Automatic Irrigation System Using IOT

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Abstract- *Water control is pivotal for sustainable agriculture, in particular in areas dealing with resource constraints. This paper provides an IOT-based definitely smart irrigation machine designed to optimize water utilization, decorate crop productivity, and improve power overall performance. The device integrates various sensors, which include soil moisture sensors, rain detectors, and environmental video display gadgets, to evaluate actual-time conditions and automate the irrigation process. A microcontroller-based totally totally manage unit ensures seamless records acquisition and gadget manipulate. The proposed machine includes capabilities collectively with 3-segment strength detection, pump health tracking the use of temperature and current sensors, and some distance off operation through the Blynk IOT platform. the integration of IOT generation enables actual-time data visualization, far flung control, and alert mechanisms, empowering farmers to make data-driven selections and manipulate irrigation with minimum manual intervention. Experimental consequences show the device's effectiveness in defensive water by way of stopping over-irrigation and reducing energy intake through automated fault detection and section tracking. This progressive approach contributes to the sustainability of agricultural practices, making it a treasured tool for farming and useful resource control. The manner of addressing worrying situations related to traditional irrigation structures which includes water wastage, tough work dependency, and unreliable electricity supply this study highlights the potential of IOT in revolutionizing agricultural techniques. future paintings goals to include extra competencies together with fertigation structures, overcurrent protection, and GSM-based totally signals to further beautify device capabilities. This paper lays the muse for scalable, inexperienced, and sustainable irrigation solutions, fostering resilience in opposition to climate variability and aid scarcity.*

I. INTRODUCTION

Water plays an important role in agriculture. However, only about 1% of the total water on the planet is accessible and suitable for human use, with about 70% of that being consumed in the agricultural sector. This underscores the urgent need to minimize water losses in agriculture. Agriculture is an important sector that maintains global food supply. Agriculture is heavily affected by inefficient water management practices, often leading to significant water waste and reduced yields. Traditional irrigation systems such as flooding and manual irrigation, lack of efficiency, and often relying on human intervention, leading to unnecessary water consumption and uneven distribution across the field.

In developing countries such as India, agricultural activities are primarily based on manual irrigation systems and unreliable power supply. Farmers often lead to excessive irrigation or subgroups, rather than actual soil or environmental conditions, based on fixed schedules or assumptions. Additionally, a considerable number of irrigation pumps work in rural areas with three phase performance. This is susceptible to irregularities such as phase loss and tension in the weight of voltage. Running the engine under these conditions can lead to overheating, dry running, and even permanent engine failure, resulting in energy waste and damage to the device.

In recent years, technology integration, particularly through the Internet of Things (IoT), has proven to be a promising solution to these challenges. Operated by microcontrollers, environmental sensors and real data analytics, intelligent irrigation systems not only improve water use efficiency, but also promote sustainable, precision-related agricultural practices.

This article presents the draft and implementation of an IoT-based smart irrigation system, integrated into power stage monitoring using the ESP32 microcontroller. The proposed system automates irrigation based on environmental parameters such as soil moisture, temperature, humidity, and precipitation. Additionally, three-phase performance detection and engine parameters monitoring are included to ensure safe and efficient operation of agricultural pumps, which are usually three-phase induction engines.

The core target of this system is to ensure efficient water consumption by automating irrigation based on real-time floor, moisture, temperature and precipitation data.

Monitor the availability of three electrical phases before turning on the engine and automatically turn it off if phase is lost during operation.

To pursue engine parameters such as power consumption and temperature, safe operation is ensured and prevent damage from dry runs or overheating.

It provides data access through the Blynk-iot platform and provides real-time remote control for farmers to monitor and manage their systems via smartphone.

The system uses several sensors to monitor both environmental and electrical conditions. Soil moisture sensors determine your irrigation needs. The DHT11 sensor records temperature and humidity. The rain sensor recognizes precipitation. The tension sensory circuit checks the availability of three phases. Additionally, the ACS712 current sensor and the LM35 temperature sensor monitor the health of the engine. Based on these inputs, the ESP32 microcontroller determines whether the pump should be turned on or off or off. This ensures resource feeding and device safety.

Compared to previous work, this system is clearly integrated:
Three-phase current fault detection using street transformer circuits and rights. Engine current and thermal monitoring extends system life and improves security.

A comprehensive platform associated with the cloud, Blynk, used for visualizing real data and remote control.

Compatible with rural delivery scenarios where irregular power supplies are a common challenge.

