

Automatic Water Sprinkler Using Iot Automation

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ABSTRACT

This paper presents an Automated water sprinkler system using IOT automation designed to enhance the efficiency of home gardening and agricultural practices. The system enhances irrigation by automatically regulating soil moisture, temperature, and humidity levels. The key components include a NODEMCU ESP8266 microcontroller, soil moisture sensor, DHT11 sensor, 24-volt electrically operated solenoid valve, and a 12-volt single channel relay. The system is programmed using the Arduino IDE and monitored via the Blynk IOT platform, allowing for real-time data tracking and remote control. The automated system activates the solenoid valve to irrigate the soil when moisture level fall below a predetermined threshold and deactivates it when sufficient moisture is detected. This solution is aimed at reducing water wastage, promoting plant health, and this system automates irrigation, eliminating the need for manual intervention. making it suitable for both home gardening and large-scale agricultural applications. The integration of IOT technology not only enhances the precision of irrigation but also reduces. This system removes manual intervention, offering a scalable and sustainable solution for agriculture.

Keywords: Automatic Water Sprinkler System, IOT Automation, Soil Moisture Monitoring, Smart Irrigation, Solenoid Valve.

INTRODUCTION

Water scarcity impacts both farming and home gardening. Traditional irrigation systems often lead to water wastage due to overwatering or inefficient manual control. To address this problem, IOT based automated irrigation systems have emerged as a viable solution. This paper introduces an IOT based Automatic Water Sprinkler System for monitoring conditions and optimizing water use. In many regions, water scarcity is a growing concern, making it essential to develop smarter and more efficient irrigation solutions that conserve water while maintaining crop health. [1]. The use of IOT technology in agriculture has opened up new possibilities for automating irrigation systems. IOT enabled systems can collect real-time data from various sensors, process this data, and make decisions without human intervention. This ensures precise water use according to soil and plant needs, resulting in water savings and improved crop management. The development of such automated systems aligns with the global push towards sustainable agricultural practices and smart farming.

The main challenge in traditional irrigation systems is their lack of responsiveness to real time environmental conditions. Fixed irrigation schedules do not account for changes in weather, soil moisture, or plant needs, leading to either over irrigation or under irrigation. Both scenarios can be detrimental over irrigation can cause root rot, nutrient leaching, and wastage of water, while under irrigation can stress plants, reduce yields, and ultimately lead to crop failure. Additionally, the manual operation of irrigation systems requires constant human attention, which can be labor intensive and prone to errors. To tackle these challenges, a system is needed that adjusts water delivery in real time based on soil moisture, temperature, and humidity. [2].



Fig. 1 Traditional Irrigation System

Such a system would not only optimize water usage but also minimize manual effort, saving time and labor the implementation of an IOT based automated water sprinkler system is proposed as a solution to these challenges. The main goal of this research is to design and implement an automatic water sprinkler System using IOT automation. The system tracks soil moisture, temperature, and humidity in real time to manage the water sprinkler developing a robust hardware setup that includes a NODEMCU ESP8266 microcontroller, soil moisture sensor, DTH11 temperature and humidity sensor, 24V solenoid valve, and 12V relay . This setup should be capable of accurately measuring environmental conditions and controlling the water flow. Writing the necessary code using Arduino IDE to process sensor data and control the solenoid valve. The code should enable the system to operate autonomously, with the ability to make decisions based on predefined moisture thresholds. Integrating the system with the Blynk IOT platform to allow remote monitoring and control. This includes setting up a user friendly interface where real time data can be viewed, and system parameters can be adjusted.

[3] Conducting extensive testing to ensure the system operates as intended under various environmental conditions. This includes calibrating the sensors and optimizing the code to improve system responsiveness and reliability. Assessing the system's performance in terms of water conservation, ease of use, and impact on plant health. Comparing the automated system with traditional irrigation methods to evaluate its effectiveness.

