DESIGN AND IMPLEMENTATION OF IOT- BASED GREEN AGRICULTURAL ENVIRONMENT MONITORING SYSTEM

by

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A project
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CERTIFICATE OF APPROVAL

The project entitled as "**Design and Implementation of IoT-based Green Agricultural Environment Monitoring System**" submitted by **Mohammad Jalal**, bearing Matric ID. **ET171033** and **Mohammad Jamsedul Islam**, bearing Matric ID. **ET171045** of session **Spring 2021**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **16th April 2022**.

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this project has been submitted elsewhere for the award of any degree or diploma.

Mohammad Jalal

Mohammad Jamsedul Islam

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Authors

ABSTRACT

In the field of agriculture farmers are mostly depend on weather condition for their cultivating crops. The IoT-based Environmental Weather Monitoring System project is used to get live reporting of weather conditions. The Internet of Things, has the largest influence in agriculture. Green networks in the Internet of Things helps to reduce emissions and pollutions, while also maximizing environmental conservation and surveillance and lowering operating costs and power usage. In this project, we present a low cost system for real-time monitoring of the environment. The system consists of several sensors is used for measuring environmental parameters. The parameters such as temperature, humidity, soil moisture, air quality, pH of the soil and rain level has been measured. The measured values from the sensors has been processed by the core controller. The Arduino Nano has been used as a core controller. To reduce the wastage of electrical cost we use solar system. This project will save our time by providing environmental parameters data in a single website with two weeks prediction value of weather using machine learning algorithm. Good result has been obtained by cultivating the crop at the specified time. Finally, the sensor data is viewed on website and LCD also displays the output correspondingly. Over all it's exceptional advantage people easily influenced to use the system, and it will be asset in field of agriculture for every country.

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LIST OF ABBREVIATIONS

IoT	Internet of Things
KNN	K-Nearest Neighbors
DHT	Digital Humidity and Temperature
IDE	Integrated Development Environment
EEPROM	Electrically Erasable Programmable Read Only Memory
GSM	Global System for Mobile Communications
SRAM	Static Random-Access Memory
ICSP	In-Circuit Serial Programming Header
USB	Universal Serial Bus
SPI	Serial Peripheral Interface
IP	Internet Protocol
PWM	Pulse Width Modulation
PCBs	Printed Circuit Boards
USART	Universal Synchronous Asynchronous Receiver Transmitter
GPIO	General Purpose Input Output
HDD	Hard Disk Drive

CHAPTER 1
INTRODUCTION

1.1 Introduction

Smart Agriculture is a concept in which information and communication technology is implemented to manage all the activities and processes related to the agriculture domain. Internet of things has the capability to influence many of the areas of the world we live in such as advanced industries, smart cities and novel technologies in connected vehicles. IoT is new computing and communication paradigm in which the objects of everyday life have equipped with sensor, microcontroller and transceiver to sense the surrounding environmental parameters. The IoT technology has realized the smart wearable's, connected devices, automated machines, and driverless cars. However, in agriculture the IoT has brought the greatest impact[1].

In 2020, the market share for IoT in agriculture reached $5.6 billion. The global smart agriculture market is expected to reach $15.3 billion by the end of 2025 compared to $5 billion in the year 2016. IoT technologies and devices will sense, collect, store and communicate data to various components in an application such as smart agriculture. Smart agriculture will become an important IoT application area in agri-products exporting countries. Recently, IOT application has been deployed for smart agriculture using wireless sensor networks (WSNs). The applications of IoT in the agriculture industry has helped the farmers to monitor the environmental parameters in real-time which makes the irrigation process more efficient. Internet of Things in Agriculture has come up as a second wave of green revolution[2]. The benefits that the farmers are getting by adapting IoT are twofold. It has helped farmers to decrease their costs and increase yields at the same time by improving farmer's decision making with accurate data. It is necessary to collect weather data to know weather condition for farmers in their agricultural field, the designed solution described in this paper illustrates an IoT-based agricultural environment monitoring system built to perform crop fields monitoring based on multiple sensors(for temperature, humidity, air quality, soil moisture, pH and rain level detect) and to improve the irrigation system. We used Arduino Nano as a core controller and convert battery power into solar power to reduce electrical cost. Collected data from sensors through arduino nano will display in a website and also show in LCD display. We were also able to forecast the weather two weeks by using machine learning algorithm[3].

1.2 Background

The IoT technology is a revolutionary computing and communication paradigm in which everyday things are equipped with sensors, microcontrollers, and transceivers to sense environmental factors. Smart wearable, networked gadgets, automated machinery, and autonomous automobiles have all been made possible by IoT technology. The Internet of Things, on the other hand, has had the largest influence in agriculture. Green networks in the Internet of Things will help to reduce emissions and pollutions, while also maximizing environmental conservation and surveillance and lowering operating costs and power usage[4]. It has allowed farmers reduce costs while enhancing yields by providing reliable data to assist them in choosing better decisions. It is necessary to collect weather data to know weather condition for farmers in their agricultural field, The developed solution discussed in this work is a Green IoT-based agricultural environment monitoring system created to perform crop field monitoring and irrigation system improvement using several sensors (for temperature, humidity, air quality, soil moisture, pH, and rain level detection). We used Arduino Nano as a core controller and convert battery power into solar power to reduce electrical cost. Collected data from sensors through Arduino Nano will display in a website and also show in LCD display. We were also able to forecast the weather two weeks by using KNN algorithm[5].

1.3 Motivation

Like many other developed and developing countries of the world, most of the people of Bangladesh are engaged in agriculture. Besides, people of other professions and also their hobbies cultivate various types of green vegetables garden. And nowadays the gardens that have been worked hard for various kinds of busyness and carelessness are ruined and damaged. But in that case, this project helps the all farmers and peoples who make gardening to measure various essential parameters for farming environment and also monitoring the environment for present and next 14 days. It is necessary to design a system that can incorporate the most up-to-date information on environmental parameters in any given location at any given moment, as this is the most efficient and advanced option for agriculture.

1.4 Project Objectives:

The objectives of the designed system are expected to accomplish to build a system where environmental parameters for agriculture of any place's in a specific website.

System are pointed bellow:

- To develop an integrated IoT based agricultural environment monitoring system.
- To design a system that can check weather live update and forecast next one week weather parameter.
- To integrate green energy in proposed system.
- To produce green energy with solar and whole system works on it.

1.5 Overview

Our approach will benefit individuals of all farmers and garden loving people, It will monitor the environment weather status and detect the necessary parameters for farming. It represent data on LCD display for taking necessary steps based on weather condition, also upload result is visible on the web server and on a mobile device. As a result, we created a website and storage data for further instructions. Our objective was to create a system that was high in accuracy yet low in cost, so that every farmer and garden loving people could use and afford it.

1.6 Report Outline

The design and development of this project are covered in six chapters. The following are the chapters and their contents:

- **Chapter 1** presents the description, inspiration and goal of the project.
- **Chapter 2** discusses previous works related to our projects and their contribution in our project.
- **Chapter 3** discusses about the hardware those we have used to build our project.
- **Chapter 4** is the methodology of the project. It includes design of the project,block diagram and flowchart.
- **Chapter 5** shows the result we got after implementing our project.
- **Chapter 6** discusses about the projects application, advantages, limitations as well as the future development for practical use.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The Internet of Things (IoT) has been envisaged to describe a number of technologies and research disciplines that enable global connectivity over the worldwide physical objects. Enabling technologies like Radio-Frequency Identification sensor networks biometrics and nanotechnologies are now becoming very common, bringing the IoT into real implementations addressing varying applications, including smart grid, e-health and intelligent transportation. They foreshadow an exciting future that closely interconnects our physical world via green networks[6]. Green networks in IoT will contribute to reducing emissions and pollutions, exploiting environmental conservation and surveillance, and minimizing operational costs and power consumption. Green IoT for agriculture represents the issue of reducing energy consumption of IoT devices which achieves a sustainable environment for IoT systems. In the field of agriculture, most processes are carried out in rural areas with little access to technology and depend on what is called family farming that produces 70% of food worldwide, being an influential economy, but that due globalization has made it difficult to be competitive and have the control that allows them to plan in the long term; which creates the need to generate benefits for farmers and lead them to modernization. Internet of things (IoT) is known as the connection of technological or electronic objects that connect to the internet.

2.2 Review of previous works

There were many related works to our project which had been done by some scholars in the recent year. Some of them are discussed below;

2.2.1 IoT based Smart Soil Monitoring System for Agricultural Production.

In this paper [7] proposed a Smart soil monitoring system based on the IoT for Agricultural production. Several sensors, such as a pH sensor, a temperature sensor, and a humidity sensor, are used to test the soil. The sensor results are relayed to the field manager via the Wi-Fi network, and the harvest recommendation is developed using the mobile app.

2.2.2 Agricultural Field Monitoring using IoT.

In this paper [8] developed an ARDUINO-based smart agricultural system with the goal of improving productivity via the use of automation and the Internet of Things. This allows for irrigation decision assistance, monitoring, and selection. The use of cloud computing technology to implement will improve the fields' water use and specific features that focus on the field's security procedures. For a greater yield, the ideal temperature range is also narrowed.

