Ph and Soil moisture monitoring System

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***Abstract*-** This study presents the use of a pH sensor and a soil moisture sensor to monitor the health of plants. These sensors aid in determining the water's and soil's moisture content. The goal is to use an Arduino to process the sensor data and show the outcomes on a 16x2 LCD screen for convenient monitoring. This approach assists gardeners and farmers in making knowledgeable choices regarding soil treatment and irrigation. A microprocessor is built into the system to analyze data and provide real-time monitoring, while sensors are used to measure the pH and moisture content of the soil. A digital interface receives the gathered data.

***Keywords:* Knowledgeable, Treatment and irrigation Determining, Microcontroller.**

I.INTRODUCTION

A pH and soil moisture monitoring system provides a modern, automated solution to address these challenges . By leveraging sensors to measure soil pH and moisture levels, the system enables farmers and agricultural researchers to collect accurate and real-time data. A pH and soil moisture monitoring system offers a solution to these challenges by providing real-time data on soil conditions**.** By integrating advanced sensors with microcontroller-based systems, this technology enables precise measurement of pH levels and moisture content. Soil health, a critical factor in agricultural productivity, is determined by various parameters, including soil pH and moisture levels. A pH and soil moisture monitoring system addresses these limitations by leveraging sensor technology, microcontrollers, and real-time data analysis to provide accurate and timely information about soil conditions. The development and implementation of this system are particularly relevant in the context of precision agriculture, where resources are optimized to maximize crop productivity while minimizing environmental impact. By empowering farmers with actionable insights, the pH and soil moisture monitoring system represents a significant step toward transforming traditional farming into a more efficient, resilient, and eco-friendly process.

II. LITERATURE REVIEW

The integration of technology into agriculture has been a significant focus of research in recent years, particularly in the domain of soil health monitoring. Soil pH plays a pivotal role in determining nutrient availability and microbial activity in the soil **[1].** Soil pH plays a pivotal role in determining nutrient availability and microbial activity in the soil **[1].** Research by Ismaili et al (2024) emphasized the need for real-time monitoring of soil pH to prevent nutrient imbalances and optimize fertilization **[1]**. Their study demonstrated the use of pH sensors integrated with microcontrollers to provide accurate and continuous data **[1]**. Similarly, N. H. M. et al. (2024) developed a low-cost, portable soil pH monitoring device that utilized electrochemical sensors, proving effective in field applications for small-scale farmers**[2].** The integration of pH and moisture monitoring into a single system has been explored to provide comprehensive soil health assessments **[2].** Abo-Zahhad, M. M. et al. (2023) developed a prototype using Arduino **[3]**. The results demonstrated significant improvements in irrigation efficiency and fertilizer management **[3].** M. et al. (2024) implemented machine learning algorithms to analyze pH and moisture data, predicting crop performance and optimizing resource usage **[4].** The application of pH in agriculture has further enhanced the capabilities of monitoring systems. Studies, such as by W. et al. (2024) have highlighted the role of Automated irrigation systems, driven by pH and moisture data, have been shown to reduce labor dependency and improve precision **[5].**

III. METHODOLOGY

Embedded systems are specialized computing systems that are designed to perform a specific task or function within a larger system **[1]**. These systems are "embedded" in devices like cars, medical equipment, home appliances, robots, etc **[1].** An embedded system typically consists of both hardware and software tailored to meet the functional requirements of the application **[2]**. Real-life embedded systems using Arduino are an excellent way to demonstrate how embedded systems can be applied practically **[3]**. Arduino, a popular open-source electronics platform, provides a straightforward approach to creating interactive and real-time systems **[4].** It is particularly favored for its simplicity, ease of use, and a wide variety of compatible sensors, actuators, and communication modules. Moisture refers to the presence of water in a substance, such as soil, air, or materials **[4].** In agriculture and gardening, soil moisture is crucial for plant growth, as it determines the availability of water for roots **[3].** Measuring moisture levels helps prevent over watering or under watering, ensuring optimal plant health **[4].** Various sensors, like capacitive or resistive soil moisture sensors, detect the water content in the soil. Moisture levels fluctuate based on weather, irrigation, and soil type **[4].** Maintaining the right soil moisture balance improves water conservation and enhances plant productivity **[3].** A capacitive or resistive soil moisture sensor is employed to measure the volumetric water content of the soil **[5].** Arduino or similar microcontrollers are used to collect data from sensors and process it for further transmission **[4].** The system is deployed in different soil types and environmental conditions to test its performance and reliability **[4].** Optimize hardware and software to reduce energy consumption and improve data accuracy **[5].**

III.A. MODELLING

The smart agriculture system is conceptualized using a model that integrates hardware, software, and environmental interactions. The model is divided into three primary modules:

1. **Hardware Module**:

   The hardware module consists of several key components, including the Arduino UNO microcontroller, various sensors, and actuators, which work together to enable the system's functionality.

