IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

Smart Irrigation System

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Abstract: *India which is predominantly reliant on agriculture, hinges heavily on water as its primary resource for farming. Presently, agriculture consumes a staggering 83% of India's total water usage. Leveraging cutting- edge smart agricultural equipment, farmers have significantly improved their efficiency in cultivating crops and managing livestock. This paper introduces an IoT-based smart farming system aimed at revolutionizing agricultural practices through automation. Central to this system is the monitoring of water availability for crops via sensors, facilitating precise irrigation control. By employing various sensors to keep record of soil moisture content, temperature, humidity in the air, pir motion sensor the proposed system assesses soil parameters and accurately measures moisture levels. The primary objective is to regulate water distribution and remotely monitor plant health using a smartphone interface. Emphasizing cost-effectiveness, this paper delineates how IoT can optimize irrigation management, which in return makes way for efficient agriculture. Moreover, this innovative approach is integrating real-time data analytics for providing actionable insights for farmers, enabling informed decision-making regarding crop management & resource allocation. By utilizing the power of IoT, this smart farming system not only to enhance productivity but promotes sustainable management practices, crucial for India's agrarian economy. Furthermore, the scalability of this system allows for seamless integration with existing agricultural infrastructure, ensuring accessibility for farmers across diverse regions. Overall, this paper underscores the transformative potential of IoT in revolutionizing traditional agricultural methods, heralding a new era of smart and sustainable farming in India.*

Keywords: Internet Of Things, Soil Moisture Sensor, smart irrigation, humidity And temperature Sensor,

I. INTRODUCTION

Irrigation stands as a cornerstone in agricultural practices, crucial for sustaining crop growth. Smart irrigation goes beyond mere water conservation; it entails supplying water based on precise crop requirements. Recently, the integration of IoT systems has significantly impacted agriculture, serving as a pivotal component in scalable, cost- effective, and sustainable smart farming solutions. The advent of IoT enables seamless integration of software and hardware, empowering farmers with intelligent decision-making capabilities.

The imperative for an automatic irrigation system arises from its simplicity and ease of control, mitigating potential manual errors. The constructed system allows farmers to monitor farm water levels continuously, with control accessible through the web interface via the internet. Whenever the moisture levels dip below predetermined threshold, sensors relay data to the app, triggering necessary actions. This system incorporates four key sensors: soil moisture, temperature and humidity, pir motion sensor with the ESP 32 Microcontroller serving as the central component.

By leveraging IoT and sensor network technologies, this system effectively minimizes water wastage. Its primary objective is to provide real-time updates on crop conditions, alerting farmers to unfavorable situations before they escalate. This smart farming system aims to optimize crop management practices, ensuring improved yields while promoting efficient water usage and environmental sustainability. Additionally, the utilization of IoT facilitates data-driven insights, enabling farmers to make prepared decision regarding soil irrigation schedules and crops health management. The scalability of this system allows for seamless integration with existing agricultural

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infrastructure, ensuring accessibility and adaptability across diverse farming environments. Furthermore, the implementation of predictive analytics can enhance the system's capabilities, forecasting crops water requirement based on Climate pattern and soil conditions. Ultimately, this smart farming approach not only enhances agricultural productivity but also creates stablity in the fluctuating environment and its conditions, contributing to the longetivity of agriculture.

II. LITERATURE REVIEW

The research highlights that precision irrigation scheduling, enabled by wireless sensor networks, allows farmers to optimize water usage by applying irrigation only when it is required. This approach reduces water mismanagement and associated costs, while also mitigating the risk of overwatering and potential damage to crops. [1]

The research paper concludes that implementing smart agricultural techniques in the 21st century is a fruitful approach to take traditional farming practices forward. By leveraging advanced technologies to make informed decisions based on real-time data, leading to improved crop management, resource efficiency, and environmental sustainability.[2]

