Design of Hybrid Sprinkler: The IOT-Powered Robot for Watering Plants

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Abstract. Innovative methods for watering plants have been developed as a result of the growing demand for efficient and automated systems in agriculture. The design of a hybrid sprinkler, an IoT-powered robot created specifically for effective and precise plant irrigation, is presented in this study. The suggested system enables autonomous operation and intelligent control by fusing the benefits of conventional sprinklers with those of IoT technology. To continuously monitor the environmental conditions, the hybrid sprinkler integrates a variety of sensors, including soil moisture sensors, temperature sensors, and humidity sensors. A central control unit receives this real-time data and uses sophisticated algorithms to establish the best watering schedule for each plant depending on its individual needs. The hybrid sprinkler's design prioritizes sustainability and energy economy. The robot has a rechargeable battery system, and to increase battery life, it uses energy-saving features like sleep modes and sophisticated power management. In a variety of agricultural and horticultural applications, this system assures optimal watering practices, conserves resources, and fosters healthy plant growth by fusing IoT technology, cutting-edge sensors, precision spraying mechanisms, and remote control capabilities.

Keywords: Hybrid, Sprinkler, IoT, Sensors, Agriculture.

1 Introduction

The world is trending towards long-term fixes for many issues. Water scarcity is one of the major problems that we are now dealing with. We must devise creative, environmentally responsible methods to address this problem. One such idea is the creation of a sprinkler robot driven by solar energy and battery powered based on an IoT strategy for watering plants. The goal of this project is to create a robot that can effectively and autonomously irrigate plants using hybrid powered. The robot will water the plants appropriately based on the amount of soil moisture it detects using IoT technology. The way we water our plants and conserve water could be completely altered as a result of this initiative. the design of a hybrid sprinkler, a cutting-edge IoT-powered robot that transforms plant watering procedures,
presented in this study. The hybrid sprinkler makes watering more effective and targeted by fusing the advantages of conventional sprinklers with those of IoT technology. The system can monitor and react to real-time environmental data by utilizing a variety of sensors and clever algorithms, assuring ideal watering schedules and water usage. The hybrid sprinkler has a strong emphasis on sustainability and energy economy. In order to increase battery life, the design incorporates a rechargeable battery system and makes use of energy-saving features including sleep modes and intelligent power management. The technology lowers operating expenses and encourages environmentally responsible behaviour by limiting energy use. This system offers a productive, accurate, and environmentally friendly method of watering plants by utilizing Internet of Things (IoT) capabilities, cutting-edge sensors, precision spraying mechanisms, and remote-control features. The individual parts and capabilities of the hybrid sprinkler will be examined in more detail in the sections that follow, illustrating how they might revolutionize horticultural and agricultural practices.

2 Methodology

2.1 Literature study:
- Make review on focusing on how to make it simple and relevance to the project title.

2.2 Conceptual design:
- Sketch up the basic design of the robot
- State the dimension for all parts.
- Draw the scaled sketching model and prepare blueprint by manual sketching.

2.3 Computer Aided Designing (CAD) model:
- Model each parts using blueprint and assemble them in position

2.4 Materials selection:
- Select the appropriate material based on model design and strength criteria.
- Select those which are Light, easy to joining and easy to manufacture and cost effective.

2.5 Report making:
- Finally make a report that includes all the things done in project starting from introduction till the modelling and material selection.
3 Design of Sprinkler

3.1 Infrastructure Design:

The LDR sensors, which absorb light and distinguish between the colors according on how much of it they take in, require that the plant's path be black on a white background. An RFID tag has been attached to each plant. The RFID EM-18 Reader Module has a range of approximately 4 inches. The autonomous robot must be 4 inches or less away from the plant. It is required that the RFID tag face the RFID Reader Module. The wireless Xbee modules in use are set up to communicate with one another and form a network. Due to the maximum weight that DC motors can drive, the system has a restricted capacity for water transport, which is 3 litre.

