Smart Irrigation System Using Arduino Board

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Abstract: The most important and respected vocation in India is agriculture. The bulk of Indians from rural origins make their living mostly from agriculture. Intelligent irrigation contributes to the development of an agricultural nation. India's agricultural sector contributes roughly 16% of the nation's GDP and 10% of all exports. Water is a vital component of agriculture. Water is the main resource used in agriculture. Among the ways to supply water is by irrigation. People are squandering more water during this irrigation process since they are missing the time. Thus, we have a great technique called the Smart Irrigation System Using IOT [Internet of Things] to save water and time. A smart system that uses automation, internet connectivity, and sensors to irrigate plants automatically is known as an Internet of Things (IoT)-based automated irrigation system. The system uses a machine learning algorithm to analyze data collected from many sensors, including temperature, humidity, and soil moisture. The analysis is then used to control the irrigation process. The user can establish the irrigation schedule and modify the irrigation settings of the system using a web interface or a mobile app. An efficient and practical technique to automate irrigation, cut down on water waste, increase crop productivity, and enable remote monitoring is through the use of smart irrigation systems.

Keywords: Agriculture, Smart irrigation, IOT, temperature, humidity, water wastage

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I. INTRODUCTION

Smart irrigation refers to the use of cutting-edge technology and data-driven methods to maximize plant, agricultural, and landscape watering efficiency. In order to effectively manage water resources and improve agricultural or landscape irrigation methods, it entails the integration of several sensors, weather forecasts, soil moisture, and automation systems. By employing smart irrigation systems, water usage can be significantly reduced, leading to the conservation of this valuable resource, as well as cost savings for farmers and property owners. In order to ensure that plants receive the right quantity of water without wasting any, these systems frequently use real-time data and algorithms to modify watering schedules and amounts based on particular environmental conditions, plant requirements, and water availability. Smart irrigation systems further improve convenience and efficiency by enabling users to monitor and control irrigation processes remotely using computer interfaces or mobile apps.

The use of appropriate soil moisture sensors, which makes it easier to track and document changes in soil moisture, is discussed in this article. The temperature is detected and examined using the Arduino Mega microcontroller, which is equipped with sensors for moisture, light-dependent resistors, and temperature. When the Internet of Things (IoT)-based irrigation system is turned on, it checks the water level, humidity, and moisture content (ESP8266). It sends out an SMS alert about the levels over the phone. The water pump starts on its own when sensors sense a drop in water level. When the temperature reaches a particular level, fans turn on. All information is displayed on the LCD display module. This is also evident in IOT, which shows information on moisture, humidity, and water level in addition to the time and date, all of which are dependent on minutes. [6]

II. TOOLS AND TECHNOLOGY

Smart irrigation systems leverage various advanced technologies to optimize water usage and enhance irrigation efficiency.

A. Sensor Technology

Soil Moisture: Determines the moisture content of the soil, enabling accurate irrigation according to the soil's needs.
Weather Sensors: Gather data on temperature, humidity, wind speed, and precipitation in real time so that irrigation

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schedules can be modified by systems in response to the weather.

Rain Sensors: Automatically shut off irrigation systems during rainfall to prevent overwatering.
Crop Sensors: Monitor specific crop conditions and growth stages, providing tailored irrigation solutions.

B. Data Analytics and Machine Learning:

Data Analysis Algorithms: Process data from sensors to analyze soil moisture levels, weather forecasts, and plant requirements, allowing for data-driven decision-making.

Machine Learning Models: Predict irrigation needs based on historical data patterns, weather forecasts, and crop-specific information, optimizing watering schedules.

C. Automation and Control Systems:

Actuators: Control irrigation valves and water flow based on data analysis, ensuring precise and timely watering.

Microcontrollers (e.g., Arduino, Raspberry Pi): Interface between sensors, data analysis algorithms, and actuators, facilitating automation.

IoT Connectivity: Enable remote monitoring and control of irrigation systems through the Internet, allowing users to adjust settings and receive notifications via smartphones or computers.

User-Friendly Apps: Provide farmers and users with intuitive mobile applications to monitor soil moisture levels, adjust irrigation schedules, and receive alerts.

Web Interfaces: Allow users to access the system via web browsers, enabling remote control and detailed data analysis.

