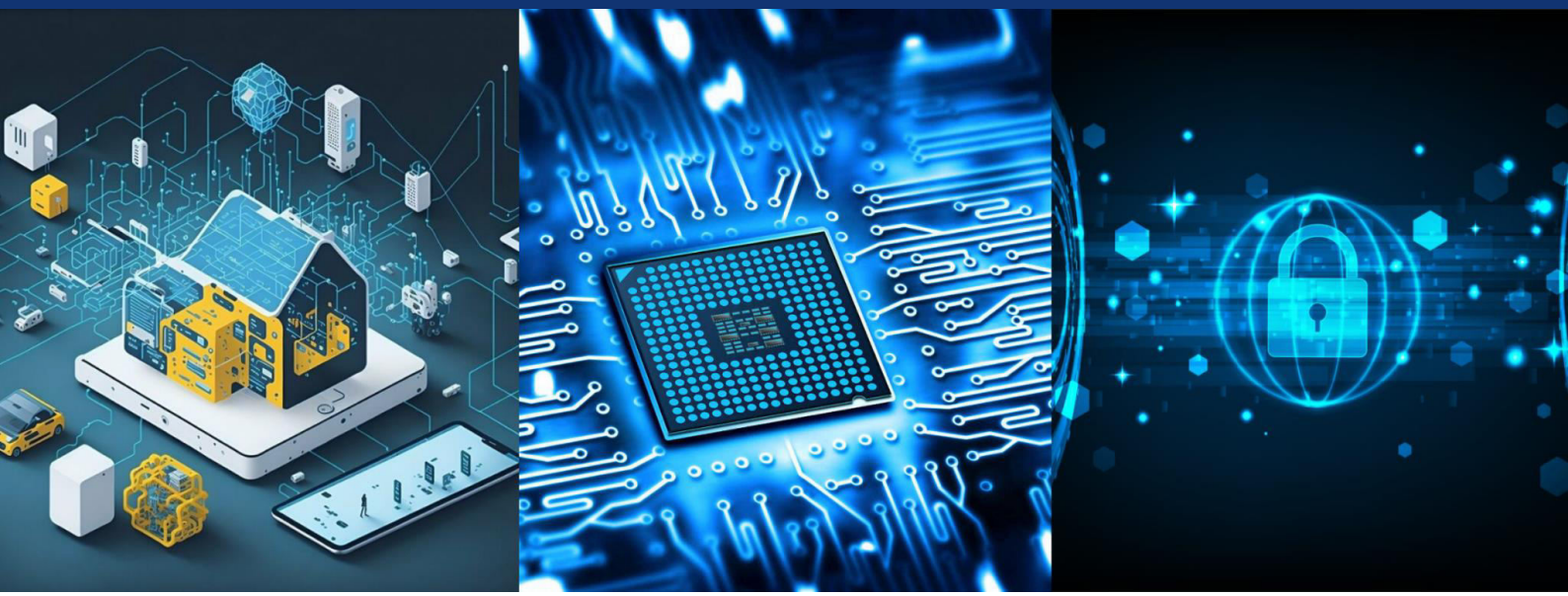
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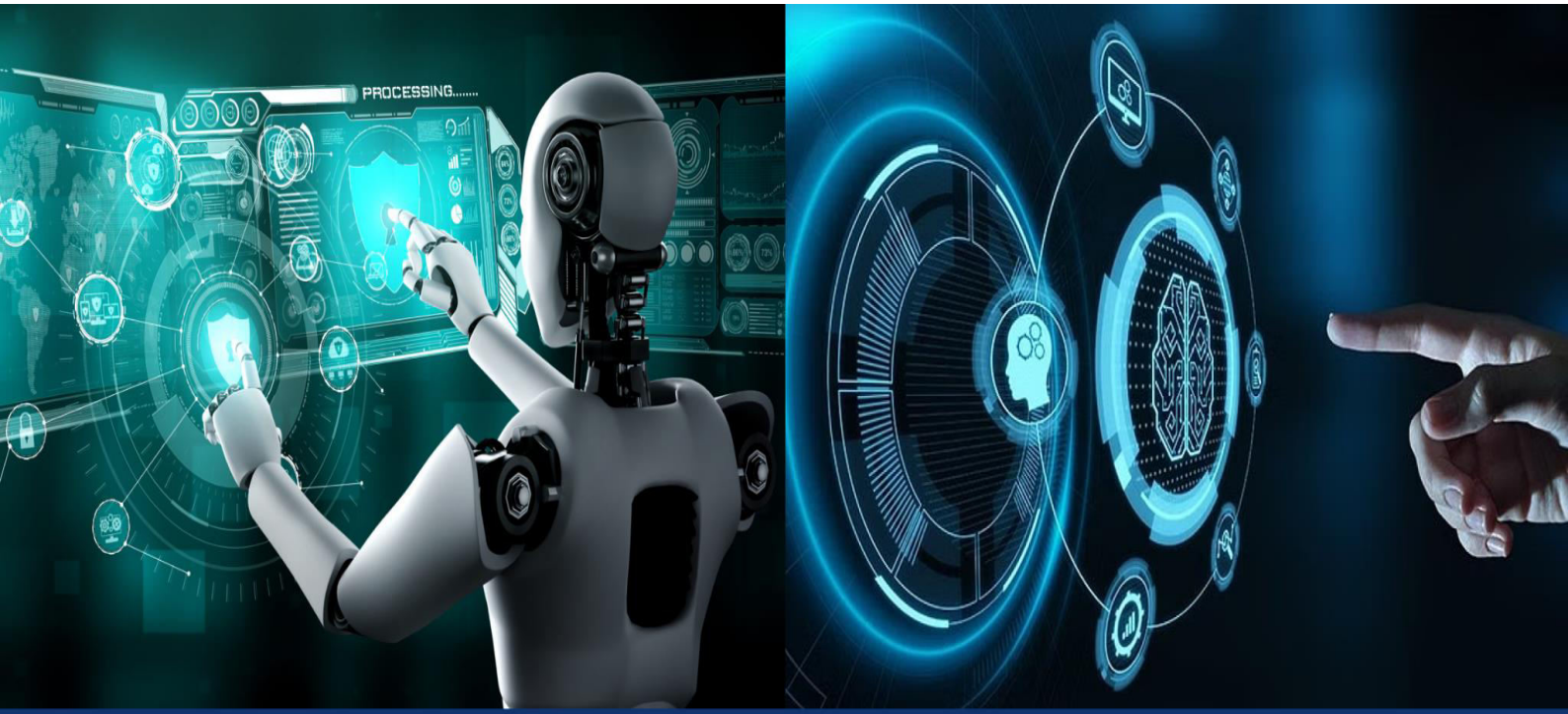
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Smart Agriculture System Design for Soil Testing and Crop Recommendation using IOT Techniques

