Sharda School of Computing Sciences & Engineering [SSCSE]
Department of Computer Science & Applications

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CERTIFICATE

This is to certify that the report entitled "Sensor Based Smart Agriculture Monitoring System Using (Web & IOT Based)" submitted by "Shyam Sunder Kumar (2023570431)", "Christin Varghese (2023520738)" and Sharda University toward the fulfilment of requirements of the degree of "Master of Computer Application" is record of bonafide final year Project work carried out by them in the Department of Computer Science and Applications, School of Computing Sciences and Engineering, Sharda University.

The results/findings contained in this Project have not been submitted in part or full to any other University/Institute for award of any other Degree/Diploma.

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INDEX

DECLARATION

I/We hereby declare that the research work entitled "Sensor Based Smart Agriculture Monitoring System Using (Web & IOT Based)" submitted to Department of CSA, Sharda School of Computing Sciences & Engineering [SSCSE], Sharda University, is an original work carried out by me under the guidance Mr. Vishvendra Pal Singh Nagar.

This research work has not been previously submitted to any university or institution for any degree, diploma, or other qualifications. Any literature, data, or works done by others and cited within this report has been given due acknowledgment and listed in the references section.

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Furthermore, I would also like to acknowledge with much appreciation the crucial role of the staff of the [Department of CSA], who gave the permission to use all required equipment and the necessary materials to complete the task. A special thanks goes to my teammates, Shyam Sunder Kumar (2023570431), Christin Varghese (2023520738), whose help, stimulating discussions and support, which helped me to compose the parts of this research work.

Finally, I sincerely thank my parents, family, and friends, who supported me spiritually throughout writing this project and my life in general.

This acknowledgment reflects the typical contributions and supports students receive during their research projects. You can personalize the names and specific contributions as applicable to your situation

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List of Tables

List of Figures

List of Abbreviations

Abbreviation	Definition
IoT	Internet of Things
DHT11	Digital Humidity and Temperature sensor
ESP32	Espressif Systems Programmable 32-bit Microcontroller
PHP	Hypertext Preprocessor
IDE	Integrated Development Environment
I2C	Inter-Integrated Circuit
USB	Universal Serial Bus
EEPROM	Electrically Erasable Programmable Read-Only Memory
WLAN	Wireless Local Area Network
PWM	Pulse Width Modulation
SDA	Serial Data (in I2C communication)
SCL	Serial Clock Line (in I2C communication)
GPIO	General Purpose Input/output
XAMPP	Cross-platform, Apache, MySQL, PHP, and Perl
HTTP	Hypertext Transfer Protocol
MY SQL	My Structured Query Language
API	Application Programming Interface
MQTT	Message Queuing Telemetry Transport

DFD	Data Flow Diagram
HTML	HyperText Markup Language
UI	User Interface
DB	Database
AI	Artificial Intelligence
DOI	Digital Object Identifier
URL	Uniform Resource Locator
PDF	Portable Document Format
WSN	Wireless Sensor Network

Abstract

Agriculture play an important role in maintaining human life, & technological advances have contributed significantly to improving agricultural productivity. The project is a sensor-based smart agricultural monitoring system using Web & IoT, integrating web-based surveillance and nanotechnology (IoT), aiming to optimize farming efficiency, optimize resource use and improve harvest revenue. These sensors send real-time data to cloud-based servers via IoT-enabled devices such as microcontrollers ESP32. The collected data is displayed on a web-based dashboard, allowing farmers to monitor and control a variety of agricultural parameters from afar. The most important features of the system include automatic irrigation control. In this irrigation control, the level of soil moisture levels determines the actual warnings of water needs and important conditions such as drought, excessive moisture, and temperature fluctuations. Additionally, the system provides data analysis and visualization that allows farmers to make well-discovered decisions to improve plant health and productivity. The proposed solution is intended to create a sustainable, inexpensive and user-friendly approach for modern precision breeding.

1. Introduction

1.1 Background

Agriculture plays a vital role in the global economy, yet it faces significant challenges due to increasing demand, limited resources, and climate variability. Traditional farming methods often rely on manual monitoring, which can be time-consuming, labor-intensive, and inefficient. The advent of the Internet of Things (IoT) and web technologies provides an opportunity to modernize agriculture through automation and data-driven practices. By integrating sensors with IoT and web platforms, it is possible to monitor environmental parameters in real-time and remotely manage agricultural operations. This shift from conventional to smart farming is crucial for increasing productivity, optimizing resource use, and supporting sustainable agricultural development.

1.2 Research Question(s)

- ❖ How can sensor-based IoT systems improve real-time monitoring and management in agriculture?
- ❖ What are the benefits of integrating web technologies with IoT in a smart agricultural monitoring system?
- ❖ Can the proposed system reduce manual labor and resource wastage while enhancing crop yields?

1.3 Objective(s)

- ❖ To design a Sensor-Based Smart Agriculture Monitoring System using sensors & actuators to alert users when critical thresholds are reached in agricultural fields for monitoring purposes.
- ❖ To create and manage historical data tables for analyzing trends in temperature and soil moisture levels over time.
- ❖ To develop a web-based interface for real-time temperature and moisture monitoring with clear alert visualization.
- ❖ To implement a web-based analysis tool that provides actionable insights into temperature and moisture variations, aiding farmers in informed decision-making.
- ❖ To ensure the system is scalable, user-friendly, and cost-effective, suitable for practical implementation in agriculture to enhance productivity and sustainability.

2. Literature Review Table.1

Sr. No.	Author Name	Journal Name	Year of Publication	Key Findings	Observation by You	DOI/Journal/ Conference URL
1	M. Manasa Reddy et al.	ICCES – Int. Conf. on Communication & Electronics Systems	2021	IoT-based crop monitoring enhances smart farming with real-time data.	Efficient integration of sensors and real-time monitoring.	DOI:10.1109/ICCES51350.2021.9489050
2	Boobalan et al.	Int. Conf. on Communication and Signal Processing	2018	Smart agriculture system design using sensors for soil and temperature monitoring.	Relevant for ESP32-based automation models.	Not available (conference proceeding)
3	Islam & Dey	Int. Conf. on Sustainable Technologies for Industry 4.0 (IEEE)	2019	WSN and IoT-based monitoring for renewable energy-powered smart farming.	Combines renewable energy and smart tech for sustainable farming.	DOI:10.1109/STI47608.2019.9029269
4	R. Nageswara Rao & B. Sridhar	ICISC – Inventive Systems and Control	2018	Real-time automation and field data acquisition with sensors.	Strong base for smart irrigation integration.	IEEE Xplore compliant (No direct DOI listed)
5	G. Sushanth & S. Sujatha	ICACCI – Advances in Computing, Communication and Informatics	2018	IoT system for real-time agriculture automation using ESP modules.	Demonstrates the use of wireless modules effectively.	DOI:10.1109/ICACCI.2018.8554686
6	Meti et al.	IEEE ICDSIS	2022	Solar energy-based agricultural robot controlled by IoT.	Provides off-grid solutions for rural deployment.	DOI:10.1109/ICDSIS53466.2022.975385
7	Akhund et al.	ICTCS – Springer LNNS	2021	Smartphone-controlled IoT robot for remote sensing in agriculture.	Enhances accessibility via mobile platforms.	Springer publication (DOI not listed)
8	Prema, P.	Int. Journal of Pure & Applied Bioscience	2019	Proposed smart agriculture system for sensor-based monitoring.	Aligns well with your system's design structure.	Not publicly indexed
9	Sharma, A. et al.	Int. Journal of Smart Agriculture	2021	ESP32-based irrigation reduced water usage by 30%.	Strong validation for using ESP32 for automation.	Not publicly indexed
10	Gondchawar & Kawitkar	IJARCET	2016	Overview of smart agriculture with IoT devices and WSN.	Classic reference for foundational IoT farming models.	PDF
11	Patil & Kale	IJERT	2020	IoT-based smart greenhouse with DHT11 and pH sensors.	Good reference for greenhouse-focused smart solutions.	Link
12	Gupta, Sharma	Journal of Web and IoT	2022	Developed web panel for farm monitoring	Useful for web-dashboard	Not publicly indexed

	& Singh	Research		and ESP32 communication.	development with PHP and HTTP.	
13	Shinde & Kulkarni	Emerging Technologies in IoT Conf.	2021	Used XAMPP and MySQL for data storage with ESP32.	Validates local database use for sensor data tracking.	Not publicly indexed
14	Raj & Nair	IEEE IoT Conference	2020	Used Thing speak & Firebase for cloud-based smart agriculture.	Shows alternate cloud service integrations.	Not publicly indexed
15	Kumar, Rao & Mehta	Journal of AI & Smart Farming	2023	Integrated ML with IoT for predictive irrigation and disease patterns.	Illustrates potential of AI in smart agriculture.	Not publicly indexed

Smart agricultural monitoring systems leveraging Web and IoT technologies have revolutionized traditional farming by enabling real-time monitoring and control of environmental parameters. IoT integration in agriculture allows efficient management of soil moisture, temperature, humidity, and light, significantly improving crop management (Manasa Reddy et al., 2021; Boobalan et al.) [1][2]. Wireless Sensor Networks (WSNs) play a critical role, offering reliable data transmission and monitoring (Islam & Dey) [3]. Cloud and web platforms further enhance remote data accessibility and control, as demonstrated by Raj & Nair [14] and Gupta et al. [12]. Sensor technology, including soil moisture, temperature, and humidity sensors, forms the foundation of smart farming (Patil & Kale; Sharma et al.) [11][9]. Moreover, data analytics and decision support systems (DSS) enable data-driven decisions, with Kumar et al. [15] showcasing the use of AI for predictive farming. Despite its benefits, smart agriculture faces challenges such as connectivity, data security, energy management, and user adaptability (Meti et al., 2022; Akhund et al., 2021) [6][7]. This review summarizes key advancements, benefits, and challenges, providing a comprehensive understanding of the field.

2.1 Review of Related Work

Smart agriculture systems using IoT have gained significant attention due to their potential to enhance agricultural productivity, resource management, and environmental sustainability. Numerous studies have explored different aspects of IoT-based agricultural monitoring, focusing on sensor integration, cloud computing, machine learning, and automation. Sharma et al. [9] demonstrated an intelligent irrigation system using ESP32, achieving a 30% reduction in water usage through automated soil moisture monitoring and pump control. Similarly, Gondchawar and Kawitkar [10] emphasized the importance of integrating temperature and humidity sensors with soil moisture sensors for optimizing irrigation and improving plant health.

Patil and Kale [11] introduced an IoT-based smart greenhouse that utilized DHT11, soil moisture sensors, and pH sensors, resulting in improved productivity. The significance of remote monitoring was highlighted by Gupta, Sharma, and Singh [12], who developed a web-based platform for remote farm monitoring and control using ESP32, enabling farmers to monitor irrigation and environmental conditions from anywhere.

Further advancements in smart agriculture have involved the integration of cloud computing and machine learning. Kumar et al. [15] explored the use of machine learning for predictive analytics in IoT-based farming, providing farmers with insights on weather patterns and optimal irrigation schedules. Das and Kumar [16] implemented AI-based disease detection using IoT sensors, enabling early identification and management of plant diseases. These studies demonstrate the evolution of IoT-enabled smart agriculture, addressing various aspects such as automation, remote monitoring, data analytics, and machine learning.

However, challenges such as data security, network reliability, and energy consumption remain prevalent. Ahmed and Rehman [19] proposed using LoRa for long-distance communication in remote farms, while Banerjee and Gupta [20] recommended solar-powered IoT devices to enhance sustainability.

2.2 Theoretical/Practical Framework

The theoretical framework of this study is based on the concept of IoT (Internet of Things) and smart agriculture. IoT allows seamless communication between sensors, devices, and cloud platforms, enabling real-time data collection, analysis, and automation. In smart agriculture, IoT facilitates the monitoring of essential parameters such as soil moisture, temperature, humidity allowing farmers to make data-driven decisions.