D. Cloud Computing:

Data Storage: Store sensor data and analysis results in cloud-based platforms, ensuring accessibility from anywhere with an internet connection.

Scalability: Cloud computing allows for scalable solutions, accommodating varying data storage and processing needs.

E. Sensing and Satellite Technology:

Satellite Imagery: Utilize satellite data to assess large agricultural areas, enabling precision irrigation planning based on regional conditions.

Remote Sensing: Use remote sensing technologies to monitor vegetation health and detect moisture stress, providing valuable data for irrigation decisions.

F. Communication Protocols:

Wireless Communication: Use wireless protocols such as LoRaWAN, Zigbee, or Bluetooth to transmit data between sensors, controllers, and the central system.

Cellular Connectivity: Enable communication via cellular networks, ensuring connectivity in remote or large agricultural areas.

G. Advanced Water Delivery Systems:

Drip Irrigation: Implement precise water delivery systems like drip irrigation, which can be easily integrated with smart technologies for efficient water distribution directly to plant roots.

Precision Sprinklers: Use advanced sprinkler systems that adjust water output based on specific areas' needs, ensuring uniform irrigation. [5]

III. REQUIRED SENSORS FOR SMART IRRIGATION

Requirements for smart irrigation are mentioned below:

A. Soil Moisture sensors:

Measuring Range: Soil moisture sensors usually have a specified measuring range, indicating the minimum and maximum soil moisture levels they can accurately measure.

Accuracy: This shows how accurate the sensor's readings of the soil moisture content are. A percentage of the measured number is frequently used to denote accuracy.

Resolution: The smallest change in soil moisture content that the sensor can detect and measure is referred to as resolution. Usually, a percentage is used to express it.

Calibration: Soil moisture sensors may need calibration to ensure accurate readings. Some sensors come pre-calibrated, while others require manual calibration.

Response Time: This indicates how quickly the sensor can provide a stable reading after being inserted into the soil. Faster response times are desirable for real-time monitoring applications.

B. Temperature Sensor:

Range: The temperature range over which the sensor can accurately measure temperature (usually in Celsius or Fahrenheit). [-40°C to 85°C].

Accuracy: How close the measured temperature is to the actual temperature, often expressed in degrees Celsius or Fahrenheit.

C. Crop Sensor:

Spectral Bands: Plant health sensors often measure specific spectral bands, such as near-infrared (NIR) and red light, to calculate vegetation indices like NDVI (Normalized Difference Vegetation Index).

Index Values Range: NDVI values typically range from -1 to 1, with higher values indicating healthier vegetation.

Resolution: Indicates the smallest detectable change in vegetation index values.

Accuracy: Specifies how close the sensor's measurements are to the actual vegetation index values.[10]

IV. METHODOLOGY

Developing smart irrigation involves several steps and stages, including planning, designing, development, testing, and deployment. Developing a smart irrigation is together requirement. This involves understanding the client's needs and expectations, determining the size and type of the irrigation system, and identifying the necessary sensors and equipment needed for the system.

System Design: A system design is produced based on the requirements that have been acquired. This includes creating the system architecture, choosing communication protocols, and picking the right hardware and software platforms. Sensor Selection and Placement: This step involves choosing and arranging sensors in key areas to monitor environmental factors like sunshine, soil moisture, temperature, and humidity. The selection and placement of sensors are critical to ensure the accuracy of the system. Development: After the system design is completed and sensors are placed, the development phase begins. This phase involves programming the microcontrollers or processors, developing the user interface, and integrating the hardware and software components of the system.

Testing: The testing phase is important to ensure that the system meets the requirements and functions as expected. The system is tested in different scenarios, and any issues found are corrected.

Deployment: After testing, the system is ready for deployment. The system is installed in the irrigation area, and the sensors are connected to the internet. The user interface is also made available for the user to control and monitor the system.

Overall, developing an IoT-based automatic irrigation system requires a multidisciplinary approach that includes expertise in hardware, software, and data analysis.

A. Hardware Component Of Smart Irrigation

Hardware components of smart irrigation are:

Arduino Uno: The Arduino Uno is a microcontroller board based on the ATmega328. It has fourteen digital input/output pins (six of which can be used as PWM outputs), six analog inputs, an ICSP header, a reset button, a USB connector, a power jack, and a 16 MHz ceramic resonator, among other features. Everything required for the microcontroller to operate is included; all you have to do is power it using a battery, an AC-to-DC converter, or a USB cable to connect it to a computer.

