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Automatic plant watering system using Ardiuno

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Abstract -An micro irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The system had a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page. The micro system was tested in a sage crop field for 136 days and water savings of up to 90% compared with traditional irrigation practices of the agricultural zone were achieved. Three replicas of the micro system have been used successfully in other places for 18 months. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.

Keywords: Microcontroller, GSM/GPRS Modem, LCD display, Temperature Sensor, Humidity Sensor, Water Level Sensor, Soil Sensor, ZIGBEE Module.

1.INTRODUCTION

Agriculture uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. There is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial,and institutional improvements .There are many systems to achieve water savings in various crops, from basic ones to more technologically advanced ones. For instance, in one system plant water status was monitored and irrigation scheduled based on canopy temperature distribution of the plant, which was acquired with thermal imaging .In addition, other systems have been developed to schedule irrigation of crops and optimize water use by means of a crop water stress index (CWSI).

2. Body of Paper

Project Architecture System Components

1. Water Conservation: Automatically optimizes water usage by supplying only the required amount to plants, reducing water wastage.

2. Soil Health Monitoring: Incorporates sensors to check soil moisture levels, ensuring balanced hydration and preventing overwatering or waterlogging.

3. Smart Agriculture: Enhances precision farming techniques by automating irrigation schedules, improving crop yield and sustainability.

4.Urban Gardening: Supports rooftop gardens and urban green spaces by automating watering processes, making gardening convenient and efficient.

5.Drought Management: Provides a reliable irrigation solution in drought-prone regions, contributing to sustainable water management practices.

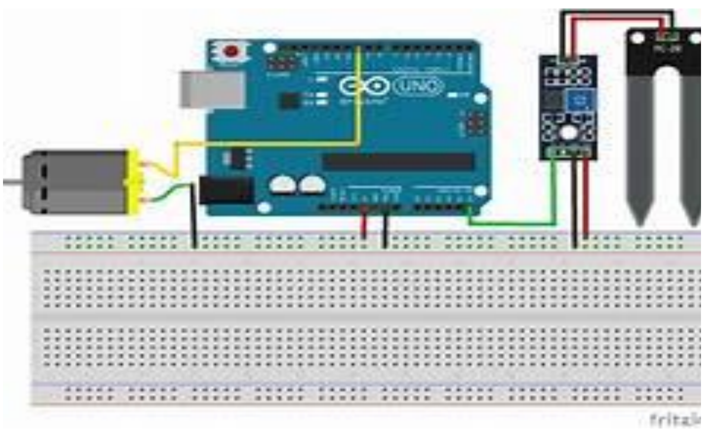
6.Climate Adaptability: Adapts irrigation practices based on weather conditions, helping plants thrive in changing environmental conditions.

7.Reduction of Human Effort: Minimizes manual intervention in irrigation, making it ideal for large-scale agricultural fields and small home gardens.

8.Sustainability in Horticulture: Promotes the growth of plants in a controlled manner, ensuring long-term sustainability of horticultural activities.

9. Energy Efficiency: Can integrate with renewable energy sources such as solar panels, reducing dependency on non-renewable resources.

10. Educational Tool: Serves as a practical example for students and enthusiasts to learn about IoT, automation, and sustainable practices in agriculture.



DETAILED PROCESS

1.Sensor Data Collection

- Soil Moisture Sensor: The core of this system is the soil moisture sensor, which is responsible for detecting the moisture content in the soil. Typically, the sensor uses capacitive or resistive technology to measure the water level in the soil.
- Capacitive Moisture Sensor: This sensor works by measuring the change in capacitance as the soil's water content varies. More water in the soil leads to a higher capacitance.
- Resistive Moisture Sensor: This sensor operates by measuring the electrical resistance between two electrodes embedded in the soil. The more water there is, the less resistance there will be between the electrodes.
- Signal Generation: The sensor generates an analog voltage signal based on the moisture level of the soil. When the soil is dry, the sensor outputs a higher voltage (indicating lower moisture content). Conversely, a wetter soil produces a lower voltage signal (indicating higher moisture content).
- Connection to Arduino: The output from the sensor is fed into one of the Arduino's analog input pins (e.g., A0). The sensor signal is processed by the Arduino, which is responsible for interpreting the soil's moisture condition.

