HYDRO-TECH GATE AUTOMATION AND MONITORING THE IRRIGATION FIELD USING SENSOR

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College	:	*Vidya Vikas Institute Of Engineering And Technology, Mysuru*
Branch	:	*Department Of Civil Engineering*
Guide(S)	:	*Prof. Anusha G S*
Student(S)	:	*Ms. Deeksha V*
		Mr. Guna Preetham N
		Ms. Inchara S Sheshadri
		Mr. Ullas R

Keywords:

Automatic Water Gates, Irrigation Sensors, Moisture Levels, Agricultural Practices.

Introduction:

Agriculture plays a vital role in India's economy and has been a fundamental source of food production since ancient times. Irrigation, an essential component of agriculture, plays a crucial role in crop production by ensuring the supply of adequate water to the soil. Traditionally, farmers manually assess the water requirements of their fields and take measures to prevent overflow, as excessive water can lead to soil erosion and a reduction in soil fertility. However, this method is labor-intensive and time-consuming, especially for large fields.

In recent years, technological advancements have introduced innovative solutions to modernize irrigation practices. Sensor-based irrigation systems are gaining popularity for their ability to monitor various parameters such as soil moisture, temperature, humidity, and pH levels. These systems enable precise and automated irrigation, significantly reducing the farmer's physical presence in the field.

This paper focuses on the development of a sensor-based automated irrigation system that utilizes a sensor capable of detecting soil moisture and atmospheric temperature. Based on threshold values, water is supplied automatically to the crops. Automatic water gates are implemented to operate based on sensor feedback.

By automating the irrigation process, it enhances water use efficiency, minimizes wastage, and improves crop productivity. This innovative approach not only reduces the burden on farmers but also allows them to manage agricultural activities alongside other occupations.

Objectives:

1. To develop a system that automates the opening and closing of irrigation gates based on real-time water levels and field conditions, reducing manual labor.
2. To optimize water distribution by monitoring soil moisture and flow rates, ensuring efficient irrigation and minimizing water wastage.
3. To create an eco-friendly system that can be adapted for different irrigation setups, ensuring long-term sustainability and expansion possibilities.
4. To enhance crop yield and quality by maintaining optimal soil moisture levels tailored to specific crop requirements.
5. To reduce dependency on manual supervision, saving time and labor costs for farmers, especially those managing multiple fields.

Methodology:

