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SMART AGRICULTURE:IoT-BASED CROP MONITORING AND MANAGEMENT SYSTEM

PROJECT PHASE I REPORT

Submitted by

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ABSTRACT

To improve crop monitoring and management, the suggested smart agricultural system makes use of IoT, image processing, and machine learning. To gather data on soil and ambient conditions in real time, the system incorporates a number of sensors, including as water level, pH, humidity, and temperature sensors. When important characteristics, such low water levels, are identified, the user is notified automatically. This data is processed and saved for decision-making purposes. Cameras take field photos of paddy crops for weed detection, and Convolutional Neural Networks (CNN) and Gradient Boosting are used to evaluate the images.These models classify and identify weed growth with high accuracy, enabling farmers to take timely action to optimize crop health and resource utilization. By combining IoT and AI-driven technologies, the system improves agricultural efficiency, reduces manual intervention, and promotes sustainable farming practices, addressing critical challenges in modern agriculture.

Keywords–IoT Based Agriculture, Yield Improvement, deep learning , Weed Detection,Crop-Health,Optimization

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LIST OF ABBREVIATIONS

IOT	-	Internet of Things
pH	-	Potential of Hydrogen
SMS	-	Short Message Service
API	-	Application Programming Interface
ML	-	MachineLearning
DHT	-	Digital Humidity and Temperature
LED	-	Light Emitting Diode
IoT Sensor	-	Internet of Things Sensor
CNN	-	Convolutional Neural Network
MCU	-	Microcontroller Unit

CHAPTER 1
INTRODUCTION

1.1 GENERAL

Innovation in agriculture has become necessary due to the growing need for food worldwide, as well as the problems caused by resource constraints, labor shortages, and climate change. Even though they worked well in the past, traditional farming methods frequently fall short of the requirements of contemporary agricultural productivity. In order to address important issues in crop monitoring, weed detection, and management, this project suggests a Smart Agriculture System that combines the Internet of Things (IoT), image processing, and machine learning. This system attempts to increase production, lower expenses, and support sustainable farming methods by automating and optimizing agricultural processes.The core of the system is built around IoT-based sensor networks, which provide real-time monitoring of environmental and soil conditions. Sensors such as temperature, humidity, pH, soil moisture, and water level sensors continuously gather data from the field. This data is processed and analyzed to detect deviations from optimal conditions, ensuring that farmers are promptly informed through an automated notification system. Alerts are sent to users via SMS, email, or mobile applications, enabling timely interventions to address critical issues such as water shortages or unsuitable environmental conditions. This reduces the need for constant manual monitoring, saving both time and labor while improving the efficiency of resource utilization.A significant innovation in this project is the Weed Detection System, which targets unwanted plant growth in crops, particularly paddy fields.Weed growth is a persistent problem in agriculture, as itcompetes with adjusting to crops for essential nutrients, water, sunlight, and space, ultimately affecting crop yield. The suggested system employs cameras to take high-resolution field photos, which are subsequently processed using image processing methods and subjected to machine learning models for analysis. In particular, gradient boosting is utilized for classification, while convolutional neural networks (CNNs) are used to extract features like texture, color, and form from the images. This combination ensures accurate differentiation between crop plants and weeds. The system then marks the areas with weed growth, providing actionable insights to farmers for weed removal. This automated approach minimizes the reliance on manual identification, reduces chemical usage, and ensures healthier crop growth.

Precision farming is being ushered in by the combination of IoT and machine learning technology in agriculture. The suggested method improves decision-making and minimizes resource waste by gathering and evaluating enormous volumes of real-time data. Additionally, by keeping farmers updated on important changes in field conditions, the automated notification system lowers the chance of crop loss and allows for proactive management.

This smart agriculture system is a step forward in achieving sustainable farming by reducing environmental impact, increasing productivity, and addressing challenges in modern agriculture. By leveraging advanced technologies, this project aims to empower farmers with tools and insights that enhance their operational efficiency and resilience to external factors. In addition, it serves as a foundation for future developments in agricultural automation, paving the way for smarter and more sustainable farming practices.

Furthermore, the proposed system emphasizes scalability and adaptability, making it suitable for various agricultural settings and crop types. While this project primarily focuses on paddy crops, the underlying technologies, such as IoT-based monitoring and AI-driven analysis, can be customized for other crops, including wheat, maize, and vegetables. The modular design ensures that additional sensors and machine learning models can be integrated as needed, allowing farmers to tailor the system to their specific requirements.

This flexibility ensures that the solution remains relevant as agricultural practices and challenges evolve.Another key aspect of the project is its user-friendly interface, which simplifies the process of accessing and interpreting data. The data collected by sensors and the results of weed detection are presented to farmers in a comprehensible format, such as graphical dashboards or mobile app notifications.These tools empower even those with limited technical expertise to make informed decisions quickly. By providing actionable insights, the system bridges the gap between advanced technology and practical farming needs.This project not only addresses immediate agricultural challenges but also contributes to long-term sustainability goals. It promotes resource conservation by optimizing water and fertilizer usage and reducing dependence on chemical weed control. Ultimately, the proposed smart agriculture system is a comprehensive solution that aligns with global efforts to improve food security, reduce environmental impact, and enhance the livelihoods of farmers.

1.1 OBJECTIVE

This project's main goal is to build and create a Smart Agriculture System that combines machine learning, image processing, and the Internet of Things to improve crop monitoring, weed identification, and farm management in general. By offering real-time data insights, facilitating accurate decision-making, and automating crucial farming procedures, this technology seeks to address major issues in contemporary agriculture.The system aims to continuously monitor soil and ambient conditions by utilizing Internet of Things-based sensors, including water level, pH, temperature, and humidity sensors. The goal is to help farmers maintain ideal growth conditions for crops by gathering data in real-time, which will increase crop output and resource efficiency. Implementing an automated weed detection module that uses Convolutional Neural Networks (CNN) and Gradient Boosting for picture classification is one of the project's main objectives. Based on particular visual attributes, this module seeks to precisely recognize and differentiate weeds from crops, especially in paddy fields. The detection system will provide actionable insights to farmers, helping them remove weeds promptly and reducing competition for resources.Another objective is to incorporate an automated notification system that alerts farmers about critical field conditions, such as low water levels or deviations in soil properties. Notifications will be sent via SMS or via Gmail, ensuring timely interventions and reducing manual labor.Ultimately, the project aims to promote sustainable agriculture by reducing resource wastage, enhancing productivity, and minimizing environmental impact. By combining technology and practical farming needs, the system aspires to empower farmers, improve decision-making, and pave the way for future innovations in precision agriculture.