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ABSTRACT: Agriculture plays an important role in food production and economic development. Traditional farming methods often depend on manual observation, which can lead to inefficient water usage and poor crop management. This research proposes an Internet of Things (IoT)-based smart agriculture system that monitors important environmental conditions such as soil moisture, temperature and humidity. Sensors collect real-time information and send it to a monitoring platform. The collected information helps farmers understand field conditions and make better decisions regarding irrigation and crop management. The proposed system aims to improve agricultural productivity, reduce manual effort and support sustainable farming practices.

KEYWORDS: Smart Agriculture, Internet of Things, IoT, Soil Moisture, Sensors, Precision Farming.

I. INTRODUCTION

Agriculture is one of the most important sectors in the world. Farmers depend on suitable environmental conditions for successful crop production. However, traditional farming methods often require continuous manual monitoring of soil and weather conditions.

Changes in soil moisture, temperature, and humidity can affect crop growth. Without proper monitoring, farmers may not identify these changes at the correct time. Manual observation also requires additional time and effort.
To overcome these challenges, this paper proposes an IoT-based Smart Agriculture System that uses sensors and artificial intelligence for real-time agricultural monitoring.

The system uses Arduino to collect environmental information through soil moisture, temperature, and humidity sensors. Python is used to process the collected sensor readings, while a web dashboard provides a visual representation of the data.

The AI analysis component helps identify unusual readings and provides information about changing environmental conditions.

The main contributions of this work are:

- Real-time collection of agricultural environmental data using Arduino sensors.
- Monitoring of soil moisture, temperature, and humidity.
- Processing of sensor information using Python.
- AI-based analysis to identify unusual environmental conditions.
- Web-based dashboard for displaying sensor readings and monitoring agricultural conditions.
- Integration of hardware and software components into a single monitoring system.

II. RELATED WORK

Several technologies have been developed to improve agricultural monitoring and farming practices.