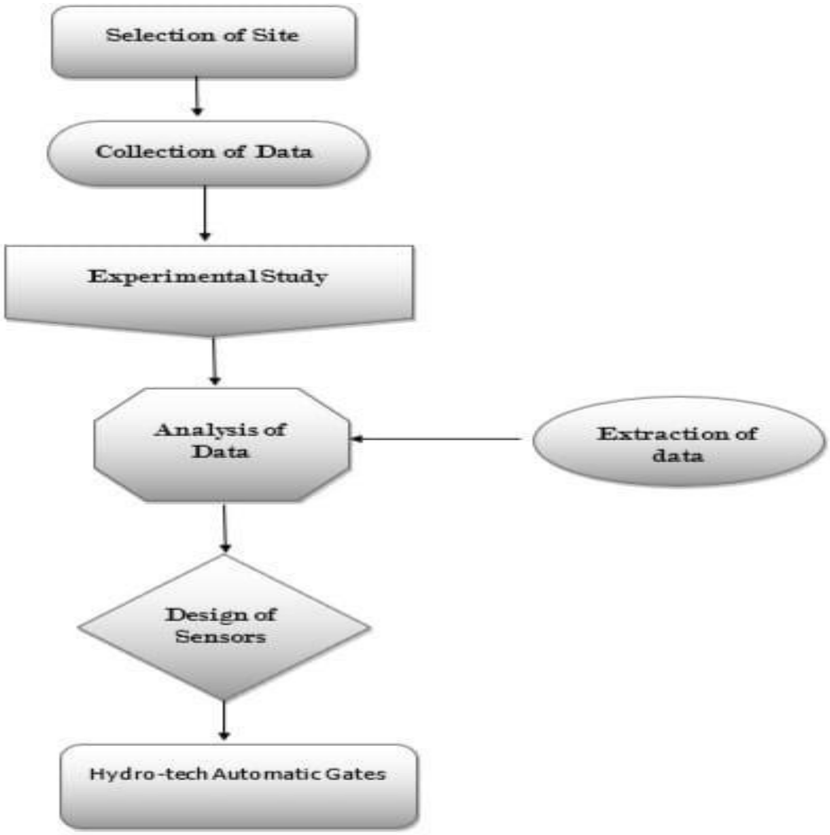


Figure 1: Flow Chart of Steps of Methodology

This methodology involves the steps, materials, and experimental methods used to study sensor performance, soil conditions, and gate automation in irrigation monitoring. It involves sensor installation, data acquisition for real-time field monitoring. Soil moisture, temperature, and humidity sensors, along with Arduino controllers, are key components. These tools help analyse soil conditions and optimize water distribution efficiently. Experimental methods include testing soil moisture levels, water absorption, and holding capacity of crops. System accuracy, sensor response time, and gate automation efficiency are also evaluated. The system aims to deliver precise irrigation while minimizing manual efforts. Performance is assessed to ensure reliability and consistency in operation.

The selected project area is Gejjala Gere in Maddur Taluk, Mandya District, Karnataka. A reconnaissance survey was conducted to assess crop patterns, soil types, and challenges like soil degradation and poor water retention. Soil samples from Gejjala Gere were tested to evaluate moisture content, texture, and water retention key factors for effective sensor performance and irrigation management. Laboratory tests, including the soil moisture content test and the Standard Proctor Compaction Test, provided data for accurate sensor calibration and optimal irrigation scheduling. This integrated systems reduce water wastage and enhance crop yield.

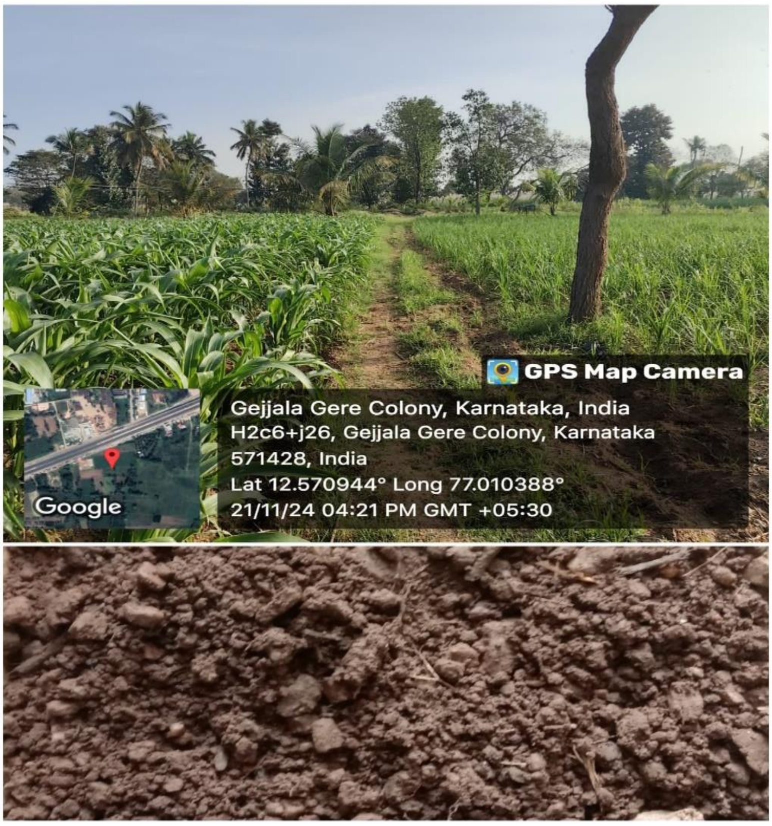


Figure 2: Agricultural Land Gejjala Gere

Rainfall, evaporation, and temperature data are crucial for managing irrigation and environmental conditions in agriculture. These parameters help assess soil moisture, plan water usage, and optimize automated sensor operations. Data become gathered from Somanahalli hydro-meteorological station among April 1 and November 21, 2024, using instruments like rain gauges, evaporimeters, and Stevenson Screens. This information supports efficient design and operation of automated irrigation systems by providing insights into rainfall patterns, evaporation rates, and temperature variations.