1.2 EXISTING SYSTEM

Traditional agricultural systems rely heavily on manual monitoring and intervention, which are time-consuming, labor-intensive, and prone to errors. Farmers often depend on visual inspections for crop health assessment, soil quality checks, and weed identification, leading to delayed actions and inefficiencies. Additionally, conventional irrigation and pest control methods can result in resource wastage and environmental harm. Existing systems lack real-time monitoring and automated insights, making it challenging to address critical field conditions promptly. While some systems incorporate basic automation, they are often limited in functionality and fail to integrate advanced technologies like machine learning and IoT for comprehensive farm management.

1.3 PROPOSED SYSTEM

The suggested system presents a Smart Agriculture Solution that combines image processing methods, machine learning models, and Internet of Things sensors for effective crop management and monitoring. Accurate environmental monitoring is ensured by sensors that continuously gather real-time data on temperature, humidity, pH, and water levels. Convolutional neural networks (CNNs) and gradient boosting are used in a specialized weed detection module to recognize and categorize weeds, giving farmers useful information to maximize crop health. Additionally, the system has an automated notification module that sends out SMS or mobile apps to customers informing them of crucial conditions like low water levels or imbalanced soil. By addressing the shortcomings of conventional systems, this all-encompassing approach seeks to increase productivity, decrease resource waste, and encourage sustainable agricultural methods.

CHAPTER 2

LITERATURE SURVEY

[1] The study by Akhilesh Kumar Singh et al. addresses challenges in traditional farming, including water wastage and crop damage caused by animals. It proposes an IoT-based smart agriculture system that integrates sensors such as soil moisture, temperature, PIR, and rain sensors with a NodeMCU microcontroller, connecting to the Blynk mobile application for real-time alerts. This implementation optimizes water usage, minimizes crop losses, and reduces manual effort, though scalability and reliance on internet connectivity pose limitations.

[2] The integration of IoT in agriculture has significantly transformed traditional farming practices by enabling real-time monitoring and precision in resource management. The study by Kumar P and kumar S V (2023) highlights a precise and accurate farming framework utilizing IoT to improve crop productivity and sustainability. This aligns with existing research focusing on IoT sensors for monitoring environmental parameters such as temperature, humidity, soil moisture, and pH levels, which facilitate informed decision-making. Additionally, advancements like automated irrigation systems and AI-driven analytics have further enhanced precision agriculture. However, challenges such as high implementation costs, connectivity issues in rural areas, and data security concerns continue to limit widespread adoption.

[3] Because of their uses in healthcare and biodiversity conservation, the identification and classification of medicinal plants using cutting-edge image processing and machine learning approaches has attracted a lot of research interest. Because they can recognize intricate patterns in the forms, textures, and colors of leaves, Convolutional Neural Networks (CNNs) have shown themselves to be quite successful in the identification of plants.Recent advancements integrate edge-based segmentation techniques to enhance accuracy by isolating key features critical for plant recognition. Studies such as Patel et al. (2022) have combined CNNs with traditional segmentation methods to improve recognition in noisy backgrounds, while Sharma and Gupta (2023) explored hybrid deep learning models for real-time applications in plant nurseries. Despite these advancements, challenges such as variability in lighting conditions, occlusions, and limited datasets remain prevalent.

[4] Manoj Ravishankar et al. describe a smart agricultural system that improves crop output and resource management by utilizing sensor and Internet of Things technologies. Using sensors for temperature, humidity, light intensity, and soil moisture, the system sends data to a cloud platform via a WeMos ESP8266 microcontroller. As a result, agricultural efficiency is increased through precision irrigation and crop health monitoring. Broad adoption, however, can be hampered by issues like sensor calibration, data quality, and expensive initial setup.

[5] Gurpreet Singh and Jaspreet Singh explore IoT's transformative potential in agriculture through a systematic review of sensor-based soil monitoring, weather prediction, and irrigation systems. The study emphasizes automation and data-driven decision-making for sustainable farming. It highlights IoT's ability to optimize resources and improve crop yields while noting barriers like cost, connectivity issues, and the need for technical expertise, particularly in developing regions.

[6] Harleen Kaur et al. review IoT applications in Indian agriculture, proposing a "smart agriculture" system that combines wireless communication techniques with sensors for soil and water monitoring. The approach improves crop productivity through real-time data collection and automated management systems. Despite its benefits, such as enhanced decision-making and cost-effectiveness, the system faces challenges, including high setup costs, technical maintenance, and infrastructure dependency.

[7] Wei-Min Cheng et al. introduce the TIAGA system, a smart agriculture implementation using IoT devices and cloud-based management. Tested in real-world conditions, this system automates farming tasks, monitors environmental factors, and provides actionable insights to farmers. It demonstrated significant reductions in labor, water, and fertilizer usage while improving crop traceability and consumer trust. High initial setup costs and reliance on stable internet connectivity remain limitations.

[8] Dr. Rashmi Sharma et al. propose an IoT-enabled precision agriculture system that uses sensors to monitor soil moisture, pH, and NPK values. The system leverages machine learning for recommending optimal crops and automating irrigation. This integration improves productivity and supports sustainable farming. However, barriers such as high investment costs and the need for technical expertise may limit its application among small-scale farmers.

[9] Jian Yang et al. propose an IoT-based framework for enhancing smart agriculture, emphasizing water management and resource optimization. Sensors monitor field parameters like soil moisture, temperature, and air quality, with data analyzed on the ThingSpeak platform for automated irrigation decisions. The framework reduces manual labor and waste while enhancing crop yield, though its cost and reliance on continuous internet connectivity pose challenges.

[10]T. Rajesh et al. tackle field management challenges through an IoT-based monitoring system that uses sensors connected to an Arduino microcontroller. Data is transmitted to the cloud via a GSM module, allowing farmers to receive SMS alerts for remote field management. The system enhances productivity by automating irrigation and monitoring water levels, temperature, and humidity. Implementation costs and technical training requirements limit its scalability.

[11]MuthumanickamDhanaraju et al. explore IoT-based sustainable farming to address environmental challenges and growing food demands. The solution integrates sensors and cloud computing for precision irrigation, pest control, and yield forecasting. The approach optimizes inputs like water and fertilizers, reducing environmental impact. However, adoption barriers include high costs, connectivity issues, and data management complexities.

[12]Dr. N. Suma et al. propose a smart agriculture system using IoT to monitor and manage environmental factors such as soil moisture and temperature. Sensors transmit data to a microcontroller for automated irrigation control. The system, adaptable to different field conditions, enhances crop yields and reduces manual labor. Its reliance on stable internet connectivity and technical expertise limits its applicability in rural areas.