2.2.3 An Internet of Things-based Economical Agricultural Integrated System for Farmers.

In this paper [9] proposed an IoT based agricultural operations depending on an IoT platform, sensors, power supply, communication technology, data storage and processing and information alert/control methodologies in this work. This research also proposes the development of an Integrated System, S-AGRO, using IoT technology that can remotely monitor agricultural functions and make smart decisions to enhance agricultural productivity, in order to review the application of IoT in several agricultural activities.

2.2.4 Design and Development of E-Sense: IoT based Environment Monitoring System.

In this paper [10] suggested the concept and development of E-Sense, an IoT-based ambience monitoring system. Temperature, humidity, air quality index, CO concentrations, rainfall, and light are only a few of the significant environmental characteristics measured by E-Sense. The ESP8266 Wi-Fi module is used to transmit the data obtained from the sensors to Thing-Speak. Thing-Speak assists in data analysis and presentation in graphical and tabular formats. A heat map of the monitored area is also provided by E-Sense.

2.2.5 IOT based air pollution monitoring system using arduino.

In this paper [11] proposed a system to monitor air pollution. Their method utilizes air quality sensors to discover the existence of venom gases in the atmosphere and transmits this information on a continuous basis. This allows authorities to keep track of and prevent pollution in diverse locations.

2.2.6 IoT Based Weather Monitoring System.

In this paper [12] proposed a system to monitor weather particles. Temperature, dampness, squeeze, Light Intensity, Sound Intensity Levels, and CO Levels in the atmosphere are all analyzed by embedded devices in order to make the environment interactive with items via wireless connection.

2.2.7 An IoT Based Air Pollution Monitoring System for Smart Cities.

In this paper [13] they designed and constructed an Internet of Things-based Air Monitoring System for Smart urban. Air quality information is retrieved in real time via smart devices and analyzed to determine the impact on city people. Temperature, Humidity, Carbon Monoxide, LPG, and Smoke in the atmosphere can all be measured by the smart gadgets. An Android application makes the obtained data available to everyone in the world.

2.2.8 Internet-of-Things Based Smart Temperature Monitoring System.

In this paper [14] developed an innovative technique for monitoring weather conditions at a specific location and making the information viewable everywhere in the world in this paper. The technicality beneath this is Internet of Things (IOT), which is an advanced and proficient solution for connecting the things to the internet and to connect the entire world of things in a network.

2.2.9 Internet of Things (IOT) based Weather Monitoring System.

In this paper [16] the system monitor three environmental parameters and they are temperature, humidity and CO level in air. After monitoring, data will be sent to web page which can be accessed anywhere in the world through internet.

2.2.10 Arduino-Based Real Time Air Quality and Pollution Monitoring System.

In this paper [15] an Arduino based air pollution detector has been developed to detect level of harmful gas in air using Arduino Uno and show them in computer software where it became documented and plotted in real time.

CHAPTER 3
HARDWARE DESCRIPTION

3.1 Introduction

In a project, the hardware is an important thing. It is very difficult to choose the necessary hardware. This chapter contains the description of the instruments which are used in our project. We are going to discuss the functions of the chosen parts. At the end of this chapter, one can understand the reason behind the choosing of used components and their functions in this project.

3.2 List of Components

3.2.1 List of Hardware Components

- Solar Cell
- Battery
- DHT11 (Humidity and Temperature Sensor)
- Rain Sensor
- MQ-135
- Moisture Sensor
- Ardunio Nano
- Wi-Fi module (ESP 8266)
- Regulator IC7805
- LCD Display (20*4)
- pH Sensor
- SN74595(Serial to Binary ,Binary to Serial Converter)
- Vero Board
- Resistor
- Variable Resistor
- Heat Sink
- Electrolytic Capacitor

3.2.1.1 Solar Cell

Solar energy begins with the sun. Solar panels (also known as "PV panels") are used to convert light from the sun, which is composed of particles of energy called "photons", into electricity that can be used to power electrical loads.

Solar panels can be used for a wide variety of applications including remote power systems for cabins, telecommunications equipment, remote sensing, and of course for the production of electricity by residential and commercial solar electric systems.

The **Fig. 3.2.1** shows that the solar cell.

Fig. 3.2.1: Solar cell [17]

3.2.1.2 DHT11 (Humidity and Temperature Sensor)

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It’s fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor reading can be up to 2 seconds old**.** The **Fig. 3.2.2** shows that the humidity and temperature sensor.

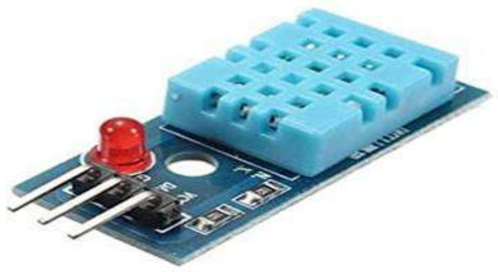


Fig. 3.2.2: DHT11 [18]

TECHNICAL DETAILS

Low cost

3 to 5V power and I/O

2.5mA max current use during conversion (while requesting data)

Good for 20-80% humidity readings with 5% accuracy

Good for 0-50°C temperature readings ±2°C accuracy

No more than 1 Hz sampling rate (once every second)

Body size 15.5mm x 12mm x 5.5mm

4 pins with 0.1" spacing

3.2.1.3 Rain Sensor

A rain sensor is one kind of switching device which is used to detect the rainfall. It works like a switch and the working principle of this sensor is, whenever there is rain, the switch will be normally closed. The **Fig. 3.2.3** shows that the rain sensor.

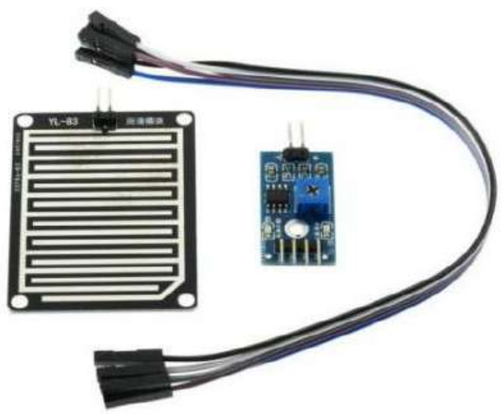


Fig. 3.2.3: Rain Sensor [19]

- This sensor module uses good quality of double-sided material.
- Anti-conductivity & oxidation with long time use
- The area of this sensor includes 5cm x 4cm and can be built with a nickel plate on the side
- The sensitivity can be adjusted by a potentiometer
- The required voltage is 5V
- The size of the small PCB is 3.2cm x 1.4cm
- For easy installation, it uses bolt holes
- It uses an LM393 comparator with wide voltage
- The output of the comparator is a clean waveform and driving capacity is above 15mA

APPLICATION

The applications of rain sensor include the following.

- This sensor is used as a water preservation device and this is connected to the irrigation system to shut down the system in the event of rainfall.
- This sensor is used to guard the internal parts of an automobile against the rainfall as well as to support the regular windscreen wiper's mode.
- This sensor is used in specialized satellite communications aerials for activating a rain blower over the opening of the aerial feed, to get rid of water droplets from the Mylar wrap to keep pressurized as well as dry air within the waveguides.

Thus, this is all about the rain sensor. From the above information finally, we can conclude that this sensor is used to detect the rain and generate buzzer sound to take necessary action in further.

3.2.1.4 MQ-135

The air quality sensor is also an MQ-135 sensor for detecting venomous gases that are present in the air in homes and offices. The gas sensor layer of the sensor unit is made up of tin dioxide (SnO_2); it has lower conductivity compare to clean hair and due to air pollution the conductivity is increased. The air quality sensor detects ammonia, nitrogen oxide, smoke, CO_2, and other harmful gases. The air quality sensor has a small potentiometer that permits the adjustment of the load resistance of the sensor circuit. The 5V power supply is used for air quality sensor. The **Fig. 3.2.4** shows that the MQ-135 sensor.

Fig. 3.2.4: MQ-135 [20]

The MQ-135 is one of the popular gas sensors from the MQ series of sensors that are commonly used in air quality control equipment. It operates from 2.5V to 5.0V and can provide both digital and analog output. It has two outputs: analog output and TTL output. The TTL output is low signal light which can be accessed through the IO ports on the Microcontroller. The analog output is a concentration, i.e. increasing voltage is directly proportional to increasing concentration. This sensor has a long life and reliable stability as well. The **Fig.3.2.5** shows that the pin description of MQ-135.

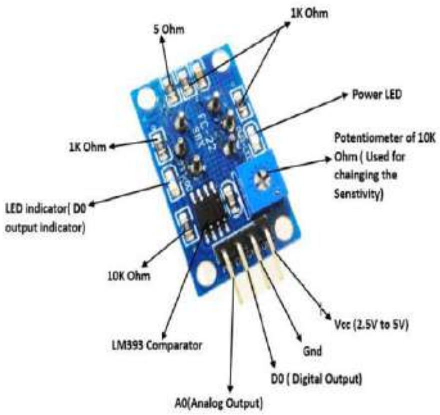


Fig. 3.2.5: MQ-135(Pin Description) [21]

Note that all MQ sensors have to be powered up for a pre-heat duration for the sensor to warm up before it can start working. This pre-heat time is normally between 30 seconds to a couple of minutes. When you power up the module the power LED will turn on, leave the module in this state till the pre-heat duration is completed.

