Report of SMART IRRIGATION SYSTEM

A report to be submitted by

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ABSTRACT

In India, the pressing need for smart irrigation systems arises from changing weather patterns and decreasing rainfall, posing a threat to agricultural productivity. Smart irrigation, facilitated by Arduino Uno Wi-Fi Rev2 interfacing with various sensors like soil moisture, DHT11, anemometers, pyranometers, and atmospheric pressure sensors, holds the key to conserving water resources, enhancing crop yields, and fostering agricultural sustainability. These sensors provide real-time data, enabling the system to make informed irrigation decisions, optimize water usage, and adapt to evolving weather conditions. This technology has the potential to ensure food security and boost economic development in the face of climate-related challenges.

Key Words: Arduino Uno Wi-Fi, soil moisture, DHT11, anemometers, pyranometers, atmospheric pressure sensors

I. INTRODUCTION

The world faces a growing crisis in the form of dwindling freshwater resources, sounding solemn alarms for over a decade. The management of water resources, particularly in the context of agriculture, has emerged as a critical concern. Traditional irrigation methods have been mired in inefficiencies, often relying on habitual routines, and lacking accurate feedback on soil moisture levels. This approach has led to suboptimal crop growth and yields, raising questions about the sustainability of our agricultural practices. However, in response to these challenges, innovative solutions have emerged. Smart irrigation systems, harnessing the power of advanced technology and the Internet of Things (IoT), have revolutionized the way we approach agriculture and water management.

This transformation is especially pertinent in regions like India, where unpredictable climate changes and diminishing rainfall patterns have significantly impacted the agricultural sector. In this context, the need to make the most of every drop of water becomes paramount. The shift from conventional irrigation practices to modern systems like drip and sprinkler irrigation has already started to make a significant difference. However, the pinnacle of this evolution is represented by the integration of smart technologies into irrigation.

In this article, we will delve into the potential of advanced irrigation techniques, such as smart drip and sprinkler systems, with the aid of IoT. By analyzing the challenges and benefits associated with these cutting-edge methods, we aim to provide insights into how technology can further enhance crop productivity, particularly in regions with unpredictable rainfall patterns. Through a comprehensive examination of various irrigation technologies, this article seeks to highlight the most efficient and sustainable approaches, ultimately resulting in water conservation and easing the burden on farmers.

The dearth of fresh water worldwide has given rise to solemn alarms for a decade. Water scarcity is a growing global concern, and its impact on agriculture is profound. In many parts of the world, unpredictable rainfall patterns and decreasing water availability are making it increasingly challenging to sustain agriculture. Without proper water management, crop production and food security are at risk. Water wastage in traditional irrigation practices exacerbates this challenge.

Traditional irrigation methods have been in practice for generations. These methods often rely on habit and routine, with water being pumped into fields at regular intervals based on farmers' customary practices. However, these routines lack precision and do not incorporate feedback mechanisms to monitor soil moisture levels. The result is suboptimal crop growth, poor yields, and the wastage of water resources. Additionally, some crops are particularly sensitive to variations in soil moisture, making the traditional approach even less suitable for maximizing agricultural productivity.

In response to these challenges, innovative smart irrigation systems have emerged as a game-changing solution. These systems utilize the Internet of Things (IoT) and advanced sensor technology to bring precision and intelligence to the irrigation process.

The ingenuous ICT technique presents an insolent system that uses a minimum-value soil wetness sensing element and temperature sensing element to manage facility in water shortage regions. These sensors are designed with low-cost materials and methods, making them accessible to a wide range of farmers. The moisture and temperature data collected by these sensors are transmitted to a centralized server through an Arduino-based system, allowing for real-time monitoring and control of irrigation.

An automation application is developed to visualize daily moisture and temperature data, empowering farmers with valuable insights. Furthermore, these smart sensors and technologies can be seamlessly integrated into automated irrigation systems, enabling precise, efficient, and decentralized water management. The results of this technology are significant, with improved crop yields, healthier soil, and a more efficient use of water resources. In essence, smart irrigation transforms traditional agriculture into a complete intelligent irrigation system.