[13]Doru Cornei and Cristian Foșalău present a low-cost IoT sensor system for small farms, tested in real-world settings for six months. The system uses affordable, hobbyist methods for data collection and storage, demonstrating robustness and reliability under harsh environmental conditions. Despite its success in providing accessible solutions

[14]Aman Jain and Abhay Kumar propose an IoT system for real-time monitoring of agricultural parameters like soil moisture, temperature, and water levels. Using sensors integrated with an ARM7 processor, the system transmits data wirelessly to an IoT platform, enabling farmers to manage conditions remotely. While increasing productivity and reducing costs, the system's dependency on reliable internet connectivity and initial investment presents challenges.

[15]Othmane Friha et al. examine emerging IoT technologies, such as UAVs and cloud computing, for optimizing smart agriculture practices. The study reviews IoT applications in water management, disease control, and blockchain-based supply chains, emphasizing scalability and sustainability. While promising, the adoption of advanced technologies like blockchain faces challenges in terms of cost, infrastructure, and practical implementation in developing regions.

[16]Gianfranco Gagliardi et al. propose an IoT-based smart agriculture system that integrates UAVs and multispectral cameras for real-time vineyard monitoring. Using sensors to track soil moisture and vegetation health, the system improves vineyard management and grape quality. However, it requires reliable network connectivity and technical expertise, which may hinder its implementation in larger farms.

[17]Kaushik Sekaran et al. introduce an IoT-based smart agriculture management system combining sensors for real-time data collection on temperature, soil moisture, and humidity. Data is stored in the cloud and analyzed to automate irrigation and fertilization processes. The scalable architecture supports multiple crop types but depends on reliable internet infrastructure and high setup costs, challenging small-scale farmer adoption.

[18]N. S. Abu et al. highlight IoT's application in precision agriculture, focusing on data collection through real-time sensors to improve decision-making. IoT systems optimize resources like water and fertilizers, reducing waste and enhancing crop yields. The study reviews scalable IoT solutions while noting barriers such as high initial costs, data management complexities, and connectivity issues.

[19]Khalid Haseeb et al. address energy inefficiencies and security challenges in IoT-based wireless sensor networks (WSNs) for agriculture. By selecting energy-efficient cluster heads and employing lightweight encryption for secure data transmission, the framework improves network

reliability. While effective for small-scale scenarios, its application in dynamic environments with frequent changes remains untested.

[20]Chunling Li and Ben Niu propose integrating IoT with big data analytics for greenhouse agriculture. Using the K-means algorithm, the system clusters environmental data to optimize farming conditions. Simulations demonstrate improved clustering efficiency and productivity, though its reliance on data quality and stable internet connectivity may limit real-world application.

[21]Amjad Rehman et al. explore IoT-based smart agriculture systems combining sensors, drones, and wireless networks for real-time monitoring of soil moisture, irrigation, and pest control. This approach reduces labor and resource wastage, enhancing productivity. However, high setup costs, infrastructure dependency, and integration complexities limit broader implementation.

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[22]Adithya Vadapalli et al. propose an IoT-based system using sensors for monitoring soil and environmental conditions. The system automates irrigation through wireless sensor networks, optimizing water usage and crop management. While it enhances efficiency, challenges include reliance on internet connectivity, technical expertise, and high initial setup costs

CHAPTER 3
SYSTEM DESIGN

3.1 GENERAL

The proposed IoT-based smart agriculture system integrates various sensors, communication modules, and control units to monitor and manage farming operations efficiently. At its core, the system includes sensors for soil moisture, temperature, humidity, and light intensity, connected to a microcontroller such as Arduino. These sensors collect real-time data on environmental conditions, which is transmitted to a cloud platform via Wi-Fi or GSM modules.The cloud platform serves as a central repository for data storage and processing. It employs analytics algorithms to interpret sensor data and provide actionable insights. Farmers access these insights through a mobile application or web interface, which displays real-time data visualizations and sends notifications for conditions requiring intervention, such as low soil moisture or abnormal temperature levels.An actuator system, integrated with the microcontroller, automates irrigation and other farm operations based on predefined thresholds. For instance, the irrigation system activates when soil moisture levels fall below a specific value, conserving water and reducing manual labor.The design emphasizes modularity, allowing scalability for different farm sizes. It also includes security measures, such as data encryption, to ensure system reliability. By leveraging IoT and automation, the system aims to optimize resource usage, improve crop yields, and enhance agricultural sustainability.

3.1.1 ARCHITECTURE DIAGRAM

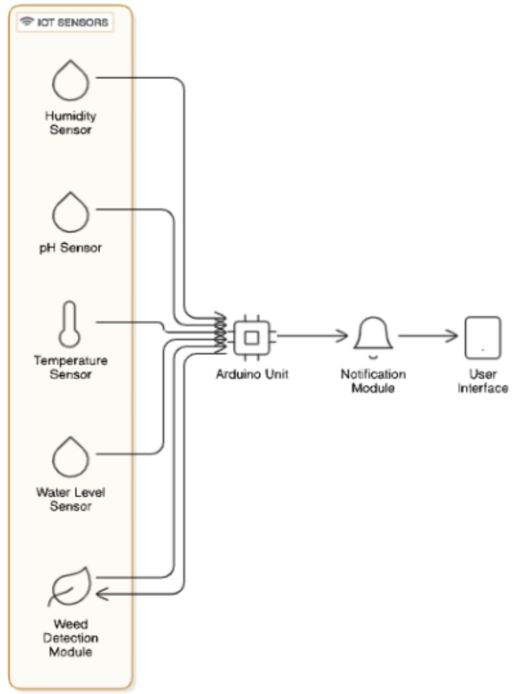

Figure3.1:Architecture Diagram

The architecture diagram illustrates a Smart Agriculture System that integrates IoT sensors, processing units, and notification modules to enable efficient crop monitoring and management. At the center of the system is the Arduino Unit, which serves as the primary location for collecting and evaluating data from a range of sensors, including those that detect water level, pH, humidity, and temperature. By continuously monitoring soil and environmental factors, these sensors provide real-time data. Additionally, the system has a Weed Detection Module that ensures targeted and effective weed control by detecting and classifying weeds in paddy fields using state-of-the-art image processing and machine learning techniques.

After gathering data from the sensors and weed detection module, the Notification Module processes the information to generate alerts. These alerts are designed to notify users about critical issues such as low water levels, improper pH levels, or the presence of weeds. The notifications are relayed to the user through a User Interface, which may be implemented as a mobile application or an SMS-based system. This interface acts as a vital connection between the farmer and the system, ensuring that actionable insights are delivered promptly to enable informed decision-making.

