Iot Based Soil Monitoring Water Sprinkler Robot

Anand Kumar Yadav[1], Prabhat Shukla[2], Aditya Kumar Sharma[3], Satyendra Kumar Gupta[4]

[1,2,3]Student of Department of Electrical Engineering, Shri Ramswaroop Memorial College of Engineering and Management, Lucknow, Uttar Pradesh, India.
[4]Assistant Professor, Department of Electrical Engineering, Shri Ramswaroop Memorial College of Engineering and Management, Lucknow, Uttar Pradesh, India.

ABSTRACT

We look after the IoT-based agricultural robotic sprinkler system for effortless water sprinkling during this era of advanced electronics. It consists of a robot that travels all over the field and sprays water in every direction. The robot obstacle detection of this machine is entirely automated. An Android robot controller for unit remote mobilization has been developed. In this project, we will perform lateral and vertical robotic bi-directional telescopic translation. The off-field supervision responsibilities of farmers will perhaps be taken more seriously, especially with developments in robotic technologies. In this project, an IoT based water sprinkler robot is designed which automatically controls the irrigation by "smart" soil moisture sensors determining soil sufficiency where water will be granted based on real time information which optimizes the irrigation process, reduces water wastage, and increases crop yield while remote monitoring and controlling without complexity increases responsible environmental stewardship. Watering becomes easier and more efficient IoT technology integrated into sprinklers transforming traditional devices into intelligent systems.

Keyword: - plant, irrigation, water, sprinkler, robot

1. INTRODUCTION

The "Hybrid Sprinkler: IoT-Powered Robot for Watering Plants" project presents a smart solution for water management in gardening and agriculture. The robot is equipped with IoT technology and sensors to measure soil moisture levels and water plants when needed. The robot conserves water by minimizing waste and can be operated remotely for convenient plant care and a green strategy.[1]-[2]

Efficient use of water is required for the healthy growth of crops and sustainable agriculture. The project "Powered Robot for Watering Plants" suggests a computerized approach that uses advanced sensors and robots to achieve maximum watering efficiency. The robot can detect the moisture level of the soil and move autonomously to supply plants with the right amount of water whenever needed. By combining automation with smart monitoring, the system reduces wastage of water, saves human labor, and facilitates eco-friendly farming.[2]-[3]

In agriculture today, efficient use of water is very vital for water conservation and increased crop yields. The "Water Pump Control and Monitoring the Moisture Using IoT" project presents an automated method of controlling soil moisture levels and governing the water pumps. Utilizing IoT technology, the system supplies water to crops when it is needed, with minimal wastage and remote control and monitoring using devices connected to the internet.[3]-[4]

The study "Internet of Things and Smart Sensors in Agriculture: Scopes and Challenges" examines how IoT and smart sensors are revolutionizing modern agriculture. The technologies help monitor soil, weather, and crop conditions in real-time, which makes the farming process more efficient. The study also names cost, connectivity, and data security as challenges to employing these systems.[4]-[5]

Proper irrigation is the core of smart farming, and automation is key to attaining it. The project "Decision Tree Method for Automation of Plant Sprinklers and Monitoring Based on Soil Moisture" utilizes a decision tree algorithm to track soil moisture content and control sprinklers according to the analysis. The system provides better utilization of water, reduces man power, and enables better crop management based on data-driven decisions.[5]-[6].

With the increasing role played by the technological side of education, Pendidikan Teknik Informatics focuses on applying information technology as a medium of teaching and learning. The project is focused on demonstrating the development and utilization of IT- based tools and systems that facilitate effective instruction in technical and vocational education and training. It seeks to innovate instruction techniques towards making teaching and learning more interactive using IT-based methods.[6]-[7]

Implementation of Internet of Things (IoT) technologies in agriculture is revolutionizing farm management. The "IoT-Based Smart Agriculture Monitoring System" project talks about using IoT devices for monitoring and controlling various environmental factors such as soil moisture, temperature, and humidity. Farmers will be able to make informed decisions with the help of this system, improving crop yield, reducing wastage of resources, and having more effective agricultural operations. The project also discusses the potential challenges of implementing IoT in agriculture and the prospects it has in the future.[7]-[8]

2. LITERATURE SURVEY

Literature survey presents a broad picture of available research and development pertinent to the project proposed. It seeks to find out the status of current knowledge, determine gaps, and present advancements in the concerned area. Through the review of past studies, technologies, and methodologies, the survey establishes a solid foundation for the project and informs the choice of the right approaches.