Applications Of MQ-135 Gas Sensor

The following are the applications of the MQ-135 gas sensor:

- Detection of harmful gases
- Domestic air pollution detection
- Industrial pollution detection
- Portable air pollution detection
- Good sensitivity to harmful gases in a wide range.
- Possesses high sensitivity to ammonia, benzene, sulfide gases.

3.2.1.5 Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing In hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks. The **Fig. 3.2.6** shows that the soil moisture sensor.

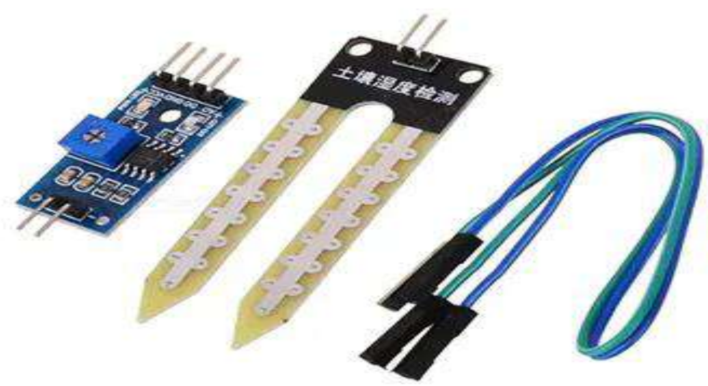


Fig. 3.2.6: Soil Moisture Sensor [22]

3.2.1.6 Arduino Nano

A tiny, compatible, adaptable, and breadboard-friendly Microcontroller board designed by Arduino.cc in Italy is based on the ATmega328p (Arduino Nano V3.x) / Atmega168 (Arduino Nano V3.x). The Arduino Nano is essentially the same as the Arduino UNO, but smaller showed in **Fig. 3.2.7.** It operates at 5V but can be supplied between 7 and 12V. The Arduino Nano has 14 digital pins, 8 analog pins, 2 reset pins, and 6 power pins. The most significant function of these Digital and Analog Pins is to be set as an input or output. When used to interface with sensors, they are input pins, but when driving a load, they are output pins. There are functions like pin Mode () and digital Write (), whereas analog Read is used for analog pins (). 10-bit analog inputs measure values from 0 to 5V. An Arduino Nano has a 16 MHz crystal oscillator. It is used to construct a precise clock by using a constant voltage source. This has a small limitation in that you cannot utilize a battery as an external power source while using the Arduino Nano. This board has no connectivity to a computer except via a Mini USB port. This tiny device's breadboard-friendly properties make it a good choice for applications where compact electrical components are important. The flash memory size varies based on the Atmega board. 16KB of flash memory, as opposed to 32KB on the Atmega328. To store code, flash memory is used. The flash memory occupied by the bootloader is 2 KB. 1KB of SRAM is available on the Atmega168/328; EEPROM is 512 bytes. This board is much smaller than other Arduino boards, thus it stands out. The Arduino IDE is a cross-platform Integrated Development Environment (IDE). The board can operate without prior agreements. All we need is a board, a USB cable, and a computer with Arduino IDE software. The application is transferred using a USB cord. Because of the built-in boot loader, no additional burner is required.

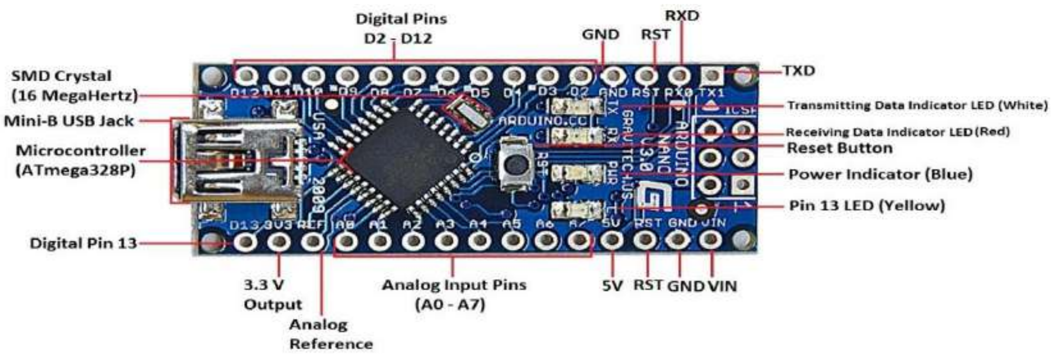


Fig. 3.2.7: Arduino Nano [23]

Nano allows us to connect to other controllers and PCs via Bluetooth. In digital pins like 0 (Rx) and 1 (Tx), Rx is used to receive data and Tx is used to transmit data. The serial monitor is a feature of the Arduino program. FTDI drivers also operate as a virtual COM port. Every time data is transferred over USB, an LED on the Tx and Rx pins blinks. Arduino Software Serial Library is used to connect the board to the computer through serial communication. Additionally, Nano offers serial, I2C, and SPI communication. The Arduino Software's Wire Library is required to use the I2C bus. The Arduino Nano is programmed using the Arduino IDE, which is a universal application that can be used to program practically any kind of board. Download the software and choose your board from the drop-down menu. Build and burn the program into the controller using the boot-loader included in the software, or use the ICSP protocol (In-circuit serial programming header).The recommended operating system is Windows.

The **Table 3.1** represents the specifications of Arduino Nano. This describes the main specifications of the Arduino Nano.

Table 3.1 Arduino Nano Specifications[25]

Microcontroller	Atmega328p/Atmega168
Operating Voltage	5V DC
Digital I/O Pins	14
Input Voltage	7-12 V DC
Flash Memory	16KB or 32KB
USB	Mini
Max. Current Rating	40mA
PWM	6 out of 14 digits pin
Analog pins	8
Crystal Oscillator	16MHz
SRAM	1KB or 2KB
USART	Yes
EEPROM	512bytes or 1KB

The **Fig. 3.2.8** shows that the pinout of Arduino Nano.

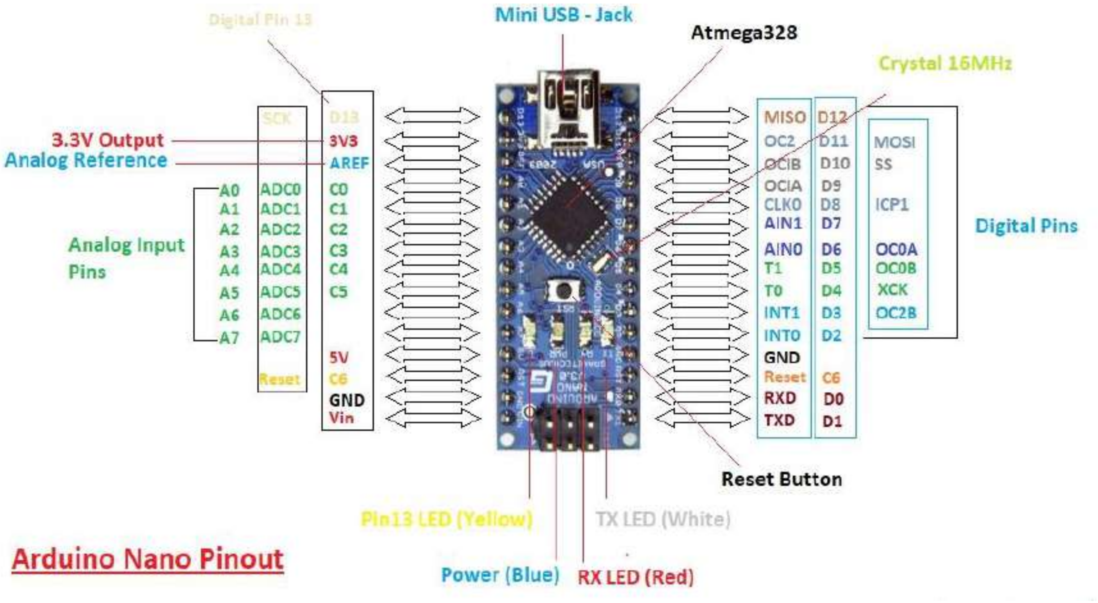


Fig. 3.2.8: Arduino Nano Pinout [24]

The **Table 3.2** shows the pin description of Arduino Nano.