2. Data Processing by Arduino

- Analog-to-Digital Conversion (ADC): The Arduino's built-in ADC converts the analog signal from the moisture sensor into a digital value that can be processed. The ADC typically provides values ranging from 0 to 1023, where 0 represents no moisture (dry) and 1023 represents maximum moisture (wet).
- Threshold Comparison: Once the digital value is obtained, the Arduino compares this value to a predefined threshold. This threshold value is set according to the type of plant and the moisture level required for optimal growth.
- For example, a threshold might be set at a value of 500. If the reading from the sensor is below this value, it indicates the soil is dry and needs watering.
- Decision Making: Based on the comparison, the Arduino decides whether the plant requires watering or if the current moisture level is sufficient. If the moisture is below the threshold, the system will activate the watering mechanism (the pump).

3. Water Pump Activation

- Relay Module: The Arduino communicates with a relay module, which acts as a switch. The relay is connected to the Arduino's digital output pin (e.g., D7). The relay controls the water pump based on the signal received from the Arduino.
- Relay Operation: When the Arduino determines that the soil is dry (i.e., the moisture level is below the threshold), it sends a high signal (digital 1) to the relay. This closes the relay switch, which allows current to flow to the water pump and turn it on.
- Watering the Plant: The water pump, powered by a separate power supply (e.g., a 12V adapter or battery), draws water from the reservoir and pumps it into the plant's root zone. This can be achieved via a drip irrigation system or a simple hose that channels water directly to the soil.
- Pump Duration: The duration for which the pump operates can either be fixed or adjustable. Typically, it runs for a few seconds to a minute, depending on the amount of water required by the plant.

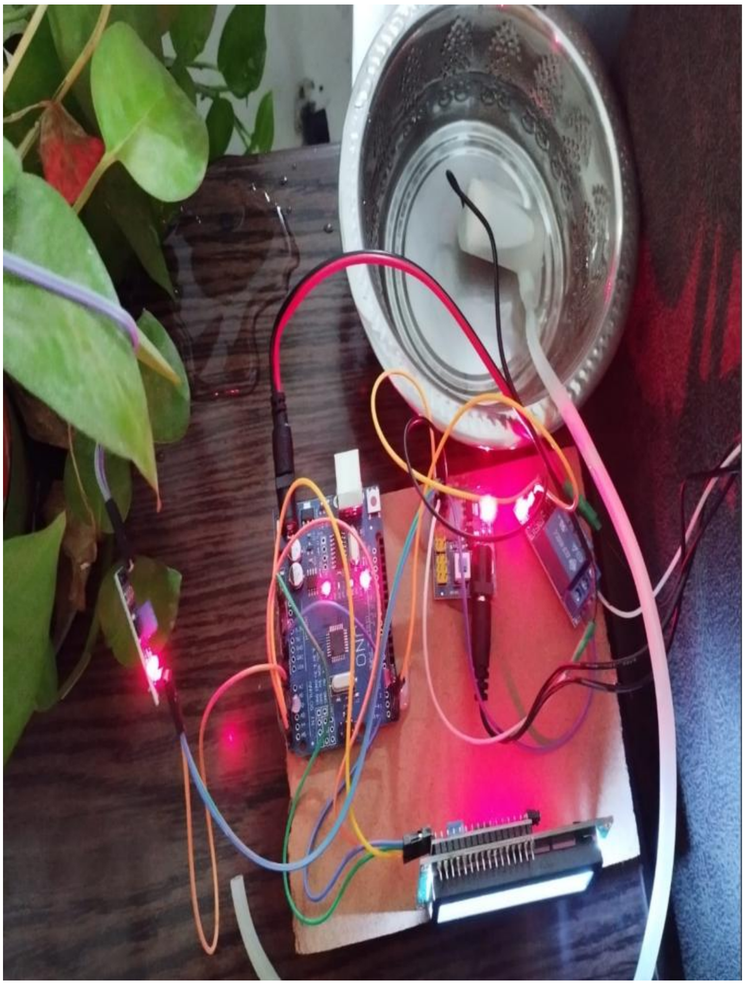
3.Automatic Pump Deactivation

- Moisture Level Check: As soon as the pump begins watering the plant, the Arduino continuously monitors the soil moisture using the sensor. Once the moisture level rises above the threshold, the Arduino detects the change in the sensor's output.
- Relay Deactivation: When the Arduino reads that the soil is sufficiently moist (i.e., the sensor value goes above the threshold), it sends a low signal (digital 0) to the relay, deactivating the water pump.
- Prevent Overwatering: This process prevents overwatering and ensures that the plant is not flooded with excessive water, which could lead to root rot or other issues related to waterlogging.