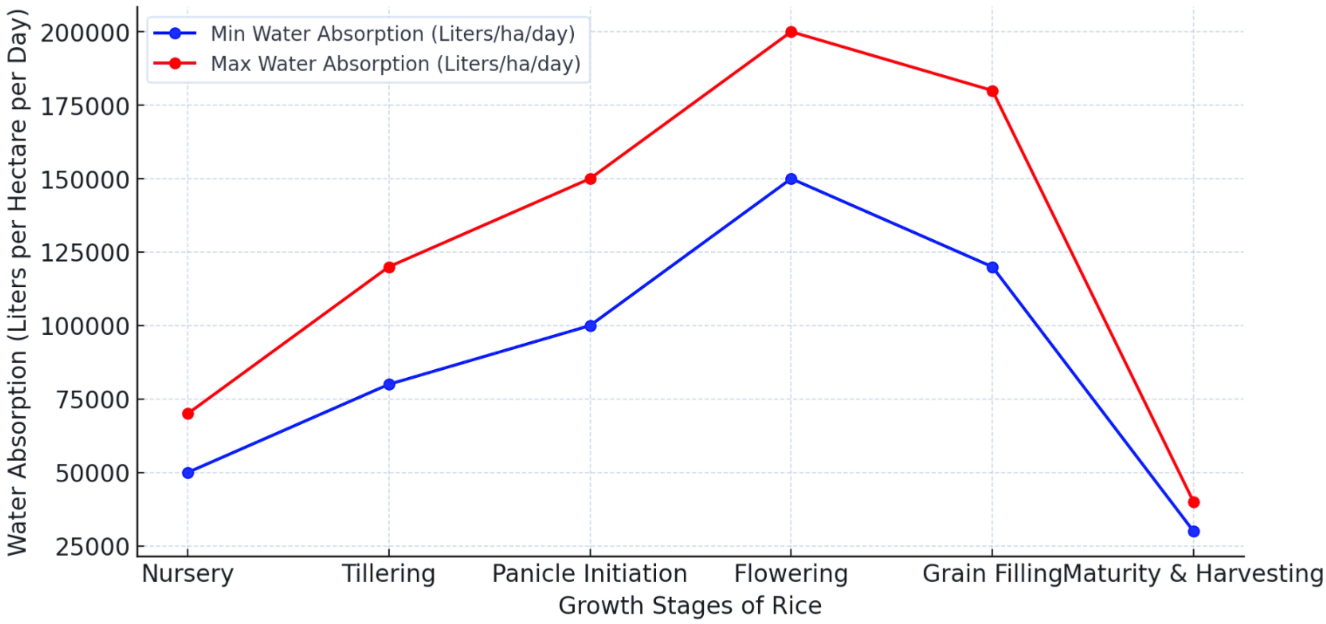
Month	Time	Rainfall in mm	Temperature of water in °C	Stevenson Screen		Temperature	
				Dry bulb	Wet bulb	Maximum	Minimum
April	8.30AM	0	27	29.7	26.2	37.5	23.3
May	8.30AM	5	27	28	25.3	34.1	23.6
June	8.30AM	2.4	27	27.2	25.1	33.1	22.2
July	8.30AM	2	26	25	23	30	21.8
August	8.30AM	1.2	25.4	26	23.7	32.4	22.4
September	8.30AM	1.6	25.2	26.3	23.7	32.2	21.9
October	8.30AM	2	24.6	25.1	23.1	30.6	22.1
November	8.30AM	1.5	24	24.8	23.1	28.3	20.4

Month	Time	Temperature of water in °C	Stevenson Screen		Temperature	
			Dry bulb	Wet bulb	Maximum	Minimum
April	5.30 PM	35.4	35.7	29.5	0	0
May	5.30 PM	32.4	32.4	27.7	0	0
June	5.30 PM	30.4	29.8	27.9	0	0
July	5.30 PM	27.1	27.1	25	0	0
August	5.30 PM	29.5	29.5	25.7	0	0

September	5.30 PM	30.6	30.6	25.4	0	0
October	5.30 PM	29.2	29.2	24.8	0	0
November	5.30 PM	28.4	28.4	25.3	0	0

Figure 3: Collected data of Rainfall, Evaporation, Temperature, & Humidity parameters

The blue line indicates minimum and the red line maximum water absorption per hectare per day. Water demand in rice is lowest during the nursery and harvesting stages, and highest during flowering and grain-filling stages due to critical processes like panicle development and fertilization. Proper irrigation during these peak stages is essential for optimal yield.



