Land Quality Analyzer using IoT

ELECTRONIC DESIGN WORKSHOP (U20ECP612)

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BONAFIDE CERTIFICATE

This is to certify that the mini project work entitled **"Land Quality Analyzer"** is a bonafide work done by, **DHARSHAN S [REGISTER NO: 21UEC038], BHARATHRAJ K [REGISTER NO:21UEC027], BALAJI T [REGISTER NO: 21UEC021],** in partial fulfilment of the requirement for the *award of Bachelor of Technology degree* in the Department of Electronics and Communication Engineering during the academic year 2024.

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INTERNAL EXAMINER	**EXTERNAL EXAMINER**

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ABSTRACT

Land Quality Analyzer using IoT is a system that allows farmers to monitor and analyze the quality of their land in real-time. The system is composed of IoT sensors that are placed on the land to gather data on various parameters such as temperature, humidity, and water flow but we can also measure moisture content, soil nutrients, and pH levels.

This system provides farmers with valuable insights into the health of their land, enabling them to make informed decisions about crop selection, irrigation, and fertilization. By optimizing these factors, farmers can improve their yields, reduce costs, and increase profitability.

The Land Quality Analyzer using IoT system is designed to be user-friendly and accessible, even to those with limited technical expertise. The system can be accessed via a web-based interface that allows farmers to view real-time data, generate reports, and set alerts for specific thresholds. This enables them to take proactive measures to prevent crop damage and ensure optimal growing conditions.

Overall, the Land Quality Analyzer using IoT system represents a significant step forward in precision agriculture, offering farmers a powerful tool to optimize their operations and maximize their yields.

The Land Quality Analyzer (LQA) is an Internet of Things (IoT) enabled system designed to monitor and analyze soil quality in agricultural fields. IoT (Internet of Things) is used in this project to detect the land quality using the parameters such as as temperature, humidity, and water flow but we can also measure moisture content, soil nutrients, and pH levels. The required parameters are obtained through corresponding sensors connected to the NodeMCU board. Based on the results of the obtained value a detailed review of the land is displayed to the user through an application. The system is equipped with sensors that measure key parameters such as temperataure content, water flow and humidity, atmosphere gas level, pH level, which are critical for maintaining healthy soil conditions. The platform employs advanced analytics algorithms to generate insights and recommendations for farmers to optimize their crop yield and quality.

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LIST OF ABBREVIATIONS

IoT	**I**nternet **O**f **T**hings
pH	**P**otential Of **H**ydrogen
CSV	**C**omma-**S**eparated **V**alues
IDE	**I**ntegrated **D**evelopment **E**nvironment
GUI	**G**raphical **U**ser **I**nterface

CHAPTER 1

INTRODUCTION

INTRODUCTION TO THE PROJECT

Land Quality Analyzer using IoT is a system designed to help farmers, agricultural experts and researchers assess and monitor the quality of soil in real-time. This technology employs a combination of IoT sensors, wireless communication, and cloud computing to collect, analyze and report data about various soil parameters such as moisture level, pH level, temperature, and nutrient content. By providing real-time information about soil quality, the system enables farmers to optimize crop yields, reduce resource wastage, and improve their overall efficiency. Additionally, the system can also be used to prevent soil degradation and promote sustainable land management practices. The Land Quality Analyzer using IoT is a highly scalable and cost-effective solution that can be deployed in small and large-scale farms, research institutions and agricultural organizations.

Land Quality Analyzer using IoT is a cutting-edge technology that integrates the Internet of Things (IoT) and soil science to assess the quality of land. This system uses sensors to collect data on various parameters such as soil pH, moisture, temperature, and nutrient content. The data is then transmitted to a cloud-based platform for analysis, where it is processed using advanced algorithms to generate a detailed report on the quality of the land. This technology has revolutionized the way farmers and landowners manage their land. It enables them to make informed decisions regarding crop selection, irrigation, fertilization, and other critical factors that affect crop yields and the overall health of the soil.

This system is also helpful in environmental monitoring and conservation efforts, enabling conservationists to analyze the impact of human activity on the land and take necessary steps to protect it. Overall, the Land Quality Analyzer using IoT is an innovative solution that has the potential to transform the agriculture and environmental industries. It offers a reliable and efficient way to monitor and analyze the quality of land, enabling farmers, landowners, and conservationists to make informed decisions that can improve land productivity and environmental sustainability.The Land Quality Analyzer using IoT technology incorporates several sensors including temperature and humidity, soil moisture, pH, and gas sensors. The temperature and humidity sensors measure the temperature and humidity levels in the soil, which are essential factors in determining the quality of the land. The soil moisture sensor measures the amount of water in the soil, which is critical for crop growth. The pH sensor measures the acidity or alkalinity of the soil, which can affect plant growth and nutrient absorption. The gas sensor detects the presence of harmful gases such as carbon monoxide and methane, which can negatively impact the environment.

The data collected from these sensors is transmitted wirelessly to a central system where it is analyzed to provide insights into the quality of the land. The system can alert farmers to potential issues such as low soil moisture, high gas levels or imbalanced pH levels,allowing them to take action quickly to improve soil quality and increase crop yield. Overall, the Land Quality Analyzer using IoT technology provides farmers with a powerful tool to monitor and improve the quality of their land. With real-time data on soil moisture, temperature, humidity, pH and gas levels, farmers can make informed decisions about irrigation, fertilization and other land management practices, resulting in healthier crops and higher yields.

Chapter 2

LITERATURE SURVEY

2.1 EXISTING SYSTEM

Soil testing refers to the chemical analysis of soils for quick characterization of the fertility status of soils and predicting the nutrient requirement of crops. It also includes testingof soils for other properties like texture, structure, pH, Cation Exchange Capacity, water holding capacity, electrical conductivity and parameters for amelioration of chemically deteriorated soils for recommending soil amendments, such as gypsum for alkali soil and lime for acid soil.

CropX: This system uses IoT-enabled sensors to collect data on soil moisture, temperature, and other parameters. The data is analyzed using machine learning algorithms toprovide real- time insights into crop health and soil quality.

Sencrop: Sencrop is a smart agriculture system that includes sensors for soil moisture, temperature, and weather conditions. The data is transmitted to a cloud-based platform where it can be analyzed and used to optimize crop management practices.

Agroop: This system uses IoT sensors to monitor soil moisture, temperature, and pH levels. The data is analyzed using machine learning algorithms to provide recommendations on crop management practices.

SenseAgro: SenseAgro is an IoT-based system that includes soil moisture and temperature sensors, as well as weather stations. The data is transmitted to a cloud-based platform where it can be analyzed and used to optimize crop management practices.

Teralytic: Teralytic is an IoT-based soil monitoring system that includes sensors for temperature, moisture, and nutrients. The data is transmitted to a cloud-based platform where it can be analyzed and used to optimize fertilizer application and crop management practices.