This part highlights the critical appraisal of major works that inform understanding of the topic, enabling making informed decisions in the design and implementation stages.

3. PREVIOUS RESEARCH WORKS ON SPRINKLER ROBOT

1. Agriculture is a significant industry in every region of India. Nevertheless, climate change and receding rainfall have greatly affected its extent. Excessive water use is often a result of the traditional methods of irrigation. This has been combated by innovative solutions like sprinkler and drip irrigation, aimed at conserving water.[9]
2. This paper presents a cost-effective IoT-based intelligent irrigation system based on devices such as Arduino Uno, ESP8266 Wi-Fi module, DHT11 sensor, and soil moisture sensor. The system water crops automatically, only when needed, by observing soil moisture content in real time. The information is sent to farmers via the Blynk app, where all data are uploaded to the cloud using built-in Wi-Fi. This invention saves much more water than conventional techniques.[10]

3. Technical progress, particularly in agriculture, has boosted food manufacturing and effectiveness significantly. In Bangladesh, where numerous people rely on agriculture, low power and unstable water supply constrain productivity. Through the use of IoT, this project automates crop irrigation, making it efficient and consistent. Sensors track the moisture and temperature of the soil, transmitting data online. If the soil is parched, the system notifies the farmer instantly, and appropriate action can be taken in a timely manner.[11]
4. The Internet of Things (IoT) is transforming agriculture by incorporating intelligent devices into agricultural operations. IoT not only saves resources but also increases productivity and decreases labor. Another application of this idea is a robot with sensors to evaluate soil conditions, plant seeds, and spray water. This battery-powered robot can be controlled via a mobile app and has a soil digger, a funnel for seed and fertilizer, and a sprayer. It enables farmers to do their work more efficiently with better results.[12]
5. Water management becomes very important in areas experiencing water shortage, particularly agriculture, as it uses ample water resources. Global warming compounds the necessity to apply adaptive approaches in order to make water resources available for crop production. Scientific study of efficient irrigation has expanded in order to mitigate this. Yet affordable sensors and recent IoT and WSN developments allow economical irrigation possibilities. This survey examines existing smart irrigation systems, major monitored parameters, prevalent technologies, and implementation issues.[13]