This system is built to advance precision agriculture by seamlessly integrating technology into traditional farming practices. Its modular design allows for scalability, enabling the addition of more sensors or functionalities as required. By automating essential processes and delivering real-time insights, the system aims to enhance productivity, minimize resource wastage, and support sustainable farming practices.

3.1.2 USE CASE DIAGRAM

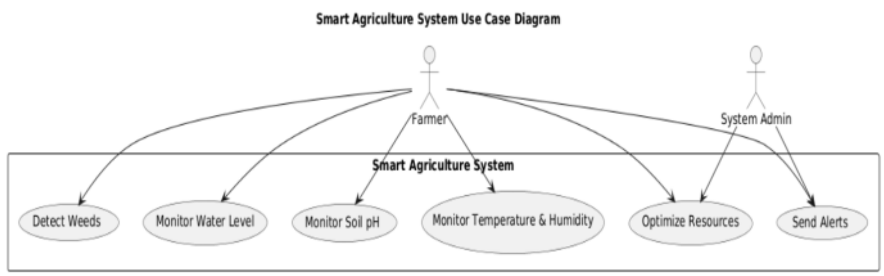

Figure3.2:Use Case Diagram

The IoT-based smart agriculture system is designed to revolutionize traditional farming practices by leveraging modern technology to monitor and manage crops effectively. To give real-time information on important environmental parameters, this system combines a number of sensors, such as those for temperature, humidity, soil pH, and water level. Farmers may use this information to make well-informed decisions that will maximize irrigation, enhance soil quality, and guarantee the general well-being of their crops.Additionally, the system includes an automated notification module that alerts users when these parameters exceed predefined thresholds, enabling timely intervention to mitigate potential risks. A unique feature of the system is its weed detection module, specifically designed for crops like paddy, which helps identify and address unwanted vegetation, reducing the reliance on manual labor and herbicides.

3.1.3 ACTIVITY DIAGRAM

Figure3.3:ActivityDiagram

The activity diagram for the IoT-based smart agriculture system illustrates the sequential flow of actions that take place in response to environmental monitoring. The process begins with continuous monitoring of key parameters such as temperature, humidity, soil pH, and water levels. These data points are collected simultaneously to provide real-time insights into the crop environment. The system then evaluates whether these parameters are within safe thresholds. If the values are optimal, the system continues monitoring. However, if any parameter exceeds or falls below the acceptable range, an alert is sent to the farmer.

3.2 CLASS DIAGRAM

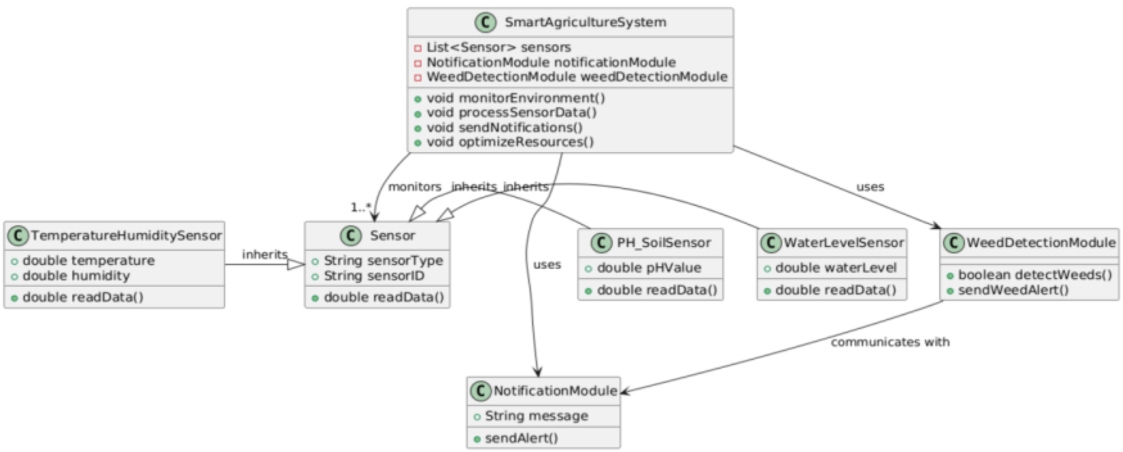

Figure3.4:Class Diagram

The class diagram for the IoT-based smart agriculture system provides a structured overview of the system's main components and their relationships. The diagram outlines the core classes, including various Sensor types (such as Temperature Humidity Sensor, PH_Soil Sensor, and Water Level Sensor), which collectively gather critical environmental data for crop monitoring. Each sensor class inherits from the general **Sensor** class, sharing common attributes like sensor type and unique ID, while offering specialized functionality to retrieve specific data. The NotificationModule class handles the communication of alerts when sensor data exceeds predefined thresholds Formars .

3.3 SYSTEM REQUIREMENTS

The proposed system requires some software and hardware requirements which help stop develop efficient IoT-Sytem. These requirements help to use the application in a productive manner to save time and efficient working.

3.3.1 HARDWARE REQUIREMENTS

The hardware requirements for the IoT-Based Smart Agriculture and Weed Detection System include a processor of Pentium IV or higher with a minimum of 4 GB RAM and 40 GB storage capacity. For image processing tasks, a Graphics Processing Unit (GPU) with at least 6 GB GDDR6/5X/5 is recommended. The system integrates an Arduino UNO microcontroller for managing sensor inputs and operations. Sensors utilized include the DHT22 for temperature and humidity measurement, a pH sensor for soil acidity, a NPK sensor, and a camera module with a minimum resolution of 1080p for weed detection. A Wi-Fi module (ESP8266) ensures seamless communication, while a 5V power adapter or battery provides the necessary power supply. Additional storage can be facilitated through an SD card with a capacity of 32 GB or higher. An optional display unit, such as an LCD or OLED, can be included for real-time monitoring. These components collectively ensure the efficient operation of the system.

COMPONENTS	**SPECIFICATION**
Processor	PentiumIVorhigher
Memory Size	4 GB RAM (Minimum)
Microcontroller	**Arduino UNO**
Sensors	DHT22 (Temperature & Humidity Sensor), pH Sensor, NPK Sensor, Camera Module

HDD/Storage	40 GB (Minimum)
Communication Module	Wi-Fi Module (ESP8266)
Power Supply	5V Power Adapter or Battery
Camera Resolution	Minimum 1080p (for Weed Detection)
Display Unit	LCD Display

Table3.1:Hardware Requirements

3.3.2 SOFTWARE REQUIREMENTS

The Software requirements for the IoT-Based Smart Agriculture and Weed Detection System include an operating system such as Windows 10/11 or Linux (Ubuntu 20.04 or higher). The project requires programming in Python (3.x) and C/C++, utilizing IDEs like Arduino IDE and Visual Studio Code for development. Image processing and machine learning tasks rely on libraries and frameworks like OpenCV, TensorFlow/Keras, and Scikit-learn.Data storage and management can be facilitated through MySQL.These software components ensure the smooth functioning and deployment of the system.