The research emphasizes that precision farming enhances resource efficiency, minimizes waste, and improves crop yield and quality. By tailoring agricultural practices to the specific needs of crops and livestock, farmers can optimize inputs to perform sustainable and eco- friendly farming practices. Furthermore, the introduction of new concepts in agricultural automation, including autonomous machinery, drones, and AI-based decision support systems, streamlines farming operations, reduces labour requirements, and increases overall productivity.[3]

This study focuses on the development of a low-cost IoT-based smart irrigation system utilizing LoRa WAN technology. The system incorporates DHT22 sensors for measuring environmental parameters and soil moisture levels. By implementing intelligent irrigation scheduling algorithms, the system optimizes water usage in agriculture, leading to water conservation and enhanced crop yields. give some more description. [4]

This research paper proposes a wireless sensor network-based on soil moisture sensor for precise agricultural use . The system uses IoT principles to collect data in real time from DHT22 sensors deployed on the field. By leveraging LoRa communication, the system enables the farmers to monitor and control the irrigation process, leading to an improvement in the water efficiency and crops yield. [5]

Our paper presents a smart irrigation system that integrates LoRa technology with IoT for efficient water management in agriculture. The system employs DHT22 sensors for monitoring environmental parameters and soils moisture content, which enables precise irrigation scheduling which optimizes water use and enhances crop yield. [6]

This research paper introduces a low-power LoRa- based soil moisture sensor tailored for precisie agriculture uses. The system employs DHT22 sensors to measure soil moisture content and environmental parameters with high accuracy. By leveraging LoRa communication technology, the system achieves long-range connectivity and low energy consumption, enabling cost-effective and efficient monitoring of soil moisture levels to support optimal irrigation management. [7]

III. PROPOSED METHODOLOGY

The smart farming system described here is a blend of both hardware and software components. The hardware segment comprises embedded systems, encompassing various hardware devices and equipment, while the software aspect involves the utilization of the web based interface, which is driven by the programming embedded in the IC ESP 32 microcontroller. At the core of this project lies IoT integration, facilitating seamless connectivity and data exchange.

Within this system, sensors including moisture, humidity, temperature, and soil ph sensor are interconnected with the IC ESP 32 . This setup aims to enhance crop growth and meet future demand by providing real-time insights into environmental conditions. The main microcontroller IC ESP 32 , serves as the central control unit, linking all sensors, transmitter and receiver side and an LCD display.

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A crucial role in assessing soils moisture content, is played by our soil moisture moinitoring sensor transmitting this data to mobile devices via the Blynk app through programmed instructions within the IC328p relaying this information to the mobile app for user notification. Similarly, the motion sensor detects movement in the surrounding area, relaying this vital information to the mobile application for prompt user notification and analysis.

Additionally, the temperature and humidity sensor, such as the DHT11, measures environmental parameters and communicates the data as serial output through an 8-bit microcontroller. This sensor is capable of accurately recording temperature from 1°C to 55°C and humidity from 25% to 89%.

In summary, this smart farming system leverages a combination of hardware and software components, facilitated by IoT technology, to monitor and optimize environmental conditions for improved crop growth and sustainable agricultural practices .