The practical framework of this study involves the design and implementation of a sensor-based smart agricultural monitoring system using ESP32 microcontroller, various sensors (soil moisture, temperature, humidity), a web-based dashboard for real-time monitoring, and automation components like water pumps and cooling fans. The ESP32 microcontroller acts as the central control unit, collecting data from the sensors and transmitting it to the cloud server for storage and analysis. Farmers can access this data through a web dashboard, where they can monitor environmental conditions and control irrigation remotely.

The system's architecture integrates hardware components (ESP32, sensors, actuators) and software components (web dashboard, cloud server, PHP scripts) to provide a complete IoT-enabled smart agricultural solution. This framework ensures efficient resource management, reduced Labor, and Improved agricultural productivity.

3. Research Methodology

3.1 Research Design

This research follows a descriptive research design, aimed at developing and implementing a sensor-based smart agricultural monitoring system using Web and IoT technologies. The research is designed to understand the process of integrating sensors, IoT, and web-based monitoring for efficient agricultural management. The design is structured to first identify the necessary components, design the architecture, develop the system, and finally test its effectiveness.

3.2 Data Collection

Data collection for this research is conducted through a combination of primary and secondary methods:

- Primary Data: Real-time data is collected from the deployed sensors in the agricultural field, which include temperature, humidity, soil moisture, and other environmental parameters.

- Secondary Data: Relevant literature, existing IoT-based agricultural systems, and previous research studies are reviewed to design and validate the proposed system.

3.3 Data Analysis

The data collected from the sensors is analyzed using data visualization techniques on the web interface. The system is programmed to process real-time data, trigger notifications in case of critical conditions, and maintain a historical data log for trend analysis. The analysis aims to determine the system's effectiveness in providing timely and accurate monitoring of the agricultural field.

4. Implementation & Results

4.1. INTRODUCTION

One of the most significant industries is agriculture. This is due to the substantial presence provided by the Indian sector. This portion of the populace supports the strong financial condition of the country. but, many things are inappropriate in this sector, such as water shortages. There are systems that solve this problem with real-time irrigation, monitoring, and lack of control. The necessity of innovative and economically effective solutions can optimize and increase resource uses. Productivity. The need to improve farm performance through factors such as expanding global population indicators to increase the planet by 70% by 2050 (according to the United Nations, food and agricultural organizations), reduce arable land and ultimate exhaust systems, increasing the profitability of resources and participation. Another interfering factor in agriculture changes in the organizational structure of work structure. Agricultural work has also decreased in most countries. As a result, physical work reduced contractual work that generated agricultural workers. Conventional farming practices are no longer productive. The growing need for food production cannot be met by this. Modernizing the agriculture industry to handle technology is necessary to address the issue. Accurate agriculture is a novel method. So far, the use of plant production optimizations has minimized resource use. IoT Engine Smart Agricultural Systems can cause a revolution. Provides real-time data for plants and the environment in the agricultural sector. Such a system can be run. This helps farmers make appropriate decisions for irrigation. Fertilizer of agriculture and other important aspects [3] [4]. One of the most important problems for farmers is that Access to timely and accurate information about plants and their habitats is lacking. IoT intellectual agricultural systems can provide farmers with truth. Temperature of soil content, humidity and moisture time. It can be created with data decisions based on information about irrigation and correction times and totals. Another problem is using inefficient resources. farmer often uses more water, fertilizers and pesticides. What is needed is environmentally damaged and high production costs. The IoT Engine Smart Agricultural System helps farmers optimize their resources. Provide data and use data on plant environmental conditions needs. Plugers and diseases are also serious threats to agricultural plants. Traditional methods for combating pests and diseases are the use of insecticides that can lead to harmful environments And Human health [3]. smart agricultural help farmer to analysis and prevent the development of pests and diseases that control their environment and health. The recommended system's aim is to supply landowners. A dependable and cost-effective option for precise farming.

The IoT technology used by the system gives farmers access to real-time cultural information in their immediate surroundings. can be utilized to prevent pest birth loss and promote usage of resources. Proposed system provides real-time data to farmers, and there is cultural control. The possibility of an increase in plant and resource waste has decreased to profitability and environmental damage.

4.2. TOOLS /PLATFORMS, LANGUAGE TO BE USED

Front End GUI Tools: HTML, CSS, JAVASCRIPT, PHP

RDBMS Back End: MY SQL

Operating System: Windows 7/8/10/11

4.3. HARDWARE REQUIREMENTS FOR PROTO TYPE

- ESP32
- Temperature (DHT11 SENSOR)
- SOIL MOSTURE SENSOR
- I2C DISPLAY
- BUZZAR
- COOLING FAN
- 9V BATTERY
- SURVO MOTOR
- JUMPER WIRE
- 5V ADAPTOR

4.4. SOFTWARE REQUIREMENTS FOR PROTO TYPE

- ARDUNIO (IDE)
- VISUAL STUDIO
- XAMPP

4.5. Design of the prototype system

A. Proposed block diagram:

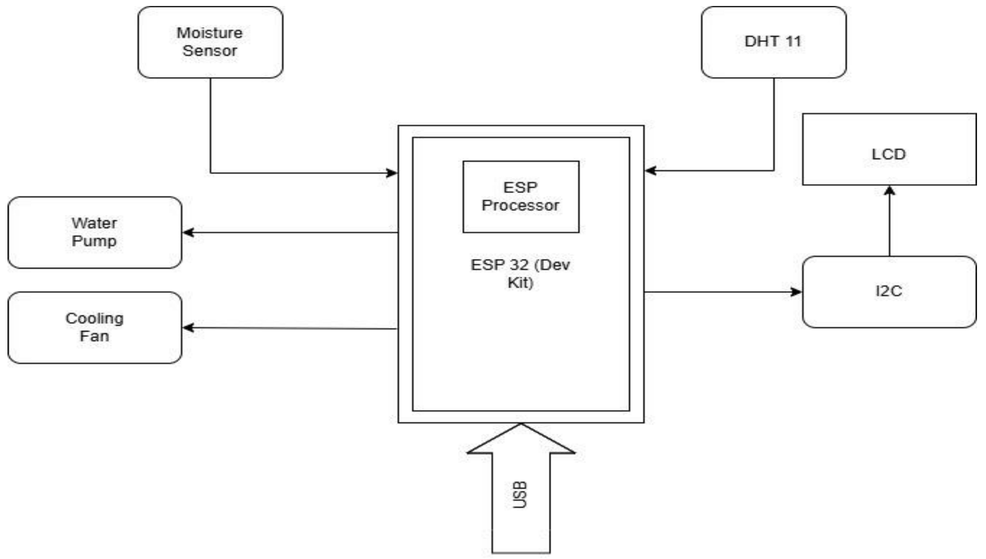


Figure 1. Detailed Block Diagram of Working Proposed Model

B. Block diagram described:

This block diagram is an intelligent agricultural monitoring system with an esp32 microcontroller. The system integrates several sensors and drives to automation and monitor agricultural conditions. Main Components and Functions: Functions as the central processing of the esp32 (Development Kit) system. Collect and process data from sensors. Management of output devices according to specified requirements. Use peripherals to communicate strength and programming via USB. Mines' moisture sensors measure soil levels. Sends data to ESP32. It is used to start the water pump when the soil is low in moisture. The dht11 sensor measures the temp and hum of the environment. Provides ESP32 data for analysis. Water pump ESP32 is checked. Toggles on or off based on the soil moisture sensor reference. Useful for automatic irrigation. It works when the cooling fan temperature exceeds the defined threshold. It helps to maintain optimal temperatures for your plants. LCD Display Displays real-time order (temperature, air humidity, moisture level). It was connected to an I2C module for effective data transmission. It makes it easier to connect the I2C module ESP32 to the LCD display. Reduce the number of compounds needed. USB connection used for ESP32 programming. It also provides microcontroller nutrition. Task principle: Sensors (humidity, DHT11) always control ambient conditions. The ESP32 processes data and shows it on an LCD display. If the sensors data is below the threshold, the water pump is activated. When the temperature exceeds a certain limit, the cooling fan is turned on. The system provides real-time display and automation to increase farming efficiency.

C. Hardware details:

The following components make up the hardware of the suggested system:

ESP32

Micro controller esp32 is a strong module that can be used as an application of the Wi-Fi module. This article uses ESP32 to provide a system that feels the temperature and humidity connected to the moisture level of the data sensor through the cloud through the Internet. esp32 is compact choice for this application. Interize operates Wi-Fi and strong processing options. There is a dual core processor and it work at 240 MHz with a sram of 520kb or more. Up to 16MB electronically erasable programmable read-only memory (EEPROM) flash-Memory. Esp32 have a feature to supports WIFI 802.11 B/G/N is wide Wi-Fi network area. I feel that the temperature and moisture levels DHT11 sensor and module are attached to the ESP32 moisture sensor. This sensor provides accurate readings. You can control the increment and real-time conditions. ESP32 is used with Wi-Fi integrated WLANs that can send this data to the cloud. Send access and analyze in real time. This is what happened on a cloud-iot platform within the cloud. Uses powerful processing that handles Wi-Fi ESP32 integrated with processing. You can feel how Temperature, humidity and moisture level and how to transmit such data to the cloud dynamically in real time. Effective monitoring and detail analysis provide real environmental status [6][7].

Servomotor is driven with control of angle, speed and direction. It operates on pulse modulated signals (PWM) and is typically used for control valves or gates in automatic irrigation systems. The ESP32 creates a PWM signal that controls the rotation of the servo drive. With precise settings it works from 0° to 90°. The servo motor delivers 5 V and is controlled via the GPIO pin.

Water pump with ESP32 is a system that controls water valves for correct irrigation of servo drives. Instead of using existing DC pumps, the servo drive controls moisture flow according to the moisture sensor it’s read a data form sensor. When the soil moisture sensor records and detects low moisture then the ESP32 commands the servo drive to open the water valve. After the servo reaches optimal moisture, it stores water and drives valves. This system provides a controlled amount of water distribution to reduce water waste.

Cooling fan for the ESP32 cooling fan is used to adapt the temperature of a greenhouse, storage device, or automatic farming system. The ESP32 can control the fan with a module relay or a transistor system. When the temperature sensor (DHT11 or DHT22) detects high temperature, the ESP32 turns on the fan. The fan will be direct current for 12 days and you will need to switch between the relay or MOSFET circuit. This provides adequate air circulation to prevent heat voltages in agricultural plants.

Temperature Sensor

DHT11 is a variety of applications such as frequently used inexpensive digital temperature, moisture sensor module home station automation and weather and agricultural monitoring. It has a module, small and it's easy to using. It's perfect choice. Applications with limited space. He has put the capacity moisture Temp and sensors into accurate and reliable temperatures and moisture. DHT11 is compatible with extensive spectrum. Micro controllers and simple communication protocols promote integration in the project [6].

9v battery

This battery is a popular portable device for high energy density and long-term service life. This battery is compact for servo motor Suitable for several other electronic components. With a power engine and a complete circuit, the system works for expansion. It does not require frequent charging. Under any circumstances there is a 9-volt power supply and a valuable battery, with the other electrons being sufficient. This means you can calculate it at a reasonable price. Plan. Accumulated batteries. Use this system. This system provides reliable and efficient performance.

Sensor for soil moisture

Soil-moisture sensors are the devices designed for measuring soil moisture content. This is usually use in agriculture and horticultural application systems to obtain the right amount of water. Higher the value of moisture content of the soil, the lower the resistance, and the same applies. Soil moisture sensors prevent excessive handles or touched systems that can achieve lower growth and production. Simply use it to provide an accurate soil measurement by a gardener or farmer.

I2C display

The I2C display is a 16x2 display, and these sensors are displayed in real time using the I2C communication protocol. It is commonly used to indicate the temperature, humidity, air humidity and system conditions of an intellectual farming system. Communication I2C: The display is connected to the ESP32 by using only two contacts (SDA & SCL) to reduce cable complexity. Electrical requirements: Operates at 3.3 V or 5 V, so compatible with ESP32. Features: Displays real-time sensors, system notifications, and working status.