COMPONENTS	SPECIFICATION
OperatingSystem	Windows10/11(64-bit)

Software	Python(Version3.9orhigher)
Tools	Kafka
Framework	React, Node JS, TensorFlow , Scikit-learn and FastAPI

Table3.2:Software requirements

CHAPTER 4

PROJECT DESCRIPTION

4.1 MODULES

4.1.1 SENSOR DATA ACQUISITION MODULE

The Sensor Data Acquisition Module is responsible for collecting real-time environmental data from various IoT-enabled sensors deployed in the agricultural field. This module acts as the foundation of the system, ensuring accurate and continuous monitoring of critical parameters essential for crop health and resource optimization.

4.1.2 DATA PREPROCESSING AND ANALYSIS MODULE

This module processes raw sensor data using techniques like noise reduction, normalization, and formatting. The cleaned data is analyzed to derive meaningful insights about field conditions, crop health, and environmental trends. This processed data is stored in a database for future use.

4.1.3 WEED DETECTION MODULE

This module utilizes image processing and machine learning techniques, including Convolutional Neural Networks (CNN) and Gradient Boosting, to identify weeds in the field. Images captured by cameras are analyzed to differentiate between crop plants and weeds, enabling precise weed identification. Marked weed locations help farmers take targeted actions to reduce competition for resources.

4.1.4 AUTOMATED NOTIFICATION MODULE

This module is designed to notify users of critical events, such as low water levels or deviations in temperature, humidity, or pH. Based on pre-set thresholds, notifications are sent through a user interface or mobile application, allowing farmers to take immediate action.

4.1.5 COMMUNICATION MODULE

A This module handles the communication between sensors, the Arduino unit, and the user interface. Using protocols like MQTT and HTTP, it ensures seamless data transmission and system coordination

CHAPTER 5

IMPLEMENTATIONS AND RESULTS

5.1 DATA PROCESSING

The hardware configuration is the first step in putting an IoT-based smart farm system into operation. This involves installing a number of sensors, including cameras for weed identification, pH sensors, water level sensors, temperature and humidity sensors (DHT22), and more. An Arduino UNO, which acts as the microcontroller to control data collection from the sensors, is connected to these sensors. Temperature, humidity, soil pH, and water levels are among the environmental data that the sensors gather in real time. High-resolution photos of the field are taken by the camera and processed to identify weed growth. After that, all sensor data is sent to the Arduino for additional processing and analysis.

A number of procedures are involved in the fundamental processing of sensor data and weed detection. Prior to being saved in a database, sensor raw data is cleaned and standardized. Convolutional Neural Networks (CNNs) and gradient boosting are two machine learning algorithms used to handle camera-captured image data. The system can correctly recognize and categorize undesired plants thanks to these models, which are taught to differentiate between crop plants and weeds based on particular visual attributes.When weeds are found or sensor values above predetermined criteria, the user is notified based on the results of the weed detection process.