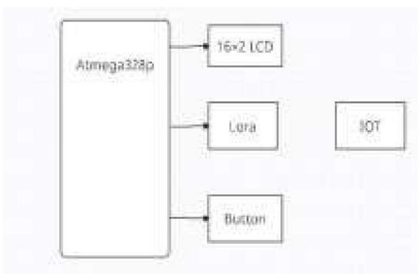

Fig 1: Flow diagram of IOT farming system

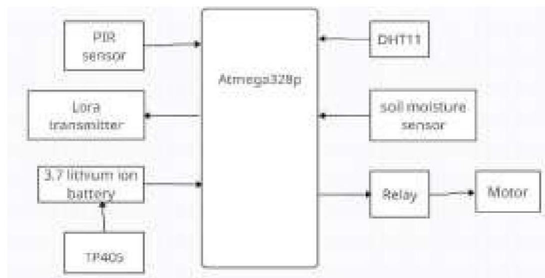

Fig 2: Flow diagram of info flow in the system

At the core of the IoT-based smart farming system lies the Microcontroller (IC ESP 32), functioning as the central processing unit. This microcontroller collects data from strategically placed sensors in the field, including the Soil moisture sensor for continuous monitoring of soil moisture levels, the PIR (Passive Infrared) sensor for detecting field movement, and the DHT11 sensor for periodic measurement of ambient temperature and humidity. Once gathered, the microcontroller processes the data and wirelessly transmits it over long distances using LoRa technology, facilitated by the LoRa transmitter. This wireless transmission ensures real- time transfer of data to a receiver, such as a computer or smartphone with internet connectivity. Farmers can remotely monitor field conditions through a user interface, making informed decisions regarding irrigation management.

Using instantaneous soil moisture readings and other sensor data, farmers can remotely control the irrigation system through the user interface. The microcontroller sends signals to the relay, subsequently activating the motor to manage valves or pumps in the irrigation system. This seamless integration of sensor data and control mechanisms optimizes water usage and promotes crop growth efficiently.

The receiver side of the IoT-based smart farming system complements the transmitter side by processing and visualizing incoming data from the field sensors. An IC ESP 32 microcontroller serves as the central processing unit on this end, receiving wireless data transmissions via LoRa communication from the field's transmitter.

Upon reception, the microcontroller interprets and processes the data, facilitating its visualization through two main channels. Local data visualization

is achieved through an LCD display, providing real- time sensor readings directly to users on-site. This display allows farmers to monitor essential parameters such as soil moisture, motion detection, and ambient temperature and humidity conveniently and in real-time.

In addition to local visualization, the receiver side interfaces with the Blynk IoT platform. By transmitting processed data to the Blynk cloud platform using Wi-Fi or Ethernet connectivity, users can access a customized mobile application on their smartphones or tablets from anywhere with an internet connection. This app presents sensor readings in a user-friendly format, enabling remote monitoring and preprogrammed decision-making regarding crops health and environmental factors. Overall, the receiver side of the IoT-based smart farming system complements the transmitter side by processing incoming sensor data and providing both local and remote visualization capabilities. Through the seamless integration of microcontroller technology, LoRa communication, and Blynk IoT platform, this

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receiver enables farmers to monitor field conditions effectively and make data-driven decisions to optimize crop health and resource management.

SPECIFICATION OF THE COMPONENTS:

A. ESP 32 :-

The ESP32 is a powerful and flexible microcontroller designed to meet the growing demands of connected devices and embedded applications. Developed by Espressif Systems, it builds upon the capabilities of earlier chips by integrating both processing power and wireless communication into a single compact unit..

Fig 3: ESP 32

B. Soil moisture sensor:-

Soil moisture sensor is a device used to estimate the water content present in soil by measuring changes in electrical properties such as resistance or capacitance. It provides real-time feedback that helps in managing irrigation efficiently and preventing overwatering or water stress in plants.

Such sensors are widely used in agriculture, gardening, and automated irrigation systems.

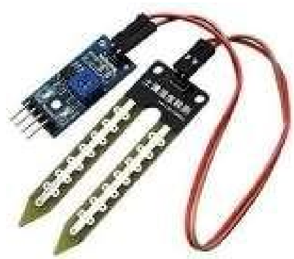

Fig 4 : Soil moisture sensor

C. Solar sensor:-

Solar sensor (light detector) is an electronic component that is designed or used as detect and trigger the automation of the system it is designed to detect the infrared radiation wave emitted naturally from the light source. these light sensors trigger the the system when light is detected.