Agriculture plays a vital role in India's economy and sustenance, but it faces numerous challenges, including climate change and unpredictable rainfall patterns. The scope of agriculture in India has been adversely affected, leading to a significant impact on food security. In traditional irrigation methods, excess water is often used, leading to water wastage and uneven distribution, hindering crop growth. This is a problem that can be overcome through modern irrigation systems.

Modern irrigation methods, such as drip irrigation and sprinkle irrigation, have made substantial improvements in reducing water wastage. However, the most significant leap forward comes with the integration of smart technologies into irrigation systems.

This smart irrigation system in India offers a flawless operation in irrigating the land. The design and implementation of this clever irrigation system have been widely tested and proven to be cost-effective, outperforming traditional methods. It leverages technology to ensure that crops receive the precise amount of water and necessary fertilizers, eliminating the guesswork that often characterizes traditional irrigation practices.

The implementation of a sensible irrigation system in India is straightforward and cost-effective, making it accessible to a broad spectrum of farmers. By incorporating soil sensors based on the size of the agriculture land, the system ensures that water is distributed uniformly, avoiding issues like water wastage and unequal irrigation. Additionally, smart irrigation systems are monitored and controlled remotely through an Android mobile application, making it convenient for farmers to manage their irrigation needs.

IoT plays a pivotal role in connecting these systems, enabling seamless communication between sensors, control systems, and farmers. The IoT infrastructure provides real-time data, allowing for timely decision-making and reducing the reliance on manual intervention. Farmers are provided with a userfriendly interface through an Android mobile application, ensuring easy access to critical information.

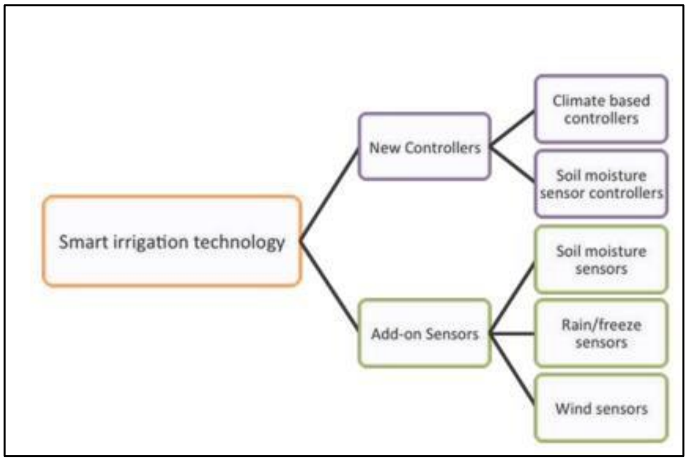
The most significant contribution of these systems is the elimination of manual operations, leading to the implementation of an entirely automatic irrigation system. By incorporating additional sensors based on the size of the farmer's land, these systems provide farmers with insights into their crops' health in all seasons. The mobile app allows farmers to check the status of their irrigation system conveniently. Even in the event of a power cut, the system can connect to a mini-up, as it consumes minimal power. Once power is restored, the system automatically reconnects to WiFi and resumes operations. This seamless connectivity ensures the continuous monitoring and control of irrigation, even under challenging circumstances.

The sensors collect data, which is then sent to the microcontroller. From there, the information is transmitted to the cloud, which is connected to the mobile app. By comparing the collected data with reference values, the system generates error signals sent to the mobile app and webpage, enabling farmers to monitor the status of the irrigation system remotely. This system optimizes water usage, ensuring that crops receive the required amount of water and fertilizers, resulting in higher yields with lower resource investment.