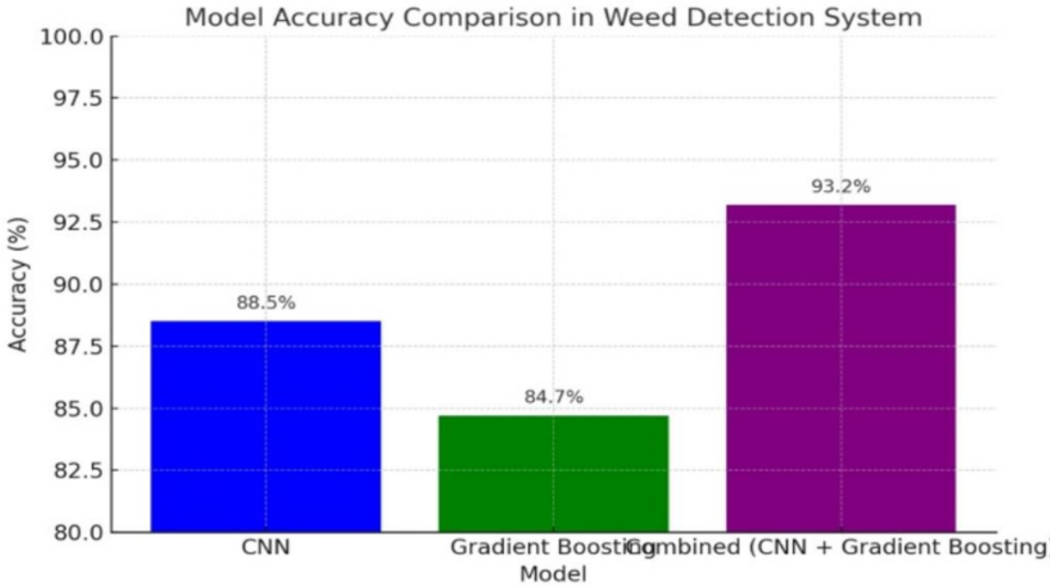

Figure5.1: Model Accuracy Comparision

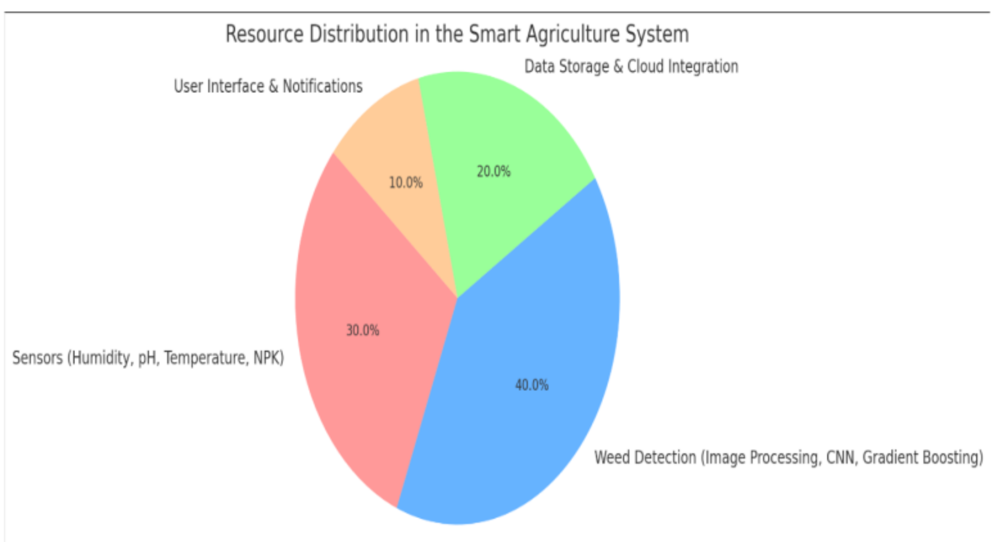

Figure5.2: Resource Distribution Pie Chart

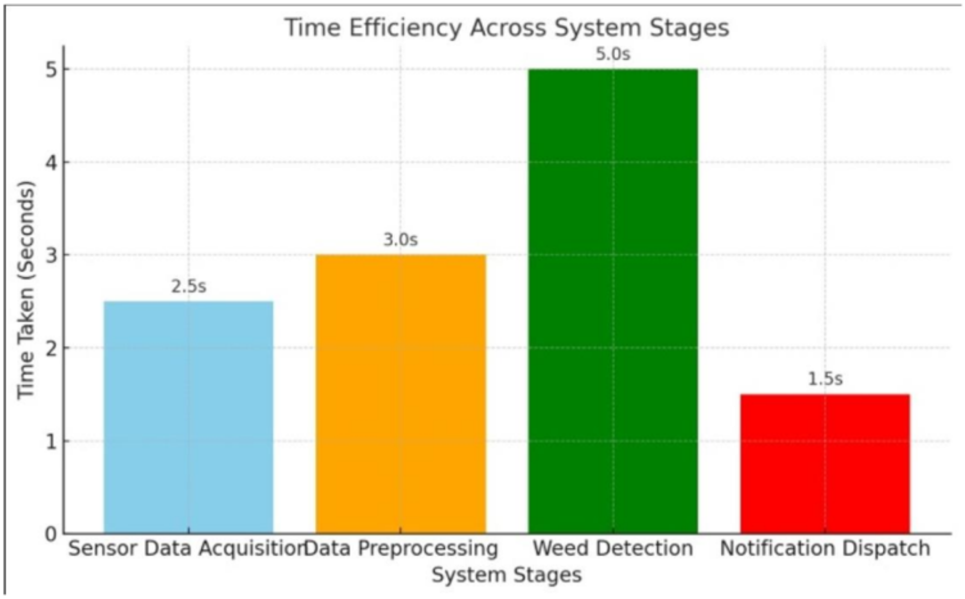

Figure5.3: Time Efficiency

The final part of the system involves delivering notifications to the user. This automated notification system is integrated with a mobile or web application, where the user can view real-time sensor data and weed detection results. Notifications are sent if any environmental parameters, such as soil pH or water levels, exceed or fall below acceptable thresholds. Users receive alerts through SMS, email, or app notifications, helping them take timely action to maintain optimal conditions for their crops. This system can be remotely monitored through cloud integration, offering users flexibility in managing their fields. Periodic testing and optimization ensure the system performs efficiently and accurately, making it a reliable tool for modern agriculture.

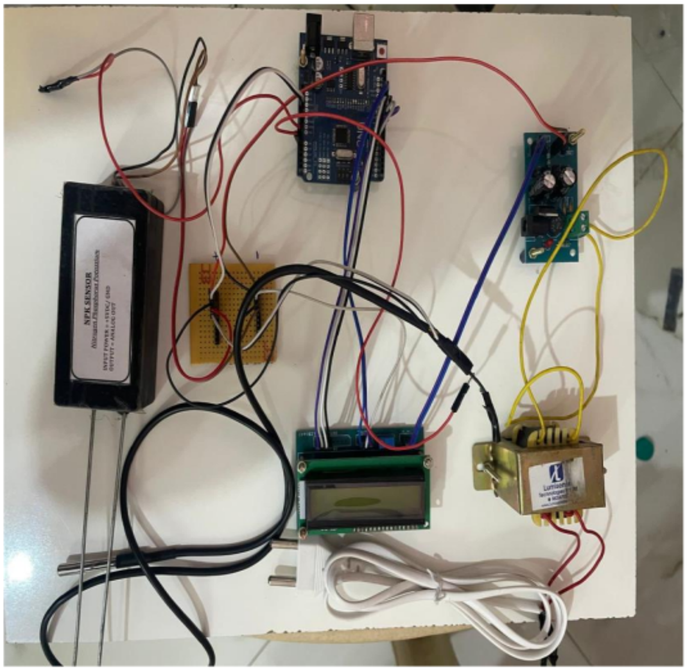

Figure5.4: Connection Sensor Implementation

For optimal irrigation, the IOT-based smart agricultural system is intended to track and regulate soil moisture levels. An Arduino microcontroller, which is at the heart of this system, analyzes data from the soil moisture sensor (MRK Sensor) to determine the soil's moisture level. An LCD panel shows the data, giving users insights in real time. Through a relay or actuator module, the system can activate external equipment, like irrigation pumps, when the moisture level falls below a predetermined threshold. By supplying the required voltage, the power supply unit guarantees the components' steady operation. This configuration facilitates effective water use and supports sustainable farming methods, making it a crucial part of a precision farming solution.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

To sum up, the Smart Agriculture System created for this research effectively combines machine learning algorithms, Internet of Things (IoT) sensors, and image processing methods to tackle important issues in contemporary farming. Through the use of sensors, the system keeps an eye on critical environmental parameters including temperature, pH, humidity, and NPK levels to guarantee ideal crop growth and effective use of resources. A weed detection module that uses gradient boosting and Convolutional Neural Networks (CNN) provides a sophisticated way to identify and control undesired plant growth while drastically cutting down on manual effort and the usage of hazardous chemicals. Additionally, the automated notification system gives farmers real-time notifications for important metrics like soil conditions and water levels, enabling them to take prompt remedial action and increase productivity. In addition to improving crop output, timely interventions, and decision-making, the integration of these technology encourages resource efficiency and sustainability in agricultural practices. In addition to simplifying farm management, this approach opens the door for further developments in precision agriculture, which will ultimately lead to more profitable and sustainable farming operations.