4.System Monitoring and Feedback

- Real-Time Monitoring: The system can be expanded to include real-time monitoring features. For example, an LCD display can be added to the Arduino circuit to show the current soil moisture level and whether the pump is on or off.

- LCD Display: A 16x2 LCD screen can be used to display the sensor reading (e.g., "Moisture Level: 350") and the status of the watering system (e.g., "Watering: ON" or "Watering: OFF").
- Wireless Communication (Optional): For advanced setups, the system can be connected to a Wi-Fi module (e.g., ESP8266) to send moisture data to a cloud platform or mobile app. This allows users to monitor and control the watering system remotely.
- IoT Integration: Through platforms like ThingSpeak, Blynk, or Firebase, users can access real-time data and even control watering schedules via a smartphone or web application.



FACTS

1.An automatic watering system helps reduce water wastage by supplying the exact amount of water needed by the plants, based on real-time soil moisture data.

2.Soil moisture sensors can either be resistive or capacitive. Resistive sensors detect changes in electrical resistance, while capacitive sensors measure changes in capacitance based on soil moisture levels.

3.The Arduino acts as the brain of the system. It reads data from the moisture sensor, makes decisions based on predefined thresholds, and controls the water pump via a relay.

4.The relay module is used to switch the water pump on and off. It is essential for isolating the low-power Arduino circuitry from the high-power pump.

8. The system can be powered using a 12V adapter or battery. A solar panel can be added for an eco-friendly, off-grid solution.

9.The moisture threshold is adjustable based on the type of plant. For example, succulents might require a lower threshold, while leafy plants might need higher moisture levels.

10. Automation reduces human intervention, making the system ideal for busy individuals, or for maintaining large gardens and agricultural fields with minimal effort.

11.Building an automatic watering system with Arduino is affordable and accessible for hobbyists, gardeners, and small-scale farmers. The required components (Arduino, sensors, pump, relay) are inexpensive and easy to source.

12.By incorporating a Wi-Fi module (e.g., ESP8266 or ESP32), the system can send real-time data to a mobile app or cloud platform, allowing remote monitoring and control.

13.The system is highly scalable. You can add more sensors and water pumps to manage multiple plants, allowing for larger garden automation or agricultural applications.

14.The system ensures that plants are not overwatered by only triggering the pump when the soil moisture drops below the set threshold. Overwatering can lead to root rot, so this feature is critical for plant health.

15.The system serves as an excellent project for learning about microcontrollers (Arduino), sensors, automation, and basic IoT concepts, making it popular among electronics and engineering students.