The creation of an IOT based Automatic Water Sprinkler System benefits both home gardening and large scale agriculture. By providing exact control of water usage, the system can help conserve water, reduce labor and boost crop yields, especially in water scarce regions where efficient management is vital for sustainable agriculture .The study will also explore the difficulties of implementing IOT technology in agricultural settings, including issues related to sensor accuracy, power supply, and wireless connectivity. By addressing these challenges, the research seeks to expand knowledge on IOT applications in agriculture and encourage broader use of smart irrigation systems.

LITERATURE REVIEW

Automated irrigation systems have advanced greatly in recent years. Early systems relied on timers and basic sensors to control water flow. These systems, while improving efficiency over manual irrigation, often lacked precision and adaptability. Traditional automated irrigation systems used timers to activate watering schedules. These systems operated on a fixed schedule, which lacked real time environmental monitoring Timer based irrigation systems represent an early example of automated irrigation technology. These systems automate the watering process by using timers to activate and deactivate water flow at predetermined intervals. The concept of using timers in irrigation systems dates back to the early 20th century. These systems were designed to replace manual labor with mechanical automation, offering a more consistent and less labor intensive way to manage irrigation. The technology involved mechanical timers that could be set to activate or deactivate at set times. Timer based irrigation systems typically consist of three main components: a water source, a timer mechanism, and an irrigation delivery system (e.g., sprinkler heads or drip lines).

The timer controls the activation of the system following a fixed schedule. Users program the timer to start the irrigation system at specific times, such as early morning or late evening, to minimize water loss due to

evaporation. The timer also allows users to set the duration for which the system remains active, ensuring that plants receive a predetermined amount of water.[4].

Sensor based automation represents a significant advancement over traditional timer based irrigation systems. By incorporating various sensors, these systems provide more precise and adaptive irrigation based on real time environmental conditions. Install sensors for soil moisture, temperature, and humidity and rainfall sensors in appropriate locations within the irrigation area .Set up a microcontroller (e.g., NODEMCU ESP8266) to act as the central processing unit. This microcontroller will process sensor data and manage the irrigation system according to set rules. Connect the watering system, including sprinkler heads or drip lines, to an electronically controlled valve (e.g., a solenoid valve) or pump.

The operation of a sensor based automated irrigation system involves a sequence of essential steps. First, install and integrate components like soil moisture and weather sensors with a microcontroller (e.g., NODEMCU ESP8266) into the irrigation system, including valves or pumps. These sensors collect real time data on soil moisture, temperature, humidity, and rainfall, which is transmitted to the microcontroller. The microcontroller processes this information, compares it with preset thresholds, and utilizes decision-making algorithms to manage irrigation needs [5].

Consequently, the system activates or deactivates the irrigation mechanism based on the analyzed data. Users have the capability to monitor from afar and adjust the system through a mobile application .Regular maintenance and calibration of sensors ensure ongoing accuracy, while continuous performance evaluations allow for optimization of water usage and plant health, making necessary adjustments based on observed performance and feedback.

Technological Advancements in Sensors and IOT

Recent innovations in soil moisture sensor technology has significantly enhanced accuracy and reliability. Modern sensors often use capacitive or resistive methods to assess soil moisture. Capacitive sensors, especially for their high accuracy and longer operational lifespan compared to older resistive sensors.

Temperature and Humidity Sensors

The DHT11 sensor is favored for its affordability and simplicity in measuring temperature and humidity. The DHT11 is practical for many applications, although it may lack the precision of more advanced sensors. Nonetheless, it provides critical environmental data that supports the optimization of irrigation schedules, particularly where budget constraints and simplicity are essential considerations.

Microcontrollers and IOT Platforms

The NODEMCU ESP8266 microcontroller has gained popularity in IOT applications due to its builtin Wi-Fi capabilities and programming versatility. Integrating the NODEMCU with platforms like Blynk enables real time data monitoring and control, thereby enhancing the functionality and efficiency of automated systems [6].