II. LITERATURE SURVEY

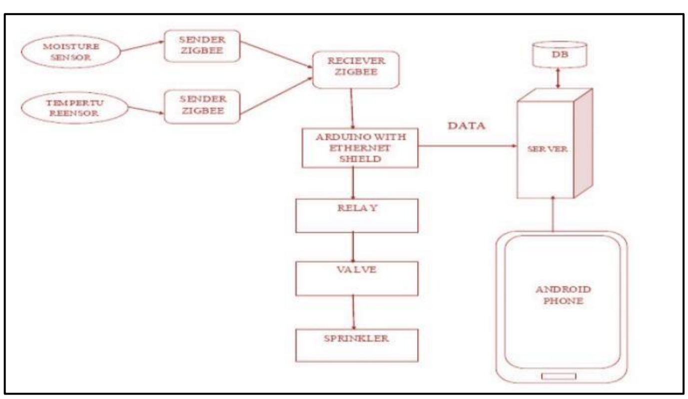
The literature survey within this paper thoroughly explores the landscape of smart irrigation systems, classifying them into two distinct categories: those under physical control and those that exhibit mechanized or semi-mechanized features. This survey underscores the integration of traditional and cuttingedge approaches, often harnessing the capabilities of the Internet of Things (IoT). Notable studies in the field are highlighted, encompassing a wide array of innovative methods and technologies. The project introduces an IoT-based solution that employs GSM technology for fully automating field irrigation, allowing for the management of irrigation systems through text messages and alerts, specifically geared towards flood control. The water flow level sensors are integrated to monitor water flow in drip irrigation pipelines, with the aim of minimizing excess water usage and promoting plant growth, a vital consideration for crops like wheat and paddy that require ample water. Moreover, the survey touches upon nutrient detection and disease monitoring through IoT and mobile applications. It also emphasizes the importance of notifying farmers about the necessary quantities of fertilizer and providing comprehensive crop-related updates. Wireless sensor integration is also explored, although certain systems may face challenges in automatically reconnecting sensors following power disruptions. These findings collectively underscore the remarkable potential of IoT-based systems in reshaping agricultural practices, conserving precious water resources, and elevating crop yields. Nevertheless, the survey acknowledges the hurdles and opportunities for further advancements within this dynamic field.

[1] The focus of this literature is on smart irrigation systems, with a particular emphasis on the integration of Internet of Things (IoT) technology into drip irrigation methods. The IoTenabled smart irrigation systems are designed to revolutionize agricultural practices by automating irrigation processes, conserving water resources, and enhancing crop yield. Various studies propose different models of smart irrigation, featuring sensors for monitoring parameters like soil moisture, temperature, and weather conditions. These sensors are connected to microcontrollers, which process the data and trigger irrigation based on predefined thresholds and algorithms. IoT technology plays a pivotal role in data collection and communication, allowing farmers to remotely monitor and control their irrigation systems through web applications or mobile devices. These smart systems also consider weather predictions and historical data to optimize irrigation, reducing water wastage, and improving resource efficiency. Such IoT-based smart irrigation systems hold great potential for sustainable agriculture and efficient water management while reducing human intervention and labor costs.



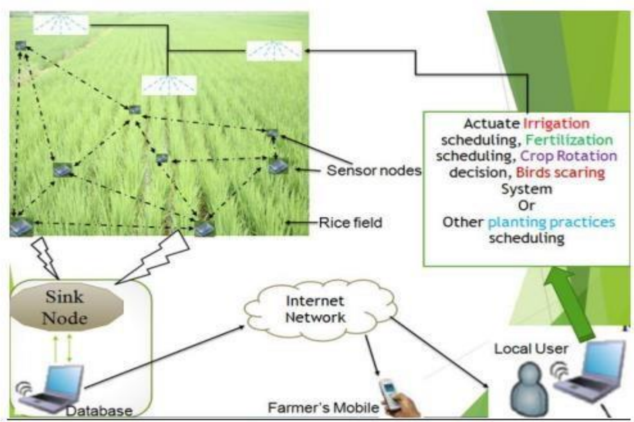
[1] Fig1.Classification of smart irrigation technologies

[2] The proposed smart irrigation system is designed with three main modules. The first module involves data collection from soil moisture and temperature sensors, with an Arduino board connected to a Wi-Fi module for internet connectivity, allowing the collected data to be stored on the cloud. In the second module, an automatic control system is implemented, where the Arduino triggers a motor to pump water into the fields when sensor data, including moisture and temperature, falls below preset threshold values. The third module comprises an Android application that offers manual control and data access to users. Registration and field information input are required within the app. Users can control water supply by sending signals to the Arduino through the server. The system's functional requirements encompass temperature and soil moisture sensors, an Arduino Uno board for control, a motor for water pumping, cloud storage for sensor data, and an Android application for system control and data viewing. The architectural design options vary, with the first design using Bluetooth for data transfer and Wi-Fi for storage, the second design employing Zigbee for data transmission to an Arduino, and the third design involving direct sensor-to-Arduino connections with remote server storage and control through the Android application.