4. METHODOLOGY

Circuit Diagram of Soil Monitoring and Water Sprinkler System

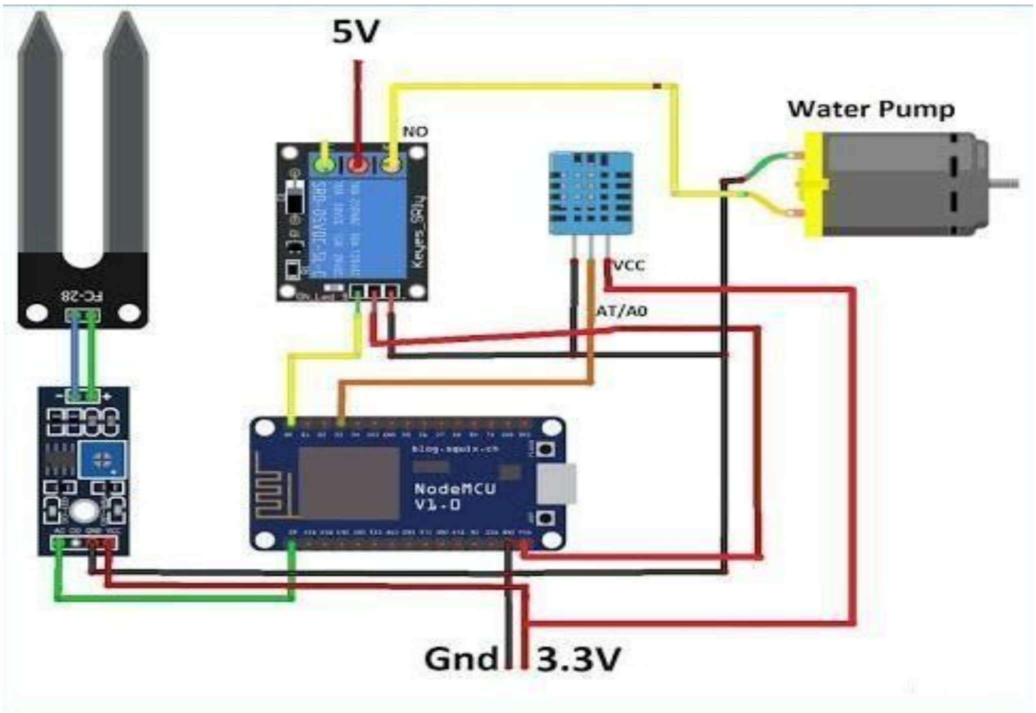


Fig.3.1 Circuit diagram of soil monitoring and water sprinkler system

Circuit Diagram of Surveillance Robot

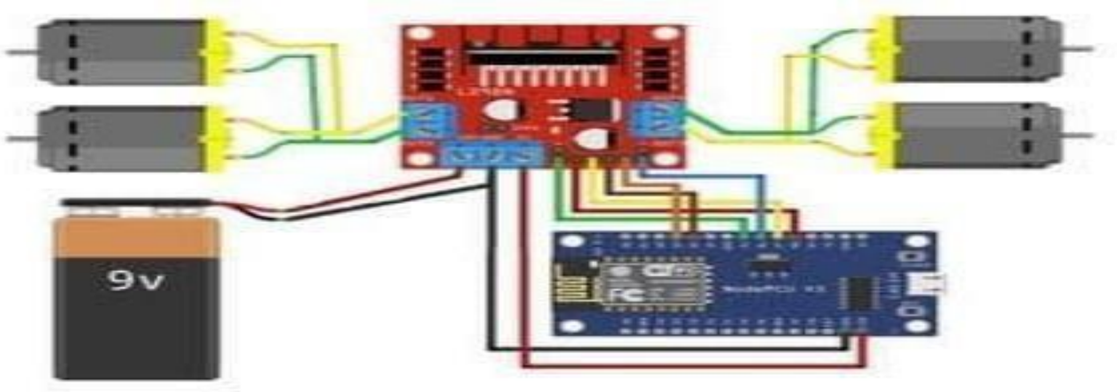


Fig.3.2 Circuit Diagram of Surveillance Robot

Software/Hardware Requirement

- Li-ion battery
- Battery Holder
- ESP32 Microcontroller
- Electrical Relay
- Soil moisture sensor
- Boost converter
- Motor drive
- Servomotor
- Brushed DC motors
- Wheel
- DHT11 Temperature and Humidity Sensor
- ESP32-CAM
- Wpc sheet
- Switch
- Jumper wire
- Blynk-iot app

5. Component description

Li-ion battery: -

Lithium-Ion is rechargeable and found in vape devices, a majority of consumer electronics like smartphones, tablets, and computers, E-Bikes, electric toothbrushes, equipment, hoverboards, motor scooters, and solar backup storage.

Fig 4.1-Li-ion battery

ESP32 Microcontroller: -

The ESP32 microcontroller is the brain of the smart farm robot. The ESP32 microcontroller is a robust and dynamic microcontroller with computational abilities, connectivity options, and sensor and actuator interfaces. The ESP32 supports data processing, decision, and control functions in the system.

Fig 4.2 - ESP32 Microcontroller

Electrical relay: -

- Relays are electrically operated switches which open. and close the circuits through receiving electrical signals from external sources.
- The major role of a relay module is to turn electrical devices or systems on and off.
- It also isolates control circuits, allowing low-power devices like microcontrollers to safely control higher voltages and currents.

Fig 4.3- Electrical relay

Soil moisture sensor: -

- The soil moisture sensor (SMS) is an irrigation system controller-connected sensor that detects soil moisture content in the active root zone prior to each scheduled irrigation event and skips the cycle if soil moisture is higher than a user-set set point.