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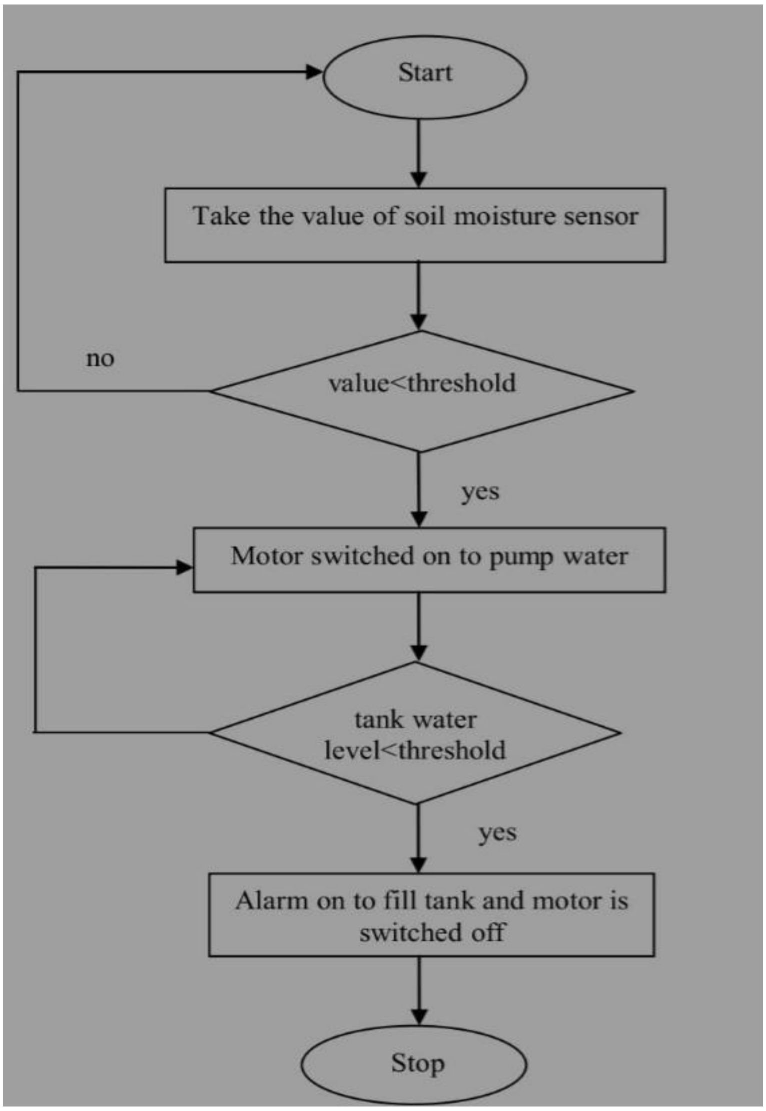


STEPS

1.Begin by gathering all necessary components: Arduino board (e.g., Arduino Uno), soil moisture sensor, relay module, water pump, jumper wires, 12V power supply for the pump, a water reservoir, and hose or drip irrigation system.

2. Connect the soil moisture sensor to the Arduino. Use the analog output from the sensor and connect it to an analog input pin on the Arduino, such as A0.

 Connect the relay module to the Arduino by linking the control pin to a digital output pin (e.g., D7). The relay will control the water pump, ensuring that the Arduino can turn it on and off.

3.Attach the water pump to the relay, ensuring that the relay can act as a switch to provide power to the pump when activated.

4.Power the system by connecting the water pump to a separate 12V power source, distinct from the Arduino's 5V power supply.

5.Write the program in the Arduino IDE to read the soil moisture data from the sensor, process the values, and compare them against a predefined threshold. If the moisture level is below the threshold, the system should activate the water pump.

6.Upload the program to the Arduino using the Arduino IDE. This will allow the system to continuously monitor the moisture levels and control the water pump accordingly.

7.Test the system by observing how the moisture sensor interacts with the soil and whether the pump activates when the moisture level falls below the set threshold, ensuring the plant is watered properly.

ADVANTAGES

1.Water Conservation: The system ensures that plants only receive water when necessary, helping to reduce water wastage by preventing overwatering.

2.Time-Saving: The automatic system eliminates the need for manual watering, saving time and effort for plant care, especially for busy individuals.

3.Consistent Care: The system provides consistent watering based on real-time soil moisture levels, ensuring that plants are always well-hydrated, even when the owner is not around.

4.Customization: The moisture threshold can be adjusted based on the plant's specific needs, making the system versatile for different plant species with varying watering requirements.

5.Scalability: The system can be easily scaled to accommodate multiple plants by adding more moisture sensors and water pumps, making it suitable for gardens, indoor plants, or agricultural setups.

6.Cost-Effective: The components required for the system (Arduino, sensors, pump, relay) are inexpensive and accessible, making the project affordable for hobbyists and small-scale gardeners.

7.Eco-Friendly: With the option to integrate solar panels or use low-power components, the system can be made energy-efficient, reducing reliance on traditional power sources.

8.Prevents Overwatering: By monitoring soil moisture levels and turning off the water pump once the soil reaches the desired moisture, the system prevents overwatering, which can damage plants.