1. IoT-Based Agriculture Monitoring:
   IoT technology connects physical sensors to computing systems. It allows farmers to collect environmental information such as soil moisture, temperature, and humidity without depending entirely on manual observation.

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2. Arduino-Based Sensor Systems:
   Arduino is commonly used in sensor-based applications because it supports the connection of different sensors and provides a simple method for collecting environmental data.
3. Artificial Intelligence in Agriculture
   Artificial intelligence helps analyze collected information, recognize patterns, and identify unusual environmental conditions. AI-based analysis can support farmers in understanding changes in agricultural environments.
4. Web-Based Monitoring Systems
   Web dashboards provide a visual interface for displaying sensor readings. They allow users to monitor environmental parameters through charts, values, and other graphical representations.

The proposed system combines these technologies into a single platform for agricultural monitoring.

III. THE PROPOSED SYSTEM AND ALGORITHM INCLUDE THE FOLLOWING

A. Design Considerations

The proposed Smart Agriculture System is designed to monitor important environmental parameters using IoT technology.

The system consists of Arduino hardware, soil moisture sensors, temperature sensors, humidity sensors, Python-based processing, an AI analysis component, and a web dashboard.

The main design considerations include:
- Continuous collection of environmental information.
- Accurate reading and processing of sensor data.
- Efficient communication between hardware and software.
- Identification of unusual environmental conditions through AI analysis.
- Simple and understandable presentation of information through a web dashboard.

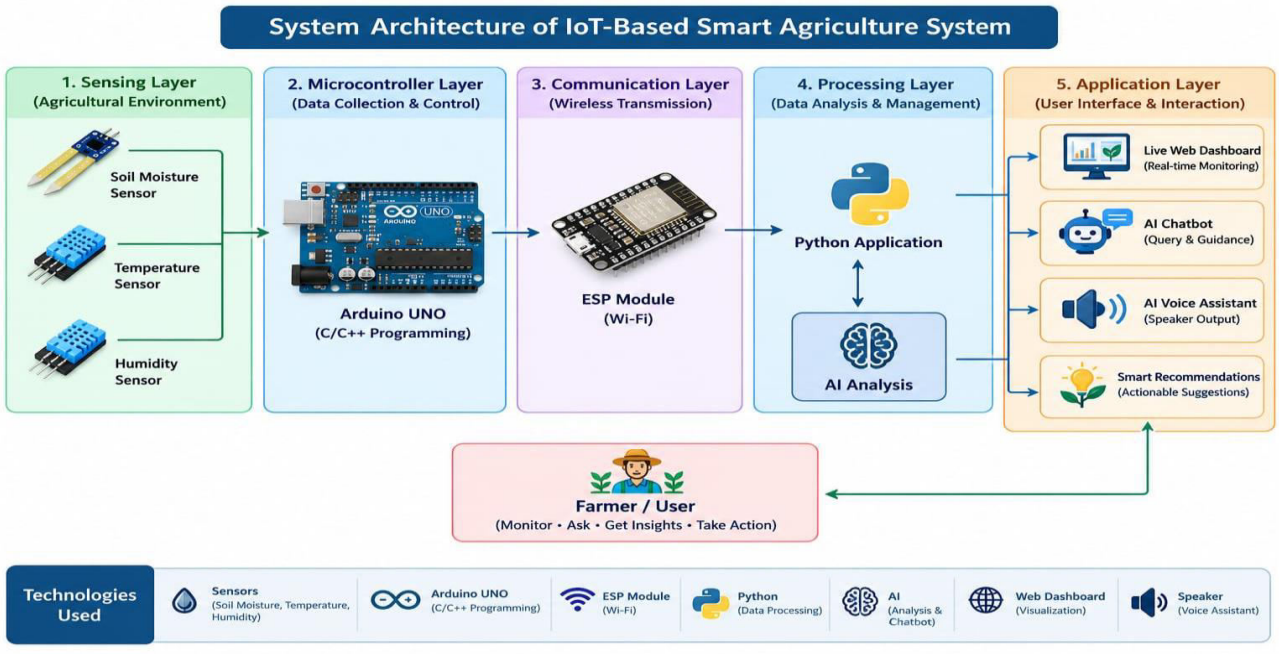


Figure 1 Architecture

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B. System Workflow

Step 1: Sensor Data Collection

The Arduino board is connected to soil moisture, temperature, and humidity sensors. These sensors collect environmental information from the agricultural surroundings.