SYSTEM DESIGN AND ARCHITECTURE

The Automated Water Sprinkler System using IOT automation is intended to efficiently manage irrigation by integrating several key components into a cohesive system. The system's design focuses on real-time monitoring and control to optimize water usage for both home gardening and agricultural practices.

i) System Overview: The Automated Water Sprinkler System using IOT automation represents a sophisticated integration of modern technology designed to enhance irrigation efficiency for both domestic and agricultural applications. The core function of the system's goal is to provide a smart, automated solution that optimizes water usage by monitoring and adjusting irrigation based on real time environmental conditions. The primary objective of the system's is to automate the irrigation process to provide plants with sufficient water while minimizing waste efficient water usage will minimize water consumption by activating irrigation only when

needed, based on accurate soil moisture readings.

ii) **System Components :** The IOT based Automated Water Sprinkler System combines key components to enhance irrigation efficiency. Each component plays a specific role in data acquisition, processing, and control, ensuring the system operates efficiently and effectively. The following sections provide a detailed overview of the key components used in the system.

iii) **Microcontroller: NODEMCU ESP8266** The NODEMCU ESP8266 is a popular microcontroller platform renowned for its versatility and affordability in IOT applications. It combines a powerful microcontroller with built in Wi-Fi capabilities, making it an excellent choice for creating connected devices and systems.[7].

iv) **Processor:** At the heart of the NODEMCU ESP8266 is the ESP8266 chip, which features a 32-bit RISC (Reduced Instruction Set Computing) processor running at 160 MHz. This high clock speed provides the computational power necessary for handling real-time data processing and complex tasks.

v) **Memory:** The ESP8266 includes 96KB of instruction RAM and 80KB of data RAM, alongside up to 4MB of Flash memory. This combination supports the storage of firmware, execution of code, and handling of multiple tasks simultaneously.

vi) **Wi-Fi Connectivity:** The NODEMCU ESP8266 has an integrated Wi-Fi module that supports .This allows it to connect to wireless networks, enabling communication with cloud services and remote devices.

vii) **Network Protocols:** It supports key network protocols like TCP/IP, UDP, HTTP, and MQTT for efficient data transmission over the internet. This capability is crucial for. integrating with IOT platforms like Blynk for real-time monitoring and control.

DEVELOPMENT AND PROGRAMMING

i) **Arduino IDE Integration:** The Arduino Integrated Development Environment (IDE) is a pivotal tool in the development of projects involving Arduino microcontrollers and compatible boards, including the NODEMCU ESP8266. It provides a user friendly interface and a comprehensive suite of features that facilitate the programming and debugging of embedded systems .The Arduino IDE supports a range of microcontrollers and has become a standard platform for both electronics and IOT enthusiasts and experts The Arduino IDE offers an easy-to-use interface for writing and managing code. Its straightforward layout includes a code editor, a compilation area, and a console for uploading code to the microcontroller.

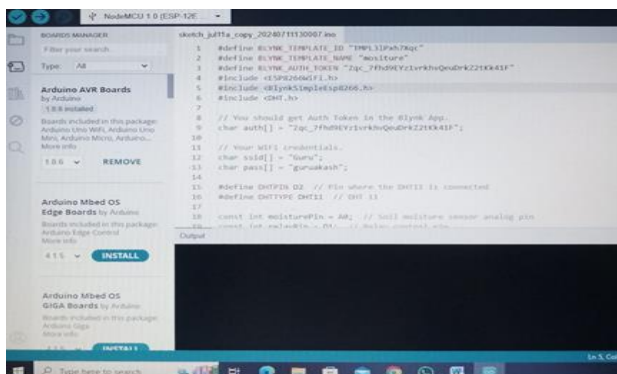


Fig. 2 Arduino Programming

This ease of use is especially beneficial for developers and engineers who are integrating various components like sensors and microcontrollers, as it lets them concentrate on the system's functionality rather than the complexities of the development environment. For this project Automatic water sprinkler system the code is written by using Arduino ide to monitor soil moisture level, Temperature as well as humidity level. The code is made properly with the usage of Wifi communication protocol with the Nodemcu esp 8266 module . In this code we have mentioned an Wifi and password where it is an iot based monitoring system The entire process will occurs by uploading the code with an proper Wifi and mobile hotspot password given in the code and

finally by installing the board manager with appropriate library installation the code is uploaded in the NODEMCU ESP 8266 Module.