This intelligent irrigation and monitoring system not only promotes sustainability, but also agrees with the broader goals of precision agriculture. It increases productivity and reduces water and energy consumption at the same time. It also provides pump protection.

II. LITERATURE REVIEW

The integration of smart technologies into irrigation systems has received significant attention in recent years, primarily aiming to address issues such as water scarcity, inefficient irrigation practices, and energy wastage. Numerous **Internet of Things (IoT)**-based irrigation models have been developed, focusing on automation, resource conservation, and remote monitoring. However, key areas like **power quality monitoring** and **motor protection**, particularly relevant in rural and agricultural settings, remain underexplored. This section reviews pertinent research contributions and highlights their limitations relative to the objectives of the proposed system. Gives solution for different problem faced by the farmer on the field.

In [1], a smart irrigation system was implemented using the **NodeMCU** microcontroller. The system continuously monitored soil moisture, humidity, and temperature to automatically regulate irrigation, with real-time data shared via the **Blynk application**. While effective in conserving water and reducing manual effort, the study primarily emphasized environmental parameters and did not address critical aspects such as motor protection or power phase detection.

Similarly, [2] proposed a solar-powered smart irrigation system aimed at providing a sustainable solution for regions with limited electricity access. Soil moisture sensors were employed to optimize water use based on detected moisture levels. Though the use of renewable energy addressed power dependency issues, the study overlooked the challenges associated with three-phase power stability—crucial for operating electric motors in rural areas.

The work in [3] introduced an **Arduino-based smart irrigation system** leveraging wireless sensor networks to enhance efficiency. While it presented a low-cost, easy-to-implement approach with real-time monitoring, it lacked comprehensive motor safety mechanisms and did not tackle the problem of inconsistent electrical supply, making it less suitable for high-capacity irrigation systems.
In [4], an automated system tailored irrigation schedules based on crop-specific soil moisture requirements. This approach improved water use precision compared to generic systems. However, it continued to depend on a stable power supply and offered no automation or protection features for motor health under variable electrical conditions.

Reference [5] detailed a smart irrigation solution for small-scale applications such as home gardens, using Arduino to automate watering. Although it showcased IoT's potential in agriculture, the system lacked cloud integration, motor monitoring, and three-phase power detection—features essential for scaling to commercial-level farming.

Finally, [6] presented a solar-powered smart irrigation model that incorporated environmental sensing with IoT-based automation. While it advanced sustainability goals, it failed to include real-time **motor health tracking** or safeguards against **three-phase power anomalies**, both of which are vital for reliable operation in large agricultural installations

III. METHODOLOGY

1. Procedure

This research focuses on the development of an innovative irrigation system that incorporates **Internet of Things (IoT)-**

based remote monitoring and **power phase detection**. The methodology involves the design, implementation, and validation of a hardware-software integrated solution aimed at enhancing water conservation, ensuring pump reliability, and delivering real-time operational insights via the **Blynk IoT** platform. It also focuses on motor protection like single phase protection and overload protection.

2. Research Strategy

The research adopts a **systematic experimental design** approach, consisting of:

- Designing a coordinated system comprising both physical and computational components capable of interfacing with multiple sensors.
- Improving sensor calibration for accurate and reliable data acquisition.
- Implementing and evaluating system performance in an agricultural environment.

The goal is to develop a solution that is both **technically efficient** and **environmentally sustainable**.

3. Block Diagram Representation

- **Sensor Units**:

Soil Moisture Sensor: Detects soil water content for irrigation control.

Temperature & Humidity Sensor (DHT11): Monitors ambient environmental conditions.

Rain Sensor: Detects rainfall to avoid unnecessary irrigation.

Pump Current Sensor (ACS712): Measures pump power consumption for fault detection.

Pump Temperature Sensor (DS18B20): Ensures the pump doesn't overheat.

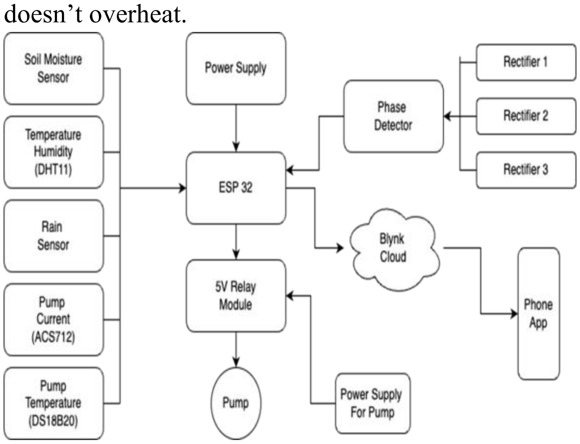

Fig. 1: Block Diagram

- **Central Control**:

ESP32 Microcontroller: Acts as the main processing unit, interfacing with sensors, actuators, and the internet.