2.2 RELATED WORKS

This paper "**Smart Agriculture to Measure Humidity, Temperature, Moisture, Ph. and Nutrient Values of the Soil using IoT** " [1] by Asadi Venkata Mutyalamma, GopisettyYoshitha, AlthiDakshyani, Bachala Venkata Padmavathi tells about concept of the explains crops of high quality by maintaining soil pH levels, moisture content, and nutrient levels. So, in this project, a micro controller is used to detect and regulate all of those characteristics. In contrast to color sensors, which are used to calculate the percentage of soil nutrients (N2, P4, and K), humidity sensors are used to measure moisture content. It will analyse the soil's nutrient content in real time, and a Ph. sensor will be used to gauge the soil's pH level.

This paper "**IoT Enabled Soil Testing**" [2] by P. Sindhu and G. Indirani tells about concept of the amount of nutrients in the soil. In addition to being one of the most significant and instructive soil parameters, pH value is also assessed to determine soil fertility. The crops that are best for a certain soil type are chosen in the suggested method. It will assess the soil's moisture content, temperature, and humidity in real time and it will also make crop suggestions based on the PH of the soil.

This paper "**IOT Based Crop-Field Monitoring And Irrigation Automation**" [3] by Rajalakshmi.P, Mrs.S.Devi Mahalakshmi tells about Smart agriculture increases crop productivity by reducing waste and making effective use of fertiliser. In this study, a system is created to manage irrigation and monitor crop fields utilising sensors (soil moisture, temperature, humidity, and light). Wireless transmission is used to transfer sensor data to a web server database. Data are encoded in JSON format and stored in the server database. If the field's moisture and temperature drop below the critical point, the watering is automated. Controlling light output is also an option in greenhouses.

This paper "**Soil & Water Compatibility Testing Based on IOT**" [4] by ManivasanV , Jothi rathinavel P, Abhilash khanna K , P.Visu tells about the only method of assessing and computing soil resources has been through soil testing, although various circumstances are taken into account so that different calculations further taken into consideration, such as the regular assessment of the crops' water content. Only for that reason, water components must be evaluated depending on the pH values we are taking into account. We will also take into account the current seasonal changes in addition to that. Sensors including soil moisture sensors, soil pH sensors, water pH sensors, WiFi modules, and others are used to generate these values.

This paper "**Automatic soil nutrients and crop detection management system using IOT**" [5] by Sonal S Udapudi , Sonika R , Aravind E M ,Prasad Shivam ,Anoop G L tells about This system uses sensors for temperature, colour, moisture, and rain. These sensors are connected to the node MCU microcontroller, which is connected to the thing Speak cloud storage. using Wi-Fi. An android application is used to analyse the data that was obtained from the cloud. The environment's circumstances affect the growth of the crop. The idea behind this technology is to make it easier for farmers to use sensor data to grow their crops appropriately.

This paper "**The IoT-Based Monitoring Systems for Humidity and Soil Acidity Using Wireless Communication**" [6] by Lia Kamelia,YugaSetyaNugraha, MufidRidlo Effendi, TediPriatnaaims to create a pH and humidity monitoring system for agriculture's soil with wireless sensor network technology based on internet of things.Intends to develop a wireless sensor network-based internet of things system for monitoring soil pH and humidity in agriculture.

This paper "**Soil gas monitoring system using low-cost sensors**" [7] by Ana M. C. Ilie, Joanna Gordon Casey,Evan Coffey, Michael Hannigan tells about present a new soil monitoring system that employs low-cost NDIR, metal oxide and electrochemical type gas sensors as well as temperature, pressure, and humidity sensors. The use of inexpensive

NDIR, metal oxide, and electrochemical type gas sensors, as well as temperature, pressure, and humidity sensors, in a new soil monitoring system.

This paper “**Design and implementation soil analyser using IoT**” [8] by P. Sharma and D. V. Padole, 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), Coimbatore, India, 2017, pp. 1-5, doi: 10.1109/ICIIECS.2017.8275947.

2.3 PROPOSED SYSTEM

The system is cost effective and easy to handle. We can make use of this system in multiple purposes by connecting different devices like, water pump and other sensors for future purpose. We can control the system by using our mobile phone with internet connectivity. The system is low power consuming. Easy to operate and hence user friendly. The data is monitored with accurate date and time.

The technology is user-friendly and economical. By connecting several devices, like a water pump and other sensors, we can use this system for a variety of applications in the future. Our mobile phone with internet connectivity can be used to control the system. The system uses little energy. User-friendly because it is simple to use. Accurate date and time areused to monitor the data.

The soil sensors are placed in the ground at a desired depth to measure moisture, pH, temperature, and humidity levels. The sensors are connected to the microcontroller, which processes the sensor data and sends it to the cloud using the Wi-Fi module. The cloud stores the sensor data and sends it to a web application. The web application displays the sensor data in real-time and provides analysis and recommendations for improving soil quality basedon the sensor data.

To reduce costs, low-cost sensors and microcontrollers can be used. Additionally, the system can be powered by a battery or solar panel to reduce the need for a power source.

CHAPTER 3
SYSTEM REQUIREMENTS

Requirement analysis determines the requirements of a new system. This project analyses on product and resource requirement, which is required for this successful system. The product requirement includes input and output requirements it gives the wants in term of input to produce the required output. The resource requirements give in brief about the software and hardware that are needed to achieve the required functionality.

3.1 HARDWARE REQUIREMENTS

Sensors	:	Humidity and Temperature, Soil moisture.
Operating system	:	Android 7.0 or more
Microcontroller	:	NodeMCU
Transmitter	:	WIFI module (ESP8266)
Power source	:	External Power Supply

3.2 SOFTWARE REQUIREMENTS

Front End	:	Web application for displaying sensor data and analysis (HTML, CSS, JS, php)
Back End	:	MySQL
IDE	:	NodeMCU

3.3 SOFTWARE FEATURES

Real-time data visualization

A web application that displays sensor data should update the data in real-time and display it in a user-friendly way, such as graphs, charts, or tables.

Data filtering and sorting

Users should be able to filter and sort the sensor data based on different parameters, such as time range, sensor type, or location.

Historical data analysis

The web application should allow users to analyze historical sensor data to identify trends, patterns, or anomalies.

Alert notifications

The web application should send alert notifications to users when a sensor data value exceeds a threshold or deviates from the expected range.

Data export and integration

The web application should allow users to export sensor data in different formats, such as CSV or Excel, and integrate with other applications or services, such as data analyticstools or IoT platforms.

Dashboard customization

The web application should allow users to customize their dashboard view byselecting which sensors to display, which data visualizations to use, and which alerts to receive.

Predictive analytics

The web application can use machine learning or AI algorithms to predict future sensor data values based on historical data and provide insights for decision making.

Mobile-friendly design

The web application should have a responsive and mobile-friendly design to enable users to access sensor data and analysis from any device or location.

Security and data privacy

The web application should have robust security and data privacy measures to protect sensitive sensor data from unauthorized access or breaches.