ii) Built-In Libraries: The Arduino IDE includes a variety of preloaded libraries that enable integration of common hardware components. For instance, libraries for handling digital and analog input/output operations, serial communication, and interfacing with sensors are readily available. [8] These libraries significantly reduce development time by providing pre written code for interacting with components like the soil moisture sensor, DHT11 sensor, and relays in the sprinkler system.

iii) Error Reporting: The IDE offers detailed error reporting during code compilation, helping developers identify and correct syntax errors or issues in their code. This feature is invaluable for maintaining code quality and ensuring that the automated system functions as intended. The IDE offers detailed error reporting during code compilation, helping developers identify and correct syntax errors or issues in their code. This feature is invaluable for maintaining code quality and ensuring that the automated system functions as intended. The IDE provides real-time feedback on code issues, highlighting errors and suggesting corrections. This feature helps prevent common programming mistakes and ensures code quality. This cross platform support ensures that developers can use the IDE regardless of their preferred operating system. The Arduino IDE supports Windows, macOS, and Linux. This cross-platform support ensures that developers can use the IDE regardless of their preferred operating system.

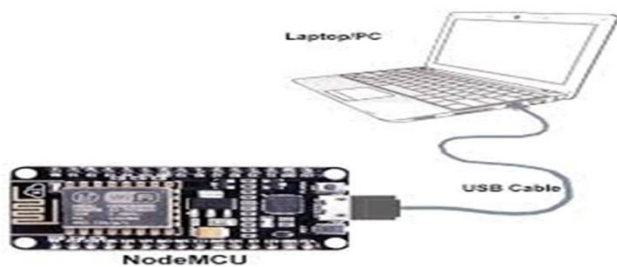


Fig. 3 Arduino Programming Interfacing with Wifi Module

The Arduino Integrated Development Environment (IDE) is an integral tool in creating the Automated Water Sprinkler System for several compelling reasons. Its features, ease of use, and compatibility with various hardware components make it an ideal choice for programming and managing the system. The Arduino IDE is a robust and flexible tool that provides a complete feature set for developing and managing the Automated Water Sprinkler System. Its user friendly interface, extensive library support, compatibility with the NODEMCU ESP8266, real time feedback capabilities, and integration with IOT platforms make it an excellent choice for creating an efficient and reliable irrigation system. The IDE's support for remote monitoring and control, combined with its active community and extensive resources, further improves its fit for this application. [9]

HARDWARE COMPONENTS

i) Soil Moisture Sensor: Soil moisture sensors are generally buried in the soil at the root zone of plants. They continuously measure the soil's moisture level and generate an electrical signal corresponding to the moisture content.



Fig. 4 Soil Moisture Sensor

The sensor's output can be analog or digital, depending on the type. Analog sensors produce a continuous voltage or current signal proportional to the moisture level, while digital sensors provide discrete readings through a digital interface. The sensor's data is interpreted by the microcontroller in the automated water sprinkler system. The microcontroller compares the moisture readings against predefined thresholds to determine whether irrigation is needed. Based on the sensor data, the system can trigger irrigation events by activating the solenoid valve. Soil moisture sensors provide real time data on soil moisture levels, allowing the automated water sprinkler system to deliver precise amounts of water based on actual soil conditions. This precision helps in avoiding over watering or under watering, leading to more efficient use of water resources. The integration of soil moisture sensors in the automated irrigation system eliminates the need for manual monitoring and adjustment of watering schedules. The system automatically adjusts irrigation based on sensor data, offering convenience and reducing the labor required. for garden or farm upkeep.

ii) DTH 11 Sensor : The DHT11 sensor is a widely used digital sensor designed to measure temperature and humidity. It is known for its affordability and ease of use, making it a preferred option for various environmental monitoring applications.