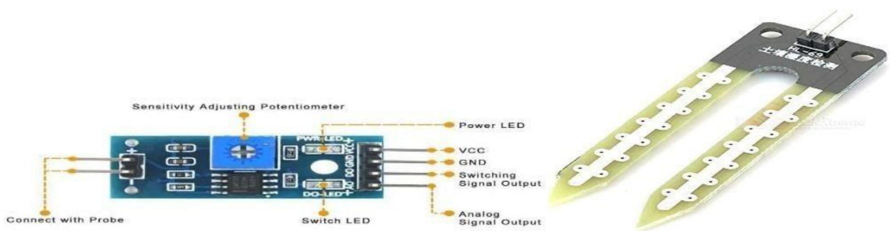


Fig 4.4- Soil moisture sensor

Motor drive: -

- Motor driver is used to control motion of a motor and its direction by feeding current accordingly.
- A motor driver output is digital so it employs the use of PWM (Pulse Width Modulation) to vary

speed of a motor.

- Motor Driver are essentially current amplifiers preceded by input signals.
- The purpose of the motor drive is to take in electrical energy from the electrical source and deliver electrical energy to the motor, so that the required mechanical output can be produced.

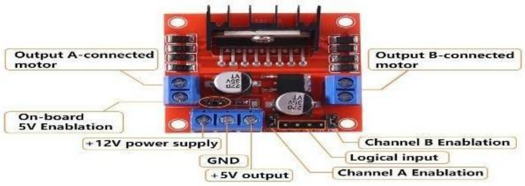


Fig 4.5- Motor drive

Servomotor: -

- A servomotor is a linear or rotary actuator permitting accurate control of angular or linear position, velocity, and acceleration in a mechanical system.
- It is a rotary or linear actuator that is able to turn to a fixed position, precisely as instructed. Servos also reliably hold and re-set position.

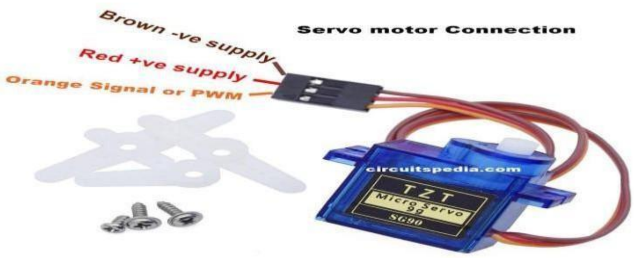


Fig 4.6- Servomotor

ESP32-CAM: -

- ESP32-CAM is a cost-effective ESP32-based development board with onboard camera, compact size. It is the best choice for IoT application, prototypes constructions and DIY projects.
- The board combines Wi Fi, standard Bluetooth and low power BLE, with 2 high-performance 32-bit LX6 CPUs.
- ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip using the TSMC low-power 40 nm technology.

Fig 4.7- ESP32-CAM

DHT11 Temperature and Humidity Sensor: -

- This sensor is utilized in several applications like sensing humidity and temperature values in air conditioning, heating, and ventilation systems.
- They are utilized to present the true condition of humidity within the air at a specific point or in a specific location.
- It senses the ambient air and provides a calibrated digital output of temperature and relative humidity.