Table 3.2 Arduino Nano Pin Description[26]

Pin	Name	Type	Function
30	VIN	Power	Supply voltage
29	GND	Power	Supply Ground
28	RESET	Input	Reset (Active Low)
27	+5V	Output or Input	+5V Output (From On-board Regulator) +5V (Input from External Power Supply)
19-26	A0-A7	Input	Analog input (0-7)
18	AREF	I/O	ADC reference
17	3V3	I/O	+3.3V Output (from FTDI)
5-16	D2-D13	I/O	Digital I/O pin
4	GND	Power	Supply Ground
3	RESET	Input	Reset (Active Low)
2	D0/RX	I/O	Digital I/O pin Serial RX pin
1	D1/Tx	I/O	Digital I/O pin Serial TX pin

3.2.1.7 Wi-Fi Module (ESP8266)

It is possible to host the ESP8266's Wi-Fi networking operations on an application processor or offload them. If the ESP8266 is the sole processor in the device, it may be booted from flash memory. The self-contained ESP8266 Wi-Fi Module, which has an integrated TCP/IP protocol stack, may be used to connect any microcontroller to a Wi-Fi network. Any processing unit other than the ESP8266 may take over control of all Wi-Fi networking capabilities. A Wi-Fi Shield and an ESP8266 module preloaded with the AT command set have almost identical capabilities. One of the most popular low-cost boards with a rapidly expanding ecosystem is the ESP8266. The development and stress on the module may be decreased by utilizing sensors or other application-specific devices with the GPIOs of this module. In order to reduce the amount of external circuitry required, on-chip integration of the front-end module is used.The **Fig. 3.2.9** shows that the ESP8266 Wi-Fi module.

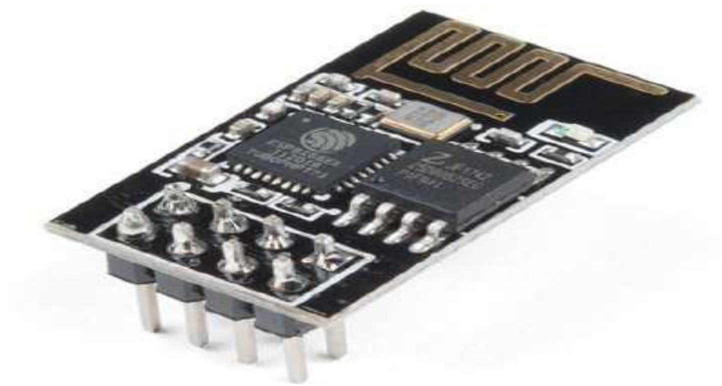


Fig. 3.2.9: Wi-Fi Module (ESP8266) [27]

Wi-Fi Module (ESP8266) Pin Configuration

The ESP-8266 Wi-Fi Module Pin configuration and pin diagram operating method are presented in **Table 3.3** as well as the alternative function of pin configuration.

Table 3.3 Wi-Fi Module (ESP 8266) Pin Configuration[28]

Pin Number	Pin Name	Normally used for	Alternate purpose
1	Ground	Connected to the ground of the circuit.	
2	TX	Connected to Rx pin of programmer to upload program.	Can act as a General-purpose Input/output pin when not used as TX.
3	GPIO-2	General purpose Input/output pin.	
4	CH_EN	Chip Enable – Active high	
5	GPIO-0	General purpose Input/output pin.	Takes module into serial programming when held low during start up
6	Reset	Resets the module.	
7	RX	General purpose Input/output pin.	Can act as a General-purpose Input/output pin when not used as RX [13]
8	VCC	Connect to +3.3V only	

3.2.1.8 Regulator IC7805

Voltage regulators are very common in electronic circuits. They provide a constant output voltage for a varied input voltage. In our case the 7805 IC is an iconic regulator IC that finds its application in most of the projects. The name 7805 signifies two meaning, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. So our 7805 will provide a +5V output voltage. The output current of this IC can go up to 1.5A. But, the IC suffers from heavy heat loss hence a Heat sink is recommended for projects that consume more current. The **Fig. 3.2.10** shows that the voltage regulator.

Fig. 3.2.10: Voltage Regulator [29]

*3.2.1.9.LCD Display (20*4)*

- In a **20×4 LCD** module, there are four rows in display and in one row twenty character can be displayed and in one display eighty characters can be shown.
- This liquid crystal module uses HDD44780 (It is a controller used to display monochrome text displays) parallel interfacing.
- The liquid crystal display interfacing code is easily accessible. We just required eleven input and output pin for the interfacing of the LCD screen.
- The electronic device can be used in different embedded systems, industries, medical devices, and portable devices like mobile, watches, laptops.
- Liquid crystal display works on two types of the signal first one is data and the second one is for control.

The **Fig. 3.2.11** shows that the LCD display.

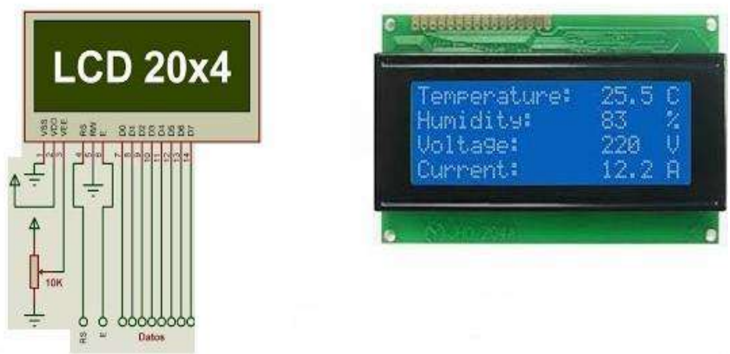


Fig. 3.2.11: LCD Display [30]

3.2.1.10 pH Sensor

A pH sensor helps to measure the acidity or alkalinity of the water with a value between 0-14. When the pH value dips below seven, the water starts to become more acidic. Any number above seven equates to more alkaline. Each type of pH sensor works differently to measure the quality of the water. The pH of water can help determine the quality of water. Measuring the pH can also provide indications of pipe corrosion, solids accumulation, and other harmful byproducts of an industrial process.

In an environmental setting, the changing pH could also be an early indicator increasing pollution. If the pH level reaches above 8.5, the water would be considered hard, which would likely cause scale development in boilers and pipes.
Keep in mind that pH fluctuations are also very costly to fix. Extra amounts of chemicals will need to be used to get rid of the waste, which leads to excess downtime and higher expenses. In a standard wastewater facility, a pH value of 6.5-8.5 is considered to be in a neutral range. The **Fig. 3.2.12** shows that the pH sensor.

Fig. 3.2.12: pH Sensor [31]

Keeping water at this level and continuously monitoring pH levels should help you keep costs down. However, it’s important that we use different pH sensors to get the best water quality. If anyone have a good monitoring system in place, the benefits can be numerous and may include:

- Reducing water waste
- Saving energy

- Meeting sustainability requirements for your supply chain
- Preventing downtime
- Maintaining a healthy workplace for your employees
- Reducing the use of hazardous chemical

APPLICATIONS

- Water characteristic testing
- Agriculture

3.2.1.11 Vero Board

Vero board is a brand of strip board, a pre-formed circuit board material of copper strips on an insulating bonded paper board which was originated and developed in the early 1960s by the Electronics Department of Vero Precision Engineering Ltd (VPE). It was introduced as a general-purpose material for use in constructing electronic circuits - differing from purpose-designed printed circuit boards (PCBs) in that a variety of electronics circuits may be constructed using a standard wiring board. The **Fig. 3.2.13** shows that the vero board.

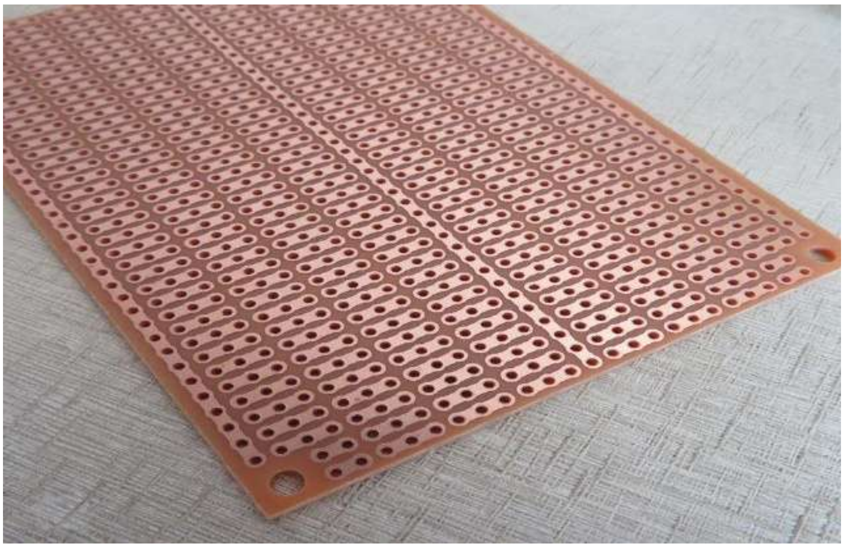


Fig. 3.2.13: Vero Board [32]

3.2.1.12 Variable Resistor

A variable resistor is the type of resistor which changes the flow of current in a controlled manner by offering a wide range of resistances. As the resistance increases in the variable resistor the current through the circuit decreases and vice versa. They can also be used to control the voltage across devices in a circuit too. Therefore, in applications where current control or voltage control is needed, these type of resistors come handy.

The **Fig. 3.2.14** shows some real life variable resistors.