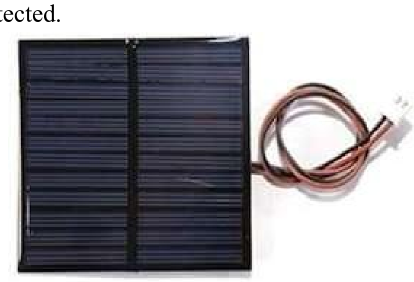

Fig 5: Solar sensor

DOI: 10.48175/IJARSCT-34357

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D. Temperature and humidity sensor:

The sensor used for the measurement of temp and moisture content is named as dht11 which is an economical sensor that provides high reliability and long-term usage . It's very simple to use it provides highly reliable and stable output . capacitive humidity sensor is used to measure the surrounding air and record the temperature in the area where it is 1deployed.

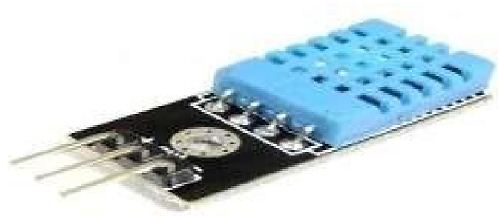

Fig 6: DHT11 Temperature and Humidity sensor

RESULT

IoT-based smart farming has revolutionized agriculture, delivering numerous benefits:

- Increased crop yields by over 20% through precision irrigation and nutrient management.
- Optimized resource usage, promoting sustainability and environmental conservation.
- Early detection of weeds and pests, which resulting in healthy crops and better production quality.
- decision-making triggered by data analyzation enhances farm management and resource allocation.
- Monitoring livestock health improves animal welfare and reduces losses.
- Enhanced food safety and traceability from farm to table.
- Economic benefits for farmers with increased profitability and market access.
- Contributes to climate change mitigation by reducing emissions and promoting sustainable practices.

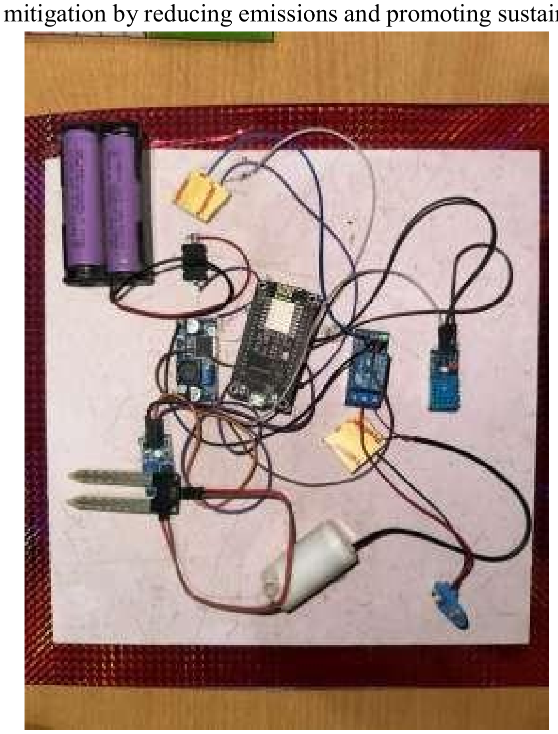

Fig :- Reference

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IV. CONCLUSION AND FUTURE WORK

The introduction of a smart irrigation system that utilizes IoT and automation technologies represents a significant advancement in overcoming the limitations of traditional irrigation techniques. This innovative approach provides a viable solution to efficiently manage water resources for agricultural purposes in a cost-efficient manner. By incorporating sensors and automated controls, the system aims to reduce water wastage and effectively monitor plant health via smartphone or mobile device interfaces. Notably, the automation and control functionalities eliminate the need for manual intervention, streamlining the irrigation process and boosting operational efficiency. Furthermore, embracing these cutting-edge agricultural technologies has the potential to transform crop quality and handling practices, ultimately benefiting the well-being and livelihoods of farmers. Through ongoing refinement and development, smart irrigation systems offer a sustainable path to enhance agricultural methods and ensure future food security.

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