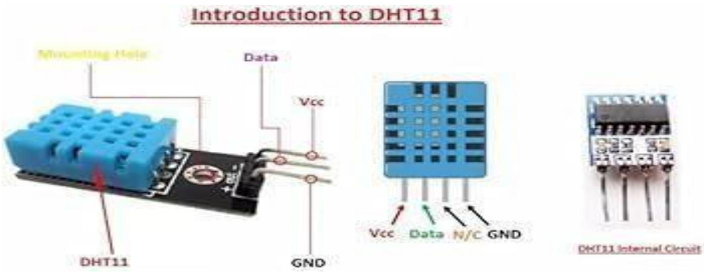


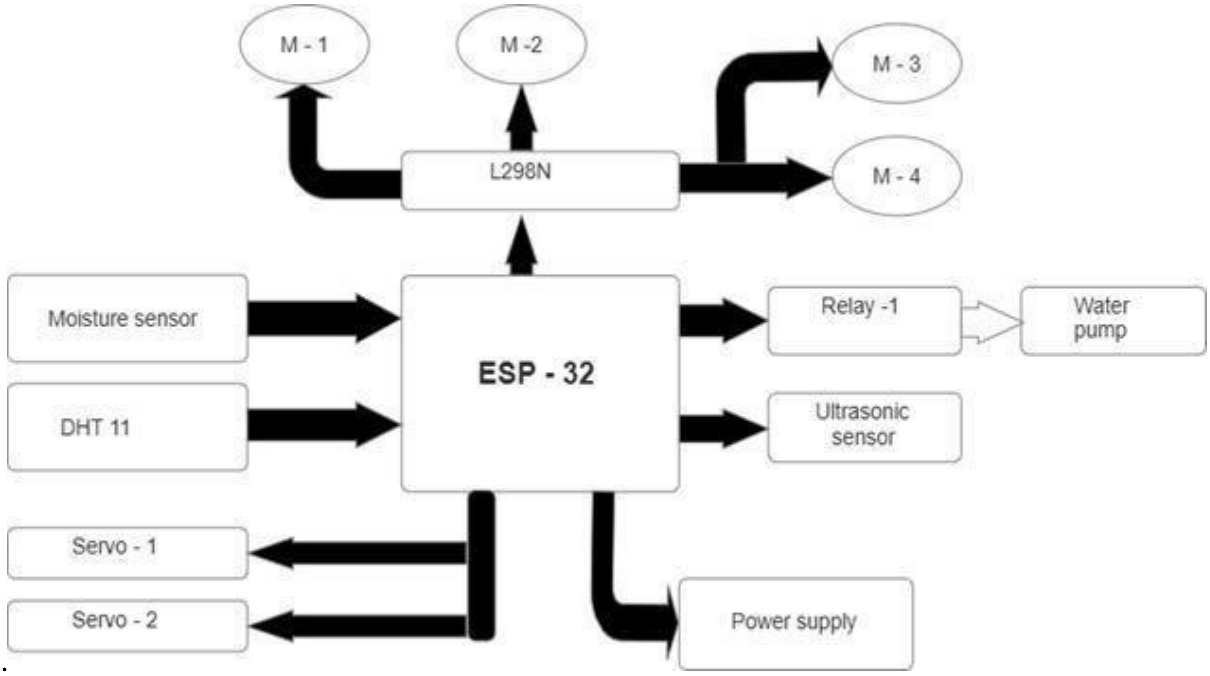
Fig 4.8-DHT11 Temperature and Humidity Sensor

Water pump: -

- 5v, 6v, 12V DC motor driven Mini Motor Pump VP30A.
- Is commonly used in desktop crafts, medical equipment, soilless cultivation, aquarium tanks, etc.
- Its operating mechanism relies on centrifugal force. The motor makes the impeller spin, sucks water into the pump body, and discharges water out through the outlet.
- Small water pump can be applied widely, and has uses in residential, agricultural, industrial and other industries.

Fig 4.9-Water pump

6. Block Diagram



Working: -

An IoT soil sensor and water sprinkler robot is meant to provide autonomous irrigation through the monitoring of soil moisture, temperature, and other climatic conditions. The robot saves data in real-time and irrigates the plants accordingly. This is how it operates:

Working Principle:

Soil Monitoring:

Sensors (temperature, humidity, moisture) detect the soil condition.

The information is transmitted to a microcontroller (e.g., Arduino, ESP32, or Raspberry Pi).

Data Processing:

The microcontroller computes sensor data and determines if watering is needed. When the level of moisture is less than a threshold, the sprinkler operates.

Water Sprinkling Mechanism:

A water pump is attached to the system. The pump switches on and sprinkles water on the ground. The pump shuts off when the required moisture level is achieved.