The FTDI USB-to-serial driver chip is not used by Uno, in contrast to all previous boards. Alternatively, it is set up with the Atmega16U2 (or Atmega8U2 up to version R2) as a serial-to-USB converter. A resistor pulls the 8U2 HWB connector on the Uno board to earth, enabling DFU mode entry. The Arduino board currently comes with the following updates:

Pinout: The added SDA and SCL pins, along with the RESET pin, are situated near the two new pins called IOREF. The shields can adjust to the voltage supplied by the board thanks to these pins. Shields will eventually work with both the 5V-powered boards that use the AVR and the 3.3V-powered Arduino Due. The other pin is marked for future use and is unplugged. Strengthened the RESET circuitry. Replace the Atmega 16U2 with the 8U2.

"Uno" signifies "one" in Italian, and it was chosen to signify the impending introduction of Arduino 1.0. The Uno and Arduino 1.0 will serve as the standard models in the future. By going to the Arduino board index, one can see how the Uno compares to earlier iterations of the platform's reference model, which is the most recent in a line of USB Arduino boards.

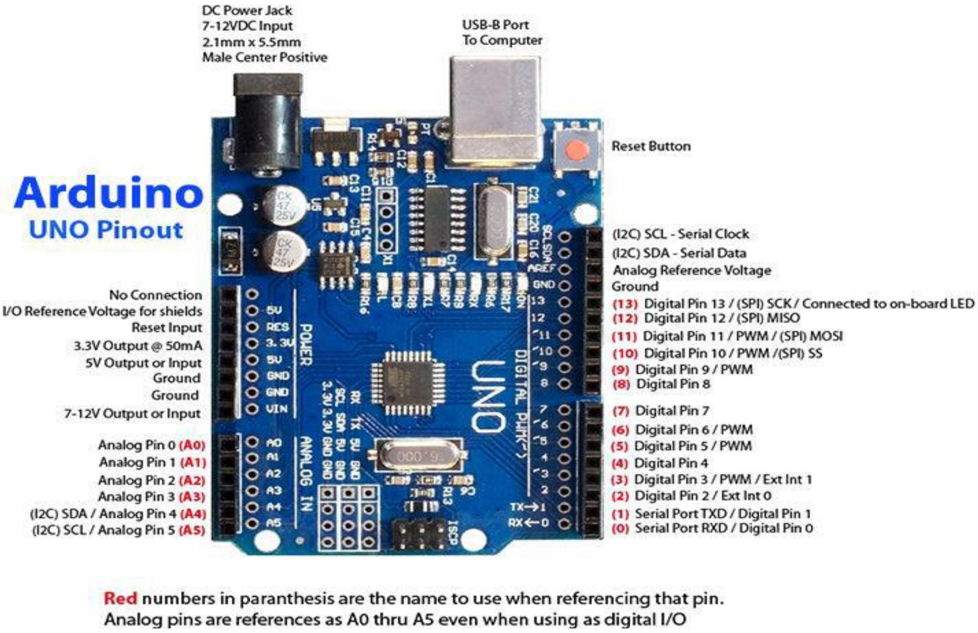

Fig.1 Arduino

B. Soil Moisture:

The moisture content of the soil is important for both irrigation fields and plant gardens. Plants receive the nourishment they require to grow from the nutrients in the soil. To change the temperature of the plants, watering is also required. Water can be utilized to change the temperature of the plant in a manner akin to transpiration. Furthermore, the root systems of plants that thrive in moist soil are more developed. Anaerobic conditions brought on by high soil moisture levels can encourage the growth of plants and soil pathogens. This page provides an overview of the functionality and applications of the soil moisture sensor.

It is necessary to alter the link between the computed property and soil moisture, which may differ based on ecological factors such soil type, temperature, and electric conductivity. Reflected microwave emission, which is mostly used in hydrology and agricultural remote sensing, can be influenced by the soil's moisture content.