Fig. 3.2.14: Variable Resistor [33]

Variable Resistor Working Principle and Construction

A typical variable resistor has 3 terminals. Out of the three, two are fixed terminals at the ends of a resistive track. The terminals are made of conducting metal. The other terminal is a moving terminal, mostly known as the wiper. It is the position of this terminal on the resistive track that decides the resistance of the variable resistor. The **Fig. 3.2.15** shows that the variable resistor construction.

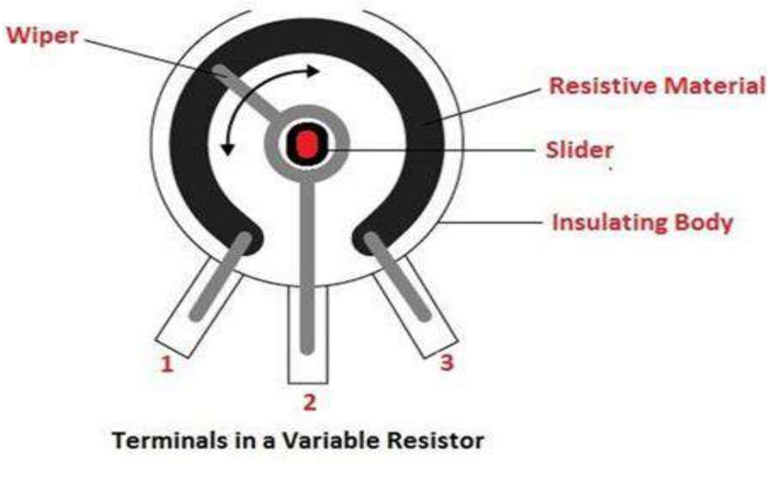


Fig. 3.2.15: Variable Resistor Construction [34]

These resistors offer a different resistance value, which means their resistance values can be adjusted to different values so as to provide the necessary control of current and/or voltage. To do so, a resistive strip is placed in between two fixed terminals of the device, a third terminal which is a movable one, is made to glide over this strip.

3.2.1.13 Electrolytic Capacitor

Commercial types of capacitors are made from metallic foil interlaced with thin sheets of either paraffin-impregnated paper or Mylar as the dielectric material. Some capacitors look like tubes, this is because the metal foil plates are rolled up into a cylinder to form a small package with the insulating dielectric material sandwiched in between them. The **Fig. 3.2.16** shows that the electrolytic capacitor.

Fig. 3.2.16: Electrolytic Capacitor [35]

Small capacitors are often constructed from ceramic materials and then dipped into an epoxy resin to seal them. Either way, capacitors play an important part in electronic circuits so here are a few of the more “common” types of capacitor available.

3.2.2 List of Software Components

- Operating system
    - Windows 10
- IDE
    - Arduino IDE
    - Proteus

CHAPTER 4

DESIGN METHODOLOGY

4.1 Introduction

This chapter contains the statement of the instruments which are used in our project. We'll also talk about the functionality of the used components. By the conclusion of this chapter, you will have a better understanding of the usage of the components in this project.

4.2 System Block Diagram

The **Fig. 4.2.1** shows that the basic blocks of the proposed system for IoT based agriculture monitoring. The sensors for identification of various parameters affecting the crop are shown in the figure. The rain sensor mainly detects the rainfall related information and its effect on the crop can be studied. Humidity, temperature and moisture sensors are used for real time monitoring of the parameters.Wi-Fi module enables the storage of real time parameters .The parameters can also be displayed on the LCD on real time basis.

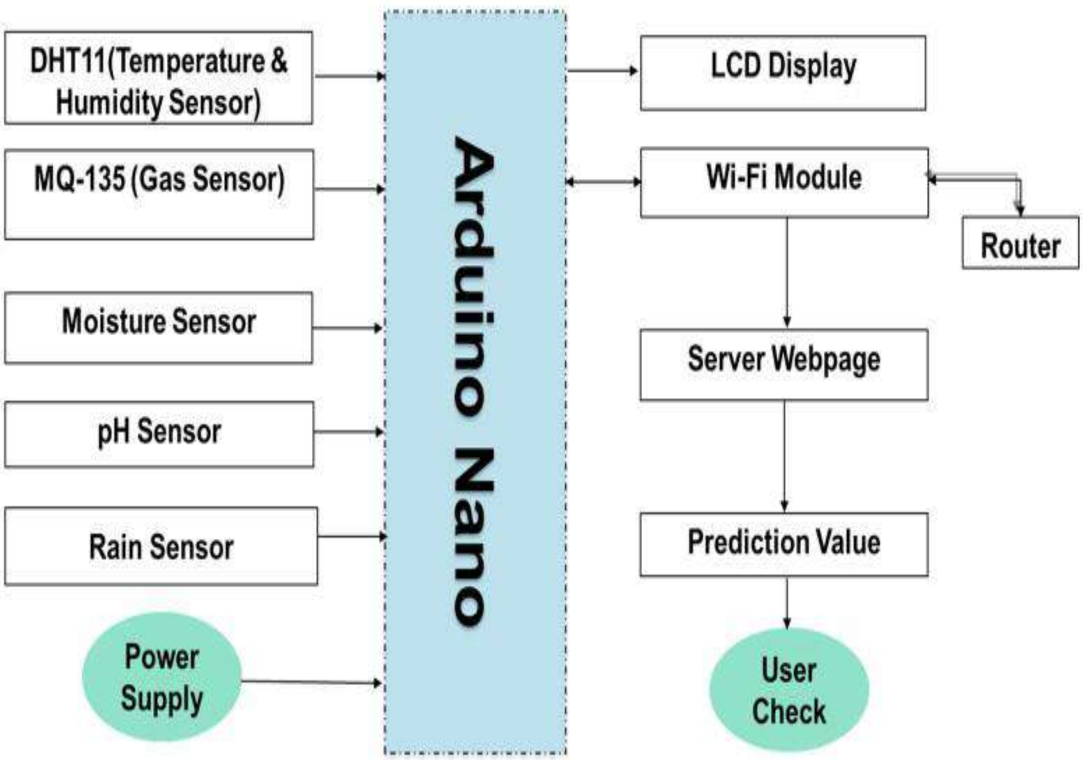


Fig. 4.2.1: System Block Diagram

4.3 System Flow Chart

The complete flow chart of the system is demonstrated in **Fig. 4.2.2**. The system will establish connection between the hardware setup and network. Then the sensors will start reading values which are collected from nature and convert analog data to digital data. After converting, data will be transmit to Arduino Nano. Arduino Nano will calibrate the data. Calibrated data will be stored in database. From database, data will be uploaded in website which is made for the user. After uploading the data in website the system will predict data value for next two weeks using KNN algorithm. Related program has been given in Appendix.

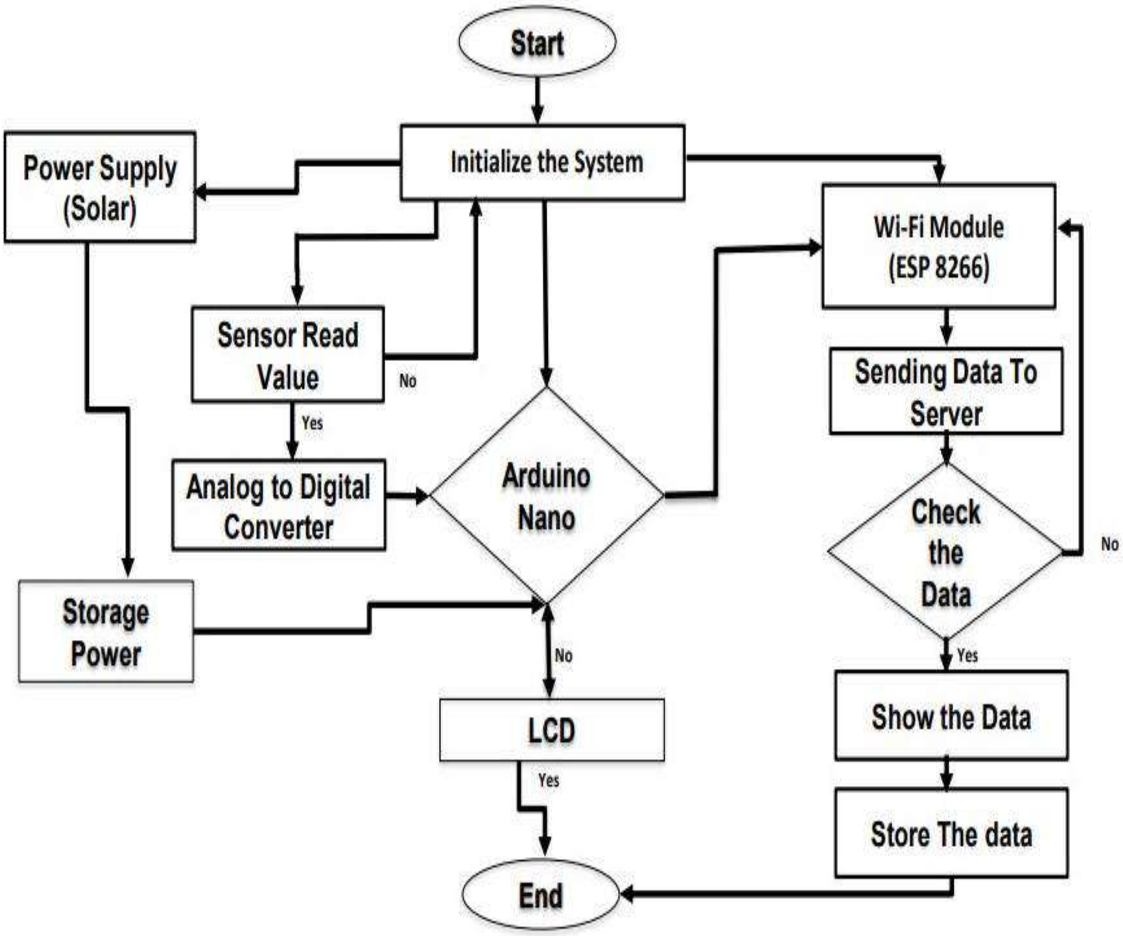


Fig. 4.2.2: System Flow Chart

4.4 Circuit Diagram

The circuit diagram of the system is shown in **Fig. 4.2.3**. Here all the equipment has voltage rating of 5 Volt. All the peripherals have been powered through this 5 Volt supply from source. We have solar power for battery charging.