Step 2: Data Acquisition and Processing

The sensor readings are transferred to the Python application. Python receives, processes, and organizes the collected information into a suitable format.

Step 3: AI-Based Analysis

The AI component analyzes the collected sensor information. It examines environmental readings and helps identify unusual conditions that may require attention.

Step 4: Dashboard Presentation

The processed information is displayed on a web dashboard. Users can observe soil moisture, temperature, and humidity readings and understand changes in environmental conditions.

C. Sensor Monitoring

The system uses three main types of sensors:

1. Soil Moisture Sensor

Measures the moisture level present in the soil. It helps identify whether the soil is relatively dry or moist.

2. Temperature Sensor

Measures the surrounding temperature. Temperature information helps users understand the environmental conditions affecting agricultural activities.

3. Humidity Sensor

Measures the humidity level in the surrounding environment. It provides information about changes in atmospheric moisture.

D. AI-Based Analysis

The AI component is used to analyze the sensor readings collected from the agricultural environment.

It examines the available information and helps identify unusual changes in environmental parameters. Based on the analysis, the system can provide useful information through the monitoring interface.

This approach supports better understanding of agricultural conditions and helps reduce dependence on continuous manual observation.

E. Algorithm

The proposed system follows these basic operations:

1. Initialize the Arduino board and connected sensors.
2. Read soil moisture values.
3. Collect temperature readings.
4. Collect humidity readings.
5. Transfer the sensor information to the Python application.
6. Process and organize the collected readings.
7. Send the available information to the AI analysis component.
8. Analyze the readings and identify unusual conditions.
9. Display the sensor readings and analysis through the web dashboard.
10. Continue monitoring the environmental parameters

IV. PSEUDOCODE

Algorithm 1: Sensor Data Collection Using Arduino

1. Start the Arduino board.
2. Initialize soil moisture sensor.
3. Initialize temperature sensor.
4. Initialize humidity sensor.
5. Repeat while the system is running:
   - Read soil moisture value.
   - Read temperature value.

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- Read humidity value.
- Organize the collected readings.
- Transmit the sensor data to Python.

6. Continue collecting sensor information.
7. Stop when the system is switched off.

Algorithm 2: Data Processing and AI Analysis Using Python
1. Start the Python application.
2. Establish communication with the Arduino.
3. Receive sensor readings.
4. Validate the received information.
5. Process the sensor readings.
6. Provide the readings to the AI analysis component.
7. Analyze the environmental information.
8. Identify unusual conditions based on the implemented analysis.
9. Generate analysis information.
10. Update the web dashboard with the latest readings and analysis.
11. Repeat the process for new sensor readings.

Algorithm 3: Web Dashboard Monitoring
1. Start the web application.
2. Load the monitoring interface.
3. Receive the processed sensor information.
4. Display soil moisture readings.
5. Display temperature readings.
6. Display humidity readings.
7. Display available AI analysis.
8. Update the displayed information when new readings arrive.

V. RESULTS AND DISCUSSION

The Smart Agriculture System integrates Arduino-based sensors, Python programming, AI analysis, and a web dashboard to provide agricultural environmental monitoring.

The system collects sensor readings and makes the information available through the monitoring interface.