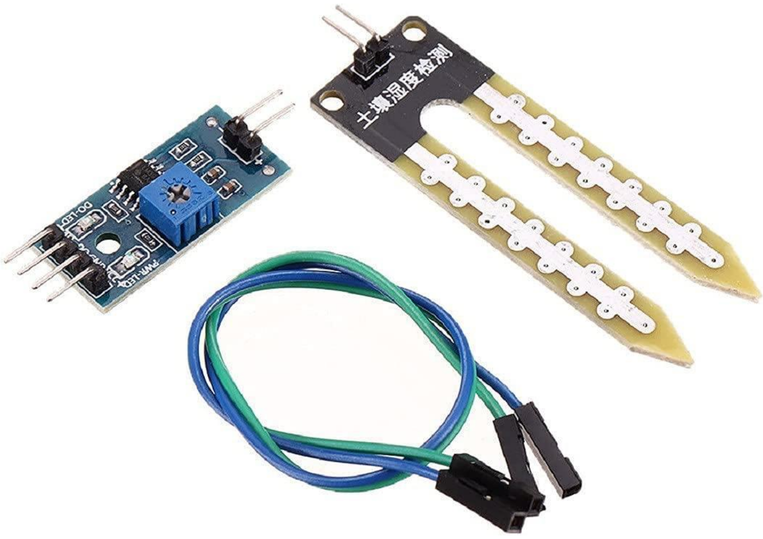

Fig.2 Soil Moisture Sensor

C. Temperature Sensor:

This project involves constant temperature monitoring. If the temperature rises beyond the preprogrammed limit, a buzzer signal is incorporated into the circuit to notify industry personnel to halt the process right away. As a result, the microcontroller must compare the temperature sensor LM35's continuous reading with the preprogrammed set temperature. The buzzers make a loud noise when the temperature sensor rises above a predetermined level, as indicated by a signal from the controller.

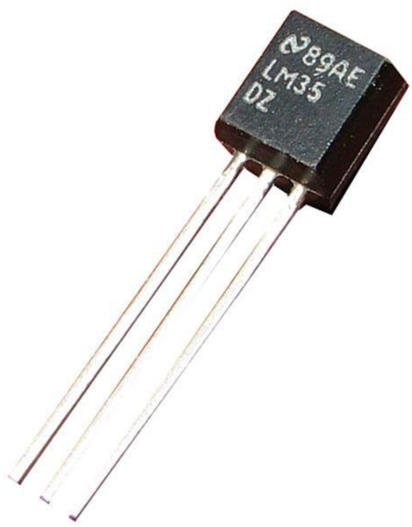

Fig.3 Temperature Sensor

D. LCD Display:

The model that is most frequently used in practice is the one that is shown here because of its great potential and inexpensive cost. It can show messages in two lines of sixteen characters each thanks to its HD44780 microcontroller (Hitachi) platform. Displays all of the alphabet, Greek letters, mathematical symbols, punctuation, etc. It is also feasible for the user to build and display bespoke symbols. Among the key features are the automated shift left and right of the message displayed on the screen, the backlight, the pointer's appearance, and more.