CHAPTER 4
SYSTEM DESIGN

System design is the process of defining the architecture, modules, interfaces and data for a system to satisfy specified requirements. System design could be seen as the application of systems theory to product development. There is some overlap with the disciplines of systems analysis can cross many different groups within an organization to ensure requirements are gathered and met for all stakeholders.

4.1 SYSTEM ARCHITECTURE DIAGRAM

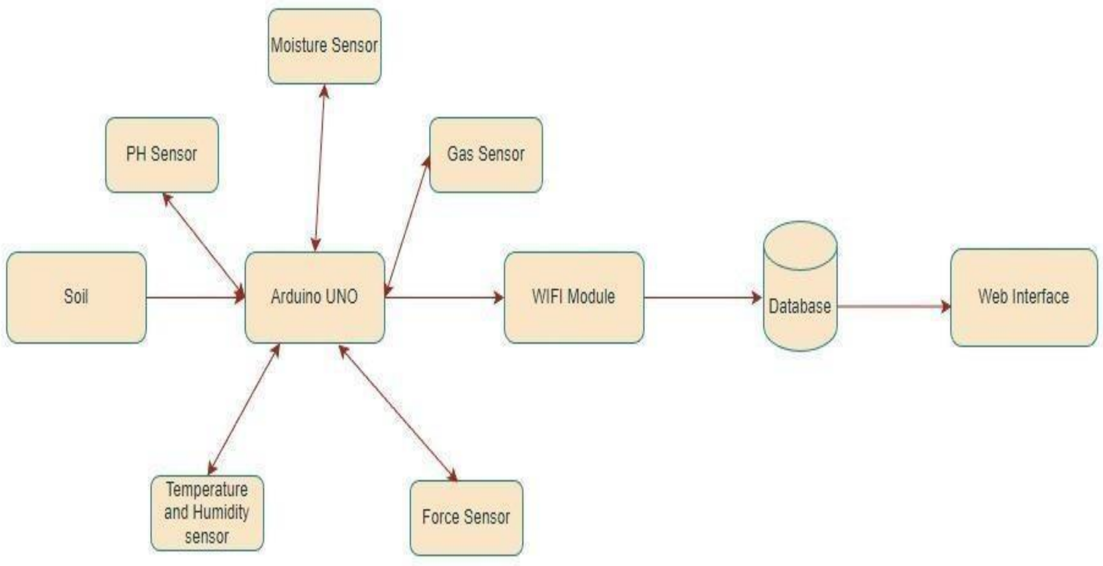


FIG 4.1 SYSTEM ARCHITECTURE DIAGRAM

Figure 4.1 shows A system architecture diagram is a visual representation of the overall structure and components of a system, including hardware, software, communication protocols, and data storage. It typically shows the different subsystems that make up the system, their interactions, and how they are connected.

4.2 USE CASE DIAGRAM

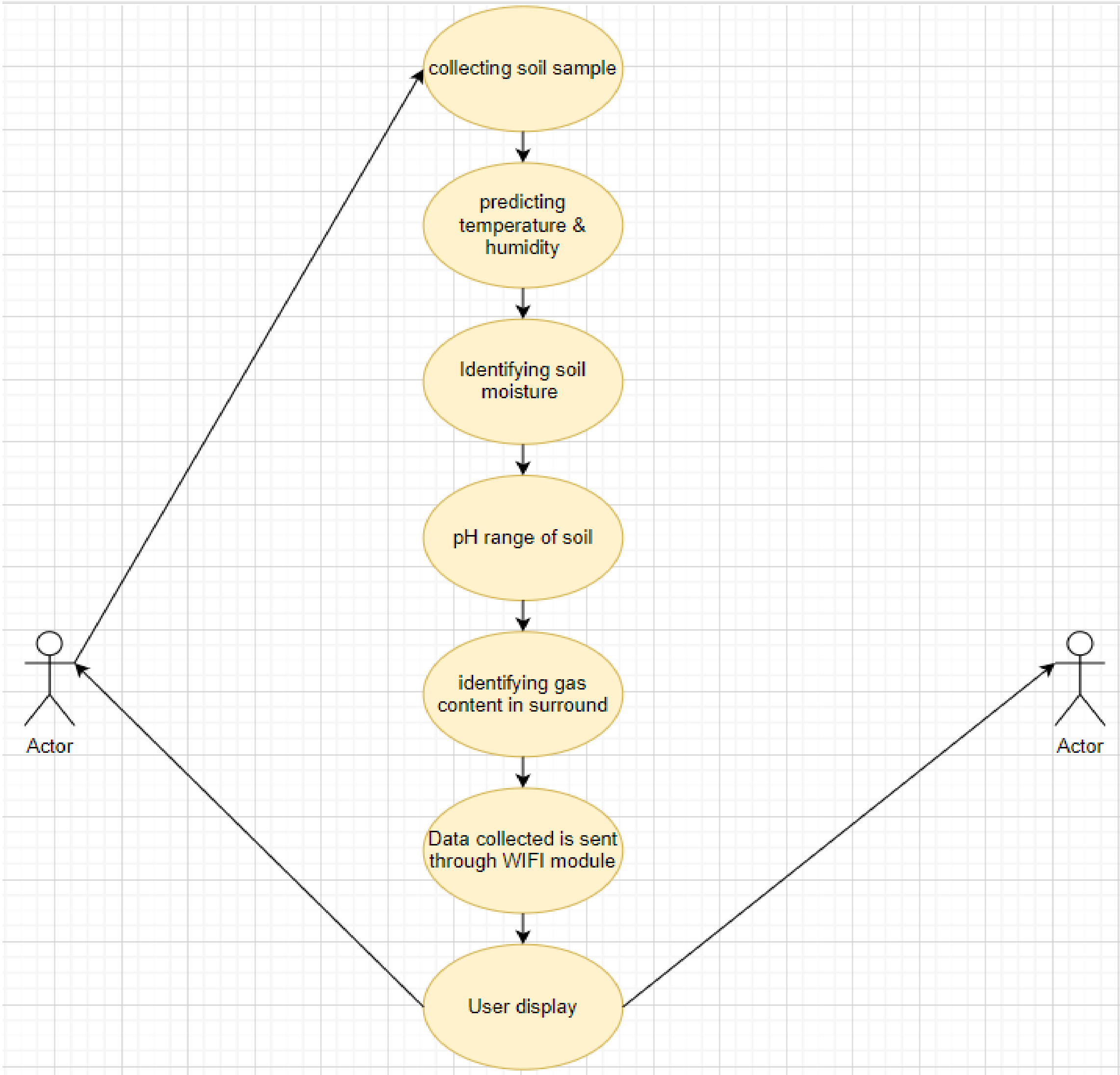


FIG 4.2 USE CASE DIAGRAM

Figure 4.2 shows help development teams understand the requirements of their system, including the role of human interaction therein and the differences between various use cases. A use case diagram might display all use cases of the system, or just one group of use cases with similar functionality.