- **Microcontroller**:
  The **Arduino UNO** serves as the core processing unit, managing the communication between sensors andactuators while executing programmed instructions.

Fig1: Arduino UNO

- **Sensors**:
  The module is equipped with the following sensors for real-time data collection:
  - **Soil Moisture Sensor**: Measures the moisture content in the soil to determine the need for irrigation.

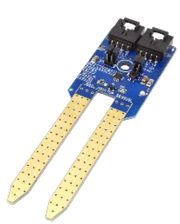


Fig2: Soil Moisture Sensor

○ **pH sensor:** Measure the pH of given water which need for irrigation **.**

Fig3: pH sensor

A pH Sensor is designed to measure the acidity or alkalinity of the water, which directly affects plant growth. It works by detecting the hydrogen ion concentration in the water and converting it into a voltage output, which is then processed into a pH value.

● **Output:**
The Liquid Crystal library allows you to control LCD displays that are compatible with the Hitachi HD44780 driver

Fig4: Liquid Crystal Displays (LCD)

2. **Software Module**:

- Utilizes the Arduino IDE for programming the system logic, defining thresholds for irrigation, and analyzing environmental conditions.

- Data is processed to determine actions, such as triggering irrigation or monitoring water levels.

3. **Environment Module**:

- Represents the physical farm environment, including soil, water and different chemical with water.
- The system interacts with this module by responding to changes in environmental parameters to optimize farming operations.

The interaction between these modules ensures a closed-loop control system where real-time data acquisition, processing, and actuation work seamlessly to achieve resource optimization and enhance productivity. The model provides a foundation for understanding the system's operation and serves as a blueprint for its implementation.

IV. RESULTS AND DISCUSSION

IV.A. Simulation Design

The pH and soil moisture monitoring system's data are consistent and dependable, and the LCD does a good job of showing the pH and soil moisture condition. When calibrated properly, the pH values fall within a suitable range, and the machine accurately determines whether the soil is wet or dry. The system optimised irrigation decisions in field experiments by providing real-time feedback. The system's ability to encourage better agricultural practices was demonstrated when it successfully warned users to check the pH levels when they deviated from the recommended range.

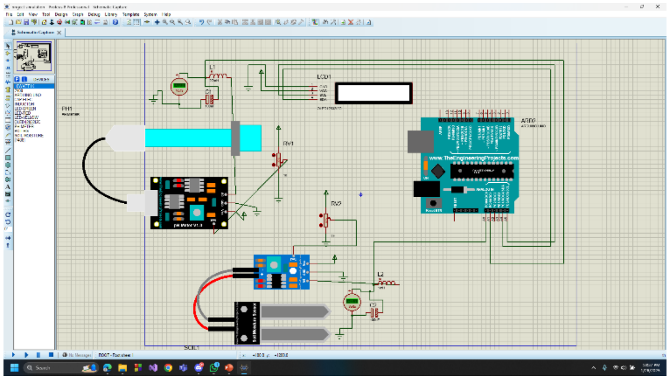


Fig5: Simulation Design

IV.B. Hardware Implementation

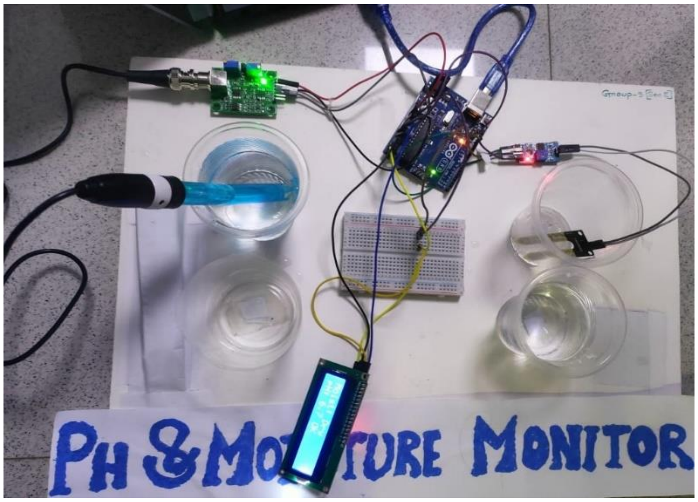


Fig6: pH & Moisture Monitoring

IV.C. Experimental Results

Using sensors that are linked to a microcontroller, the pH and soil moisture monitoring system continuously assesses the state of the soil. It uses a voltage-to-pH conversion to determine pH and categorizes the soil as "Wet" or "Dry" according to moisture content. The LCD provides real-time feedback, indicating "Check pH" if remedial action is required or "pH OK" if the soil is dry and the pH is within the optimal range. Every two seconds, the system refreshes, offering useful information for improved fertilization and irrigation. Reliable findings depend on accurate sensor calibration, which makes this system a useful tool for raising agricultural sustainability and production.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Initialize the LCD (set the I2C address to 0x27, adjust if necessary)
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Pin definitions
const int moisturePin = A0;  // Moisture sensor pin
const int phPin = A1;       // pH sensor pin