9.Remote Monitoring and Control: With the integration of IoT features (such as Wi-Fi modules), users can monitor the soil moisture levels and control the system remotely via a mobile app or web interface.

10.Educational Value: The system serves as a great learning project for students and hobbyists, offering hands-on experience with sensors, microcontrollers (Arduino), automation, and basic IoT concepts.

APPLICATIONS

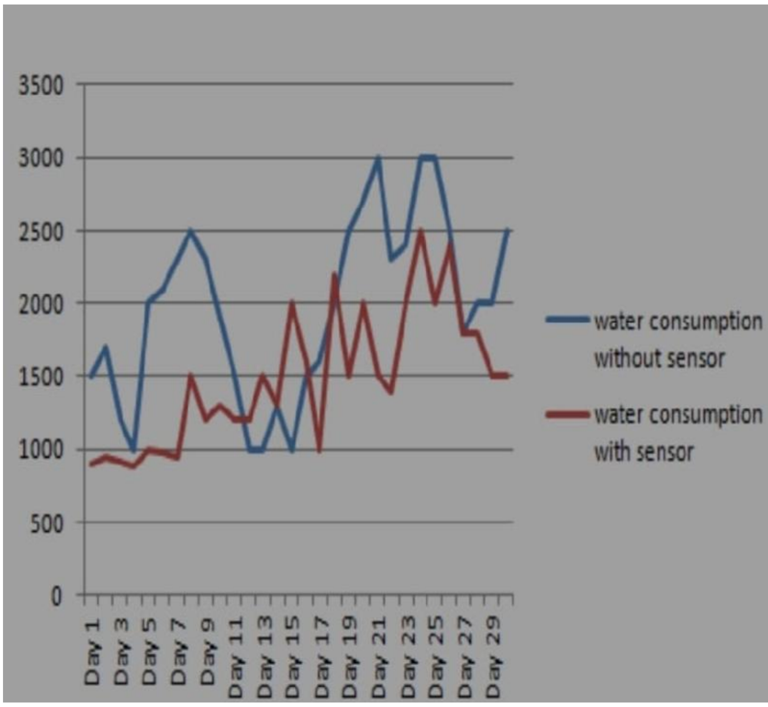
1. .An automated system that waters houseplants or garden plants based on soil moisture levels, ensuring plants receive the right amount of water, even when you're away.
2. In greenhouses, this system can optimize water usage by adjusting irrigation according to environmental factors (temperature, humidity) and soil moisture, improving plant health.
3. For people who want to keep indoor plants like succulents or orchids alive, an Arduino-based watering system can automatically maintain the ideal moisture level for each plant type.
4. Large-scale farms can use Arduino-controlled watering systems to deliver water only when necessary, reducing water waste and improving crop yield.
5. A small-scale watering system can be used for automated watering of plants inside closed ecosystems like terrariums, maintaining optimal humidity levels for delicate plants.
6. In vertical farming systems, the Arduino-based watering system can manage multiple plant tiers and efficiently deliver water to the roots of each tier.
7. For community gardens or public spaces, an Arduino watering system can automate irrigation, saving time and water, while maintaining the health of various plants.
8. The system can be set up to water plants in different sections of a botanical garden, adjusting the water flow based on specific plant needs and environmental conditions.
9. In agricultural research facilities, an Arduino watering system can be used to experiment with various watering schedules and moisture levels to determine the best conditions for plant growth.
10. For schools or educational projects, Arduino-based automatic watering systems can serve as a learning tool to teach students about electronics, programming, and the importance of sustainable agriculture.