[2] Fig2. Architectural Design

[3] The related work in this paper explores different approaches to smart irrigation systems, highlighting both the physically and mechanically controlled systems. One approach utilizes IoT, while the other is more traditional. An IoT-based project employs GSM technology for fully automatic field irrigation and flood control through text messages and alerts. Another system uses a water flow level sensor to monitor drip irrigation pipelines, ensuring optimal water usage for plant growth. However, in fields like wheat and paddy, excess water is required, with percolation water containing nitrogen for crop rotation, and addresses disease detection and growth rate prediction. Some systems, such as integrate mobile apps with IoT for monitoring and control. In contrast, systems like lack mobile apps and fail to provide fertilizer notifications. relies on human labor for garden irrigation and lacks crop notifications. interfaces sensors with wireless communication but may struggle to reconnect after power failures. focuses on automated organic irrigation for efficient water and electricity allocation. involves smart irrigation software development, while integrates a microcontroller with Raspberry Pi for data transfer. emphasizes water efficiency to reduce waste. features a fully manual system, uses a short-range mesh network with Xbee modules, and employs fuzzy logic, which is more complex and manual. Finally, relies on LAN networks but lacks farmer notifications and indicators.



[4] Fig3. Paddy field Growth Monitoring System

Smart irrigation systems offer innovative solutions for water management in agriculture; however, they come with both advantages and challenges that warrant consideration.

Pros of Smart Irrigation System:

- **<u>Water Conservation</u>**: Smart irrigation systems significantly reduce water wastage by precisely delivering the right amount of water to crops based on real-time data, thus conserving a precious resource.
- **<u>Enhanced Crop Yield</u>:** These systems optimize irrigation, ensuring that crops receive the ideal conditions for growth, resulting in higher crop yields and improved agricultural productivity.

- **Reduced Labor Costs**: Automation reduces the need for manual labor in irrigation processes, leading to cost savings for farmers.
- **Sustainable Agriculture**: Smart irrigation promotes sustainable agriculture by efficiently managing water resources, minimizing environmental impact, and reducing the reliance on unsustainable irrigation practices.
- **Remote Monitoring:** Farmers can remotely monitor and control their irrigation systems through web applications or mobile devices, offering convenience and flexibility in managing their fields.

Cons of Smart of Irrigation System:

- **Initial Investment:** Implementing smart irrigation systems can involve a significant upfront cost, which may be a barrier for small-scale farmers with limited resources.
- **Technical Expertise:** Farmers may require training to operate and maintain smart irrigation systems, and some may find the technology intimidating or complex.
- **Reliance on Technology:** Smart irrigation systems are dependent on technology and may face issues such as sensor malfunctions, connectivity problems, or power outages, which can disrupt the irrigation process.
- **Data Security:** Storing data on the cloud or connecting to the internet may raise concerns about data security and privacy, particularly for sensitive agricultural information.
- **Compatibility:** Integrating IoT and smart irrigation technology may require compatible hardware and software, and older irrigation systems may not easily adapt to these advancements.
- **Reliability on Power:** Smart irrigation systems depend on a stable power supply; power outages can disrupt the functionality of these systems, especially in regions with unreliable electricity.
- **Data Overload:** The vast amount of data collected by sensors can be overwhelming, and analyzing it effectively may require additional skills and tools.
- **Limited Accessibility:** In remote or underserved areas with poor internet connectivity, accessing and managing smart irrigation systems can be challenging.
- **Maintenance Complexity:** Maintaining and troubleshooting smart systems may require technical expertise, and breakdowns can result in crop loss if not promptly addressed.

III. PROPOSED METHODOLOGY

To enhance the existing smart irrigation system, we've introduced some critical changes that significantly improve its functionality and efficiency.

One fundamental addition is the integration of solar panels to power the sensors and the entire system. This sustainable energy source not only reduces operating costs but also ensures off-grid operation. The application offers guidance on solar panel installation and connection, making it accessible for users to adopt this eco-friendly and cost-effective power solution.