// Thresholds
const int moistureThreshold = 500; // Adjust based on your sensor's calibration
const float phMin = 5.0;
const float phMax = 8.0;

void setup() {
  lcd.begin(16, 2); // Initialize the LCD with 16 columns and 2 rows
  lcd.backlight();
  lcd.print("Initializing...");
  delay(2000);

  lcd.clear();
  lcd.print("Moisture & pH");
  delay(2000);

  lcd.clear();
  pinMode(moisturePin, INPUT);
  pinMode(phPin, INPUT);
}

void loop() {
  // Read sensor values
  int moistureValue = analogRead(moisturePin);
  int phValueRaw = analogRead(phPin);

  // Convert pH sensor value to voltage (0-5V range)
  float voltage = phValueRaw * (5.0 / 1023.0);

  // Convert voltage to pH value (calibration may vary)
  float phValue = 3.5 * voltage; // Adjust the multiplier based on sensor calibration
```

```
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Moisture: ");
  if (moistureValue > moistureThreshold) {
    lcd.print("Dry");
  } else {
    lcd.print("Wet");
  }

  lcd.setCursor(0, 1);
  lcd.print("pH: ");
  lcd.print(phValue, 1);

  if (moistureValue > moistureThreshold && phValue >= phMin && phValue <= phMax) {
    lcd.setCursor(0, 1);
    lcd.print("pH OK");
  } else if (moistureValue > moistureThreshold) {
    lcd.setCursor(0, 1);
    lcd.print("Check pH");
  }