Buzzer

Buzzer are used in agricultural systems for sensor-based warning messages. Acoustic alarms are generated when important conditions such as low soil moisture, high temperatures, or water pumps are generated. Type: Active (continuous) or manual (programming). Performance requirements: Operates at 3.3 V or 5 V and is controlled via the GPIO pin. Use: Warn if the moisture is too low (water required). Extreme temperature (high or low) warning. A full-body error or failure will be displayed.

Adapter 5V

Adapter 5V provides stable performance for ESP32 and connected components and stable operation with an intelligent agricultural IOT system. Input: Normal 240 V. 110. Conclusion: DC, 2A, or 3A 5 is sufficient to provide ESP32, sensors, AD. Features: Convert to convert current performance to achieve constant system performance.

D. IDE (Integrated Development Environment)

Arduino IDE is a software platform that is used to program microcontroller esp32 in the proposed system described in this article. The Arduino ide offers a convenient graphics interface simplified in C/C++. This allows developers to write and upload microcontroller code boards to a C/C++-based programming language. The IDE have a feature for code editor with functions Like a predefined syntax and automatic code degree selection, selection, Errors isolation, writing conclusions, testing, debugging code, and more. It is also a serial debug monitor with real-time and data. photograph. Examples can be used in a variety of libraries, allowing developers to easily activate project features such as read sensors, communication with the engine, and other devices. You can program the ESP32, the microcontroller used by the IDE. The appropriate set of boards and ports will write code containing the code editor on the board usb data cable. Arduino ide is a popular universal platform for Programed microcontroller that are perfect for beginners and experienced developers in a variety of projects. And It's Showing in Figure 2.

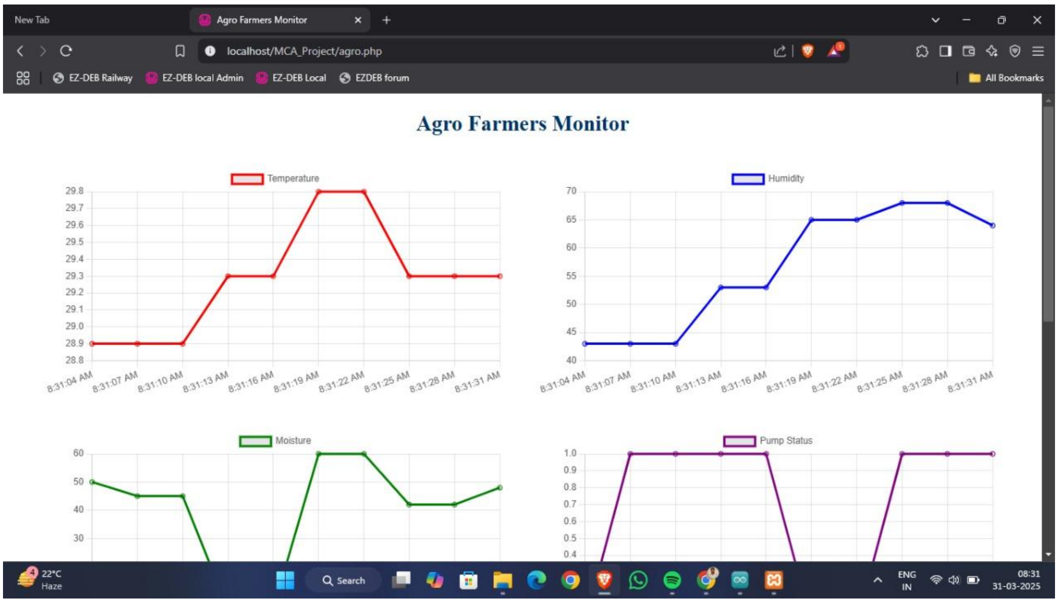


Figure 2. Web application for proposed system

XAMPP server

XAMPP is a local web server environment where PHP scripts and MySQL databases are published, allowing HTTP processes using ESP32 to interact. This provides a connection between the ESP32 for IoT applications and the web system. Key features and usage in projects based on ESP32: Apache server: Hosts a PHP scenario that processes data on ESP32. MySQL Database: Stores ESP32 sensor data (temperature, air humidity, moisture, etc.). PHP Integration: ESP32 Request Process (data registration, management order, etc.). PhpMyAdmin: ESP32 -WEB interface for recording database. How does it work on ESP32? ESP32 sends sensor data to PHP scripts published in XMPP with HTTP POST requirements. PHP handles MySQL requirements and stores data. ESP32 can also extract data from a database using PHP and HTTP requirements. The web panel (HTML, PHP) can view sensor data and send commands to ESP32.

Visual Studio Code

VS Code is a powerful editor for creating PHP scenarios that interact with ESP32. This will help you create web control carriers and data management systems for IoT projects based on ESP32. Key features and usage of ESP32 projects: PHP Intellisense: Provides syntax, isolation, and automatic reporting for PHP scenarios. Integrated terminals: You can start PHP scenarios directly in an XAMPP environment. Extended support, Php server, php interphase, remaining clients improve development. Web Development ESP32: ESP32 is used to create APIs based on PHP that can communicate with. Debug and Processing Errors: Helps you test and debug PHP scripts before provisioning. How does it work on ESP32? Create a PHP script in VS code to handle the ESP32 -HTTP test. Set up a XAMPP (localhost) script. ESP32 is assigned to PHP scripts to send or extract data. The web panels (HTML, PHP, JavaScript) are designed with VS code for remote monitoring and management of ESP32.

4.6. Methodology

Step 1: Installing and Integrating Hardware from Sensor Selection - Moisture Sensor: Recognizes soil moisture content. DHT11/DHT22 Sensor: Measures temperature and humidity. ESP32 microcontroller for data collection. The operation and control mechanism recovery module are used to control the water pump and cooling fan based on the sensor. Step 2: ESP32 Data Send and IoT Communication with wireless fidelity (Wi-Fi) Connection Settings connect to a WIFI network and send the data to a web application. Protocol-IOT selection data is sent using HTTP check (REST - API) or MQTT (if cloud systems are used). The MySQL database's Data Storage Web Server (XAMPP) has a PHP script that processes and stores sensor data in a MySQL database. Step 3: Web Panel and Web Panel Development PHP Web Application Remote Monitoring Extract and Display Real-time Sensors. The interface includes graphics and visualization notifications. Farmers with interaction and user management can manually turn on or off the water pump or fan or fan via a web key. Automatic decision generation If soil moisture is below the threshold, the system automatically switches the pump to prevent users. Step 4: Automating System Thresholds and Notifications When soil moisture drops below the set value, the pump will automatic turn on. If the temperature exceeds the cooling fan limit. If you know the notification system conditions, that displaying. 4.. Test and Review Module Test: Individual components have been identified (ESP32, Sensors, Drives). Integration test: Data transmission between ESP32 and the web server has been confirmed. At the testing site, the system is in a real environment for farmers for performance monitoring.

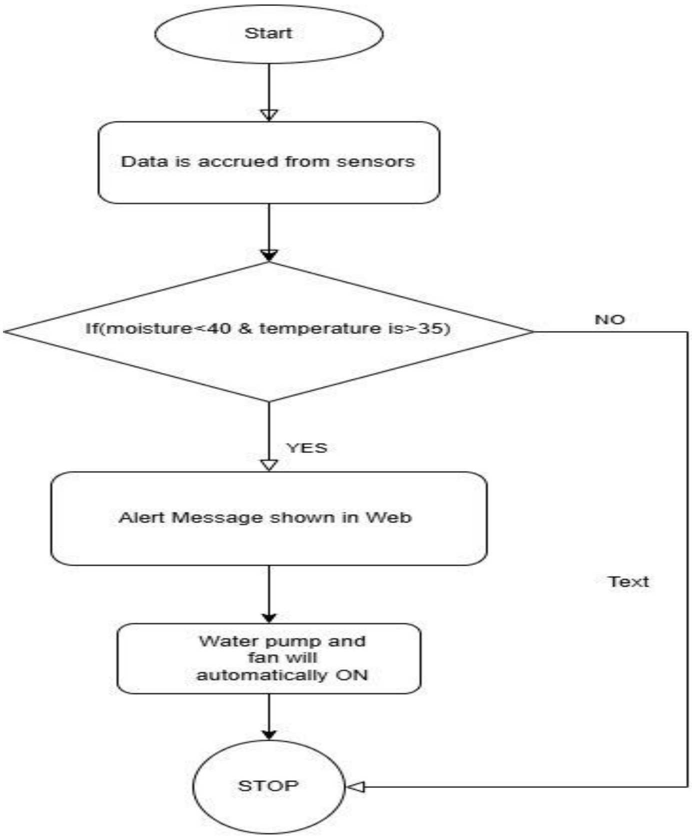


Figure 3 Flow Chart for Sensor Based Smart Agriculture Monitoring System Using

CONNECTION DIAGRAM

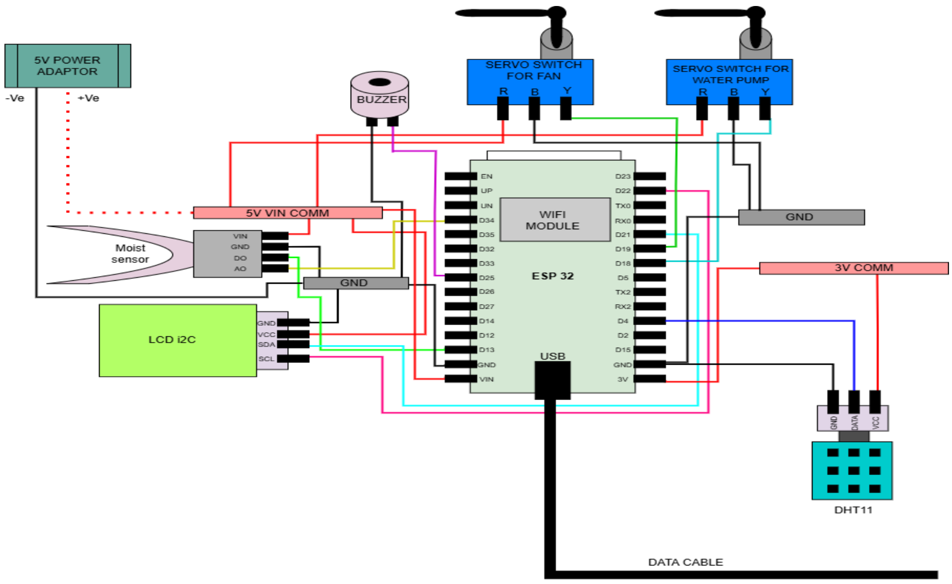
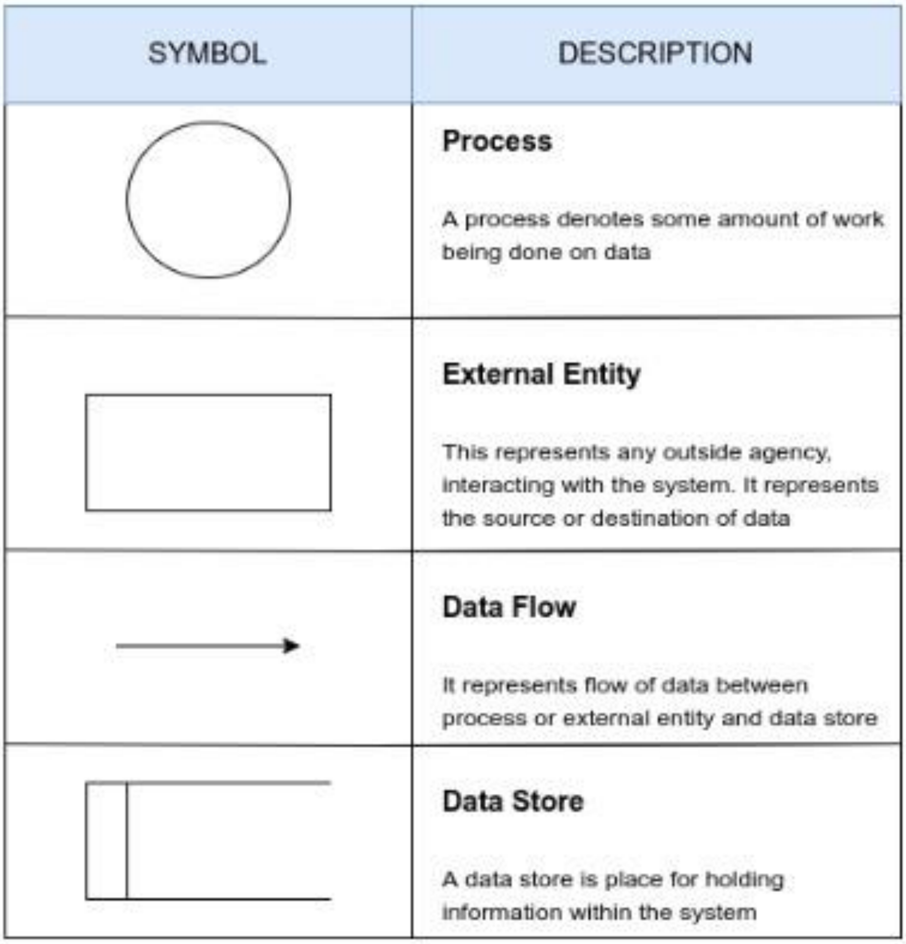


Figure 4. Connection Diagram of Sensor Based Smart Agriculture Monitoring System

4.7. DATA FLOW DIAGRAM (DFD)

A data-flow diagram is a way of representing a flow of data through a process or a system (usually an information system). The DFD also provides information about the outputs and inputs of each entity and the process itself. A data-flow diagram has no control flow, there are no decision rules and no loops. For each data flow, at least one of the endpoints (source and / or destination) must exist in a process. The refined representation of a process can be done in another data-flow diagram, which subdivides this process into sub-processes. The data-flow diagram is a tool that is part of structured analysis and data modeling.