5V Relay Module: Controls the pump based on ESP32 signals.

Power Supply: Provides stable power (3.3V/5V) to the ESP32 and sensors.

- **Phase Monitoring Subsystem**:

Rectifiers (1, 2, 3): Convert AC from three phases to DC.

Phase Detector: Monitors each phase to ensure pump safety during outages.

- **IoT Integration**:

Blynk Cloud: Enables real-time remote monitoring and control.

Phone App: User interface to monitor parameters and receive alerts.

- **Pump & Power Supply**:

Pump: The end actuator controlled by the system.

Dedicated Power Supply for Pump: Separate high-power circuit for pump operation.

4. Design and Elements of the System

The system is divided into three major components:

- **Irrigation Control Subsystem**: Utilizes soil moisture and rain sensors to enable automated irrigation decisions.
- **Environmental Monitoring Subsystem**: Employs a DHT11 sensor to continuously monitor temperature and humidity variations.
- **Power Management Subsystem**: Incorporates rectifier circuits to detect the presence of electricity in each phase, ensuring pump safety during phase interruptions. Provide power to the system

The **ESP32 microcontroller** serves as the main processing unit, managing data collection, sensor integration, system control, and IoT communication.

5. System Integration and Implementation

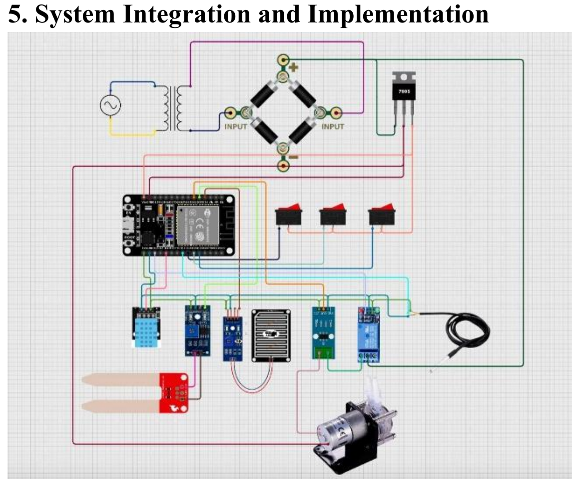

Fig. 2: Circuit Design

Circuit Design: The ESP32 is interfaced with sensors and actuators via specific GPIO pins. Rectifier circuits are employed for power phase detection. A reliable internet connection is established for IoT functionalities.

Integration & Testing: Each component is tested individually to ensure functionality. Sensor data is validated against reference instruments. IoT features are tested for remote communication and monitoring.
Deployment: The complete system is deployable in a real agricultural field using a pump. This system is also used in water treatment plant and in different type of food industries.

6. Device Setup

The system integrates multiple physical components, including:

- **ESP32 Microcontroller**: Handles data acquisition, analysis, and internet connectivity.
- **Sensors**: The **Soil Moisture Sensor** measures the water content in the soil to help regulate irrigation effectively. The **Rain Sensor** detects rainfall, ensuring the system avoids unnecessary watering during wet conditions. The **DHT11 Sensor** is used to measure both ambient temperature and humidity levels. The **DS18B20 Sensor** monitors the pump's temperature to prevent it from overheating. Lastly, the **ACS712 Module** tracks current consumption, enabling fault detection in the electrical system.
- **Actuators and Modules**: The **Relay Module** controls the operation of the water pump based on system logic. The **Rectifier Circuits** are used to monitor the availability of electrical phases, ensuring safe operation during phase interruptions. The **Power Supply** provides a regulated 3.3V or 5V output required for powering the sensors and the microcontroller.

7. Software Development and Blynk Interface

The ESP32 is programmed using the **Arduino IDE**, utilizing the following libraries:WiFi.h and Blynk.h for IoT communication. DHT.h, OneWire.h, and DallasTemperature.h for sensor integration.
Key functionalities include:

- Connecting to the Blynk IoT platform via Wi-Fi.
- Real-time collection and analysis of sensor data.
- Using logical conditions for automated irrigation based on soil moisture and rainfall.

- Monitoring phase availability and pump health.
- Delivering real-time updates and notifications to the Blynk mobile interface.