In this system we have used Arduino Nano. According to the program we have connected all equipment with Arduino Nano. It has total 36 pins. Out of these 8 are analog input pins marked as A0-A7 and 14 digital input/output pins starting from D0- D13.We connected our sensors with analog pin of Arduino. Like DHT11 has been connected with A0 pin of Arduino. Similarly, pH sensor, moisture sensor, rain sensor, air sensor has been connected with A1, A2, A3, A4 analog pin. SPI protocol of Arduino is used to transmit data between microcontrollers and other peripherals. It has four pins 10, 11, 12, 13.To transfer data from Arduino to Wi-Fi module we connected Tx and Rx pin of Wi-Fi module with D11 and D12 number pin of Arduino. To show device status we used 20*4 LCD display. We connected Reset pin and Enable pin D4,D5,D6,D7 of LCD with D1,D3,D4,D5,D6,D7 number pins of Arduino. Here,D4,D5,D6,D7 pin of LCD is called Data pins .These pins are used to transmit data to the display.74L8595 IC has been connected with D8,D9,D10 number pins of Arduino and it will check whether the sensors are sensing or not. We drew this circuit using proteus.

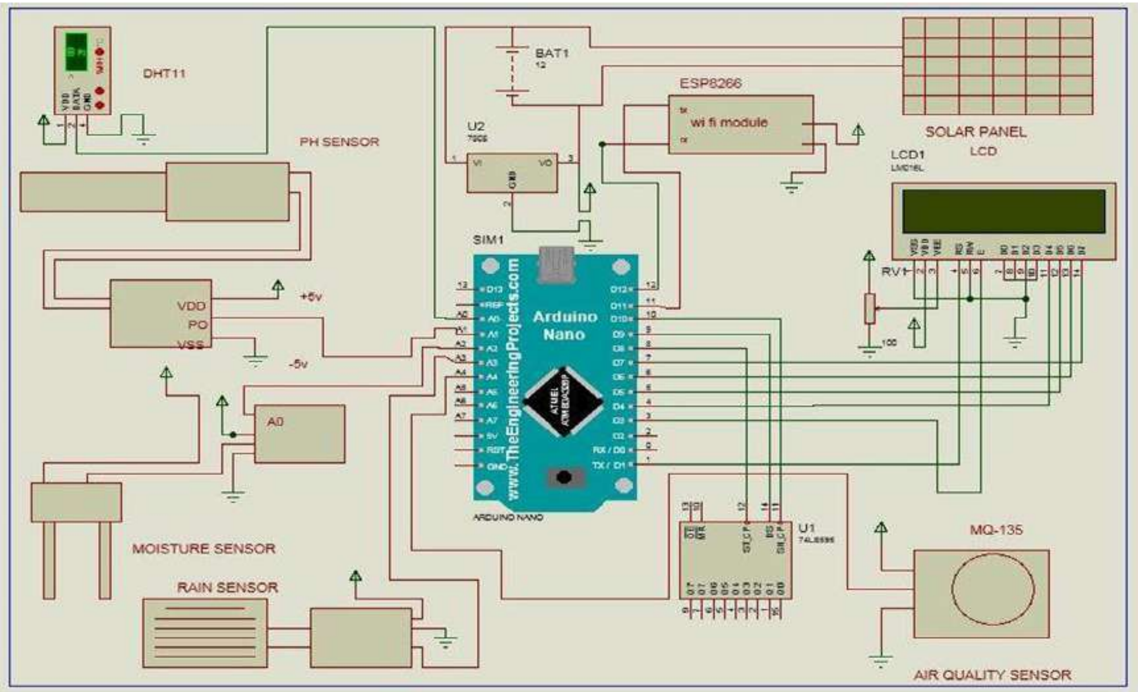


Fig. 4.2.3: Circuit Diagram

CHAPTER 5

IMPLEMENTATION AND RESULT

5.1 Introduction

The whole construction of the project as well as the objective rationale have been described in this chapter, along with the suitable demonstration.

5.2 Project Overview

Arduino Nano has placed in the center of the enclosure and other necessary sensors, solar panel and battery have attached to the side. The 20*4 Liquid Crystal Display alongside with the 20C Module, has place with the top lid of the enclosure. This has placed in this position to give access user to watch clearly system status. The analog pin of the Arduino has been linked to the DHT11 sensor. In the same way pH sensor, soil moisture sensor, rain sensor and MQ-135 is also being attached to the analog pin of Arduino. On the other hand Wi-Fi module ESP-8266, LCD has been connected to the digital pin of Arduino. Solar panel also is linked to the Arduino. The whole system will be works on 5 volt. The complete hardware overview has shown in **Fig. 5.2.1**

Fig. 5.2.1: Total Project Implementation View

5.3 Hardware Implementation

The below **Fig. 5.3.1** is showing the Arduino Nano and Wifi module part. Arduino Nano read the all sensing data and transferred in LCD and Wifi module. Wifi module storage the data in server.

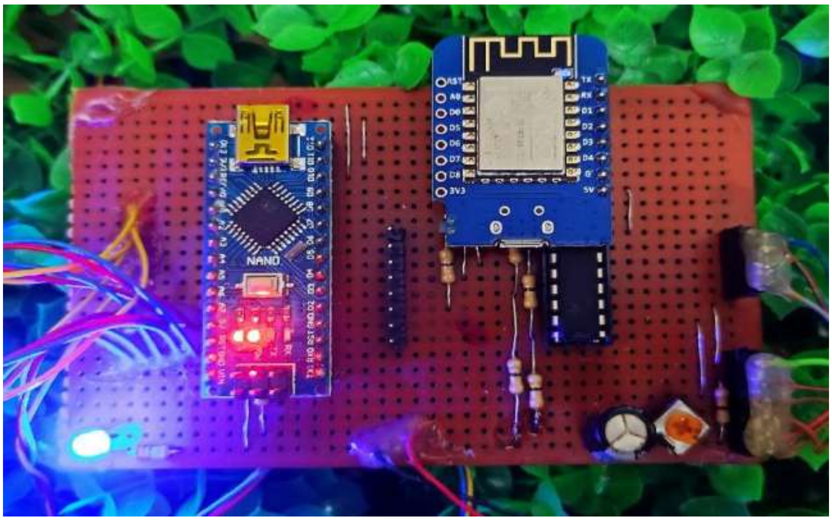


Fig. 5.3.1: Arduino Nano and Wi-Fi Module

The below **Fig. 5.3.2** is showing the DHT11 (Humidity and Temperature Sensor) it sense the humidity and temperature value of environmental air and transferred the value in Arduino Nano.

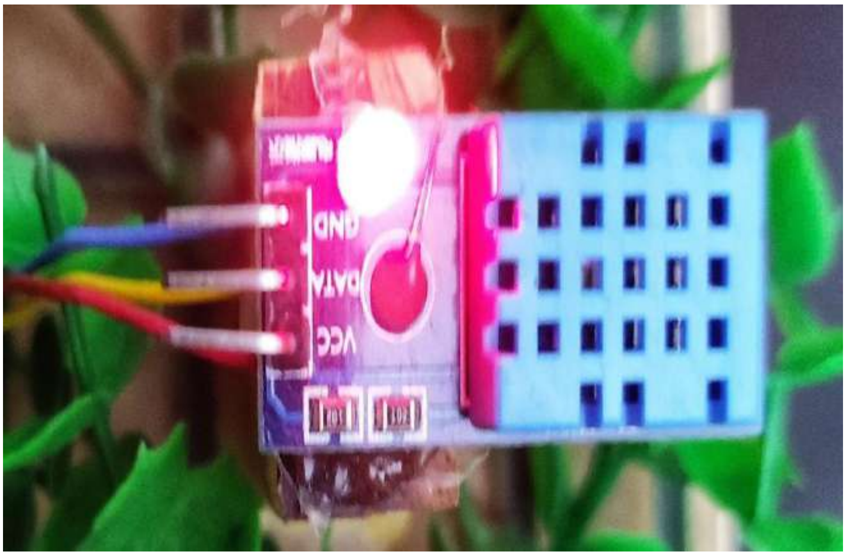


Fig. 5.3.2: DHT11 (Humidity and Temperature Sensor)

The below **Fig. 5.3.3** is showing the MQ-135 (Dust and Gas Sensor) it sense the dust and various gas from environmental air and transferred the value in Arduino Nano.