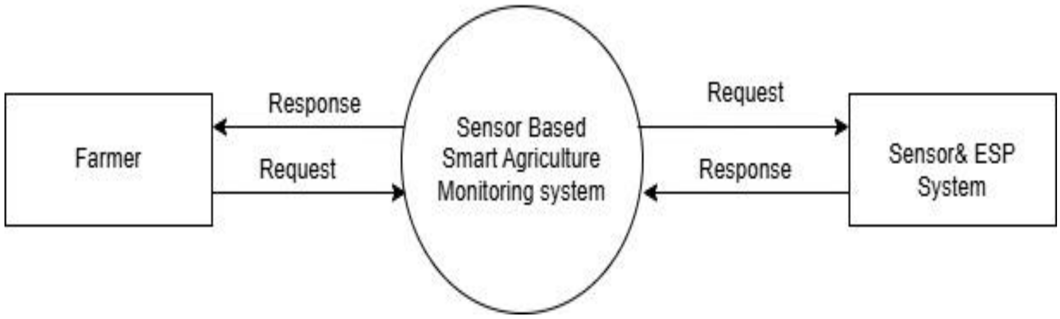
The basic elements of Data Flow Diagram are:



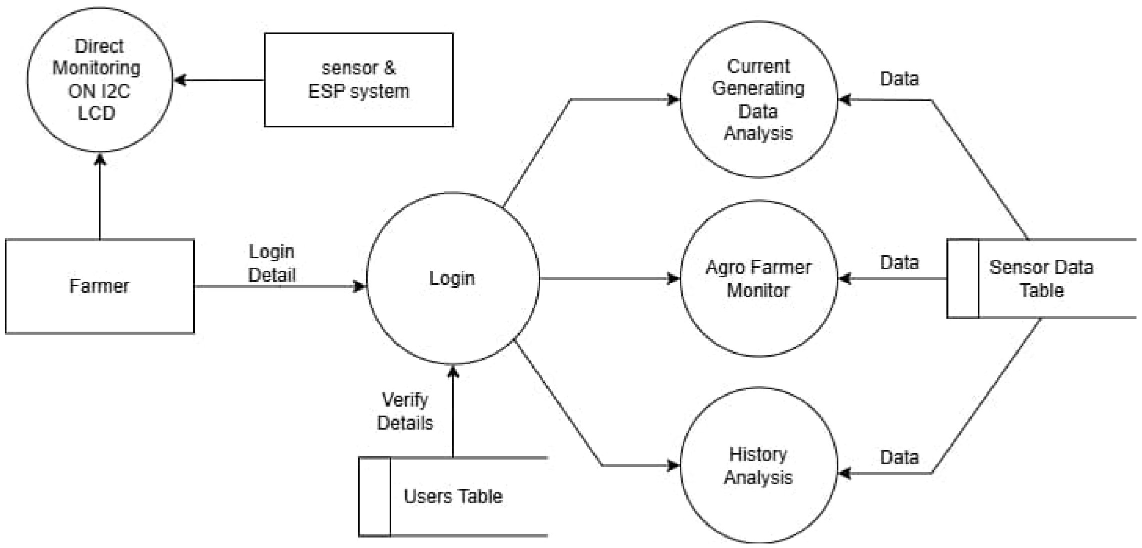
SYMBOL	DESCRIPTION
	Process A process denotes some amount of work being done on data
	External Entity This represents any outside agency, interacting with the system. It represents the source or destination of data
	Data Flow It represents flow of data between process or external entity and data store
	Data Store A data store is place for holding information within the system