6.2 FUTURE WORK

More sophisticated features and technologies can be added to the Smart Agriculture System in the future to increase crop monitoring and management's accuracy and efficiency. For example, in addition to the information obtained from IoT sensors, the use of satellite imaging and remote sensing technology may offer more thorough insights into the development and health of crops. More sophisticated machine learning methods, including reinforcement learning or transfer learning, could also help the weed identification system identify weeds more accurately in a variety of environmental settings.The system could also be expanded to monitor soil health more comprehensively, with additional sensors to measure parameters like soil texture, organic matter content, and microbial activity. Furthermore, integrating weather forecasting data into the system could allow for better decision-making regarding irrigation and pest control, making the system more adaptive to unpredictable climate conditions. The addition of automation, such as robotic weeding systems and autonomous drones for field monitoring and pesticide application, could reduce labor costs and improve precision in crop management. Lastly, enhancing the system with a user-friendly mobile application or dashboard for farmers could improve accessibility and real-time decision-making, enabling them to receive timely alerts and insights on their crops' health.

APPENDIX I

PUBLICATION STATUS

PUBLICATION STATUS OF PHASE I PAPER

TITLE OF THE PAPER:	CUSTOMER Smart Agriculture:IoT-Based Crop Monitoring And Management System
AUTHORS:	M.Divya MADAN AC MAKESH KUMAR S
CONFERENCE:	IEEE International Conference on Advances in Computer Science, Electrical, Electronics and Communication Technologies(CE2CT)
MODE OF PUBLICATION:	ONLINE
STATUS:	SUBMITTED

APPENDIX II
SOURCE CODE

```
#include <Wire.h>
#include <DHT.h>
#include <Adafruit_Sensor.h>
#include <LiquidCrystal_I2C.h>
#include <EEPROM.h>      // For storing data persistently

#define DHTPIN 2
#define PH_PIN A0
#define NPK_PIN A1

#define DHTTYPE DHT22   // DHT sensor type

DHT dht(DHTPIN, DHTTYPE); // Initialize DHT sensor

LiquidCrystal_I2C lcd(0x27, 16, 2);  // I2C address, columns and rows for LCD

void setup() {
  Serial.begin(9600);


  dht.begin();

  // Initialize LCD screen
  lcd.begin();
  lcd.backlight();
  lcd.print("Initializing...");

  delay(2000); // Wait for LCD to settle
}

void loop() {
  float temperature = dht.readTemperature();
  float humidity = dht.readHumidity();

  int pHValue = analogRead(PH_PIN);
  float pH = map(pHValue, 0, 1023, 0, 14

  int npkValue = analogRead(NPK_PIN);
  float npk = map(npkValue, 0, 1023, 0, 100); // Adjust the range based on NPK sensor


    Serial.print("Temperature: ");
  Serial.print(temperature);
```

```
  Serial.print(" °C ");


  Serial.print("Humidity: ");
  Serial.print(humidity);
  Serial.print(" % ");


  Serial.print("pH: ");
  Serial.print(pH);
  Serial.print(" ");


  Serial.print("NPK: ");
  Serial.print(npk);
  Serial.println(" %");

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Temp: " + String(temperature) + "C");
  lcd.setCursor(0, 1);
  lcd.print("pH: " + String(pH));


  delay(5000);
}

void sendDataToServer(float temperature, float humidity, float pH, float npk) {



  Serial.print("Sending data to server: ");
  Serial.print("Temp: " + String(temperature) + "C ");
  Serial.print("Humidity: " + String(humidity) + "% ");
  Serial.print("pH: " + String(pH) + " ");
  Serial.print("NPK: " + String(npk) + "% ");
  Serial.println();
}

void setup() {

  Serial.begin(9600);
  dht.begin();
  lcd.begin();
  lcd.backlight();
```

```
  lcd.print("Initializing...");

  if (!rtc.begin()) {
    Serial.println("Couldn't find RTC");
    while (1);
  }
  if (!rtc.isrunning()) {
    Serial.println("RTC is NOT running, setting the time!");
    rtc.adjust(DateTime(F(__DATE__), F(__TIME__)));
  }

  delay(2000);
}

void loop() {
  float temperature = dht.readTemperature();
  float humidity = dht.readHumidity();
  int pHValue = analogRead(PH_PIN);
  float pH = map(pHValue, 0, 1023, 0, 14);
  int npkValue = analogRead(NPK_PIN);
  float npk = map(npkValue, 0, 1023, 0, 100);

  DateTime now = rtc.now();

  Serial.print("Timestamp: ");
  Serial.print(now.timestamp());
  Serial.print(" Temp: ");
  Serial.print(temperature);
  Serial.print(" Humidity: ");
  Serial.print(humidity);
  Serial.print(" pH: ");
  Serial.print(pH);
  Serial.print(" NPK: ");
  Serial.println(npk);

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Temp: " + String(temperature) + "C");
  lcd.setCursor(0, 1);
  lcd.print("pH: " + String(pH));

  storeDataToEEPROM(now, temperature, humidity, pH, npk);
```

```
  checkAndAlert(temperature, humidity, pH, npk);

  delay(5000); // Wait for 5 seconds
}

void storeDataToEEPROM(DateTime timestamp, float temperature, float humidity, float pH,
float npk) {
  int address = 0;
  EEPROM.put(address, timestamp.unixtime());
  address += sizeof(unsigned long);
  EEPROM.put(address, temperature);
  address += sizeof(float);
  EEPROM.put(address, humidity);
  address += sizeof(float);
  EEPROM.put(address, pH);
  address += sizeof(float);
  EEPROM.put(address, npk);
  Serial.println("Data stored to EEPROM");
}

void checkAndAlert(float temperature, float humidity, float pH, float npk) {
  if (temperature > TEMP_THRESHOLD) {
    Serial.println("Alert: Temperature exceeds threshold!");
  }
  if (humidity > HUMIDITY_THRESHOLD) {
    Serial.println("Alert: Humidity exceeds threshold!");
  }
  if (pH < PH_LOW_THRESHOLD || pH > PH_HIGH_THRESHOLD) {
    Serial.println("Alert: pH out of range!");
  }
}

void retrieveDataFromEEPROM() {
  int address = 0;
  unsigned long timestamp;
  EEPROM.get(address, timestamp);
  address += sizeof(unsigned long);

  float temperature, humidity, pH, npk;
  EEPROM.get(address, temperature);
  address += sizeof(float);
  EEPROM.get(address, humidity);
  address += sizeof(float);
  EEPROM.get(address, pH);
  address += sizeof(float);
  EEPROM.get(address, npk);
```

```
  Serial.print("Retrieved Data - ");
  Serial.print("Timestamp: ");
  Serial.print(timestamp);
  Serial.print(" Temp: ");
  Serial.print(temperature);
  Serial.print(" Humidity: ");
  Serial.print(humidity);
  Serial.print(" pH: ");
  Serial.print(pH);
  Serial.print(" NPK: ");
  Serial.println(npk);
}
```

REFERENCES

[1] Kumar, P., Kumar, S.V. (2023). Precise and Accurate Farming Framework Utilizing IoT. In: Joshi, A., Mahmud, M., Ragel, R.G. (eds) Information and Communication Technology for Competitive Strategies (ICTCS 2022). ICTCS 2022. Lecture Notes in Networks and Systems, vol 623. pp 293-301, Springer, Singapore

[2] K. P, V. K. S and S. P. S(2024), "CNN and Edge-Based Segmentation for the Identification of Medicinal Plants," 2024 5th International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV), Tirunelveli, India, 2024, pp. 89-94, doi: 10.1109/ICICV62344.2024.00021.