  delay(2000); // Wait for 2 seconds before next reading
}
```

Fig8: Code Setup

V. CONCLUSION

In conclusion, by giving real-time information on soil conditions, the pH and soil moisture monitoring system provides a workable way to enhance agricultural practices. The device helps farmers make educated decisions about fertilisation and irrigation by continuously monitoring pH and moisture levels, which ultimately maximises resource utilisation and supports sustainable farming. Although precise sensor calibration is essential for trustworthy outcomes, the system's ease of use, low cost, and efficiency make it a useful tool for both large and small farms.

VI. FUTURE WORK

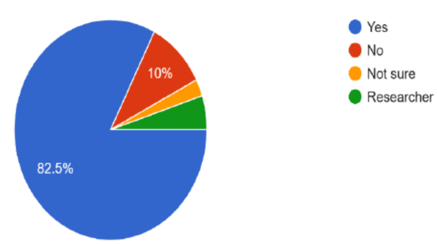
- **Advanced Analytics**: Incorporating machine learning to analyze historical data for predictive insights, such as pest outbreak forecasts and optimal planting schedules.
- **Scalability**: Expanding the system to accommodate larger agricultural setups and diverse crop types.
- **User-Friendly Interface**: Developing a mobile or web application to provide farmers with intuitive controls and real-time data visualization.

VII. APPENDIX

Smart Agriculture System: Leveraging Technology for Sustainable Farming

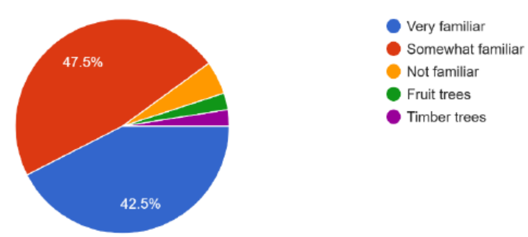
1. Have you heard about smart watering systems like pH Flow?

40 responses

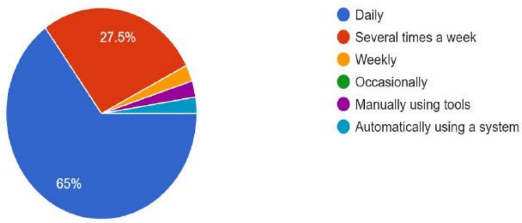


2. How familiar are you with soil moisture and pH control in gardening?

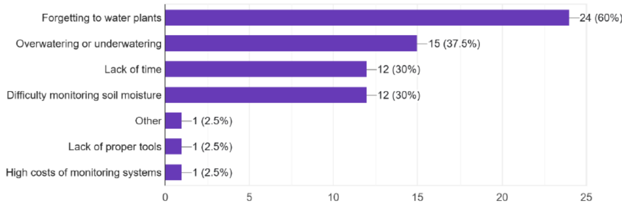
40 responses



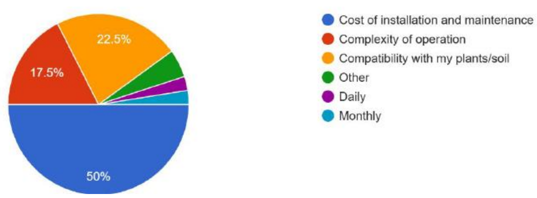
3. How often do you water your plants manually?
40 responses



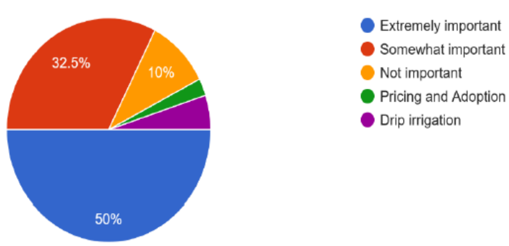
4. What challenges do you face with manual plant watering?
40 responses



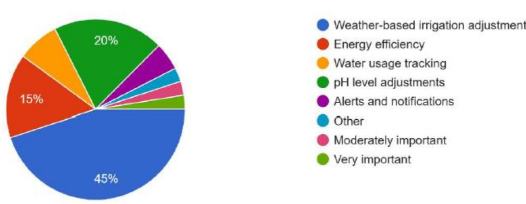
5. What challenges do you foresee in using a smart watering system like pH Flow?
40 responses



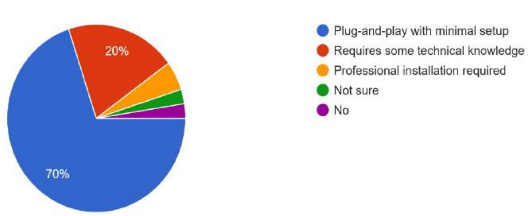
6. How important is it for the system to have energy-efficient components?
40 responses



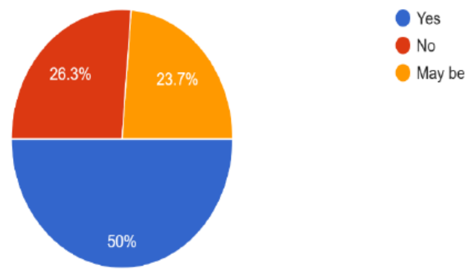
7. Which additional features would you like in a smart watering system?
40 responses



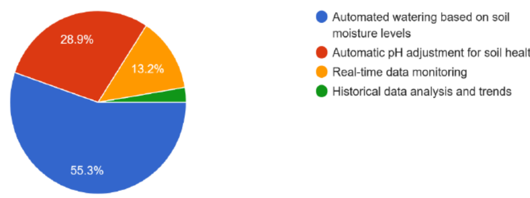
8. How easy should it be to set up a system like pH Flow?
40 responses



9. Would you prefer a system that integrates additional sensors?
38 responses



10. Which feature of pH Flow appeals to you the most?
38 responses



VIII. REFERENCES

[1] Ismaili, S., Idrizi, F., Rustemi, A., Ibraimi, M., & Idrizi, H. (2024, September). IoT-Based Irrigation System for Smart Agriculture. In *2024 XXXIII International Scientific Conference Electronics (ET)* (pp. 1-6). IEEE.

[2] Mahmudin, N. S. A., & Radzi, N. H. M. (2024). Application of Internet of Things (IoT) on Monitoring EC and pH Values for Fertigation System. *Journal of Advanced Research in Applied Mechanics*, *126*(1), 188-206.

[3] Abo-Zahhad, M. M. (2023). IoT-Based Automated Management Irrigation System Using Soil Moisture Data and Weather Forecasting Adopting Machine Learning Technique. *Sohag Engineering Journal*, *3*(2), 122-140.

[4] Shahab, H., Iqbal, M., Sohaib, A., Khan, F. U., & Waqas, M. (2024). IoT-based agriculture management techniques for sustainable farming: A comprehensive review. *Computers and Electronics in Agriculture*, *220*, 108851.

[5] Qian, M., Qian, C., Xu, G., Tian, P., & Yu, W. (2024). Smart Irrigation Systems from Cyber–Physical Perspective: State of Art and Future Directions. *Future Internet*, *16*(7), 234.