Agriculture Monitoring System

Level 0
DFD



LEVEL 1
Farmers DFD



LEVEL 2
DFD

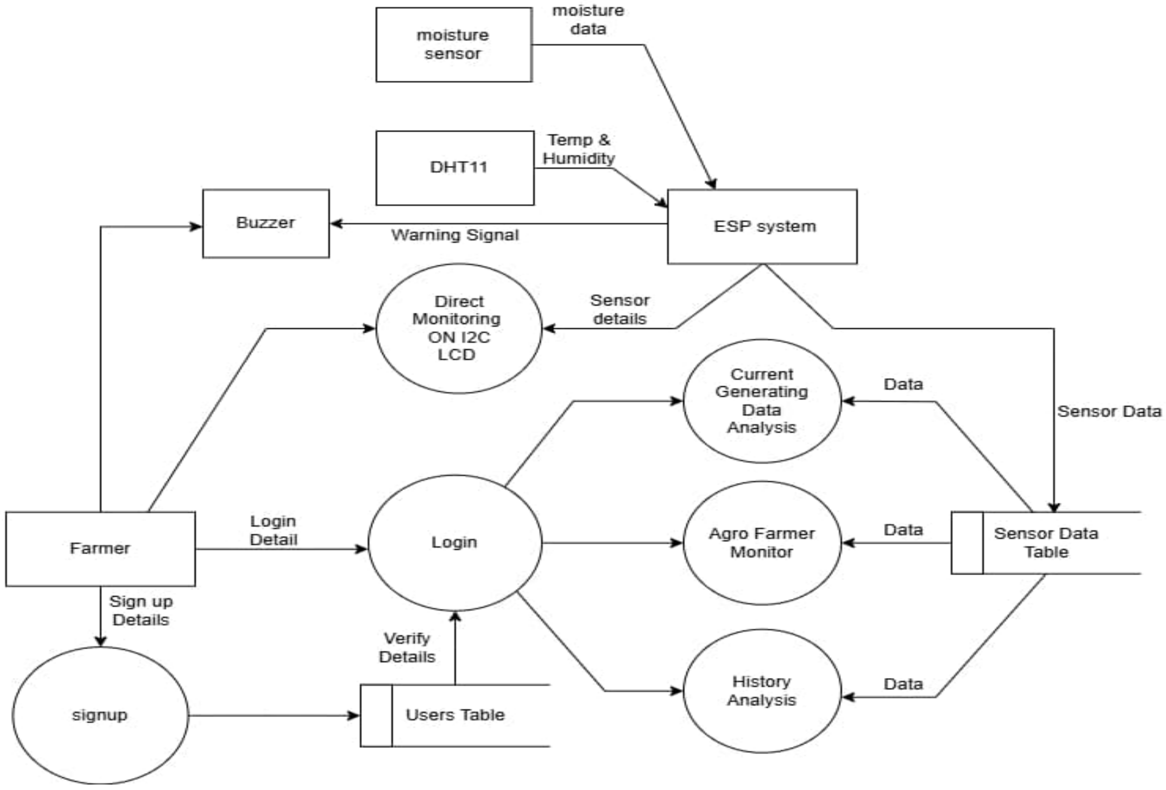


Figure 5 DFD

4.8. Source code

Login code

```
<?php
session_start();
ob_start();

$conn = new mysqli("localhost", "root", "", "smart_agriculture");
if ($conn->connect_error) {
    die("Connection failed: " . $conn->connect_error);
}

$error_message = "";
$success_message = "";

if ($_SERVER["REQUEST_METHOD"] == "POST") {
    if (isset($_POST["signup"])) {
        $email = $_POST["email"];
        $password = $_POST["password"];
```

```
        $sql = "INSERT INTO users (email, password) VALUES ('$email', '$password')";
        if ($conn->query($sql) === TRUE) {
            $success_message = "Signup successful! Please login.";
        } else {
            $error_message = "Error: " . $conn->error;
        }
    } elseif (isset($_POST["login"])) {
        $email = $_POST["email"];
        $password = $_POST["password"];

        $result = $conn->query("SELECT * FROM users WHERE email='$email' AND password='$password'");
        if ($result->num_rows > 0) {
            $_SESSION["user"] = $email;
            header("Location: agro.php");
            exit();
        } else {
            $error_message = "Invalid email or password. Please try again or Signup";
        }
    }
}

ob_end_flush();
?>


<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title> Farmer Login & Signup Form</title>
    <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Poppins:400,500,600,700&display=swap">
    <style>
        *{
            margin: 0;
            padding: 0;
            box-sizing: border-box;
            font-family: 'Poppins', sans-serif;
        }
        html,body{
            display: grid;
            height: 100%;
            width: 100%;
            place-items: center;
            background: -webkit-linear-gradient(left, #003366,#004080,#0059b3, #0073e6);
        }
        .wrapper{
            overflow: hidden;
            max-width: 390px;
            background: #fff;
            padding: 30px;
            border-radius: 15px;
            box-shadow: 0px 15px 20px rgba(0,0,0,0.1);
        }
        .wrapper .title-text{
            display: flex;
            width: 200%;
        }
        .wrapper .title{
```

```
   width: 50%;
   font-size: 35px;
   font-weight: 600;
   text-align: center;
   transition: all 0.6s;
}
.wrapper .slide-controls{
   position: relative;
   display: flex;
   height: 50px;
   width: 100%;
   overflow: hidden;
   margin: 30px 0 10px 0;
   justify-content: space-between;
   border: 1px solid lightgrey;
   border-radius: 15px;
}
.slide-controls .slide{
   height: 100%;
   width: 100%;
   color: #93a5b7;
   font-size: 18px;
   font-weight: 500;
   text-align: center;
   line-height: 48px;
   cursor: pointer;
   z-index: 1;
   transition: all 0.6s ease;
}
.slide-controls label.signup{
   color: #000;
}
.slide-controls .slider-tab{
   position: absolute;
   height: 100%;
   width: 50%;
   left: 0;
   border-radius: 15px;
   background: -webkit-linear-gradient(left,#003366,#004080,#0059b3, #0073e6);
   transition: all 0.6s;
}
input[type="radio"]{
   display: none;
}
#signup:checked ~ .slider-tab{
   left: 50%;
}
#signup:checked ~ label.signup{
   color: #fff;
   cursor: default;
   user-select: none;
}
#login:checked ~ label.signup{
   color: #000;
}
.wrapper .form-container{
   width: 100%;
   overflow: hidden;
}
```

```
.form-container .form-inner{
    display: flex;
    width: 200%;
}
.form-container .form-inner form{
    width: 50%;
    transition: all 0.6s;
}
.form-inner form .field{
    height: 50px;
    width: 100%;
    margin-top: 20px;
}
.form-inner form .field input{
    height: 100%;
    width: 100%;
    outline: none;
    padding-left: 15px;
    border-radius: 15px;
    border: 1px solid lightgrey;
    font-size: 17px;
    transition: all 0.3s ease;
}
form .btn{
    height: 50px;
    width: 100%;
    border-radius: 15px;
    position: relative;
    overflow: hidden;
}
form .btn .btn-layer{
    height: 100%;
    width: 300%;
    position: absolute;
    left: -100%;
    background: -webkit-linear-gradient(right,#003366,#004080,#0059b3, #0073e6);
    border-radius: 15px;
    transition: all 0.4s ease;
}
form .btn:hover .btn-layer{
    left: 0;
}
form .btn input[type="submit"]{
    height: 100%;
    width: 100%;
    z-index: 1;
    position: relative;
    background: none;
    border: none;
    color: #004080;
    font-size: 20px;
    font-weight: 500;
    cursor: pointer;
}
.main-heading {
     text-align: center;
     font-size: 28px;
     font-weight: 700;
     color: #003366;
```

```
            margin-bottom: 20px;
        }
        .wrapper {
            text-align: center;
        }
    </style>
</head>
<body>

    <div class="wrapper">
        <h2 class="main-heading">Farmers Agro Monitor</h2>
        <div class="title-text">
            <div class="title login">Login Form</div>
            <div class="title signup">Signup Form</div>
        </div>
<?php
    if (!empty($success_message)) {
        echo "<p style='color: green;'>$success_message</p>";
    }
    if (!empty($error_message)) {
        echo "<p style='color: red;'>$error_message</p>";
    }
?>
        <div class="form-container">
            <div class="slide-controls">
                <input type="radio" name="slide" id="login" checked>
                <input type="radio" name="slide" id="signup">
                <label for="login" class="slide login">Login</label>
                <label for="signup" class="slide signup">Signup</label>
                <div class="slider-tab"></div>
            </div>
            <div class="form-inner">
            <form action="login.php" method="POST" class="login" onsubmit="return validateEmail('loginEmail', 
'loginError')">
        <div class="field">
            <input type="email" id="loginEmail" name="email" placeholder="Email Address" required>
            <span class="error" id="loginError"></span>
        </div>
        <div class="field">
            <input type="password" name="password" placeholder="Password" required>
        </div>
        <div class="field btn">
            <input type="submit" name="login" value="Login">
        </div>
        <div class="signup-link">Not a member? <a href="#">Signup now</a></div>
    </form>

    <form action="login.php" method="POST" class="signup" onsubmit="return validateForm()">
    <div class="field">
        <input type="email" id="signupEmail" name="email" placeholder="Email Address" required>
        <span class="error" id="signupError"></span>
    </div>
    <div class="field">
        <input type="password" id="password" name="password" placeholder="Password" required>
    </div>
    <div class="field">
        <input type="password" id="confirmPassword" name="confirm_password" placeholder="Confirm password" 
required>
        <span class="error" id="passwordError"></span>
```

```
    </div>
    <div class="field btn">
      <input type="submit" name="signup" value="Signup">
    </div>
  </form>

  <script>
    function validateForm() {
      var email = document.getElementById("signupEmail").value;
      var emailError = document.getElementById("signupError");
      var password = document.getElementById("password").value;
      var confirmPassword = document.getElementById("confirmPassword").value;
      var passwordError = document.getElementById("passwordError");

      var emailPattern = /^[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\.[a-zA-Z]{2,}$/;

      // Validate email
      if (!emailPattern.test(email)) {
        emailError.innerText = "Invalid email format!";
        return false;
      } else {
        emailError.innerText = "";
      }

      // Validate password match
      if (password !== confirmPassword) {
        passwordError.innerText = "Passwords do not match!";
        return false;
      } else {
        passwordError.innerText = "";
      }

      return true;
    }
  </script>

        </div>
      </div>
    </div>
    <script>
      const loginText = document.querySelector(".title-text .login");
      const loginForm = document.querySelector("form.login");
      const loginBtn = document.querySelector("label.login");
      const signupBtn = document.querySelector("label.signup");
      const signupLink = document.querySelector("form .signup-link a");
      signupBtn.onclick = () => {
        loginForm.style.marginLeft = "-50%";
        loginText.style.marginLeft = "-50%";
      };
      loginBtn.onclick = () => {
        loginForm.style.marginLeft = "0%";
        loginText.style.marginLeft = "0%";
      };
      signupLink.onclick = () => {
        signupBtn.click();
        return false;
      };
      function validateEmail(emailId, errorId) {
        var email = document.getElementById(emailId).value;
```

```
        var errorSpan = document.getElementById(errorId);
        var emailPattern = /^[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\.[a-zA-Z]{2,}$/;

        if (!emailPattern.test(email)) {
          errorSpan.innerText = "Invalid email format!";
          return false;
        } else {
          errorSpan.innerText = "";
          return true;
        }
      }
    </script>

</body>
</html>
```

Dashboard home page

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Agro Farmers Monitor</title>
    <script src="https://cdn.jsdelivr.net/npm/chart.js"></script>
    <style>

body {
        background: -webkit-linear-gradient(left, #003366,#004080,#0059b3, #0073e6);
        font-family: Arial, sans-serif;
        margin: 0;
        padding: 0;
    }
    .wrapper {
        background-color: white;
        padding: 20px;
        border-radius: 10px;
        box-shadow: 0px 0px 10px rgba(0, 0, 0, 0.1);
        max-width: 1200px;
        margin: 20px auto;
    }
    .data-table {
        background-color:rgba(255, 255, 255, 0.88);
    }
    .data-table th {
        background-color: #003366;
    }

        .main-heading {
          text-align: center;
          font-size: 28px;
          font-weight: 700;
          color: #003366;
          margin-bottom: 20px;
        }
        .wrapper {
          text-align: center;
        }
        .dashboard {
          display: flex;
```

```
    flex-wrap: wrap;
    justify-content: center;
}
.chart-container {
    width: 45%;
    margin: 20px;
}
.data-table {
    margin: 20px auto;
    width: 80%;
    border-collapse: collapse;
}
.data-table th, .data-table td {
    border: 1px solid #ddd;
    padding: 8px;
    text-align: center;
}
.data-table th {
    background-color: #003366;
    color: white;
}
.main-heading {
    text-align: center;
    font-size: 32px;
    font-weight: 700;
    color: #003366;
    margin-bottom: 20px;
}
.canvas-container {
    display: flex;
    flex-direction: column;
    align-items: center;
    margin-bottom: 30px;
}
.canvas-container a {
    text-decoration: none;
    color: white;
    font-size: 24px;
    font-weight: bold;
    display: flex;
    align-items: center;
    gap: 15px;
    background-color: #003366;
    padding: 10px 70px;
    border-radius: 15px;
    box-shadow: 5px 5px 15px rgba(0, 0, 0, 0.3);
}
.canvas-container img {
    width: 120px;
    height: 120px;
    border-radius: 15px;

}
.canvas-container p {
    color: red;
    font-size: 18px;
    font-weight: bold;
    margin-top: 10px;
}
```

```
        .instruction {
            text-align: center;
            font-size: 20px;
            font-weight: bold;
            color: red;
            margin: 20px 0;
        }
        .history-btn {
    display: inline-block;
    padding: 10px 20px;
    background-color:#003366;
    color: white;
    text-decoration: none;
    font-size: 16px;
    border-radius: 5px;
    transition: background 0.3s ease;
}

.history-btn:hover {
    background-color:#003366;
}


    </style>
</head>
<body>
    <div class="wrapper">
        <h2 class="main-heading">Agro Farmers Monitor</h2>

        <div class="canvas-container">
        <a href="http://localhost/MCA_Project/Tabledata.php">
            <img src="smart_agriculture_icon.png" alt="Smart Agriculture Icon">
            Click here to see data
        </a>
        <p>Click above for Smart Agricultural Data<span class="hand-icon">□</span></p>
         </div>

         <div class="instruction">

         <div id="warningSection">Loading warnings...</div>

<script>
function fetchWarnings() {
    fetch('fetch_warnings.php')
        .then(response => response.json())
        .then(data => {
            let warningSection = document.getElementById("warningSection");
            if (data.warnings && data.warnings.length > 0) {
                warningSection.innerHTML = data.warnings.map(warning => `<p>${warning}</p>`).join("");
            } else {
                warningSection.innerHTML = "<p>No warnings.</p>";
            }
        })
        .catch(error => {
            console.error('Error fetching warnings:', error);
            document.getElementById("warningSection").innerHTML = "<p>Error loading warnings.</p>";
        });
}
```

```
// Fetch warnings every 5 seconds
setInterval(fetchWarnings, 5000);
fetchWarnings();
</script>


    </div>

        <h3>Sensor Data & Status</h3>
        <table class="data-table">
            <thead>
                <tr>
                    <th>Temperature</th>
                    <th>Humidity</th>
                    <th>Moisture</th>
                    <th>Pump Status</th>
                    <th>Fan Status</th>
                </tr>
            </thead>
            <tbody id="sensorData">
            <?php
$servername = "localhost";
$username = "root";
$password = "";
$database = "smart_agriculture";

$conn = new mysqli($servername, $username, $password, $database);
if ($conn->connect_error) {
    die("Connection failed: " . $conn->connect_error);
}

$sql = "SELECT * FROM sensor_data ORDER BY id DESC LIMIT 1";
$result = $conn->query($sql);
if ($result->num_rows > 0) {
    $data = $result->fetch_assoc();
    echo "<tr>
            <td>{$data['temperature']}°C</td>
            <td>{$data['humidity']}%</td>
            <td>{$data['moisture']}%</td>
            <td class='" . ($data['pump_status'] == 1 ? "on" : "off") . "'>" . ($data['pump_status'] == 1 ? "ON" : "OFF") . "</td>
            <td class='" . ($data['fan_status'] == 1 ? "on" : "off") . "'>" . ($data['fan_status'] == 1 ? "ON" : "OFF") . "</td>
          </tr>";
}
$conn->close();
?>


            </tbody>
        </table>
        <a href="history.php" class="history-btn">Click here to navigate to Agro History Analysis</a>
        <div class="dashboard">
            <div class="chart-container"><canvas id="tempChart"></canvas></div>
            <div class="chart-container"><canvas id="humidityChart"></canvas></div>
            <div class="chart-container"><canvas id="moistureChart"></canvas></div>
            <div class="chart-container"><canvas id="pumpChart"></canvas></div>
            <div class="chart-container"><canvas id="fanChart"></canvas></div>
        </div>
```

```
    </div>


    <script>
      let tempChart, humidityChart, moistureChart, pumpChart, fanChart;

      function fetchData() {
        fetch('fetch_data.php')
          .then(response => response.json())
          .then(data => {
            updateChart(tempChart, data.temperature);
            updateChart(humidityChart, data.humidity);
            updateChart(moistureChart, data.moisture);
            updateChart(pumpChart, data.pump_status);
            updateChart(fanChart, data.fan_status);

            document.getElementById("sensorData").innerHTML = `
              <tr>
    <td>${data['temperature']}°C</td>
    <td>${data['humidity']}%</td>
    <td>${data['moisture']}%</td>
    <td class="${data['pump_status'] == 1 ? 'on' : 'off'}">${data['pump_status'] == 1 ? 'ON' : 'OFF'}</td>
    <td class="${data['fan_status'] == 1 ? 'on' : 'off'}">${data['fan_status'] == 1 ? 'ON' : 'OFF'}</td>
  </tr>`;
          })
          .catch(error => console.error('Error fetching data:', error));
      }

      function createChart(ctx, label, color) {
        return new Chart(ctx, {
          type: 'line',
          data: {
            labels: [],
            datasets: [{
              label: label,
              data: [],
              borderColor: color,
              fill: false
            }]
          }
        });
      }

      function updateChart(chart, value) {
        let now = new Date().toLocaleTimeString();
        chart.data.labels.push(now);
        chart.data.datasets[0].data.push(value);
        if (chart.data.labels.length > 10) {
          chart.data.labels.shift();
          chart.data.datasets[0].data.shift();
        }
        chart.update();
      }

      document.addEventListener("DOMContentLoaded", function() {
        tempChart = createChart(document.getElementById('tempChart').getContext('2d'), 'Temperature', 'red');
        humidityChart = createChart(document.getElementById('humidityChart').getContext('2d'), 'Humidity', 'blue');
        moistureChart = createChart(document.getElementById('moistureChart').getContext('2d'), 'Moisture', 'green');
        pumpChart = createChart(document.getElementById('pumpChart').getContext('2d'), 'Pump Status', 'purple');
```