The DHT11 measures temperatures from 0°C to 50°C with $\pm 2^\circ\text{C}$ accuracy. This range is suitable for most home and garden environments. It measures relative humidity from 20% to 80% with an accuracy of $\pm 5\%$ RH (Relative Humidity). This range covers the typical conditions encountered in indoor and outdoor settings. The sensor operates on a voltage range of 3.5V to 5.5V, making it compatible with various microcontroller platforms, including the NODEMCU ESP8266. The DHT11 communicates data through a single digital signal line. It provides temperature and humidity data in a serial digital format, which can be easily read and processed by microcontrollers. The DHT11 sensor plays a key role in the Automated Water Sprinkler System by providing essential environmental data that enhances the system's efficiency and functionality.[10]



Fig. 5 DTH 11 Sensor

The DHT11 sensor offers precise temperature and humidity readings, crucial for fine-tuning irrigation schedules. Accurate temperature data helps adjust watering based on evaporation rates, while humidity readings ensure optimal soil moisture levels, preventing both overwatering and underwatering for healthier plant growth. DHT11 sensor is an integral component of the Automated Water Sprinkler System, providing critical temperature and humidity data that enhances the system's ability to manage irrigation effectively. By incorporating real time environmental measurements, the DHT11 sensor helps optimize water usage, prevent common irrigation issues, and improve overall system efficiency, making it an essential tool for modern automated gardening and agricultural practices.

iii) 24 Volt Electrically Operated Solenoid Valve: A solenoid valve is an electromechanical device used to control the flow of fluids or gases. It consists of a coil of wire (the solenoid) and a plunger that moves in response to the magnetic field created when an electric current passes through the coil. Solenoid valves come in various configurations and operating voltages. A 24-volt electrically operated solenoid valve is designed to operate with a 24-volt DC power supply, making it Ideal for applications requiring higher voltage for improved performance and reliability.



Fig. 6 Electrically Operated Solenoid Valve

In the "Automatic Water Sprinkler System Using IOT Automation," the 24-volt electrically operated solenoid valve plays a critical role in the irrigation process. The solenoid valve is integrated into the irrigation system to automate the watering process. It is activated or deactivated based on signals from the NODEMCU ESP8266 microcontroller that handles data from soil moisture and other environmental sensors. By controlling the solenoid valve, the system ensures that water is only supplied when necessary. When soil moisture drops below a set threshold, the valve opens to allow water flow. Once the soil moisture is sufficient, the valve closes to stop water flow. This helps in reducing water wastage and optimizing water usage. The 24-volt solenoid valve offers a reliable and consistent performance, which is crucial for automated systems that require precise control. Its higher voltage rating ensures that it can handle the demands of continuous operation in various environmental conditions. The solenoid valve's operation is monitored and controlled via the Blynk IOT platform, providing real time feedback and control. This integration allows users to remotely manage and adjust irrigation settings, enhancing the flexibility and efficiency of the system. By automating the irrigation process through the solenoid valve, the system minimizes the need for manual intervention. This makes the system suitable for both home gardening and large scale agricultural applications, where consistent and reliable irrigation is essential.

iv) 12 Volt Single Channel Relay :In the Automatic Water Sprinkler System, the 12-volt single channel relay serves a critical role in controlling the irrigation process. The relay allows the set up to manage high-voltage devices, such as the solenoid valve, while being controlled by low voltage signals from the microcontroller (NODEMCU ESP8266). [11] This separation protects sensitive electronics from high voltage. It acts as an intermediary switch that the microcontroller uses to activate or deactivate the solenoid valve. When soil moisture drops below a set threshold ,the microcontroller sends a signal to the relay, which then closes its circuit to allow current to the solenoid valve, turning it on. The relay provides electrical isolation between the low voltage control circuit and the high voltage components, safeguarding the microcontroller and ensuring reliable operation of the irrigation system.