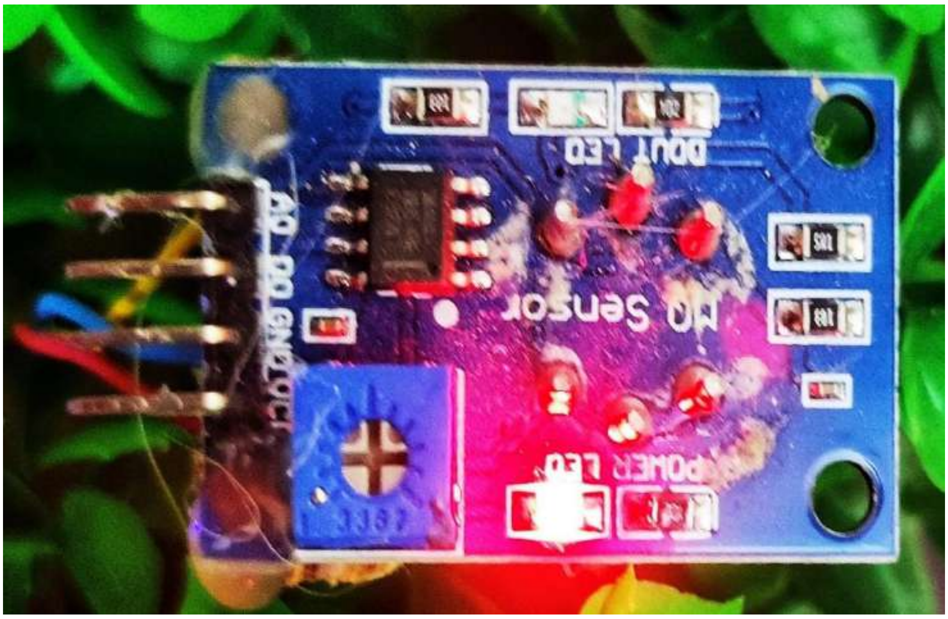


Fig. 5.3.3: MQ-135

The below **Fig. 5.3.4** is showing the Soil Moisture Sensor it sense the moisture from soil and transferred the value in Arduino Nano.

Fig. 5.3.4: Soil Moisture Sensor

The below **Fig. 5.3.5** is showing the Rain Sensor it sense the water quantity from environmental and transferred the value in Arduino Nano.

Fig. 5.3.5: Rain Sensor

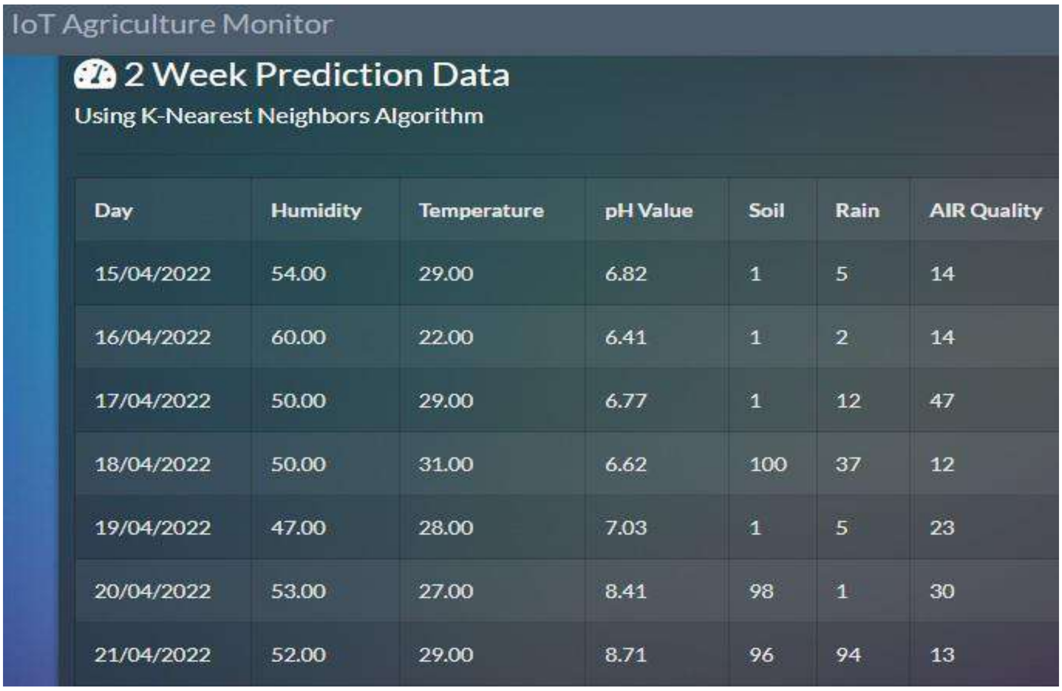
The below **Fig. 5.3.6** is showing the pH Sensor it sense the pH value of soil and water then transferred the value in Arduino Nano.

Fig. 5.3.6: pH Sensor

5.4 Result Analysis (IoT Monitoring)

The below **Fig. 5.4.1** and **Fig. 5.4.2** show the Humidity, Temperature, pH value, Soil moisture, Ran drop, air quality of an ideal agricultural environment and 14 days prediction value of that parameter respectively. And **Fig. 5.4.3** indicates the storing data on server for every 30 seconds.

Fig. 5.4.1: Server Data



IoT Agriculture Monitor

2 Week Prediction Data

Using K-Nearest Neighbors Algorithm

Day	Humidity	Temperature	pH Value	Soil	Rain	AIR Quality
15/04/2022	54.00	29.00	6.82	1	5	14
16/04/2022	60.00	22.00	6.41	1	2	14
17/04/2022	50.00	29.00	6.77	1	12	47
18/04/2022	50.00	31.00	6.62	100	37	12
19/04/2022	47.00	28.00	7.03	1	5	23
20/04/2022	53.00	27.00	8.41	98	1	30
21/04/2022	52.00	29.00	8.71	96	94	13

Fig. 5.4.2: Two Weeks Prediction Data on Server

Agriculture Monitor

Sensor Data Table

1022	04:26:26pm	15/04/2022	76.00	30.00	5.93	70	2	39
1023	04:26:56pm	15/04/2022	77.00	31.00	6.08	70	2	38
1024	04:27:27pm	15/04/2022	76.00	31.00	6.10	70	2	37
1025	04:27:57pm	15/04/2022	76.00	31.00	6.26	70	2	37
1026	04:28:27pm	15/04/2022	75.00	31.00	6.33	69	2	36
1027	04:28:58pm	15/04/2022	75.00	31.00	6.33	69	2	36
1028	04:29:28pm	15/04/2022	75.00	31.00	6.49	70	2	36

Fig. 5.4.3: Sensor Data Table on Server

In **Fig. 5.4.4** it showing the value of Humidity, Temperature ,pH ,Soil moisture, Rain drop, Air quality of agriculture environment on LCD display.

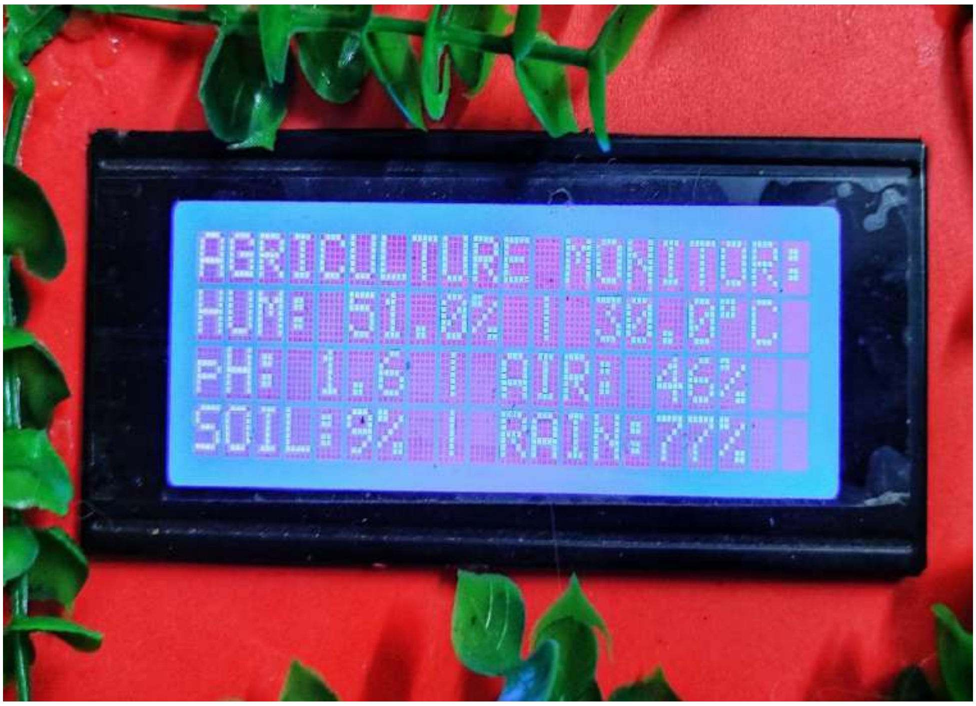


Fig. 5.4.4: Output Value on LCD

Here is the reference value of various parameters to tally with present value of environment.