```
        fanChart = createChart(document.getElementById('fanChart').getContext('2d'), 'Fan Status', 'orange');
        setInterval(fetchData, 3000);
      });
    </script>



</body>
</html>
```

History

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Agro Farmers History Dashboard</title>
    <script src="https://cdn.jsdelivr.net/npm/chart.js"></script>
    <style>
        body {
            background-color: #f4f4f9;
            font-family: Arial, sans-serif;
            margin: 0;
            padding: 0;
            text-align: center;
        }
        .wrapper {
            max-width: 1000px;
            margin: 20px auto;
            padding: 20px;
            background-color: white;
            border-radius: 10px;
            box-shadow: 0px 0px 10px rgba(0, 0, 0, 0.1);
        }
        h2 {
            color: #003366;
        }
        .grid-container {
            display: grid;
            grid-template-columns: repeat(2, 1fr);
            gap: 15px;
        }
        .chart-container {
            width: 90%;
            height: 250px;
            background: #fff;
            border-radius: 10px;
            box-shadow: 2px 2px 10px rgba(0, 0, 0, 0.1);
            padding: 10px;
        }
        canvas {
            width: 100% !important;
            height: 180px !important;
        }
        .system-chart-container {
    display: flex;
    justify-content: center;
    align-items: center;
    width: 100%;
```

```
    margin-top: 20px;
    margin-left: 210px; /* Adjust this value to move it slightly */
}

.system-chart-container .chart-container {
    width: 250px;
    text-align: center;
}

.home-btn {
        display: inline-block;
        padding: 10px 15px;
        background-color: rgb(40, 49, 167);
        color: white;
        text-decoration: none;
        font-size: 16px;
        border-radius: 5px;
        transition: background 0.3s ease;
        position: absolute;
        top: 20px;
        left: 20px;
    }

    .home-btn:hover {
        background-color:rgb(17, 42, 70);
    }


    </style>
</head>
<body>
    <div class="wrapper">
        <h2>Agro Farmers History Analysis</h2>
        <a href="agro.php" class="home-btn">Home</a>
        <div class="grid-container">
            <div class="chart-container">
                <h4>Pump ON/OFF</h4>
                <canvas id="pumpChart"></canvas>
            </div>

            <div class="chart-container">
                <h4>Fan ON/OFF</h4>
                <canvas id="fanChart"></canvas>
            </div>

            <div class="chart-container">
                <h4>Temperature Trends</h4>
                <canvas id="temperatureChart"></canvas>
            </div>

            <div class="chart-container">
                <h4>Moisture Trends</h4>
                <canvas id="moistureChart"></canvas>
            </div>

            <div class="system-chart-container">
             <div class="chart-container">
             <h4>System ON/OFF</h4>
             <canvas id="systemChart"></canvas>
```

```
          </div>
         </div>



       </div>
    </div>

    <script>
       function fetchHistoryData() {
          fetch('fetch_history.php')
             .then(response => response.json())
             .then(data => {
                updateBarChart('pumpChart', ['ON', 'OFF'], [data.pump_on, data.pump_off], 'Pump Status');
                updateBarChart('fanChart', ['ON', 'OFF'], [data.fan_on, data.fan_off], 'Fan Status');
                updateLineChart('temperatureChart', data.timestamps, data.max_temp, data.min_temp, 'Temperature (°C)');
                updateLineChart('moistureChart', data.timestamps, data.max_moisture, data.min_moisture, 'Moisture (%)');
                updatePieChart('systemChart', ['All ON', 'Mixed', 'All OFF'], [data.all_on, data.mixed, data.all_off], 'System
Status');
             })
             .catch(error => console.error('Error fetching data:', error));
       }

       function updateBarChart(chartId, labels, data, label) {
          new Chart(document.getElementById(chartId), {
             type: 'bar',
             data: { labels, datasets: [{ label, data, backgroundColor: ['#28a745', '#dc3545'] }] },
          });
       }

       function updateLineChart(chartId, labels, maxData, minData, label) {
          new Chart(document.getElementById(chartId), {
             type: 'line',
             data: {
                labels,
                datasets: [
                   { label: 'Max ' + label, data: maxData, borderColor: 'red', fill: false },
                   { label: 'Min ' + label, data: minData, borderColor: 'blue', fill: false }
                ]
             }
          });
       }

       function updatePieChart(chartId, labels, data, label) {
          new Chart(document.getElementById(chartId), {
             type: 'pie',
             data: {
                labels,
                datasets: [{ label, data, backgroundColor: ['green', 'orange', 'red'] }]
             }
          });
       }

       fetchHistoryData();
    </script>
</body>
</html>
```

Full Data Table

```
<?php
$servername = "localhost";
$username = "root";
$password = "";
$database = "smart_agriculture";

$conn = new mysqli($servername, $username, $password, $database);
if ($conn->connect_error) {
    die("Connection failed: " . $conn->connect_error);
}

$sql = "SELECT * FROM sensor_data ORDER BY id DESC";
$result = $conn->query($sql);
?>

<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Smart Agriculture Data</title>
    <style>
        body {
            font-family: Arial, sans-serif;
            margin: 20px;
            background-color: #f4f4f4;
        }
        h2 {
            text-align: center;
            color:rgb(40, 53, 167);
            font-size: 24px;
            margin-bottom: 20px;
        }
        table {
            width: 100%;
            border-collapse: collapse;
            background: #fff;
        }
        th, td {
            padding: 12px;
            border: 1px solid #ddd;
            text-align: center;
        }
        th {
            background:rgb(40, 49, 167);
            color: white;
        }
        tr:nth-child(even) {
            background: #f2f2f2;
        }
        .on {
            color: green;
            font-weight: bold;
        }
        .off {
            color: red;
            font-weight: bold;
        }
```

```
        .home-btn {
          display: inline-block;
          padding: 10px 15px;
          background-color: rgb(40, 49, 167);
          color: white;
          text-decoration: none;
          font-size: 16px;
          border-radius: 5px;
          transition: background 0.3s ease;
          position: absolute;
          top: 20px;
          left: 20px;
        }

        .home-btn:hover {
          background-color:rgb(17, 42, 70);
        }
      </style>
    </head>
    <body>
      <h2>Smart Agriculture Monitoring Data</h2>
      <a href="agro.php" class="home-btn">Home</a>
      <table>
        <tr>
          <th>ID</th>
          <th>Temperature (°C)</th>
          <th>Humidity (%)</th>
          <th>Moisture (%)</th>
          <th>Pump Status</th>
          <th>Fan Status</th>
          <th>Buzzer Status</th>
          <th>Timestamp</th>
        </tr>
        <?php
        if ($result->num_rows > 0) {
          while($row = $result->fetch_assoc()) {
            echo "<tr>";
            echo "<td>" . $row['id'] . "</td>";
            echo "<td>" . $row['temperature'] . "</td>";
            echo "<td>" . $row['humidity'] . "</td>";
            echo "<td>" . $row['moisture'] . "</td>";
            echo "<td class='" . ($row['pump_status'] ? "on" : "off") . "'>" . ($row['pump_status'] ? "ON" : "OFF") . "</td>";
            echo "<td class='" . ($row['fan_status'] ? "on" : "off") . "'>" . ($row['fan_status'] ? "ON" : "OFF") . "</td>";
            echo "<td class='" . ($row['buzzer_status'] ? "on" : "off") . "'>" . ($row['buzzer_status'] ? "ON" : "OFF") . "</td>";
            echo "<td>" . $row['timestamp'] . "</td>";
            echo "</tr>";
          }
        } else {
          echo "<tr><td colspan='8'>No data available</td></tr>";
        }
        $conn->close();
        ?>
      </table>
    </body>
    </html>
```

Warning/Alert

```php
<?php
header('Content-Type: application/json');

$servername = "localhost";
$username = "root";
$password = "";
$database = "smart_agriculture";

$conn = new mysqli($servername, $username, $password, $database);
if ($conn->connect_error) {
    echo json_encode(["error" => "Connection failed"]);
    exit;
}

$sql = "SELECT * FROM sensor_data ORDER BY id DESC LIMIT 1";
$result = $conn->query($sql);
$data = $result->fetch_assoc();

$warnings = [];
if ($data) {
    if ($data['moisture'] < 30) {
        $warnings[] = "WARNING! Moisture is less, ensure the proper water content of crop. Water pump is running ON.";
    }
    if ($data['temperature'] > 29) {
        $warnings[] = "WARNING! Make sure there is proper air for crops. The temperature is increasing.";
    }
    if ($data['moisture'] > 50) {
        $warnings[] = "INFORMATION: You can use good fertilizers because your crop soil moisture is good.";
    }
    if ($data['moisture'] > 70) {
        $warnings[] = "CAUTION! Water content in soil is increasing. Your water pump may turn OFF.";
    }
}

$conn->close();
echo json_encode(["warnings" => $warnings]);
?>
```

4.9. Result

Sensor Based Smart Agriculture Monitoring System Using (Web & IOT Based)