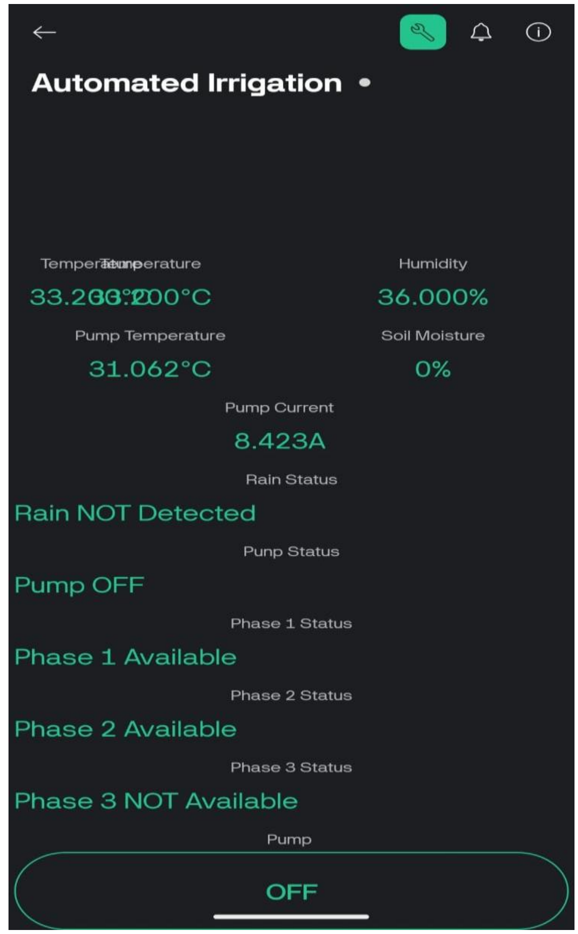

Fig. 3: Blynk Interface

This Blynk interface shows the automatic and manual operation mode of pump. It shows the atmospheric parameter like Temperature, Humidity and rain detection and also monitor the temperature of pump and current drawn by pump.

8. Evaluation of Results

Sensor Accuracy: Soil moisture thresholds are calibrated for dry, optimal, and saturated conditions. Rain sensor is tested if rain is detected. DHT11 and DS18B20 readings are compared with standard devices for precision.
System Testing: Simulated real-world scenarios such as humidity changes, rainfall, and power outages are used to evaluate system response. The Blynk app enables real-time monitoring of pump operation and phase status. IoT performance is assessed under various network conditions.

9. Data Collection and Analysis

Data Logging: Real-time data including soil moisture, temperature, humidity, pump activity, and phase status is recorded. Water and energy usage, along with system alerts, are monitored.
Analytical Review: Water and energy usage are compared with traditional irrigation practices. Overall system efficiency

and reliability are evaluated across diverse environmental conditions.

10. Verification of Results

Through rigorous testing and real-world deployment, the following outcomes are validated:

Precision Irrigation: Water delivery is optimized using real-time field data.

Fault Detection: Phase failure and pump overheating are detected and addressed automatically.

Resource Optimization: Water consumption is reduced by 20–30%, and pump runtime is minimized, improving energy efficiency.

IV. RESULT AND DISCUSSION

Results: Automated irrigation system effectively tracks soil moisture levels and regulates the water pump as needed. The pump activates when the soil moisture is insufficient and deactivates when the necessary moisture level is attained, or rain is detected.

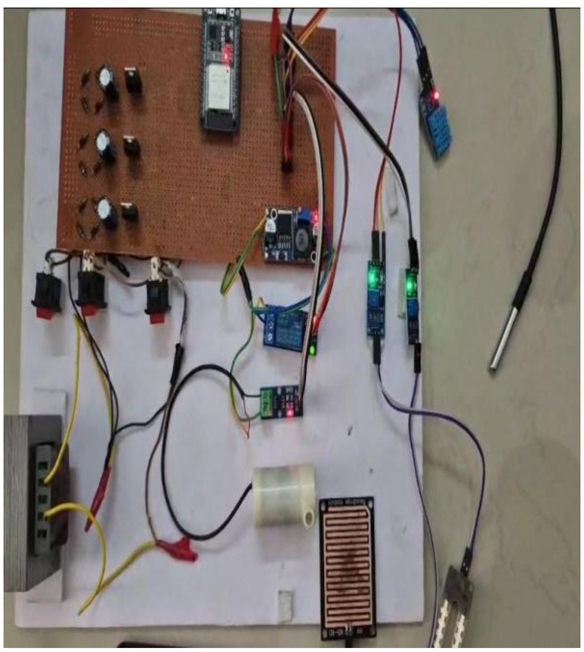

Fig. 4: Working Model of Automatic Irrigation System

Electricity phase detection: the system effectively identifies the presence of three electrical phases using rectifier circuits. The real-time status of the phase is displayed on the Blynk IOT app. Users can experiment with the system by manipulating three manual switches to imitate phase failures. Pump monitoring: the ds18b20 temperature sensor accurately tracks the pump's temperature. The current sensor in the acs712 device precisely measures the pump's current usage, enabling the detection of overload or malfunctioning situations.