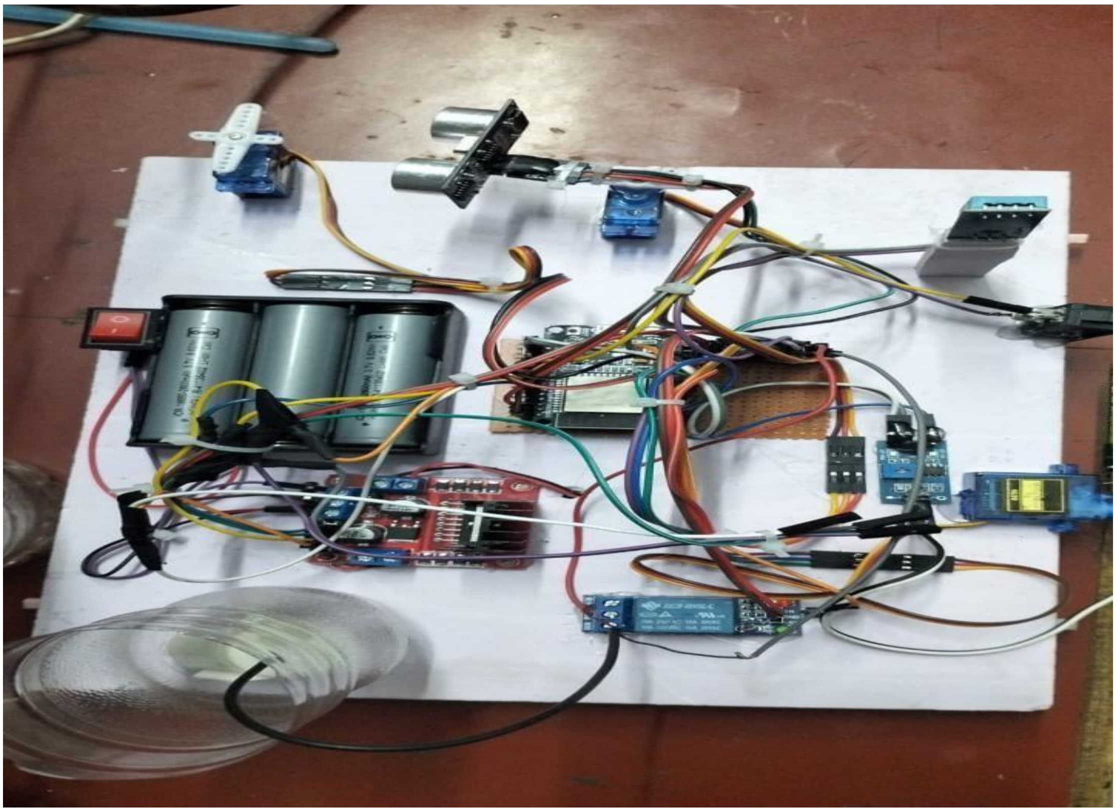
IoT Connectivity:

The system communicates with a cloud platform (Thing Speak, Firebase, or Blynk) over Wi-Fi. Users may view real-time data and also remotely control the system using a mobile application or web interface.

Mobility:

The robot moves freely or via remote control using motors and wheels. It sweeps through various zones, analyzes soil humidity, and irrigates wherever necessary. Obstacle-avoidance or GPS sensors can be incorporated for navigation.

7. RESULT ANALYSIS



The results and discussion section is where the findings and results of the IoT-based soil monitoring and water sprinkler robot are presented. It entails the performance assessment, comparison with conventional irrigation systems, and impact on plant growth, water usage, and overall efficiency.

Performance Analysis: The performance of the IoT-based soil sensor and water sprinkler robot can be analyzed in terms of a number of parameters, such as accuracy of soil moisture measurement, system response to environmental changes, and consistency of irrigation decisions. The system must be compared with manual readings or reference sensors to determine its accuracy and efficiency.

Comparison with Conventional Irrigation Techniques: The IoT soil monitoring and water sprinkler robot can be compared with conventional techniques to find the benefits and advantages of the installed system. Parameters like water savings, energy efficiency, labor needs, and overall cost-effectiveness must be taken into consideration.