![Flowchart of Infrastructure of sprinkler](image-url)

**Fig. 1.** Infrastructure of sprinkler
3.2 Circuit Design:

3.2.1 Circuit design of transmitter module:

- YL-69 Soil Moisture Sensor: The YL-69 soil moisture sensor is inserted into the soil around the plants that need to be watered in order to measure the soil's moisture content values and determine how much water the plants actually need. It consists of a two-legged lead that is inserted into the ground or other location where the amount of water has to be measured. Two header pins on it connect to an amplifier/A-D circuit, which is connected to the Arduino through a separate circuit.
- 1602 Liquid Crystal Display (LCD): The LCD provides real-time data on the soil's moisture content at a distance from the irrigation robot (receiver module). To make connecting to the Arduino simpler, it interfaces using an I2C module. The module reduces the LCD's 16 pin interface to 4 pins.
- Xbee (Series 1) Module (Transmitter Configuration): The mobile robot is equipped with a wireless connection device called an Xbee that is used to relay information about the moisture content of the soil. It covers a linear area of around 100 meters (300 feet) long.
- Power Supply: A 9 V battery attached to the power port of the Arduino provides power to the transmitter module. The Arduino provides power to other components.

3.2.1 Circuit design of receiver module:

- L293D and DC motors: The irrigation robot was propelled by two 12 V geared motors. There was only one L293D IC in charge of them.
- IR Sensor: This IR sensor uses a TCRT5000 to measure distance and color.
- Relay and Water Pump: Due to the voltage and current the 12 V pump draws, the Arduino Uno is unable to control it directly. Instead, a 12 V single channel relay module (SPDT) was used to switch the pump between its ON and OFF states.

![Fig. 2. Block diagram of system](image-url)
3.3 Computer aided design model:

Initially a rough sketch is drawn and dimensions are decided and then the 3 dimensional model is created using the CATIA software. A tank is provided at the back for storage of water and pump and other auxiliary systems are to be mounted within the robot body, it travels with the help of 4 wheels driven by motor.

![Fig. 3. Views of sprinkler](image)

![Fig. 4. Isometric front view](image)

![Fig. 5. Isometric rear view](image)
3.4 challenges faced during the design or implementation phases:

The development of dependable software algorithms to enable intelligent functionalities and the smooth integration of hardware components like sensors and spraying mechanisms are the fundamental technical challenges. Although crucial, ensuring the consistency and accuracy of sensor data is vulnerable to things like environmental interference and sensor deterioration. Similar to mission-critical, reliable internet access is similarly susceptible to interruptions that could obstruct real-time control and monitoring. An efficiency challenge is to optimise power management to balance energy conservation with sensor sampling rates. Software designers must take careful UX factors into account when creating a user interface that is feature-rich and intuitive while encapsulating system complexity.

Moreover, adaptive algorithms are required to enable adaptability across various conditions and plant species to suit specific watering requirements. Even if more technological investments are needed for upgraded capabilities, cost control is essential for accessibility. To ensure reliability, thorough testing and validation across simulated scenarios are necessary yet time-consuming. The optimisation of the watering schedule may also be impacted by the dependence on other datasets, like as weather predictions. The complex technical rigour is further enhanced by other aspects such as regulatory compliance, maintaining performance through component maintenance, and scaling without sacrificing efficiency. An intelligent watering system that is robust must ultimately consider hardware, software, and environmental elements holistically.

4 Advantages of proposed sprinkler robot:

- Precise and Targeted Irrigation
- Improved Water Efficiency
- Adaptability to Environmental Conditions
- Intelligent Decision-Making
- Remote Monitoring and Control
- Energy Efficiency
- Customization and Adaptation
- Data-Driven Insights
- Reduction in Manual Effort
- Sustainable Plant Irrigation

5 Conclusion:

- The system aims to enable precise, efficient, and adaptable plant irrigation by integrating sensors, algorithms, spraying mechanisms and remote monitoring/control capabilities.
- It makes use of RFID tags on each plant for identification and LDR sensors to determine the plant's route. This makes it possible to irrigate particular plants only.
- The RFID reader's limited range is around 4 inches. For the robot to come close enough to read the tags, it must navigate precisely in this situation.
- Xbee wireless modules allow components to communicate with one another and create a network for data transfer.
The DC motors' weight limits impose limitations on the water carrying capacity of three litres. This could need to be refilled quite often.

Important information for figuring out watering requirements and schedules is provided by the soil moisture sensor that is embedded in the soil.

The robot is powered by 12V DC motors, while the transmitter module is powered by a 9V battery.

Potential challenges to consider: upfront costs; technical complexity; sensor reliability issues; connectivity disruptions; ongoing maintenance requirements. When well-implemented and managed, the system can promote sustainable agriculture through optimized water usage and plant health monitoring. Further evaluation of tradeoffs is warranted. Overall, it is a promising innovation for efficient, tech-driven irrigation if adoption barriers can be addressed.

References