The **Table 5.1** shows that air condition of environment, which measure by MQ-135 sensor.

Table 5.1 MQ-135 sensor value.

Observation No.	MQ-135 Sensor Value	Air Condition
1	29%	Healthy
2	63%	Bad

The **Table 5.2** represents the soil condition of environment, measure by moisture sensor.

Table 5.2 Moisture sensor value.

Observation No.	Moisture Sensor Value	Soil Condition
1	1%	Dry
2	15%	Moist
3	67%	Wet

The **Table 5.3** represents the pH condition of soil and water of environment, measure by pH sensor.

Table 5.3 pH sensor value.

Observation No.	pH Sensor Value	pH Condition
1	5.7%	Acidic
2	7%	Neutral
3	7.5%	Alkaline

The **Table 5.4** shows that the temperature of environment, measure by DHT11 sensor.

Table 5.4 DHT11 (Temperature) sensor value.

Observation No.	DHT11 Sensor Value (Temperature)	Weather Condition
1	35.3℃	Hot
2	25℃	Normal
3	20℃	Cool

The **Table 5.5** shows that the humidity of environment, measure by DHT11 sensor.

Table 5.5 DHT11 (Humidity) sensor value.

Observation No.	DHT11 Sensor Value (Humidity)	Weather Condition
1	61%	Good
2	78%	Bad

The **Table 5.6** represents the rain condition of environment, measure by rain sensor.

Table 5.6 Rain sensor value.

Observation No.	Rain sensor Value	Rain Condition
1	69%	Rainy
2	1%	Not Rainy

5.5 Cost Analysis

The **Table 5.7** shows the overall cost of our project. The agriculture environment monitoring system cost total around **4325 BDT**. It is cost effective comparing to other agriculture environment monitoring system considering the features.

Table 5.7 Cost Analysis

No	**Name of the equipment**	**Quantity**	**Price (BDT)**
01	Arduino Nano	1	350/-
02	Wi-Fi module (ESP8266)	1	600/-
03	Moisture Sensor	1	150/-
04	DHT11	1	180/-
05	MQ-135	1	145/-
06	Rain Sensor	1	450/-
07	pH Sensor	1	1200/-
08	Vero Board	1	100/-
09	LCD Display	1	500/-
10	Power Supply		150/-
11	Others		500/-
12	**Total**		**4325/-**

5.6 Comparative Study

The **Table 5.8** shows that the comparative study between proposed system and related works.

Table 5.8 Comparative Study

Point of view	Related Project	Proposed System
Operation System	Monitored weather by three sensor.	Our proposed system is used five sensor for monitoring the whole system.
System Update	They did not give any prediction value and database of weather.	In this system we find next two weeks prediction value of weather.
Monitoring & Controlling Section	Physically monitoring & Controlling system.	Both physically and server based monitoring & controlling.
Quality	Comparatively less.	More advance and effective.
Cost	It takes more than 3000 BDT	It's around 4325 BDT
Extra Feathers	Maximum essential sensor are not available.	Maximum essential sensor are available.

From the above comparison we see that our agriculture environment monitoring system is cost effective relatively with the related project.

CHAPTER 6

CONCLUSION

6.1 Introduction

The overall project's applications, limitations and scope of development for future are discussed in this chapter. This chapter covers conclusion, applications, advantages, limitations and difficulties and future development.

6.2 Conclusion

Most of the people in our country are dependent on agriculture. Therefore, it is important to know the weather conditions of the farm for their cultivation. Knowing the weather forecast, they will be able to take any action before harvesting. In this project we have created an integrated system using five sensors to measure six environmental parameters. It has ability to measure temperature, humidity, CO2 level, soil moisture, pH level, rain level for a specific area. On the other hand, it will give two-weeks weather forecast. As we used solar panel for power supply so it is environment friendly project.

6.3 Advantage of our system

Our agricultural environment monitoring system can be applied to a agricultural sector because of its features. The unique features make it suitable to use in this platform.

6.3.1 Feature

- The entire system runs on solar power, so there is no extra cost and no hassle of monitoring in case of power outage.
- One of the benefits of using IoT in agriculture is the increased agility of the processes. Farmers can quickly respond to any significant change in weather, humidity, air quality as well as the health of each crop or soil in the field and take decision to save crops.
- Today's agriculture is in a race. Farmers have to grow more product in deteriorating soil, declining land availability and increasing weather fluctuation. IoT-enabled agriculture allows farmers to monitor their product and conditions in real-time. They get insights fast, can predict issues before they happen and make informed decisions on how to avoid them.

- Since we have used very familiar equipment here, it is very easy to maintenance.
- It doesn't take much money to implement the whole system, it is possible to run the whole system at low cost.

6.3.2 Application

- To monitor the agriculture environment.
- Analyze the weather data for good farming.
- Predict climate condition.

6.4 Limitation & Difficulties

We have some limitation of work-

- Eligible for only a certain area.
- Total system depends on solar system.
- It is data dependency.

6.5 Future Development

- To implement more sensor like air velocity (EE671) measurement sensor.
- Improve efficiency
- Action taking feature can be include which make it more advanced.
- Implement GSM module for instead notifications.

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APPENDIX

Arduino program for the project:

```
#include <SoftwareSerial.h>
#include "src/LiquidCrystalSerial/LiquidCrystalSerial.h"
#include "DHT.h"

#define HUM_OUT   85
#define TMP_OUT   33
#define PHV_OUT  4.5
#define SOIL_OUT  60
#define RAIN_OUT  60
#define GAS_OUT   60

String HOST = "http://kitsware.com/projects/IoTAgriculture/update_machine.php";

SoftwareSerial wifi(11, 12);
LiquidCrystalSerial lcd(10, 8, 9);
DHT dht(A0, DHT11);

float hum, temp, pHVal;
int soil, rain, gas;
long prevMs, pTime;

void setup() {
  Serial.begin(9600);
  wifi.begin(9600);
  lcd.begin(20, 4);
  dht.begin();

  wifi.println("CON=Jarvis!,thereisnopassword,");
  delay(1000);
  prevMs = millis();
}

void loop() {
  checkDHT();
  checkPH();
  checkSoil();
  checkRain();
  checkGas();

  if (millis() - pTime >= 30000) {
    String link = (String)"WEB=0," + HOST + "?hum="
              + hum + "&temp="
              + temp + "&ph="
              + pHVal + "&soil="
              + soil + "&rain="
              + rain + "&gas="
              + gas + "$";
    wifi.println(link);
```

```
    pTime = millis();
  }

  if (millis() - prevMs >= 1000) {
    lcd.setCursor(0, 0);
    lcd.print(F("AGRICULTURE MONITOR:"));
    lcd.setCursor(0, 1);
    lcd.print("HUM: ");
    lcd.print(hum, 1);
    lcd.print("% | ");
    lcd.print(temp, 1);
    lcd.print((char)223);
    lcd.print("C ");

    lcd.setCursor(0, 2);
    lcd.print("pH: ");
    lcd.print(pHVal, 1);
    lcd.print(" | AIR: ");
    lcd.print(gas);
    lcd.print("% ");

    lcd.setCursor(0, 3);
    lcd.print("SOIL:");
    lcd.print(soil);
    lcd.print("% | RAIN:");
    lcd.print(rain);
    lcd.print("%  ");

#ifdef DEBUG
    Serial.print(F("H: "));
    Serial.println(hum);
    Serial.print(F("T: "));
    Serial.println(temp);
    Serial.print(F("pH: "));
    Serial.println(pHVal);
    Serial.print(F("S: "));
    Serial.println(soil);
    Serial.print(F("R: "));
    Serial.println(rain);
    Serial.print(F("G: "));
    Serial.println(gas);
    Serial.println();
#endif
    prevMs = millis();
  }

}

void checkDHT() {
  hum = dht.readHumidity();
  temp = dht.readTemperature();
  if (isnan(hum) || isnan(temp)) return;
```

```
}
void checkPH() {
  unsigned long int avgValue = 0;

  for (int i = 0; i < 20; i++) {
    avgValue += analogRead(A1);
    delay(10);
  }
  avgValue = avgValue / 20;
  pHVal = 14.0 - (avgValue * (14.0 / 1023));
  pHVal = pHVal - 1.8;
  Serial.print(avgValue);
  Serial.print(" | ");
  Serial.println(pHVal);
}

void checkSoil() {
  int value = analogRead(A2);
  soil = map(value, 0, 1023, 100, 1);
}

void checkRain() {
  int value = analogRead(A3);
  rain = map(value, 0, 1023, 100, 1);
}

void checkGas() {
  int value = analogRead(A4);
  gas = map(value, 0, 1023, 0, 100);
}
```