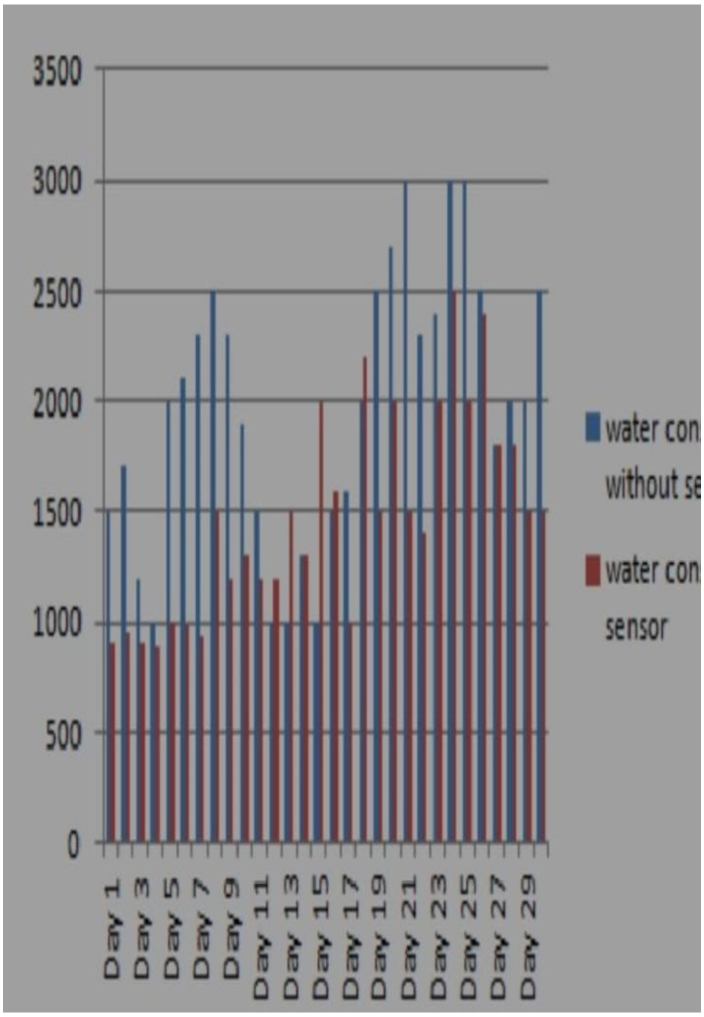
CHANGES IT WILL BRING / FUTURE SCOPE

Here are 10 potential changes and future scopes for automatic plant watering systems using Arduino:

1. These systems can significantly reduce water wastage by delivering water only when necessary, contributing to sustainable agriculture practices and better resource management.
2. Automated watering ensures optimal soil moisture levels for plants, promoting healthier crops and potentially higher yields, especially in large-scale agricultural settings.

3. Automated systems eliminate the need for manual watering, reducing labor costs and freeing up time for other farm tasks, making agriculture more efficient.
4. As part of a larger Internet of Things (IoT) ecosystem, these systems can be connected to weather data and environmental sensors, enabling real-time monitoring and adjustments based on weather patterns and soil conditions.
5. Future systems could be more customizable, offering specific watering schedules or moisture level thresholds for different types of plants, creating tailored care for diverse ecosystems.
6. With mobile app integration, users could remotely monitor and control their watering system, making it easier to manage plants, especially when on the go or away from home.
7. These systems could be integrated with solar or wind power sources to make them more energy-efficient and environmentally friendly, reducing dependency on electricity.
8. Future developments could help farmers and gardeners adapt to changing climates by adjusting watering patterns based on real-time climate data, ensuring plants thrive even under shifting conditions.
9. By collecting data on soil moisture, temperature, and humidity, these systems could provide valuable insights into plant health and environmental conditions, aiding research and decision-making.
10. In the future, these systems could be integrated into broader smart home or smart farm ecosystems, allowing for full automation of plant care, including fertilization and pest control, all managed via one central hub.





3. CONCLUSIONS

In conclusion, the development and implementation of an automatic plant watering system using Arduino have the potential to revolutionize both home gardening and large-scale agriculture. These systems offer numerous benefits, including water conservation, increased crop yield, reduced labor costs, and tailored plant care. The integration with IoT devices and renewable energy sources opens up possibilities for smarter, more efficient systems that are eco-friendly and adaptable to changing environmental conditions. As these systems continue to evolve, their ability to provide real-time data, optimize plant growth, and integrate with broader agricultural technologies will play a key role in the future of sustainable farming and smart gardening practices. Ultimately, automatic plant watering systems have the power to make plant care more efficient, accessible, and environmentally responsible.

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These references focus on various aspects of automatic plant watering systems, from soil moisture sensing to IoT integration, providing useful resources for a research paper or further study.