Source: **Agricultural research publications and studies from ICAR (Indian Council of Agricultural**

Figure 4: Graph Showing the Water Absorption Levels across the stages

a) Materials Used:

- ESP32 or Arduino
- LCD Display
- Moisture Sensor
- Humidity Sensor
- MG90S Servo Motor
- Power Supply

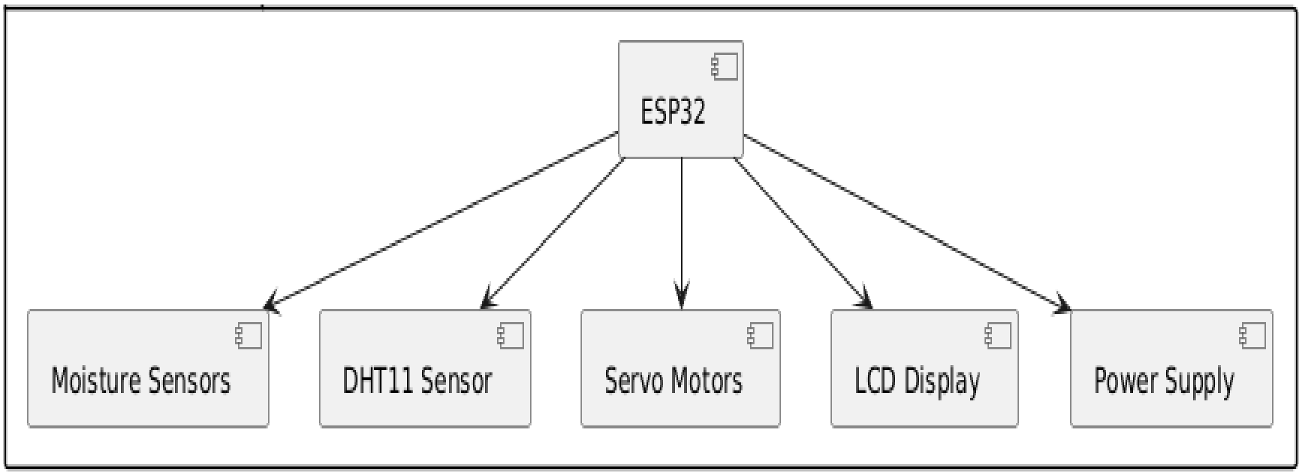


Figure 5: Block Diagram of the Automated Irrigation System

The automated irrigation system uses ESP32 or Arduino as the main controller to manage water distribution based on real-time sensor data. Soil moisture and humidity sensors monitor field conditions, while an LCD displays key parameters like moisture and system status. An MG90S servo motor controls the irrigation gate, allowing water flow only when needed. A reliable power supply ensures consistent performance. This included device conserves water, reduces guide labour, and promotes crop growth, supplying a clever and sustainable farming solution.

Result and Conclusion:

Smart irrigation is essential in modern agriculture for efficient water use, increased crop productivity, and reduced manual labour. Traditional methods often lead to water wastage and uneven distribution, affecting yield and sustainability.

Our project, Hydro-Tech Gate Automation and Monitoring of Irrigation Field Using Sensors, integrates ESP32, soil moisture sensors, and DHT11 temperature and humidity sensors to automate irrigation. The system continuously monitors soil moisture and environmental conditions to determine irrigation needs and automatically operates irrigation gates using servo motors. It minimizes both overwatering and under watering, as well as reduces unnecessary energy consumption, while ensuring precise water delivery. Farmers can organize their irrigation schedules based on the specific needs of their crops and anticipated weather conditions. This smart system enhances crop health, improves yields, and lowers labour costs by eliminating the need for constant manual supervision. Rice crops, which require high water input, especially benefit from this technology. The system provides timely irrigation and maintains optimal soil conditions throughout the growth stages.

The project supports sustainable and precision farming, especially valuable in regions with water scarcity or unpredictable climate. Cost-effective, scalable, and energy-efficient, the Hydro-Tech system represents a modern solution for global smart farming needs.

Project Outcome & Industry Relevance

The project successfully delivers an automated irrigation system that addresses the limitations of traditional manual methods. By integrating sensors with a microcontroller-based system (ESP32/Arduino), the solution enables precise, real-time monitoring and control of water flow based on soil moisture and environmental conditions. This reduces reliance on human judgment and minimizes labor requirements. The system helps prevent overwatering and under-watering, conserves water, and reduces soil erosion due to overflow. It ensures efficient irrigation scheduling even during irregular water supply hours, enhancing crop yield and sustainability.