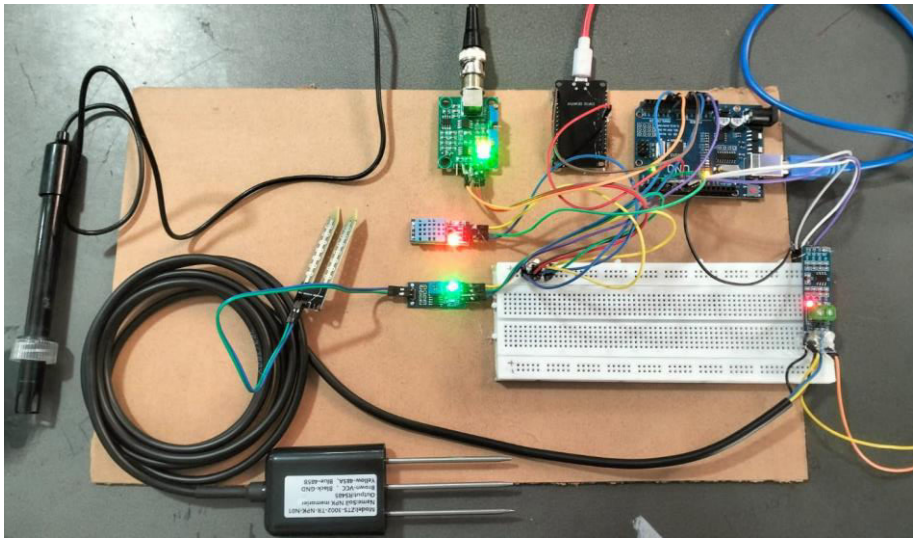


Figure 2 Physical Hardware Setup

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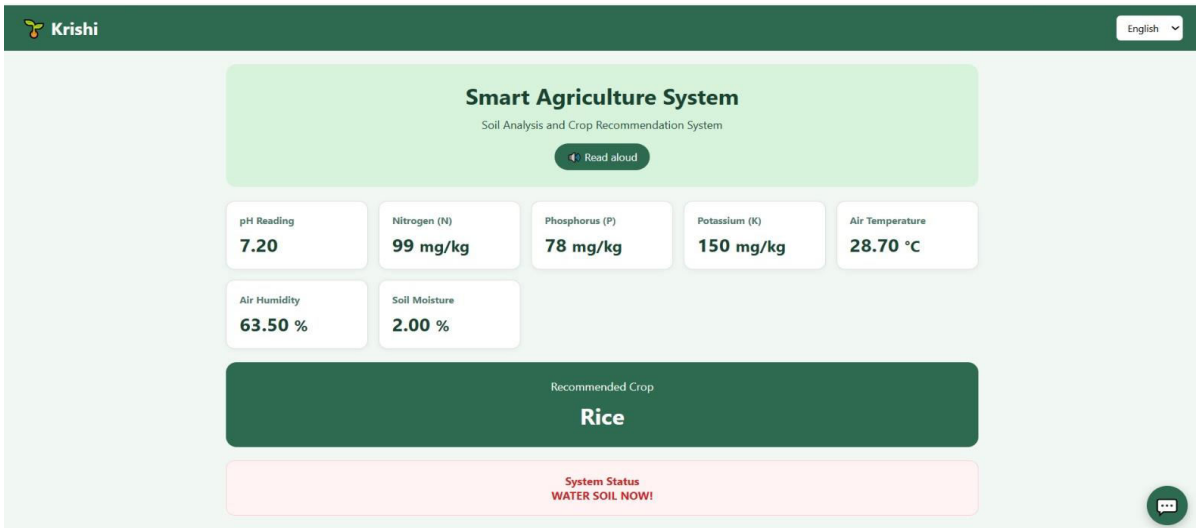


Figure 3 Homepage of the Software

The following functional capabilities are addressed:
1. Sensor Data Collection
The Arduino board collects environmental readings using soil moisture, temperature, and humidity sensors.
2. Data Processing
Python receives and processes the sensor information for further analysis and presentation.
3. AI-Based Analysis
The AI component analyzes the collected information and helps identify unusual environmental conditions.
4. Live Dashboard Monitoring
The web dashboard displays the available sensor readings and analysis information, allowing users to monitor agricultural conditions.
5. Integrated System Operation
The hardware and software components work together to provide a unified agricultural monitoring platform.
The system demonstrates the use of IoT and AI technologies for improving agricultural monitoring and supporting data-based farming decisions.

VI. CONCLUSION AND FUTURE WORK

This paper presents an IoT-based Smart Agriculture System that integrates Arduino sensors, Python programming, artificial intelligence, and a web-based dashboard for real-time environmental monitoring.

The system collects soil moisture, temperature, and humidity readings and processes the information for AI-based analysis. The web dashboard provides an accessible interface for observing environmental conditions and understanding changes in agricultural surroundings.

The proposed system helps reduce manual monitoring efforts and supports better awareness of agricultural conditions. It demonstrates how modern technologies can be integrated to support smart and sustainable agriculture.

VII. FUTURE WORK

Several improvements can be considered for future development:
- Integration of automatic irrigation based on soil moisture conditions.
- Addition of NPK sensors for monitoring soil nutrients.
- Implementation of crop recommendation systems.
- Integration of weather forecasting.
- Development of a mobile application for farmers.

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- Improvement of AI models for more accurate agricultural predictions.
- Expansion of the system to support multiple agricultural fields.

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