4.3 SEQUENCE DIAGRAM

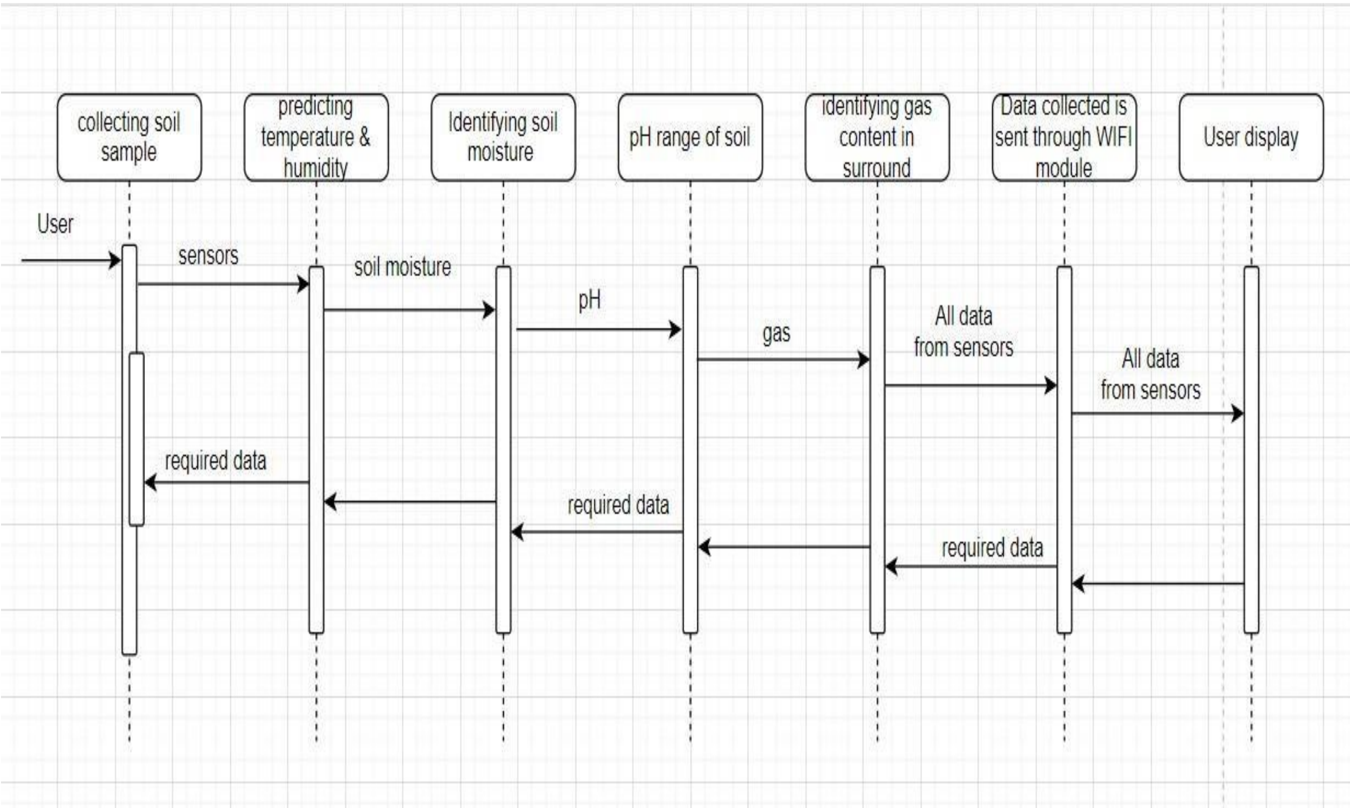


FIG 4.3 SEQUENCE DIAGRAM

Figure 4.3 shows A sequence diagram is a type of interaction diagram that illustrates the flow of messages between objects or components in a system or application. It shows the sequence of actions and the order in which those actions occur in a particular scenario.

