.
- The system can be further improved to predict weather useful for disaster management.
- Addition of more sensors e.g. rain sensors, to predict more weather conditions.

Designing the system to allow duplex communication between the user and the system. Mobile users can request for weather parameters without having to wait for a time period to elapse. This reduces the cost of SMS sent at short interval.

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APPENDICES

APPENDIX A: BILL OF ENGINEERING MEASUREMENT AND EVALUATION (BEME)

Item	Description	Quantity	Unit price (Rwf)	Amount (Rwf)
Micro Controller	ATMEGA 328P	1	1000	10000
GSM Module	SIM800L	1	22000	22000
Temperature and Humidity Sensor	DHT11 And DSB1820	1	12000	12000
Light Intensity Sensor	LDR	1	500	500
Board	Breadboard	1	7400	7400
	Vero Board	1	200	1000
Jumper Wires	M - M	40		3000
	F - M			4000
Display	20*4	1	8000	8000
Packaging	Terminal Box	1	1500	1500
Power Supply	2,500mAh Battery	1	2500	2500
Total				71900

APPENDIX B: SOURCE CODE FOR THE ARDUINO

```
#include <SimpleDHT.h>
#include <Adafruit_Sensor.h>
#include <Wire.h>
#include <SoftwareSerial.h>
#include <LiquidCrystal.h>
```

```
#include <LiquidCrystal_I2C.h>

int pinDHT11 = 4;
SimpleDHT11 dht;

float hum;
float temp;
int light;
SoftwareSerial sim800l(2, 3); // A6 Tx & Rx is connected to Arduino #2 & #3

int ldr = A0; // LDR analog PIN
LiquidCrystal_I2C lcd(0x27,16,2);
const int rs = 13, en = 12, d4 = 11, d5 = 10, d6 = 9, d7 = 8;
LiquidCrystal Display(rs, en, d4, d5, d6, d7);
char incomingChar;
void setup() {

lcd.init(); // initialize the lcd
lcd.init();
Display.begin(16, 2);

Serial.begin(9600);
pinMode(ldr, INPUT);

lcd.backlight();

lcd.setCursor(1,1);
lcd.print("ULK Polytechnic");
delay(5000);
lcd.clear();

lcd.setCursor(1,1);
lcd.print("Weather Station");
delay(5000);
lcd.clear();

lcd.setCursor(1,1);
lcd.print("Presented by:");
```

```
delay(3000);
lcd.clear();

lcd.setCursor(1,1);
lcd.print("AMPA BAHATI");
delay(5000);
lcd.clear();

sim800l.begin(9600);   // Setting the baud rate of GSM Module
Serial.begin(9600);    // Setting the baud rate of Serial Monitor (Arduino)
delay(100);
sim800l.println("AT");
delay(1000);
sim800l.println("AT+CFUN=?");
delay(5000);
//sim800l.println("AT+CFUN?");
//delay(5000);
sim800l.println("AT+CFUN=1");
delay(5000);

}
void loop() {

byte temperature = 0;
byte humidity = 0;
int err = SimpleDHTErrSuccess;


if ((err = dht.read(pinDHT11, &temperature, &humidity, NULL)) !=
SimpleDHTErrSuccess) {
    Serial.print("No reading , err="); Serial.println(err);delay(1000);
    return;
  }

  Serial.print("Readings: ");
  Serial.print((int)temperature); Serial.print(" Celcius, ");
  Serial.print((int)humidity); Serial.println(" %");
```

```
 hum =  (int)humidity; //Read Humidity
 temp = (int)temperature; //read Temperature

lcd.setCursor(0,0);
lcd.print("Hum:");
lcd.setCursor(4,0);
lcd.print(hum);
lcd.setCursor(9,1);
lcd.println("%");
lcd.setCursor(10,0);
lcd.print("L:");
lcd.setCursor(12,0);
lcd.print(light);
lcd.setCursor(0,1);
lcd.print("Temp:");
lcd.setCursor(5,1);
lcd.print(temp);
lcd.setCursor(10,1);
lcd.println("*C");


if(SMSRequest()) {
if(readData()) {
  Serial.begin(9600);
  while(!Serial);

  sim800l.begin(9600);
  delay(500);

  Serial.println("Sending Text...");

  sim800l.write("AT+CMGS=\"0784173187\"\r");
  delay(100);
  String dataMessage =("Temperature:  " + String(temp) + "*C" + "Humidity:  " +
String(hum) +
  "%" + "Light Intensity: " + String(light)+ "Hello, above is Today's Meteo\r");
  sim800l.print(dataMessage); //send the SMS text message
  delay(100);
```

```
  sim800l.write((char)26); //end the AT command with ^Z, ASCII code 26
  delay(200);

  Serial.println("Text Sent");
  delay(5000); //give the module time to send
}
}
delay(10);
}

boolean SMSRequest() {
if(sim800l.available() > 0) {
incomingChar=sim800l.read();
if(incomingChar=='S') {
delay(10);
Serial.print(incomingChar);
incomingChar=sim800l.read();
if(incomingChar=='T') {
delay(10);
Serial.print(incomingChar);
incomingChar=sim800l.read();
if(incomingChar=='A') {
delay(10);
Serial.print(incomingChar);
incomingChar=sim800l.read();
if(incomingChar=='T') {
delay(10);
Serial.print(incomingChar);
incomingChar=sim800l.read();
if(incomingChar=='E') {
delay(10);
Serial.print(incomingChar);
Serial.print("...Request Received \n");
return true;
}
}
}
}
```

```
}
}
return false;
}

boolean readData() {
light = analogRead(ldr);
}
```