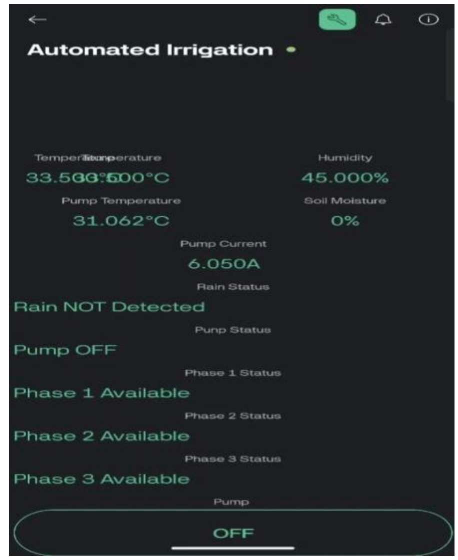

Fig. 5: Online Mode of Blynk Interface

Blynk IOT integration: the Blynk IOT app provides real-time sensor data, such as temperature, humidity, soil moisture, and pump status, which are displayed on the app. Users are notified for: high water content (pump deactivation). Phase detection of failure. Pump malfunction or excessive power usage. Users have the option to manually control the pump's operation through the app.

V. CONCLUSION

This study affords an IOT-primarily based computerized irrigation system that efficiently integrates clever farming ideas with superior era to decorate agricultural performance. By automating water distribution primarily based on actual-time soil moisture ranges, rainfall detection, and environmental conditions, the system minimizes water wastage and optimizes resource utilization. The incorporation of energy phase monitoring ensures reliable pump operation, lowering downtime and shielding device. The mixing with the Blynk IOT platform presents real-time tracking, control, and fault detection capabilities, allowing farmers to make data-driven choices and decrease manual intervention. This innovation contributes significantly to sustainable agricultural practices by way of keeping water, reducing energy intake, and improving crop productiveness. Notwithstanding its preliminary costs and dependence on strong energy and net connectivity, this machine holds great promise for scalability and adaptableness throughout numerous agricultural programs, together with city farming and massive-scale agriculture. Destiny enhancements, inclusive of overcurrent protection, GSM-primarily based alerts, and fertigation structures, can further beautify its capability and effect, solidifying its position in the evolution of smart agriculture.

FUTURE SCOPE

Integration of Advanced Sensors

Incorporate additional sensors including pH, salinity, and nutrient sensors to enable fertigation and soil health monitoring. Use multi-spectral imaging sensors for crop health assessment.

AI and Machine Learning Integration

Develop predictive models for irrigation schedules based on historical data, weather forecasts, and crop-specific requirements. Implement anomaly detection algorithms for identifying sensor malfunctions or unusual environmental conditions.

Scalability and Adaptability

Extend the system for use in large-scale farming operations with multi-zone irrigation capabilities. Adapt the system for various soil types and different climatic conditions.

Water Level and Motor Health Monitoring

Integrate water level indicators to monitor tank or reservoir levels in real-time, preventing overflows and pump dry runs. Add motor health monitoring capabilities to track motor temperature, vibration, and power consumption for predictive maintenance.

Better Connectivity

Integrate GSM modules for areas with limited internet access, enabling SMS-based alerts and controls. Explore low-power wide-area networks (LPWAN) such as LoRaWAN for rural deployments.

Mobile and Web Application Features

Enhance user interfaces with advanced analytics, real-time alerts, and crop management tools. Offer multi-language support for farmers in diverse geographic regions.

IoT Security and Reliability

Develop robust encryption protocols to safeguard data transmission and prevent unauthorized access. Implement fault-tolerant architectures to ensure system reliability in case of hardware or network failures.

Integration with Smart Farming Ecosystems

Connect with other IoT-based systems such as pest control, crop monitoring, and supply chain management for a holistic approach. Explore blockchain integration for transparent tracking of water usage and the crop lifecycle.

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