SCREENSHOTS

Login UI

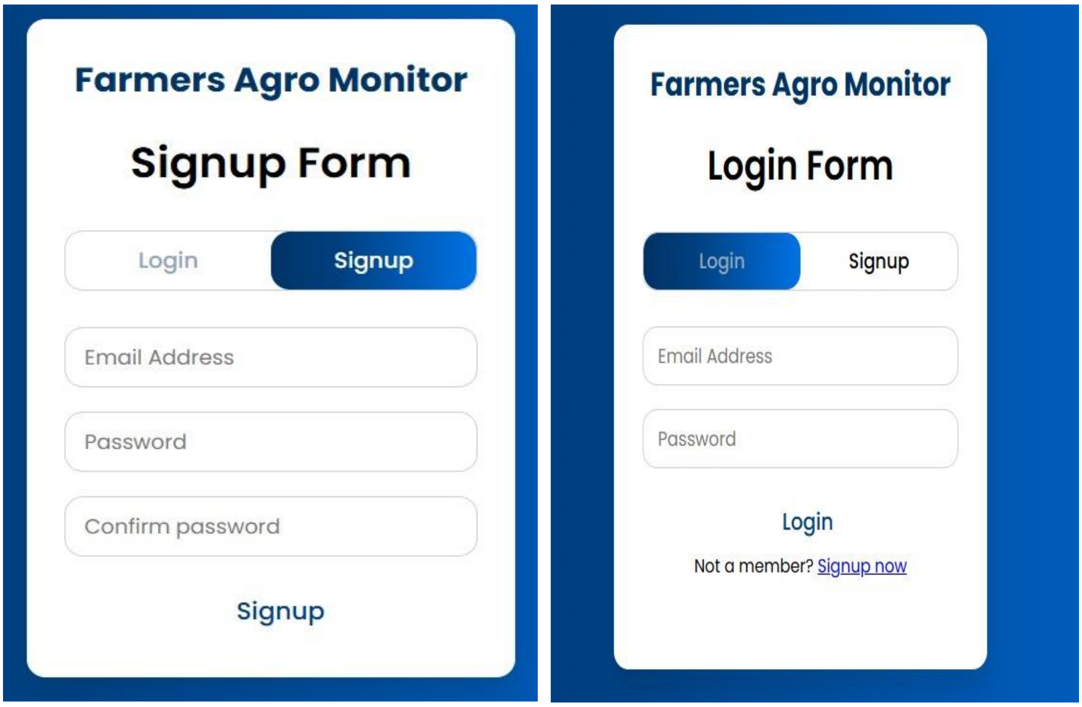


Fig 6 Login page

Dashboard Home Page

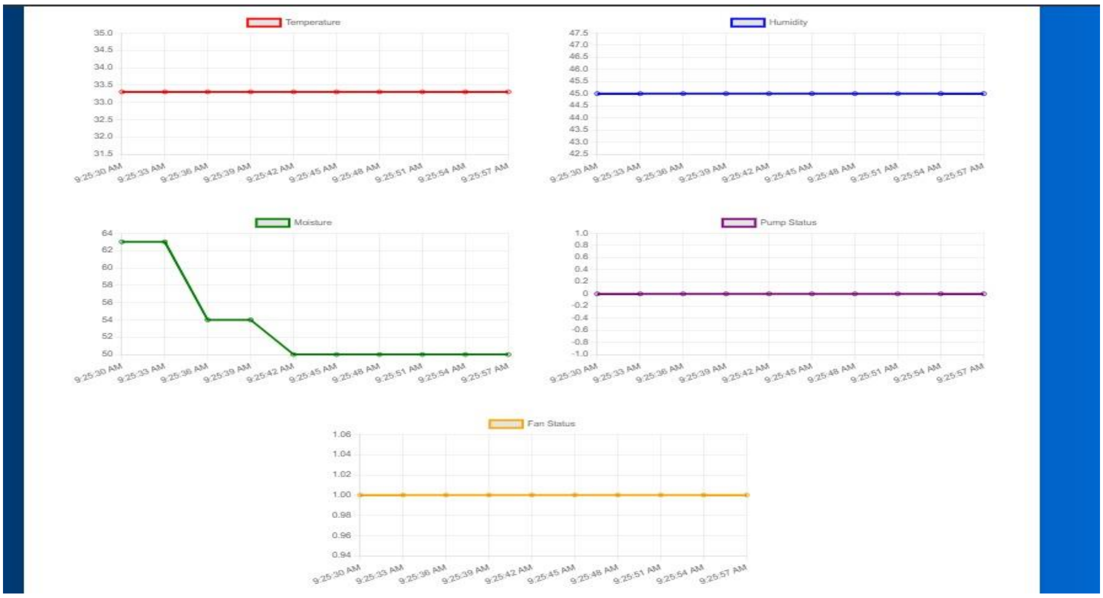


Fig 7 Home Page

Fig 8 Dashboard

Fig.9 Data Record According to Sensors

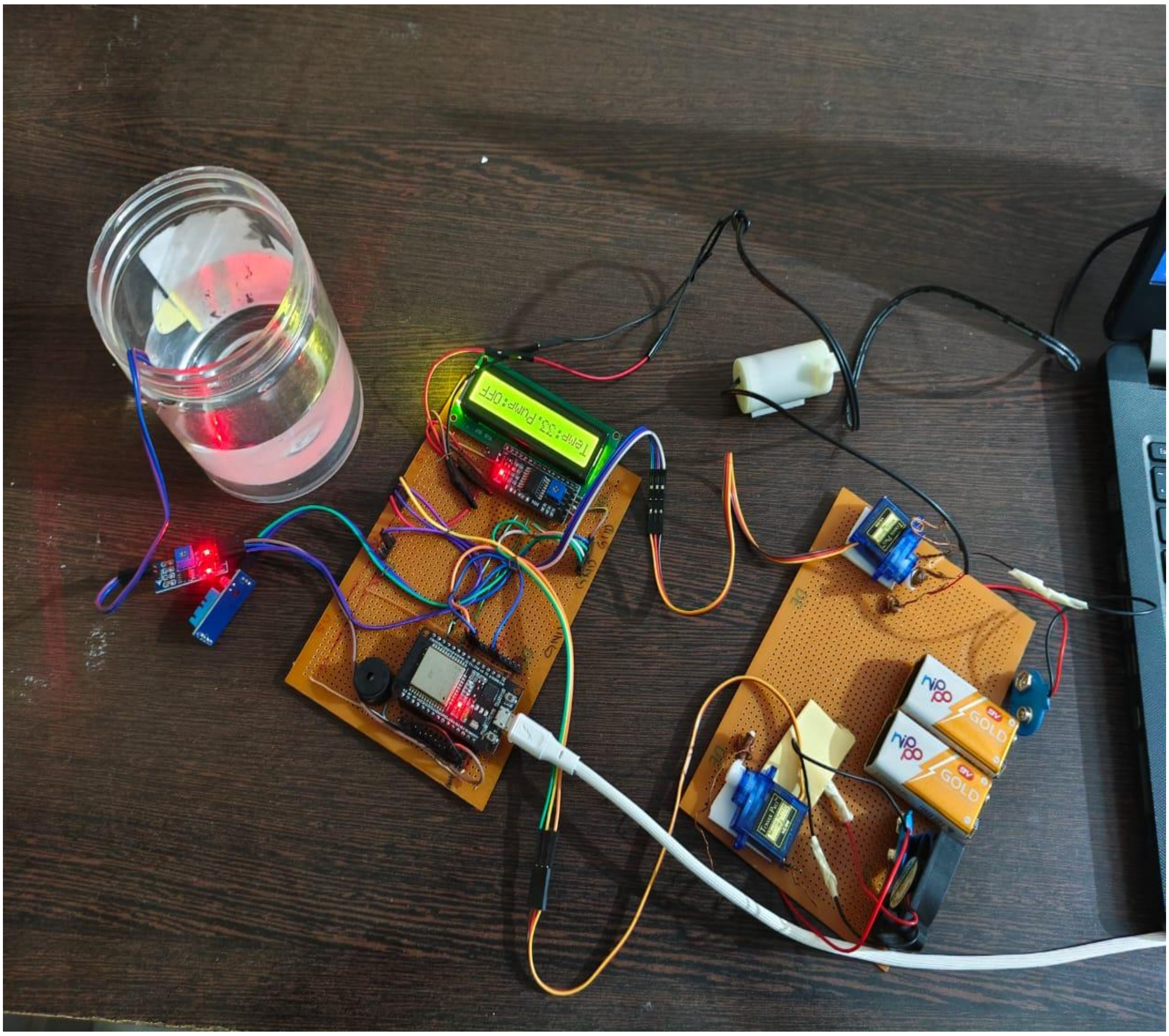
Home

Smart Agriculture Monitoring Data

ID	Temperature (°C)	Humidity (%)	Moisture (%)	Pump Status	Fan Status	Buzzer Status	Timestamp
1128	33.3	45	52	OFF	ON	OFF	2025-05-12 09:23:13
1127	33.3	45	56	OFF	ON	OFF	2025-05-12 09:23:07
1126	33.3	45	63	OFF	ON	OFF	2025-05-12 09:23:02
1125	33.3	45	65	OFF	ON	OFF	2025-05-12 09:22:56
1124	33.3	46	67	OFF	ON	OFF	2025-05-12 09:22:51
1123	33.3	46	0	ON	ON	ON	2025-05-12 09:22:46
1122	33.3	46	0	ON	ON	ON	2025-05-12 09:22:41
1121	33.3	45	0	ON	ON	ON	2025-05-12 09:22:35
1120	33.3	45	51	OFF	ON	OFF	2025-05-12 09:22:26
1119	33.3	45	52	OFF	ON	OFF	2025-05-12 09:22:18
1118	33.3	45	54	OFF	ON	OFF	2025-05-12 09:22:13
1117	33.3	45	53	OFF	ON	OFF	2025-05-12 09:21:57
1116	33.3	46	53	OFF	ON	OFF	2025-05-12 09:21:52
1115	33.3	46	54	OFF	ON	OFF	2025-05-12 09:21:46
1114	33.3	46	58	OFF	ON	OFF	2025-05-12 09:21:40
1113	33.3	46	64	OFF	ON	OFF	2025-05-12 09:21:34
1112	33.3	46	65	OFF	ON	OFF	2025-05-12 09:21:29
1111	33.3	46	0	ON	ON	ON	2025-05-12 09:21:23

Fig.10 History Analysis

Fig.11 Prototype Devices



5. Discussion

Discussion-The sensor-based smart agricultural monitoring system using Web and IoT has demonstrated significant advantages in optimizing agricultural practices. The system efficiently collects real-time data on soil moisture, temperature, and humidity, which allows farmers to monitor and control environmental conditions remotely. The automated irrigation feature based on soil moisture levels has led to optimized water usage, reducing water waste and ensuring that crops receive adequate hydration.

Furthermore, the ability to monitor environmental conditions has helped farmers to proactively address potential issues such as extreme temperatures, which can negatively impact crop health. This approach reduces manual labor and minimizes the risk of crop damage due to delayed intervention.

The system's integration with a web interface has enhanced accessibility, allowing farmers to make data-driven decisions from any location. The graphical data visualization and real-time notifications have empowered farmers to take timely actions, thus improving overall crop productivity.

Despite its benefits, the system also has certain limitations. It relies heavily on internet connectivity, making it less effective in remote areas with poor network coverage. Additionally, the initial setup cost of the system can be a barrier for small-scale farmers. Regular maintenance of sensors is also required to ensure accurate data collection.

In summary, the sensor-based smart agricultural monitoring system offers a scalable and efficient solution for modern agriculture, with the potential for further enhancements through the integration of advanced AI and machine learning techniques for predictive analytics and automated decision-making.

Table 2 Comparison with Traditional Farming

Parameter	Traditional Farming	IoT-Based Smart Farming
Water Usage	High (Manual Irrigation)	Optimized (Automated Control)
Labor Requirement	High (Manual Monitoring)	Reduced (Remote Access)
Data Monitoring	No Real-Time Data	Continuous Sensor Data
System Efficiency	Low	High (Data-Driven)
Response Time	Delayed Actions	Instant Alerts & Control

5.1 Future Directions: The future of the sensor-based smart agricultural monitoring system using Web and IoT can be directed towards several promising advancements:

1. Artificial Intelligence and Machine Learning Integration:

- ❖ Develop predictive models for crop yield estimation, disease detection, and optimized irrigation scheduling.
- ❖ Use AI for automated pest and disease recognition through image processing.

2. Enhanced Communication Technologies:

- ❖ Integrate 5G and Lora WAN for better connectivity in remote areas.
- ❖ Use edge computing for faster data processing and reduced cloud dependency.

3. Advanced Sensor Technology:

- Employ multi-parameter sensors that can measure soil pH, nutrient levels, and weather conditions.
- Use drone-based sensors for large-scale field monitoring.

4. Energy Optimization:

- Implement solar-powered IoT devices for sustainable energy consumption.
- Explore energy-efficient communication protocols to extend device battery life.

5. Blockchain for Data Security:

- Use blockchain technology for secure and tamper-proof data storage.
- Enable secure transactions for smart contracts in agriculture.

6. Scalable System Architecture:

- Design modular systems that can be easily scaled for large farms or multiple sites.
- Use cloud-based microservices for efficient data handling and processing.

7. Automated Decision-Making:

- Enhance automation with intelligent control systems for irrigation, fertilization, and pest control.
- Integrate voice assistants for hands-free operation by farmers.

8. User-Friendly Web and Mobile Applications:

- ❖ Improve user interfaces for ease of use by farmers with minimal technical knowledge.
- ❖ Develop mobile apps with multi-language support for better accessibility.

9. Multi-Platform Compatibility:

- ❖ Ensure the system can work seamlessly on various platforms, including web, Android, and iOS.
- ❖ Integrate with existing smart farm management systems for unified control.

10. Environmental Sustainability:

- ❖ Promote precision agriculture practices to minimize water and chemical usage.
- ❖ Develop automated waste management solutions using IoT

6. Conclusion and Recommendations

3.1 Summary

This project presented a sensor-based smart agricultural monitoring system using Web and IoT, aiming to optimize agricultural practices through automation, remote monitoring, and data-driven decision-making. The system utilized an ESP32 microcontroller integrated with various sensors, including soil moisture, temperature, and humidity sensors. Real-time data from these sensors were transmitted to a web-based dashboard, allowing farmers to monitor and control environmental conditions remotely. Key features included automated irrigation, real-time alerts, and data visualization. The system successfully reduced water usage, minimized manual Labor, and improved resource management, contributing to more sustainable and efficient agricultural practices.