4.4 WORKFLOW DIAGRAM

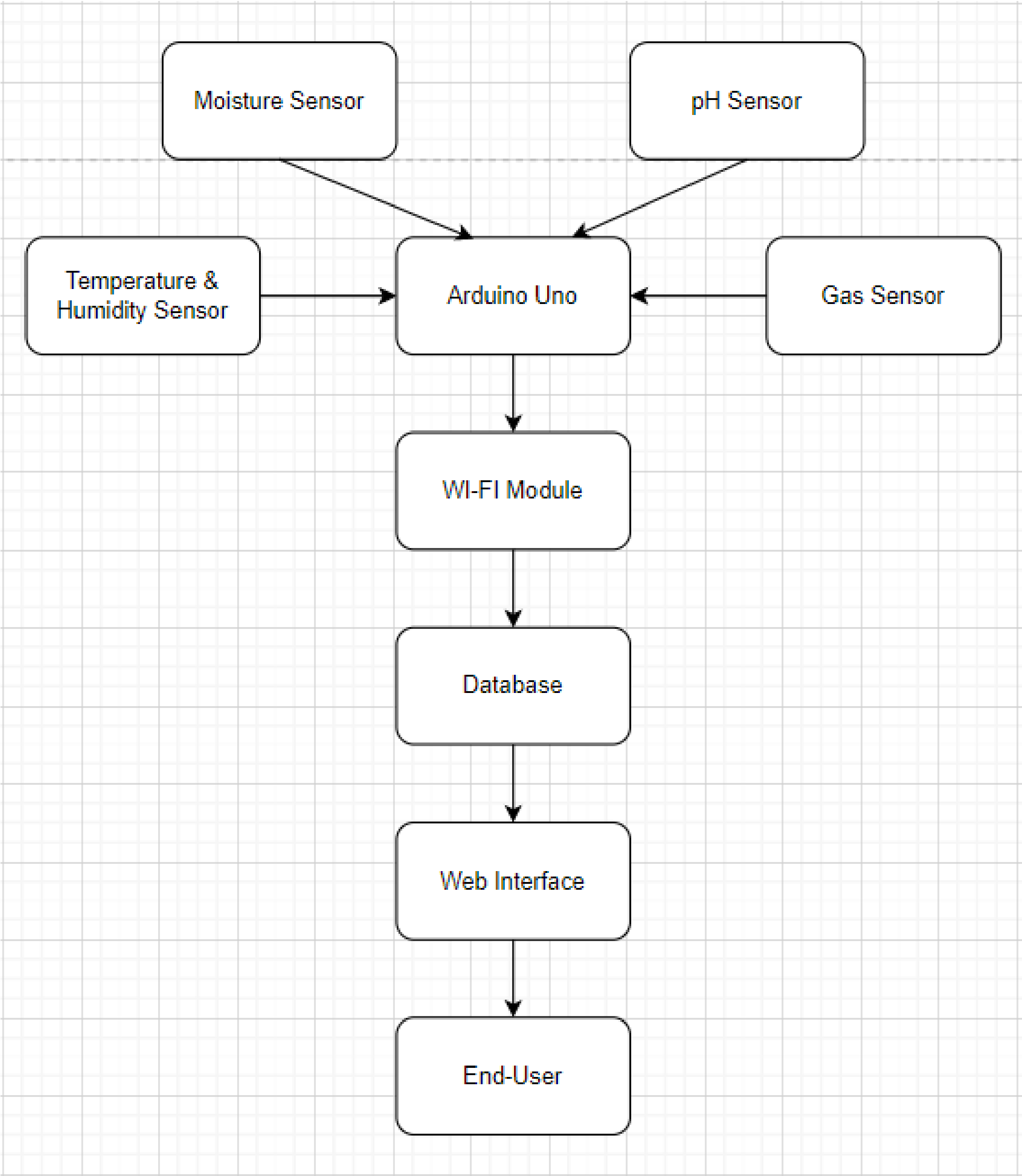


FIG 4.4 WORK FLOW DIAGRAM

Figure 4.4 shows a workflow diagram, also known as a flowchart or process flow diagram, is a visual representation of the steps involved in completing a task or process. Itdepicts the sequence of actions or decisions that need to be taken in order to complete a specific task or achieve a particular goal.

CHAPTER 5

SYSTEM IMPLEMENTATION

AIM:

One of the main purpose is to provide accurate and real-time analysis of soil properties, such as moisture content, pH level, nutrient composition, and temperature, to enable farmers and agricultural businesses to make informed decisions about crop selection, irrigation, fertilization, and other key farming practices.

OBJECTIVE:

To develop a smart land quality analyzer using IoT technology that can efficiently analyze the soil and provide accurate data on the quality of the land. The objective of this device is to enable farmers, gardeners, and other agricultural professionals to make informed decisions regarding soil management, crop selection, and fertilization to increase crop yield and ensure sustainable agriculture practices. The device will be designed to be low-cost, portable, and easy to use, making it accessible to a wide range of users. Additionally, it will utilize cloud-based data storage and analysis, enabling real-time monitoring and analysis of soil conditions for remote access and analysis.

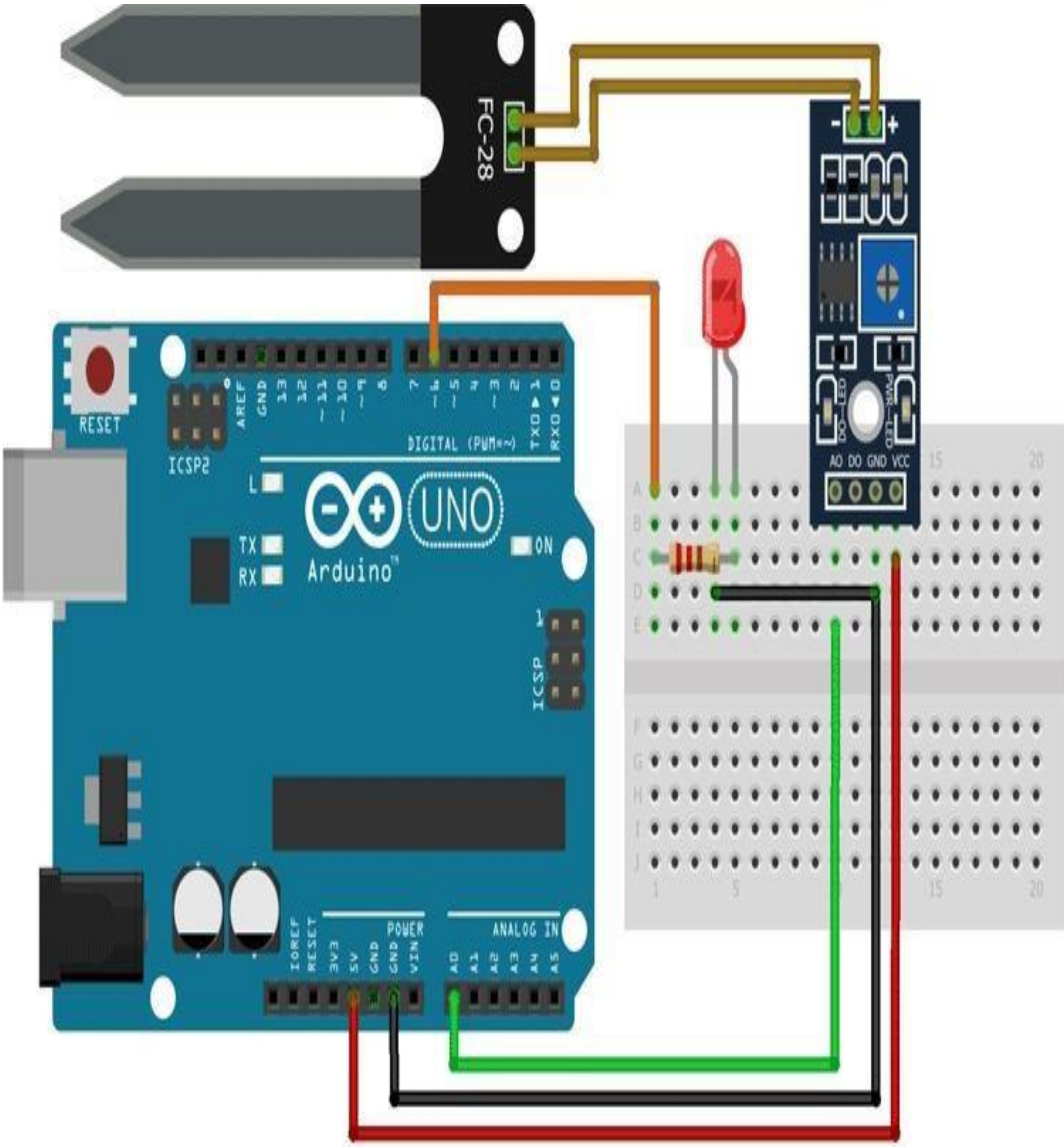
SCOPE OF THE PROJECT:

The scope of the project is to develop a land quality analyzer using IoT that will measure various parameters of the land, such as soil moisture, pH level, temperature, and humidity. The analyzer will use sensors to collect data from the land, and the data will be transmitted wirelessly to a cloud-based platform where it can be analyzed and visualized in real-time.

MODULES

1. Getting data from land using sensor
2. Process the data through NodeMCU
3. Sending data to MySQL through Python
4. Storing the data in Database
5. Data visualization from Database

6. Web interface



1. Displaying data visualization in web interface

5.1 GETTING DATA FROM LAND USING SENSOR

Getting data from land using sensors is a common practice in many industries, such as agriculture, environmental monitoring, and mining. The process typically involves installing sensors on the ground that can measure various environmental variables, such as temperature, humidity, soil moisture, and vegetation health. The data collected by these sensors can then be used to make informed decisions about how to manage the land.