[3] Jaiswal, S. P., Bhadoria, V. S., Agrawal, A., & Ahuja, H. (2019). Internet of Things (IoT) for Smart Agriculture and Farming in Developing Nations. International Journal of Scientific & Technology Research (IJSTR), 8(12), 1049–1056.

[4] Elijah, O., Rahman, T. A., Orikumhi, I., Leow, C. Y., &Hindia, M. N. (2018). An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and Challenges. IEEE Internet of Things Journal, 5(5), 3758–3775. DOI: 10.1109/JIOT.2018.2844296.

[4] Lokhande, S. A. (2021). Effective Use of Big Data in Precision Agriculture. Proc. Int. Conf. Emerg. Smart Comput. Informat. (ESCI), 312–316. DOI: 10.1109/ESCI50559.2021.9396813.

[5] Kounalakis, T., Triantafyllidis, G. A., &Nalpantidis, L. (2019). Deep Learning-Based Visual Recognition of Rumex for Robotic Precision Farming. Computers and Electronics in Agriculture, 165, Article 104973. DOI: 10.1016/j.compag.2019.104973.

[6] Chang, C.-L., & Lin, K.-M. (2018). Smart Agricultural Machine with a Computer Vision-Based Weeding and Variable-Rate Irrigation Scheme. Robotics, 7(3), Article 38. DOI: 10.3390/robotics7030038.

[7] Shamshiri, R. R., Weltzien, C., Hameed, I. A., Yule, I. J., Grift, T. E., Balasundram, S. K., ... Chowdhary, G. (2018). Research and Development in Agricultural Robotics: A Perspective of Digital Farming. International Journal of Agricultural and Biological Engineering, 11, 1–14.

[8] Murugesan, R., Sudarsanam, S. K., Malathi, G., Vijayakumar, V., Neelanarayanan, V., Venugopal, R., ... Saha, S. (2019). Artificial Intelligence and Agriculture 5.0. International Journal of Recent Technology and Engineering, 8, 1870–1877.

[9] Li, S., Yuan, F., Ata-UI-Karim, S. T., Zheng, H., Cheng, T., Liu, X., ... Cao, Q. (2019). Combining Color Indices and Textures of UAV-Based Digital Imagery for Rice LAI Estimation. Remote Sensing, 11, Article 1763.

[10] Li, S., Ding, X., Kuang, Q., Ata-UI-Karim, S. T., Cheng, T., Liu, X., ... Cao, Q. (2018). Potential of UAV-Based Active Sensing for Monitoring Rice Leaf Nitrogen Status. Frontiers in Plant Science, 9, 1–14.

[11] Alonso, R. S., Sittón-Candanedo, I., García, Ó., Prieto, J., & Rodríguez-González, S. (2020). An Intelligent Edge-IoT Platform for Monitoring Livestock and Crops in a Dairy Farming Scenario. Ad Hoc Networks, 98, Article 102047.

[12] Han, L., Yang, G., Yang, H., Xu, B., Li, Z., & Yang, X. (2018). Clustering Field-Based Maize Phenotyping of Plant-Height Growth and Canopy Spectral Dynamics Using a UAV Remote-Sensing Approach. Frontiers in Plant Science, 9, 1–18.

[13] Boonchieng, E., Chieochan, O., &Saokaew, A. (2018). Smart Farm: Applying the Use of NodeMCU, IOT, NETPIE, and LINE API for a Lingzhi Mushroom Farm in Thailand. IEICE Transactions on Communications, 101(1), 16–23.

[14] Cambra, C., Sendra, S., Lloret, J., & Lacuesta, R. (2018). Smart System for Bicarbonate Control in Irrigation for Hydroponic Precision Farming. Sensors, 18, Article 1333.

[15] Azimi Mahmud, M. S., Buyamin, S., Mokji, M. M., & Abidin, M. S. Z. (2018). Internet of Things-Based Smart Environmental Monitoring for Mushroom Cultivation. Indonesian Journal of Electrical Engineering and Computer Science, 10(3), 847–852.

[16] Jawad, H., Nordin, R., Gharghan, S., Jawad, A., Ismail, M., & Abu-AlShaeer, M. (2018). Power Reduction with Sleep/Wake on Redundant Data (SWORD) in a Wireless Sensor Network for Energy-Efficient Precision Agriculture. Sensors, 18(10), 3450.

[17] Jin, X.-B., Yang, N.-X., Wang, X.-Y., Bai, Y.-T., Su, T.-L., & Kong, J.-L. (2020). Hybrid Deep Learning Predictor for Smart Agriculture Sensing Based on Empirical Mode Decomposition and Gated Recurrent Unit Group Model. Sensors, 20(5), Article 1334.

[18] Xue, J., Fan, Y., Su, B., & Fuentes, S. (2019). Assessment of Canopy Vigor Information from Kiwifruit Plants Based on a Digital Surface Model from Unmanned Aerial Vehicle Imagery. International Journal of Agricultural and Biological Engineering, 12, 165–171.

[19] Uddin, M. A., Mansour, A., L. Jeune, M., Ayaz, M., & Aggoune, E.-H. M. (2018). UAV-Assisted Dynamic Clustering of Wireless Sensor Networks for Crop Health Monitoring. Sensors, 18, Article 555.

[20] Sadowski, S., &Spachos, P. (2020). Wireless Technologies for Smart Agricultural Monitoring Using Internet of Things Devices with Energy Harvesting Capabilities. Computers and Electronics in Agriculture, 172, Article 105338.

[21] Sadowski, S., &Spachos, P. (2020). Wireless Technologies for Smart Agricultural Monitoring Using Internet of Things Devices with Energy Harvesting Capabilities. Computers and Electronics in Agriculture, 172, Article 105338.

[22] Han, L., Yang, G., Yang, H., Xu, B., Li, Z., & Yang, X. (2018). Clustering Field-Based Maize Phenotyping of Plant-Height Growth and Canopy Spectral Dynamics Using a UAV Remote-Sensing Approach. Frontiers in Plant Science, 9, 1–18

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