Influence on Plant Growth: The IoT-based water sprinkler robot and soil monitoring influence on plant growth can be measured by comparing the growth, yield, and health of plants irrigated by the system to plants irrigated by conventional means. Plant height, leaf growth, flowering, and crop yield should be monitored to determine the effectiveness of the system in facilitating healthy plant growth.

Water Usage: The water usage by the IoT-based water sprinkler robot and soil monitoring can be quantified and compared with conventional irrigation systems. The system's capacity to utilize water optimally using real-time sensor data can result in massive water savings. This comparison can give an indication of the system's efficiency in water saving.

The discussion needs to incorporate the analysis of outcomes, emphasizing strengths and weaknesses of the smart irrigation system that has been implemented. It must report any difficulties during the implementation stage and suggest likely improvements or prospective future enhancements.

In general, the outcomes and discussion section serves to present an extensive overview of the performance of the IoT-based smart irrigation system, its effect on plant growth and water usage, as well as its possibility of adoption in extensive use in agriculture and horticulture activities.

8. CONCLUSION

Ultimately, the conceptualization and implementation of the IoT-empowered water sprinkler and soil monitoring robot project represent a major leap for precision agriculture. Through the synergy of advanced IoT technology, advance sensor systems, and autonomous robotics platforms, the project has attempted to address the critical challenges that face contemporary farming, particularly those of water control and soil status monitoring. Over the course of the project, some notable achievements have been realized:

Firstly, the project has successfully designed and implemented an integrated system that has the ability to automate irrigation process and provide real-time soil conditions.

Using IoT sensors and wireless communication technologies, the system successfully tracks soil moisture levels, temperature variations, and nutrient levels with remarkable accuracy.

In addition, the use of machine learning algorithms has enabled the system to filter through vast sensor data and extract actionable insights for optimizing irrigation schedules and resource allocation. This data-driven approach has made water usage more efficient, with significant levels of water wastage reduction and increased crop output.

REFERENCE

1. JK KA, M Akhtar, CM Talha, VG Gokul "Design of Hybrid Sprinkler: The IOT-Powered Robot for Watering Plants "MATEC Web of Conferences,2024 matec- conferences.org
2. Powered Robot for Watering Plants" MATEC Web of Conferences, 2024•matecconferences.org
3. MC Babu, D Mohan, E Rahul, N Kumar "Water Pump Control and Monitoring the Moisture Using IOT" biogecko.co.nz
4. P Rajak, A Ganguly, S Adhikary, S Bhattacharya "Internet of Things and smart sensors in agriculture: Scopes and challenges", Journal of Agriculture and Food Research, 2023
5. M Muchlasin, M Hasbi, S Siswanti "Decision Tree Method For Automation Of Plant Sprinklers And Monitoring Based On Soil Moisture" Jurnal Nasional

6. Pendidikan Teknik Informatika: JANAPATI, 2023•ejournal.undiksha.ac.id
7. Mini, Ajit Divakaran, et al. "IoT based smart agriculture monitoring system." International Research Journal of Engineering and Technology 10.4 (2023): 14421448.
8. Kumar, Gigyashu, and Jamal Akhtar Khan. "Iot Based Weather Monitoring System Using ESP 32 and Blynk." Kilby 100 (2023): 7th.
9. Kurniawan, Fery Andika, et al. "Implementation of an ESP-32 Wi-Fi CAM & Arduino- Based Robot for IoT Surveillance." Seminar Nasional Teknik Elektro. 2023.
10. Subramanyam, M. V., et al. "IoT Based Farm Protection from Animals and Human Theft using Esp32 with Camera Module." International Research Journal of Modernization in Engineering Technology and Science 5.4 (2023).
11. Alagarsamy, Manjunathan, et al. "Automation irrigation system using arduino for smart crop field productivity." Int J Reconfigurable & Embedded Syst ISSN 2089.4864 (2023): 4864.
12. Azman, Nurhadirah, Darmawaty Mohd Ali, and Yusmardiah Yusuf. "Smart Agricultural Monitoring System using IoT Application for Chili Plants." Journal of Advanced Research in Applied Sciences and Engineering Technology 33.1 (2023): 53-66.