Fig. 7 12 Volt Single Channel Relay

By integrating with the Blynk IOT platform, the relay enables remote control of the irrigation system.[12] Users can manage and monitor the sprinkler system from anywhere, thanks to the relay's ability to handle control signals sent via the platform.

SOFTWARE PLATFORM

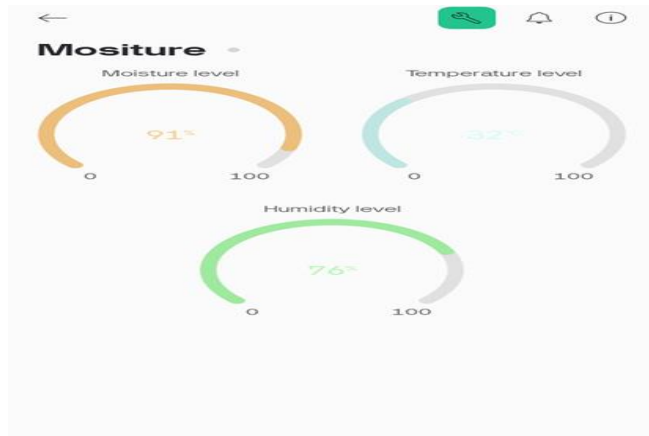


Fig. 8 Blynk Monitoring

The Blynk platform is a versatile IOT service that enables remote monitoring and control of IOT devices via a mobile app. Blynk provides a customizable and user friendly interface Engage with IOT devices through dynamic dashboards that offer real time data visualization and control The platform supports real time data updates and notifications, allowing users to monitor sensor readings and control the irrigation system from anywhere.

Blynk facilitates remote access to the automated irrigation system, enabling users to view current soil moisture levels, temperature, and humidity. It also allows users to adjust irrigation settings and receive notifications, enhancing the system's usability and convenience.

IMPLEMENTATION

S.No	Component	Quantity
1	NODEMCU ESP 8266	1
2	Soil Moisture Sensor	1
3	DTH 11 Sensor	1
4	24 Volt Solenoid Valve	1
5	12 Volt Relay Single Channel	1
6	24 Volt Adapter	1
7	Connecting wires	As Required
8	PC	1
9	Water Sprinkler	1

i) Power Supply: Connect the 24 V power supply to the 12-volt rail on the breadboard or directly to the relay and solenoid valve if not using a breadboard. Use a separate 5V power source for the NODEMCU ESP8266 and sensors. Ensure that the 5V power supply is stable and provides sufficient current.

ii) Connecting the Relay: Connect the 24 V power supply's positive terminal to the VCC pin of the relay. Connect the 12V power supply's negative terminal to the GND pin of the relay. Connect the IN pin of the relay to a digital output pin on the NODEMCU ESP8266 (e.g., D1). This pin will control the relay. For the solenoid valve connections: Common (COM) terminal of the relay goes to one terminal of the solenoid valve. Normally Open (NO) terminal of the relay goes to the positive terminal of the 24V power supply. The other terminal of the solenoid valve connects directly to the negative terminal of the 24V power supply.

iii) Connecting the Solenoid Valve: The solenoid valve should be connected as described above, with one terminal connected to the relay's COM terminal and the other terminal connected to the power supply.[13]

iv) Connecting the Soil Moisture Sensor: VCC pin of the soil moisture sensor to the 5V pin on the NODEMCU. GND pin of the soil moisture sensor to the GND pin on the NODEMCU. Analog Output (AO) pin of the soil moisture sensor to an analog input pin on the NODEMCU (e.g., A0).