3.2 Significance

The significance of this sensor-based smart agricultural monitoring system is highlighted by several critical advantages it offers:

- Enhanced Resource Management: The system ensures optimal water usage through automated irrigation based on real-time soil moisture data.
- Improved Agricultural Efficiency: Real-time monitoring of environmental parameters enables farmers to make informed decisions, improving crop health and yield.
- Reduced Manual Labor: Automated control of irrigation and environmental conditions minimizes the need for constant human supervision.
- Cost-Effective Solution: The integration of IoT and web technologies provides an affordable yet highly functional agricultural monitoring solution.
- Environmental Sustainability: Reduced water usage and optimized resource application support sustainable farming practices.
- Scalability: The system can be easily expanded to accommodate larger farms, making it adaptable for both small-scale and commercial agricultural operations.
- Remote Accessibility: Farmers can monitor and control their farms from any location through the web-based dashboard, enhancing convenience.

3.3 Recommendations

Based on the findings and performance of the system, the following recommendations are proposed:

1. Integration of Advanced Sensors: Future versions of the system should include sensors for soil pH, nutrient levels, and pest detection for a more comprehensive monitoring approach.
2. Energy Optimization: Solar-powered modules should be explored for sustainable and continuous system operation, especially in remote areas.
3. Enhanced Data Security: Blockchain technology can be used to secure data transmission and protect sensitive agricultural data from cyber threats.
4. Scalable Architecture: The system should be designed for easy expansion, enabling it to support larger farms without significant performance degradation.
5. AI-Powered Analytics: Integrate machine learning algorithms to predict irrigation schedules, detect plant diseases, and optimize crop yield.
6. User-Friendly Interface: Continuously improve the user interface for better accessibility, especially for farmers with limited technical knowledge.
7. Field Testing: Conduct extensive field tests in diverse climatic conditions to ensure system robustness and adaptability.
8. Multi-Platform Compatibility: Develop mobile applications alongside the web dashboard for enhanced accessibility.

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8. Proof of PROJECT Outcome

3rd International Conference on Artificial Intelligence, Machine Learning and Cybersecurity : Submission (484) has been created. Inbox x

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Paper Title: Sensor Based Smart Agriculture Monitoring System Using(Web & IOT Based)

Fig.12. Paper Submission

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Dear Christin Varghese

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We are glad to inform you that your manuscript has been accepted for the presentation in conference ICAMC 2025 and for publication in proceeding/journal after revision.

Also, we would like to inform you that your manuscript has been reviewed and the comments from reviewers are at the bottom of this e-mail. Please incorporate the reviewers stated concerns and update the revised paper (in Camera ready paper, both word and pdf)

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Conference Mode- Online/Offline (Hybrid)

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We are pleased to inform you that the conference will be held on 1 -2 May, 2025. The detailed schedule are attached here in the link.

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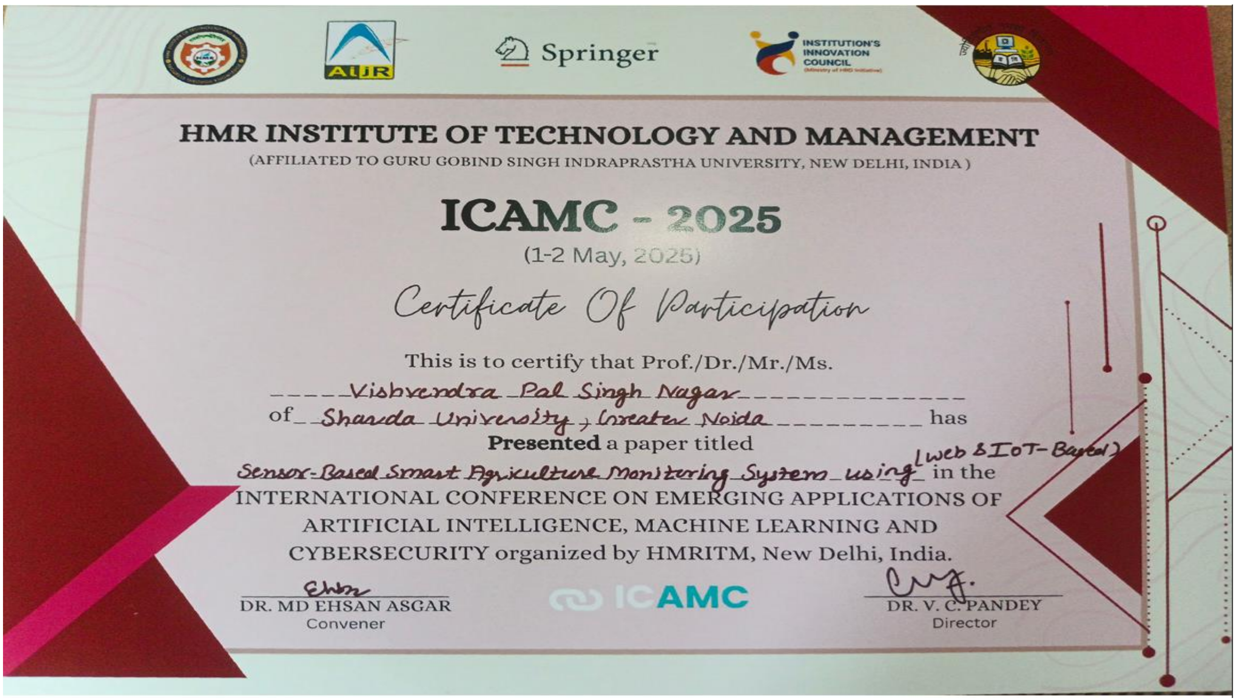

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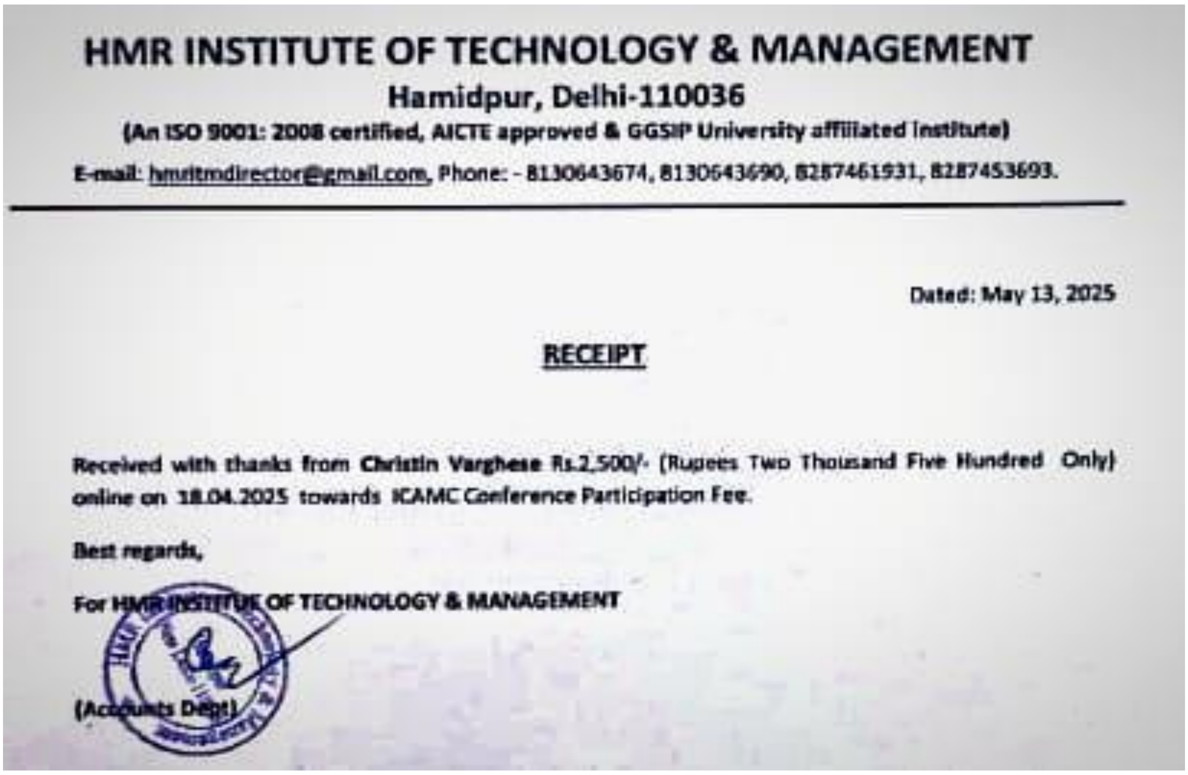

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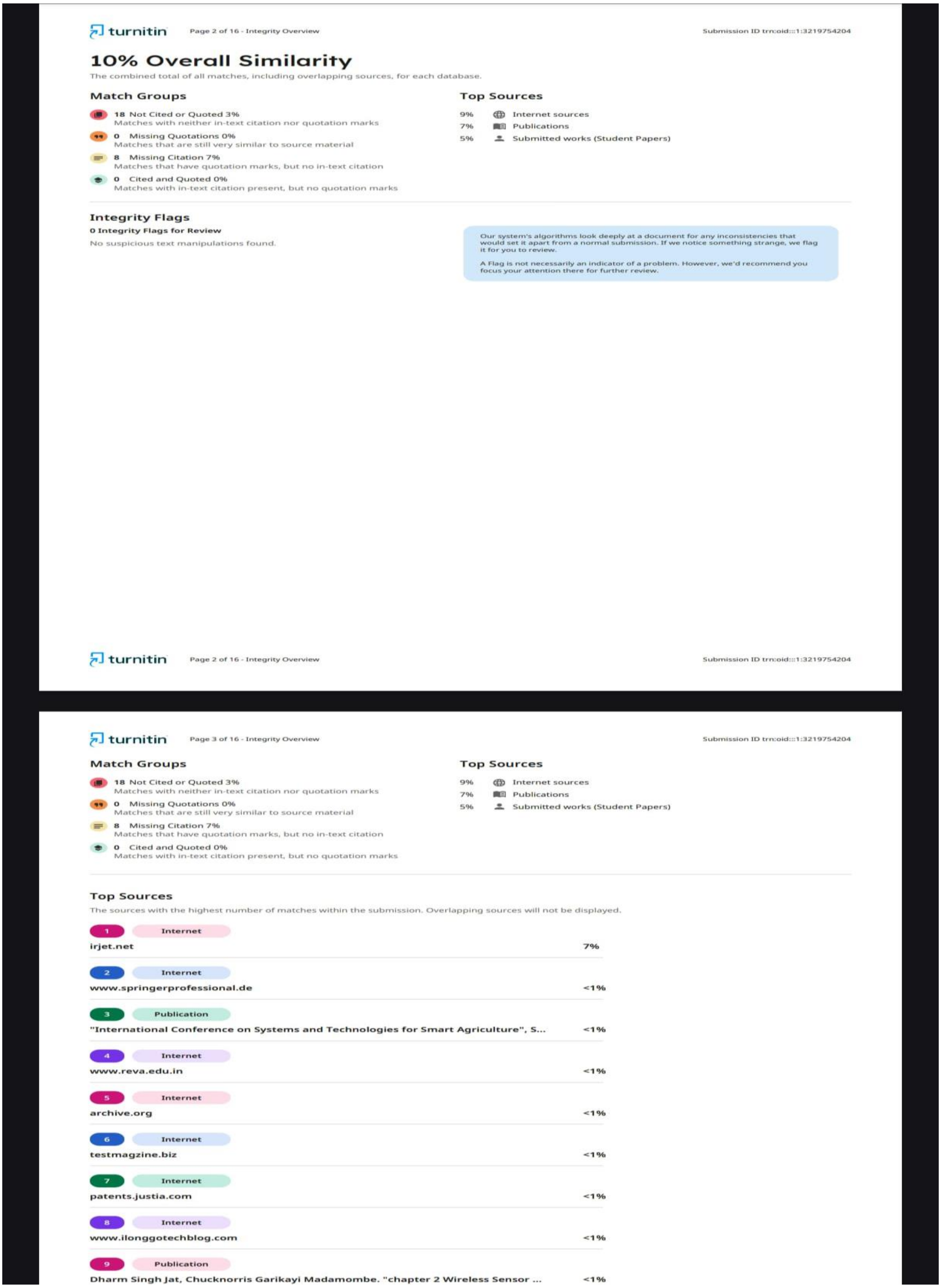

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