To provide more accurate weather-related data, the integration of an atmospheric pressure sensor and a pyranometer is implemented.

The atmospheric pressure sensor contributes by monitoring changes in atmospheric pressure, allowing the system to anticipate weather patterns more accurately. Sudden drops in pressure can signal the approach of low-pressure systems associated with storms or rain. By considering atmospheric pressure data, the system can adapt its irrigation scheduling in response to impending weather changes, thereby conserving water and optimizing irrigation.

The pyranometer, on the other hand, measures solar radiation, providing critical insights into the availability of sunlight for crop growth. This data is invaluable for optimizing irrigation, as it helps determine the actual energy input received by the crops. By integrating pyranometer data, the system can tailor its irrigation strategies to match the varying solar conditions throughout the day, ensuring more efficient water use and crop health.

To make the smart irrigation system more robust, userfriendly, and data-driven we've introduced some software developments.

Data management is optimized with a focus on data prioritization. Users are presented with a customizable dashboard displaying real-time sensor data. They can prioritize critical parameters essential for their crops, enabling them to make informed decisions quickly. The system generates alerts for crucial events, such as low soil moisture levels or extreme weather conditions, ensuring timely responses to potential issues.

Efficiency is further improved through the removal of data redundancy. Data compression techniques are employed to streamline data transmission and storage, reducing unnecessary redundancy. This not only conserves valuable storage space but also facilitates faster data retrieval and analysis.

Data security is fortified with authentication mechanisms, including read-only access for authorized individuals, like farm managers and consultants. Strong authentication, including two-factor authentication, safeguards user access and system settings. Users can set up custom alerts based on sensor data, enhancing their ability to respond proactively to changing environmental conditions.

Historical data analysis empowers users to review past sensor data, identify trends, and make well-informed decisions for future irrigation and crop management strategies.

The integration of real-time weather data and forecasts enhances irrigation decision-making by providing insights into anticipated weather conditions. Moreover, regular backups of sensor data are maintained, ensuring data integrity and the ability to recover historical data when needed.

Integrated Components :

- Soil Moisture Sensor: Optimizes irrigation by measuring soil moisture levels.
- DHT11 Temp and Humidity Sensor: Provides realtime temperature and humidity data for environmental monitoring.
- 6410 Anemometer (Wind Sensor): Measures wind speed, aiding in crop management.
- BMP180 Atmospheric Pressure Sensor: Monitors atmospheric pressure for weather insights.
- Apogee Pyranometer - Model SP-110: Precisely measures sunlight intensity for solar data-driven decisions.
- Solar Panel Integration: for providing sustainable and off-grid power.
- Arduino Uno Microcontroller: The heart of the system, the Arduino Uno, serves as the central processing unit. It acts as the control hub for collecting and processing data from the various sensors.

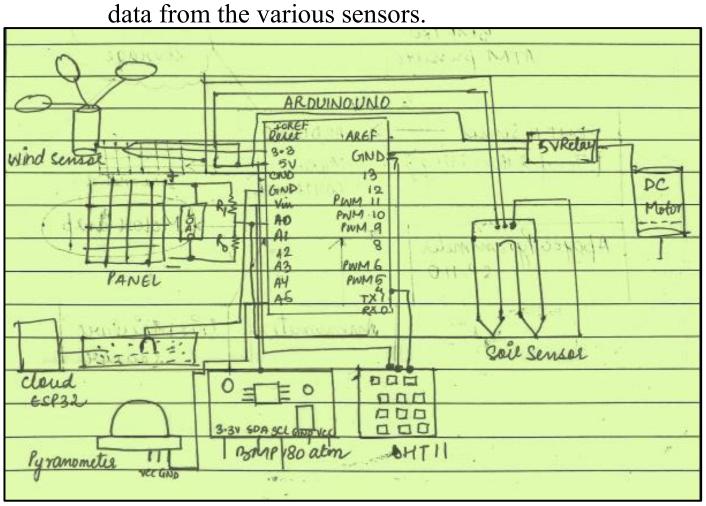


Fig 4. Circuit Diagram

Working of the Methodology:

The sensor data collected from the field is transmitted to a microcontroller, which compares it against specific reference values for the crop variety being cultivated. This comparison serves as the basis for decision-making in the irrigation system.