There are many types of sensors that can be used for this purpose, including:

1. Temperature sensors - These can be used to monitor the temperature of the soil or air.
2. Humidity sensors - These can be used to measure the amount of moisture in the air or soil.
3. Soil moisture sensors - These can be used to measure the amount of water in the soil, which is important for agriculture.
4. pH sensors – pH sensor help to determine the soil's acidity or alkalinity, which can significantly impact plant growth and the success of farming operations.
5. Gas sensors - These can be used to detect the presence of gases in the air, such as pollutants or greenhouse gases.

Once the data is collected, it can be transmitted to a central database or computer system for analysis. This analysis can help farmers, land managers, and other stakeholders make informed decisions about how to manage the land in a sustainable and efficient way.

5.2 PROCESS DATA WITH NodeMCU

NodeMCU is a popular open-source hardware and software platform that can be used to create a wide range of electronic projects. It can be programmed using a language based on C++ and can interface with various sensors, actuators, and other electronic components.

To process data through NodeMCU, you will need to follow these steps:

1. Choose the appropriate NodeMCU board for your project: There are various types of NodeMCU boards available with different capabilities and features. Choose a board that best fits your project requirements.

2. Connect the sensors or other input devices to the NodeMCU: Use appropriate wires or connectors to connect the sensors or other input devices to the appropriate input pins on the NodeMCU board. You may need to refer to the datasheet of the sensor or input device to determine which pins to use.

3. Write the NodeMCU code: Use the NodeMCU Integrated Development Environment (IDE) to write the code that will process the data from the input devices. The code should include instructions on how to read the input data, how to process it, and how to output the results.

4. Upload the code to the NodeMCU board: Connect the NodeMCU board to your computer using a USB cable and upload the code to the board using the NodeMCU IDE.

5. Test and refine the code: Test the code to make sure it is working as expected. Refine the code as necessary to optimize performance or add additional functionality.

6. Connect the output devices to the NodeMCU: Use appropriate wires or connectors to connect the output devices to the appropriate output pins on the NodeMCU board.

7. Test the complete system: Test the complete system to make sure that the input data is being properly processed and that the output devices are responding appropriately.

Processing data through NodeMCU can be a great way to create a wide range of electronic projects, from simple sensors and actuators to more complex systems such as robotics and automation.

5.3 SENDING DATA TO MYSQL THROUGH PYTHON

To send data to MySQL using Python, you can use the mysql-connector-python library. Here are the steps:

1. Install the MySQL Connector Python package, if not already installed.

2. Import the MySQL Connector Python module in your Python script.

3. Create a connection object by passing the host, username, password, and database name to the connect() method of the MySQL Connector module.
4. Create a cursor object by calling the cursor() method on the connection object.
5. Execute a SQL query to insert data into the desired table using the execute() method of the cursor object. Use placeholders in the query to avoid SQL injection attacks.
6. Commit the changes to the database using the commit() method of the connection object.
7. Close the cursor and connection objects using the close() method.

5.4 STORING THE DATA IN DATABASE

Storing data in a database is a common way to organize and manage information for businesses, organizations, and individuals. Databases are designed to store and retrieve data efficiently and securely, making it easy to access and manage large amounts of information.

There are many types of databases available, including relational databases, NoSQL databases, and object-oriented databases. Each type has its own strengths and weaknesses, so it's important to choose the right one for your specific needs.

When storing data in a database, it's important to design a schema that defines the structure of the data and how it will be organized. This includes defining tables, columns, and relationships between tables. It's also important to consider data integrity and security measures to ensure that data is accurate and protected from unauthorized access.

There are several popular database management systems (DBMS) available, including MySQL, Oracle, SQL Server, and PostgreSQL, each with their own features and benefits. Choosing the right DBMS for your needs will depend on factors such as the size of your database, the type of data you're storing, and your budget.

Overall, storing data in a database can provide many benefits, including improved data organization and retrieval, increased security, and easier management of large amountsof information.

5.5 DATA VISUALIZATION FROM DATABASE

To create data visualizations from a database, you will need to follow these steps:

1. Identify the data you want to visualize: Determine the data you want to analyze and the database tables or views that contain that data.

2. Connect to the database: Use a database management tool or programming language to connect to the database and retrieve the data.

3. Transform the data: If necessary, transform the data into a format suitable for visualization. For example, you may need to aggregate or filter the data to create a chart.

4. Choose a visualization tool: Select a visualization tool that can display the type of chart you want to create. There are many options, including Excel, Tableau, Power BI, and R.

5. Create the visualization: Use the selected visualization tool to create a chart that displays the data in a clear and informative way. Make sure to choose appropriate colors, labels, and titles to help viewers understand the data.

6. Share the visualization: Save or export the chart as an image, PDF, or interactive dashboard and share it with others who need to see the data.

Remember to choose the appropriate visualization type depending on the data and the message you want to convey. Line charts, bar charts, and scatterplots are some of the most common types of visualizations used to analyze data from databases.

5.6 WEB INTERFACE

A web interface is a graphical user interface (GUI) that is accessed through a web browser. It allows users to interact with web-based applications and services by using a combination of buttons, menus, forms, and other graphical elements.

Web interfaces are commonly used for a wide variety of purposes, including e-commerce websites, social networking platforms, online banking, web-based email clients, and many other types of web applications. They are often designed to be intuitive and easy to use, with a focus on providing a seamless user experience.

Web interfaces are typically built using a combination of HTML, CSS, and JavaScript, along with server-side technologies such as PHP, Java, or Python. They can also incorporate various third-party libraries and frameworks, such as React, Angular, or Vue.js, to provide additional functionality and interactivity.

Overall, web interfaces have become an integral part of modern web development, enabling developers to create rich and engaging web-based experiences that can be accessed from anywhere with an internet connection.

5.7 DISPLAYING DATA VISUALIZATION IN WEB INTERFACE

Displaying data in a web interface can be done in various ways depending on the type of data and the purpose of the interface. Here are some common ways to display data on a web interface:

1. Tables: Tables are commonly used to display structured data such as lists, schedules, and pricing plans. Tables can be formatted using CSS to make them visually appealing and user-friendly.

2. Charts and graphs: Charts and graphs are used to display data trends and comparisons in a visual format. They are commonly used for statistical data, financial reports, and analytics.

3. Images and videos: Images and videos are used to display visual content such as product photos, promotional videos, and tutorials.

4. Maps: Maps are used to display location-based data such as store locations, service areas, and delivery routes.

5. Interactive elements: Interactive elements such as sliders, filters, and drop-down menus allow users to customize their data views and interact with the data in real-time.

It's important to keep in mind the accessibility and usability of the data display, so that it is easily understandable by the users. Additionally, the design of the web interface should be responsive to different screen sizes, ensuring a consistent experience across different devices.