This project is highly relevant to the modern agricultural industry, where there is an increasing need for smart and sustainable irrigation practices. With climate change and water scarcity becoming critical challenges, automated systems like this one offer scalable, cost-effective solutions. The technology can be adapted to a wide range of crops and field sizes, making it valuable for both small-scale farmers and large agricultural enterprises. It supports the transition towards precision agriculture, boosts productivity, and promotes environmental conservation aligning with the goals of sustainable farming and Agri-Tech innovation.

Working Model:

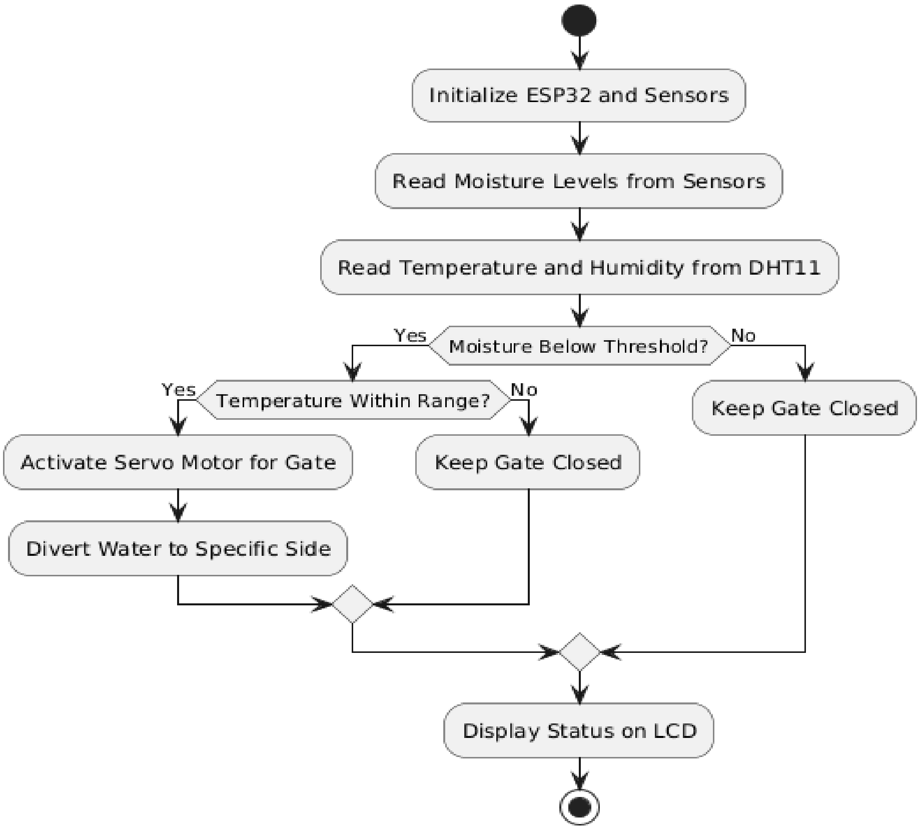


Figure 6: Flow chart showing Step by Step Working of Prototype

An automated irrigation system is crucial for assessing its performance, dependability, and efficiency, which provides insights for large-scale deployment. It aids in examining the operation of sensors, ESP32, and servo motors while optimizing water consumption to avoid excessive or insufficient irrigation. The prototype facilitates seamless component integration, detects system problems. It also supports automation testing, reducing the need for human involvement and enhancing irrigation efficiency. Moreover, collecting real-time data on soil moisture, temperature, and humidity aids in making informed decisions. User feedback and adjustments further refine the system for practical agricultural application.

Figure 7: Operational Prototype of Hydro-Tech gate Automation and Monitoring the Irrigation field Using Sensor

Future Scope:

The future scope of this project includes:

1. Implementing solar-powered irrigation systems to lessen reliance on external energy sources.
2. Introducing automated bore well water supply systems to improve the efficiency of groundwater utilization.
3. Artificial Intelligence (AI) and Machine Learning (ML) algorithms hold the promise of advancing field monitoring, precisely forecasting crop water needs, and effectively automating irrigation schedules.