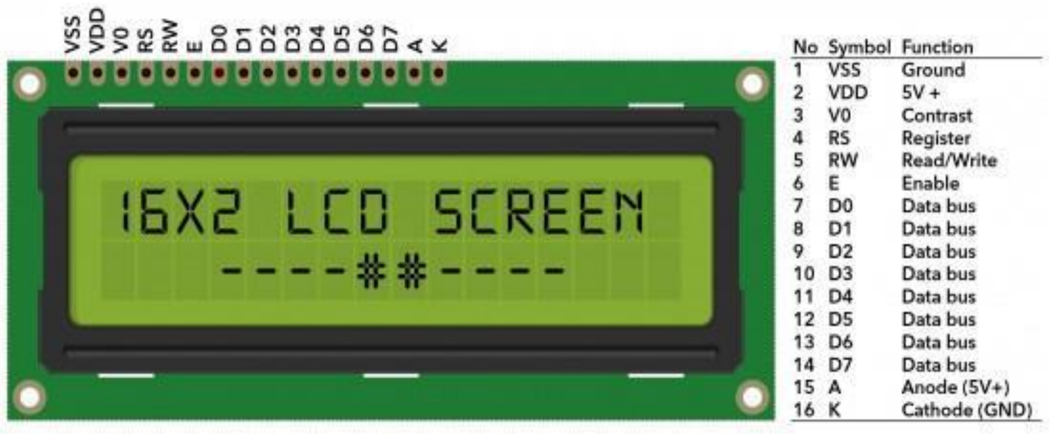

Fig.4 LCD Display

V. ANALYSIS

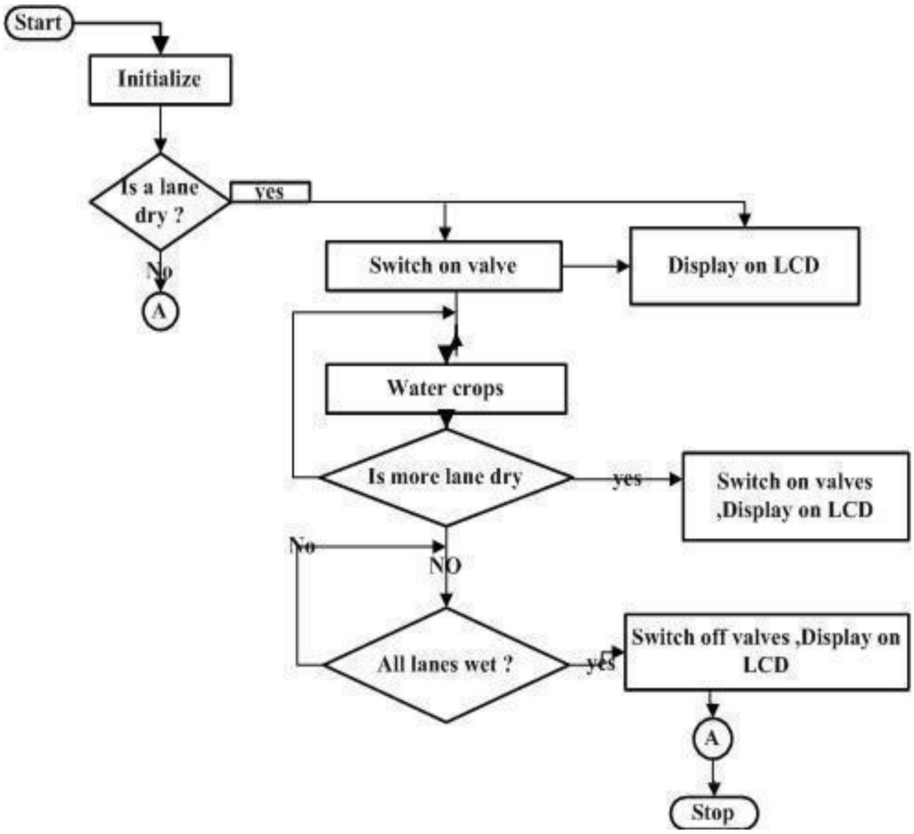

Fig.5 Low Chart of Soil Moisture Sensor

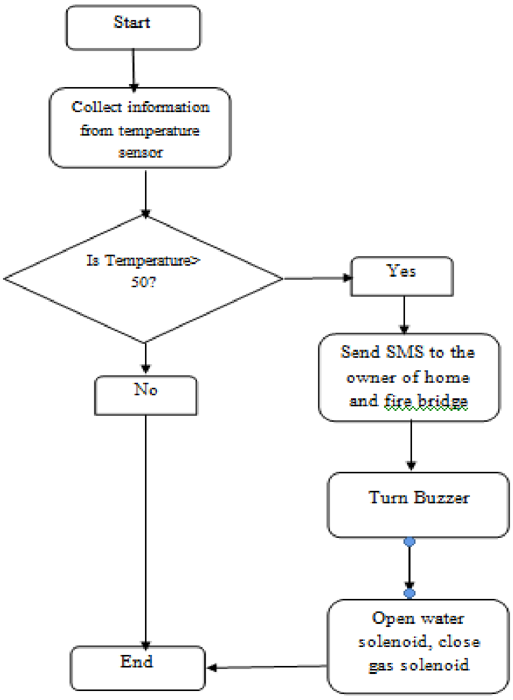

Fig. 6 Flow Chart of Temperature Sensor

VI. CIRCUIT DIAGRAM

Fig.7 Soil Moisture Sensor

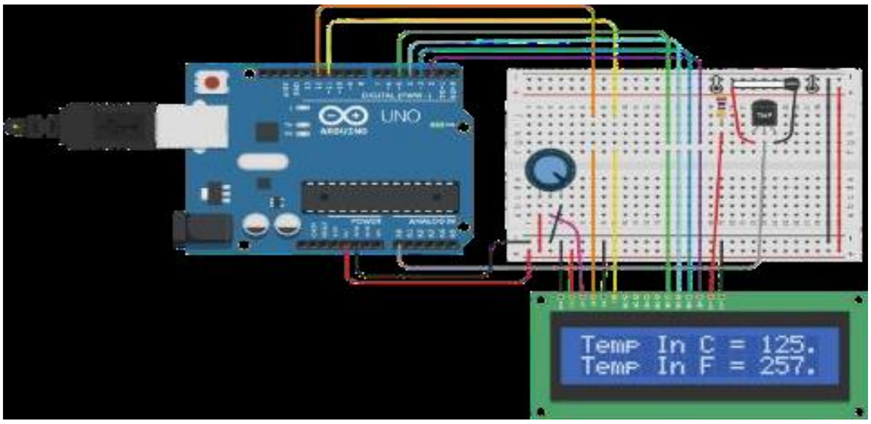

Fig. 8 Temperature Sensor

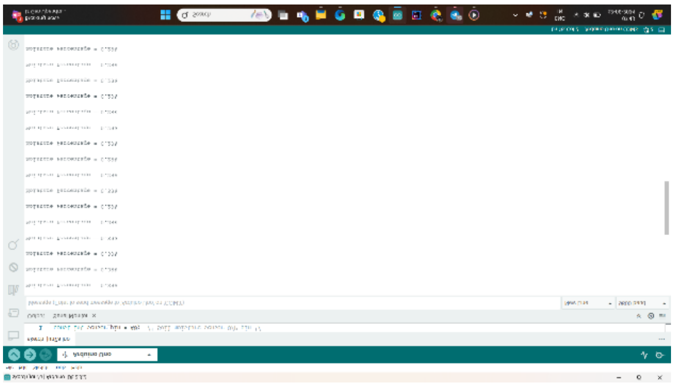

Fig. 9 Measurement for dry soil

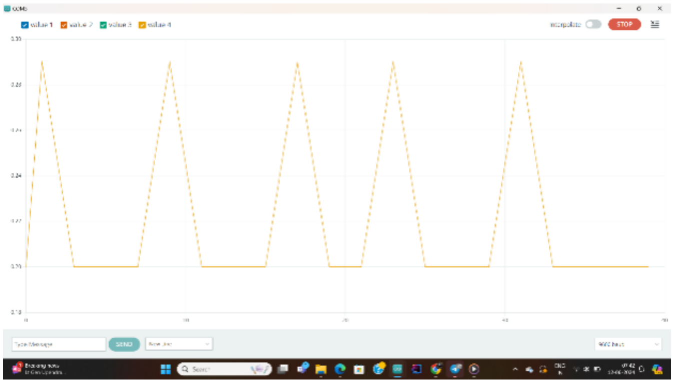

Fig. 10 Graph for dry soil

Fig. 11 Measurement for wet soil

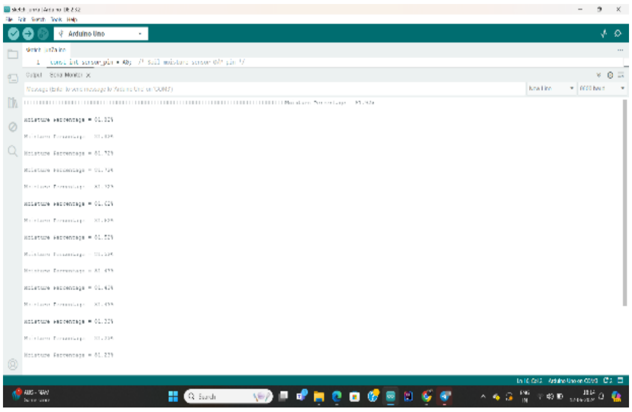

Fig. 12 Graph for wet soil

VII. CONCLUSION

The ability to remotely monitor and control irrigation schedules through mobile apps or web-based platforms provides convenience and flexibility for farmers and groundskeepers. As concerns over water scarcity and conservation continue to grow, the adoption of these intelligent irrigation solutions is likely to increase, promoting more sustainable and efficient water management practices across various sectors.

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