CHAPTER 6

RESULTS AND EVALUATION

The proposed system implementation includes a Hardware Interface along with a Cloud based Web Interface. The hardware interface includes sensors and components including, pH sensor, Humidity sensor, Soil moisture sensor, NodeMCU board and Relay switches. The cloud interface includes an AWS SQL database to maintain relational data storage of the retrieved information. The user interface includes a web application that displays a dashboard like visualization of the inferred data. The primary objective of this project is to assist novice farmers by providing them with a better understanding of their land's fertility and acting as a guide for those who are new to farming. By using a sensor-based land quality analyzer, beginners can obtain accurate and real-time data on soil properties, such as moisture, temperature, and pH levels, which are crucial for optimal crop growth.

6.1 PERFORMANCE ANALYSIS

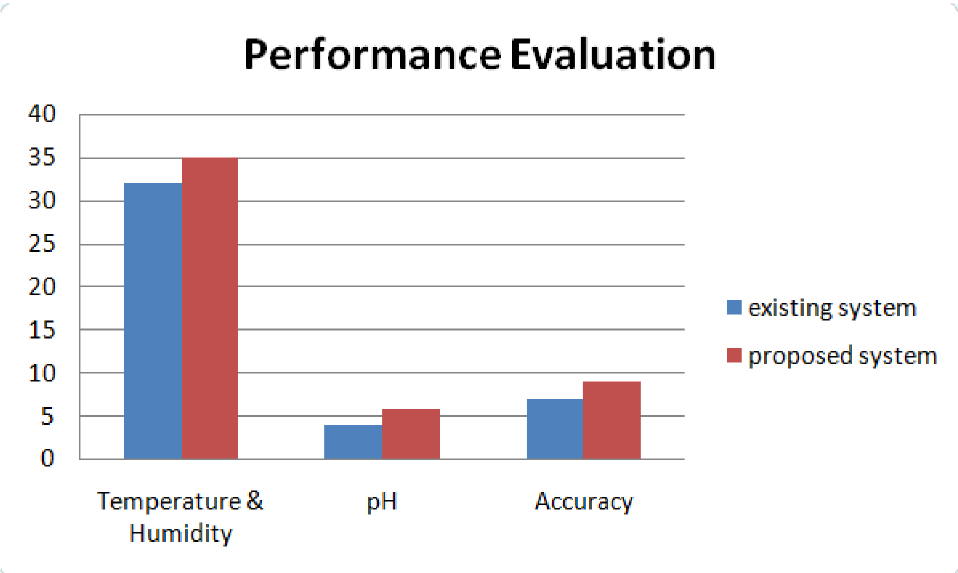


Figure 6.1 System Parameter Comparisons for Accuracy

The above graph shows the bar graph representation of a comparison between the existing system and our proposed system. The sensors used in the proposed system are updated and show slightly precise values than the existing system. They are faster and accurate compared to the older version of sensors.

6.2 COMPARISONS BASED ON FEATURE EVALUATION

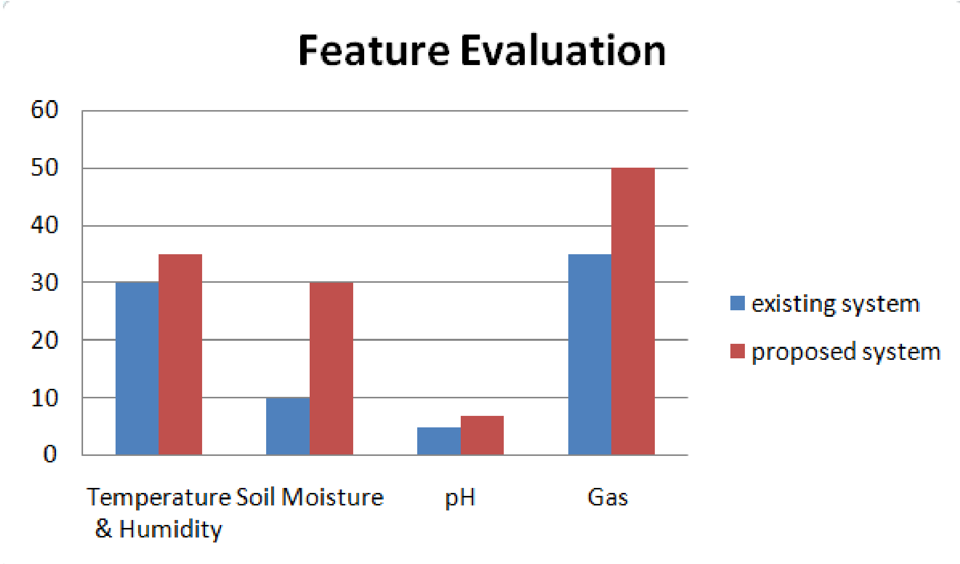


Figure 6.2 Comparison based on feature evaluation

Comparing the features of an existing system with the proposed system, most of the existing systems are a single stand-alone systems(i.e. the system consists of only one or two sensors).Whereas the proposed system is made up of a combination of 4 sensors in a single circuit that contain newly updated sensors that play a major role in determining the quality of the soil. Also the results of all the sensor outputs are shown in an interactive web page.

CHAPTER 7

7.1 CONCLUSION

The development of a sensor-based land quality analyzer using the Internet of Things (IoT) has immense potential for improving agricultural practices. The primary objective of this project is to assist novice farmers by providing them with a better understanding of their land's fertility and acting as a guide for those who are new to farming.

By using a sensor-based land quality analyzer, beginners can obtain accurate and real- time data on soil properties, such as moisture, temperature, and pH levels, which are crucial for optimal crop growth. Utilizing this information can assist individuals in making well- informed decisions, optimizing the utilization of resources, and enhancing crop yields. This approach facilitates making decisions based on data, effectively managing resources, and ultimately improving crop productivity.

Furthermore, the use of wireless sensors reduces labor and cost associated with traditional soil testing methods. Overall, the sensor-based land quality analyzer using IoT is a promising solution to the challenges facing modern agriculture.

7.2 LIMITATION

The accuracy of the land quality analyzer depends on the sensors and other IoT devices used. If the sensors are not calibrated properly or are of low quality, the results may be inaccurate. The land quality analyzer can only cover a limited area. To analyze a large area, multiple analyzers may be required, which can be costly.

There are several limitations for land quality analyzer using IoT, including:

1. Data security: IoT-based systems are vulnerable to cyber-attacks, and the data collected can be hacked, leading to data breaches or loss.
2. Limited sensor accuracy: The accuracy of IoT sensors is limited, and their readings may not be entirely reliable. This inaccuracy can result from various factors such as environmental factors, calibration issues, and the type of sensor used.
3. Power supply: IoT sensors require a power source to operate, and this can be a limitation for remote or inaccessible areas where power supply is limited.
4. Complexity: The complexity of setting up IoT-based land quality analyzers can be a limitation, requiring specialized knowledge and technical expertise

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7.3 FUTURE ENHANCEMENT

This system consists of sensors and components that are cost efficient and can be used within a certain range. In future, the system can be developed by advancing with more sensors and can be made to cover larger range of land.

Also the system can be incorporated with the latest machine learning or Artificial Intelligence concepts that can add more qualities and benefits to the system. The system can be connected to a Raspberry Pi for any advancement in future. The system can also be connected to Cloud based data storage.