The sensor data is continuously updated to a cloud-based database for ongoing data processing. Using artificial intelligence (AI) algorithms, the data is analyzed to make informed decisions about irrigation needs.

Once the AI algorithms have processed the data, the microcontroller receives the resulting signals containing precise information about the irrigation requirements for the crops.

The microcontroller acts as a bridge, transferring the information from the sensor units to both a mobile application and a webpage.

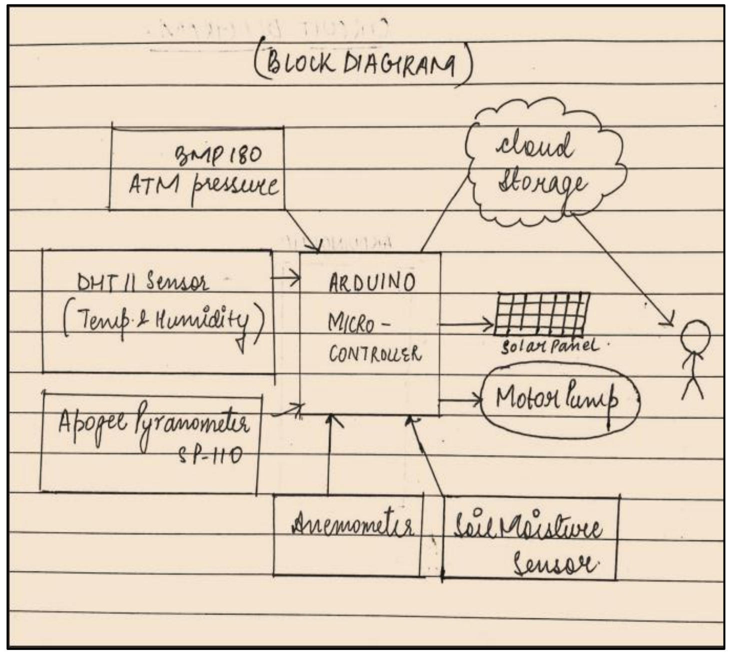


Fig 5. Block Diagram

IV. CONCLUSION

The intelligent irrigation system represents a revolutionary solution for agriculture, offering crop-specific management tailored to the unique needs of each crop. This precision-based approach empowers producers to optimize their yields while conserving water resources. The system's accessibility through an Android application enables remote control from anywhere, enhancing its usability and convenience.

This smart irrigation technology not only boosts water use efficiency but also makes farming more profitable for growers. It contributes to the overall sustainability of agriculture and plays a crucial role in water conservation planning.

This system accelerates crop growth while minimizing the use of fertilizers, thanks to IoT integration and the Android application. Farmers receive real-time updates on crop conditions, water requirements, and fertilizers, facilitating better crop management. They can easily monitor and manage the irrigation system with the mobile app and webpage provided to them.

V. REFERENCE

1. Drashti Bhavsar, Bhargav Limbasia, Yash Mori, Mohmmadali Imtiyazali Aglodiya, Manan Shah, A comprehensive and systematic study in smart drip and sprinkler irrigation systems,
   Smart Agricultural Technology, Volume5, 2023, 100303, ISSN 2772-3755.

2. Shiny Rajendrakumar, Dr. Rajashekarappa, Prof. V.K. Parvati, Dr. Parameshachari B.D
   Automation of irrigation system through embedded computing technology. *Conference Paper · January 2019*
   DOI: 10.1145/3309074.3309108

3. V.Manimegalai, A. Little Judy, A.Gayathri, S.Ashadevi, V.Mohanapriya
   Smart Irrigation System with Monitoring and Controlling using Iot.
   International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958 (Online), Volume-9 Issue-4, April 2020

4. Yuthika Shekhar, Ekta Dagur, Sourabh Mishra, Rijo Jackson Tom Veeramanikandan and Suresh Sankaranarayanan.
   Intelligent IoT Based Automated Irrigation System
   International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 18 (2017) pp. 7306-7320