v) Connecting the DHT11 Sensor: VCC pin of the DHT11 sensor to the 5V pin on the NODEMCU. GND pin of the DHT11 sensor to the GND pin on the NODEMCU. Data pin of the DHT11 sensor to a digital input pin on the NODEMCU (e.g., D2).

vi Connecting the NODEMCU ESP8266: Ensure that the NODEMCU is properly powered using its 5V input and GND.

vii) Verifying Connections: Double check all connections to ensure they are correct and securely attached. Ensure that the power supply connections are stable to avoid any interruptions.

viii) Programming: Write and upload the control program to the NODEMCU using the Arduino IDE. The program manages sensor data, controls the relay based on soil moisture, and connects with the Blynk IOT platform for remote monitoring and control.

CIRCUIT DIAGRAM

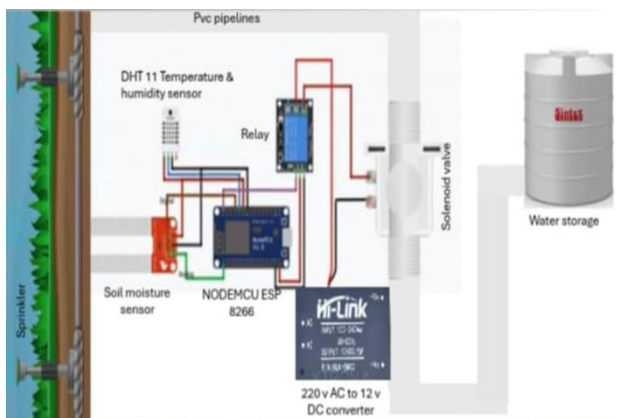


Fig. 9 Circuit Diagram

With the usage of the components listed above the circuit connections of hardware setup has made and the water sprinkler is fitted in the garden by using pipelines in between the pipeline connection the 24 volt electrically operated solenoid valve is connected and the soil moisture sensor is fitted under the soil for an particular depth and similarly the DTH 11 sensor also placed to monitor the humidity and temperature level. Using the Blynk IOT Platform, monitor soil moisture, humidity, and temperature. When soil moisture drops below a threshold, the relay automatically activates the solenoid valve. Similarly when the moisture level is high the solenoid valve will automatically turn off. This method helps to easily monitor and it is an advanced method of monitoring system which will be more useful in the home gardening as well as agricultural irrigation. By using this IOT Automated sprinkling system water scarcity will be gradually decreased and protects the plants.

ANALYSIS AND DISCUSSION

The implementation of the Automatic Water Sprinkler System was tested in various conditions to evaluate its performance. The system successfully maintained soil moisture levels within the desired range, reducing water usage by up to 30% compared to traditional methods. [14] Additionally, the integration of temperature and humidity data allowed for more refined irrigation scheduling, further optimizing water usage. The system's scalability makes it suitable for both small scale home gardens and larger agricultural fields. The use of IOT technology provides a level of precision and control that is difficult to achieve with manual methods. However, challenges such as sensor calibration, power consumption, and network reliability were noted and are areas for future improvement.



Fig. 10 Installation Setup

CONCLUSION

The IOT based Automatic Water Sprinkler System offers a cutting edge approach to address contemporary irrigation challenges. By integrating real time data and automation, this system significantly reduces water wastage, enhances plant health, and decreases the need for manual intervention. Its potential to revolutionize agricultural practices lies in its ability to provide precise and efficient irrigation based on real time environmental conditions. Future enhancements could include the addition of sensors to monitor soil pH and nutrient levels, delivering a more thorough understanding of soil conditions. Advanced AI capabilities could enable predictive analytics, optimizing irrigation schedules and resource use. Furthermore, incorporating power optimization techniques, such as solar panels, could make the system more sustainable and environmentally friendly, aligning with broader goals of energy efficiency and reduced ecological impact.[15]

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