By using remote sensing techniques such as satellite imagery and drone technology, the analyzer could collect data on a much larger scale, allowing for more comprehensive assessments of soil quality across larger areas. Remote sensing could also allow for real-time monitoring of changes in soil quality, which would be particularly useful for farmers and other land managers. By combining remote sensing with machine learning algorithms, the analyzer could potentially become a powerful tool for optimizing soil management practices and improving overall agricultural productivity.

The machine learning algorithms could be trained using large amounts of data collected from various regions and soil types, allowing the analyzer to make more precise recommendations for improving soil quality. Additionally, the machine learning algorithms could be designed to continuously learn and adapt to new data inputs, improving the analyzer's accuracy over time.

APPENDICES

SAMPLE SOURCE

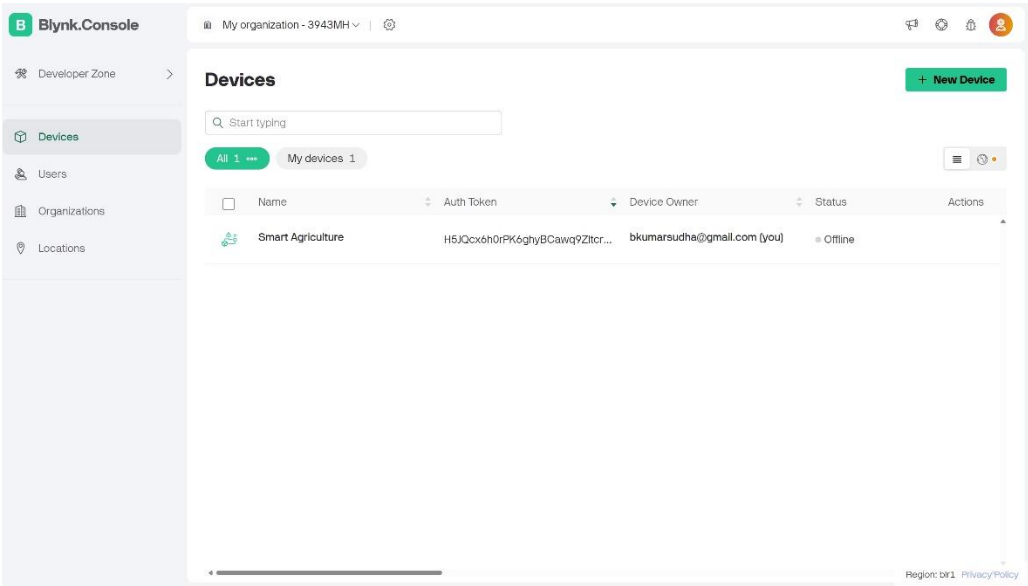
NODEMCU CODE

```
//Include the library files
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>

//Define component pins
#define soil A0
#define WaterFlow D3

char auth[] = "H5JQcx6h0rPK6ghyBCawq9ZltcrBvhq1";  //Enter your Blynk Auth token
char ssid[] = "sivaharin";  //Enter your WIFI SSID
char pass[] = "sivaharin";  //Enter your WIFI Password


volatile long pulse;
unsigned long lastTime;
float volume;
int value;

DHT dht(D1, DHT11);//(DHT sensor pin,sensor type)  D1 DHT11 Temperature Sensor
BlynkTimer timer;


void setup() {
Serial.begin(9600);
Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
dht.begin();
attachInterrupt(digitalPinToInterrupt(WaterFlow), increase, RISING);
//Call the function
timer.setInterval(100L, soilMoistureSensor);
timer.setInterval(100L, DHT11sensor);
}

//Get the DHT11 sensor values
void DHT11sensor() {
float h = dht.readHumidity();
float t = dht.readTemperature();

if (isnan(h) || isnan(t)) {
Serial.println("Failed to read from DHT sensor!");
return;
}
Blynk.virtualWrite(V0, t);
```

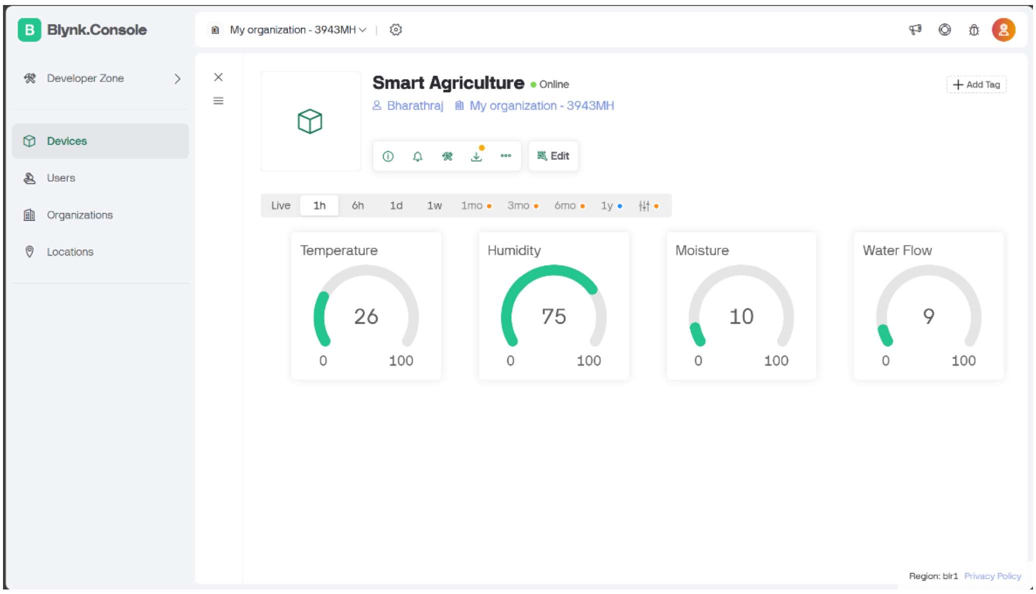
```
Blynk.virtualWrite(V1, h);

Serial.print("T:");
Serial.println(t);

Serial.print("H:");
Serial.println(h);

}


//Get the soil moisture values
void soilMoistureSensor() {
value = analogRead(soil);
value = map(value, 0, 1024, 0, 100);
value = (value - 100) * -1;

Blynk.virtualWrite(V2, value);
Serial.print("S:");
Serial.println(value);
if(value <= 10){
}
else{
}

}

void loop() {
volume = 2.663 * pulse / 2000 * 30;
if (millis() - lastTime > 2000) {
pulse = 0;
lastTime = millis();
}
Blynk.virtualWrite(V3, volume);
Serial.print(volume);
Serial.println(" L/m");
Blynk.run();//Run the Blynk library
timer.run();//Run the Blynk timer
}
ICACHE_RAM_ATTR void increase() {
pulse++;
}
```

SCREENSHOT

DASH BOARD



TEMPERATURE, HUMIDITY, MOISTURE AND WATER FLOW



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