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Smart irrigation system using Arduino to identify temperature, humidity, pressure, moisture, light intensity, and air quality

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Abstract
Agriculture has a huge impact on economic development as well as growth. For sustainability life, it is an essential part of human existence. It significantly contributes to economic operations in other areas of the economy as a supply of industrial raw materials. The daily increase in water consumption raises the possibility of a water scarcity. Despite being aware of the recommended quantities for these crops, irrigation systems formerly depended on the mills to water the area in the conventional manner. These out-of-date systems, which are a primary cause of vast quantities of water waste, cause certain crops to be damaged due to insufficient water supply. Water conservation and watering systems monitor moisture related circumstances on your property and robotically adjust watering to ideal levels make up smart irrigation systems, which combine sophisticated technology sprinklers with nozzles that increase coverage. Our proposed system used Internet of Things (IoT) as a main technology for smart irrigation system. Also for tasks like measuring the moisture in the soil, we use a soil moisture sensor and an Arduino microcontroller to perceive and control the object. Similarly, BMP 180 sensor, DHT 11 sensor, LDR sensor, MQ 135 Gas sensor and other devices are used to implement the system. We implemented to prepare for real-world implementation using the Arduino and Proteus software. The system helps to view temperature of the soil, humidity, light intensity, pressure and air quality. The valve will open when the soil is completely dry, allowing water to reach the crops.

Keywords: *Arduino, Internet of Things (IoT), irrigation, Proteus, sensors*

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I. INTRODUCTION

The economics of a nation is significantly impacted by agriculture, particularly in emerging nations. Water shortage become a concern as a result of the daily water demand. The chore of irrigating a field has become increasingly challenging for farmers these days as a consequence of their lack of regularity in their neglect and labour. Smart Agricultural Systems have advanced quickly in the past few years since the swift arise of smart city development across the globe [1]. In fact, nearly 70% of the population in developing countries like India, Sri Lanka, Pakistan etc., depends on the crucial agricultural industry. Despite knowing the proper amounts of these crops, irrigation systems in the past relied on the mills to water the plot using traditional methods. Due to inadequate water supplies, some crops are destroyed by these outdated systems, which are a major cause of enormous amounts of water wastage. But with recent technology advancements, there have been creative irrigation systems that don't need the farmer to get information of the plant in manual way [2].

Our proposed system benefits to display the temperature of the soil, humidity, pressure, moisture, light intensity and air quality of the ground. So the farmer or the irrigation responsible person can easily identify the above details which shows in the LCD display. The main advantage of the system is that the LED turns on in line with the code whenever the value of the soil moisture sensor drops below a threshold value. It implies that the valve will open when the soil becomes dry, allowing water to reach the crops. The proposed system is very simple. Also farmer no need worry about the watering to the plants. The water valve will open when the soil is dry and also it will close or turn off when soil gets required water level.

II. LITERATURE REVIEW

Smart irrigation system is one of the most famous and intelligent systems among smart agriculture field. In that case, most of the system used IOT for smart irrigation. Most probably there are various technologies used under IoT in Smart Irrigation in existing research papers. As is well known, several monitoring and irrigation systems will need to be installed for this technology to be used in farms. LoRa WLAN technology employ for that particular case. Long Range Radio, often known as LoRa, intends to create M2M and IoT [3][4][5] networks. LoRa is a wireless technology that was created primarily for long-distance, low-power communication [6]. There are numerous added options, even if it may seem more demanding and challenging, such as creating a complex network of connections between plants of the same species or the so-called "Internet of Plants." There are many more experimental as well as challenge like concepts, for example timing for establishing irrigation system, employing solar power supply, etc., in addition to using many sensors as part of an experiment [7].

When comparing different irrigation systems, sprinkler irrigation approaches feature a sprinkler at the top of the setup, although this irrigation technique tends to lose quite a bit more water than drip irrigation. Based on the moisture content shown on the LCD screen [8], the controller included into the autonomous irrigation system determines whether to switch the motor ON or OFF. In comparison to other methods, the autonomous irrigation approach is more dependable and offers several benefits. For instance, this technique covers the entire field, saves on labor expenses, conserves water, and is simple to operate [9]. In this system, an ATMEGA 328 microcontroller [10] is utilized to program it to accept input signals of changing soil moisture [11] conditions from the sensor setup. Additionally, it displays the soil's temperature, water tank overflow, The water container's water level is low, automated motor OFF/ON capability, also irrigating the plants with a predetermined quantity of fertilizer [12].

If the pH of the soil is detected, a pH sensor [13] could determine whether or not the soil wants additional water [14]. A sample of the soil that is completely dry is obtained [15]. The soil moisture sensor [16] is securely positioned on the soil's surface and is wired to both the Arduino [17][18] and the 6V DC motor pump. The Arduino [19] board is powered by a 12V external power supply, and a 6V DC pump is submerged in a pool of water. Separately affixed to the Arduino [20][21] enclosure is the Arduino setup. Immediately the switch is ON, the moisture sensor measures the soil's wetness and compares it to the pre-set parameters. Given the kind of soil, watering the plant according to the expected moisture value is optimum. Being regularly monitored for soil moisture levels makes it the best prototype for watering plants [22].

Also Six subsystems a soil moisture sensor [23], a servo motor, a motor driver, LCD I2C module, a liquid crystal display, and a water pump perform the whole task. A tiny DC motor is used to build the micro water pump that serves as the pumping unit. The condition of the different components is also displayed in real time on an integrated Liquid Crystal Display (LCD) [24] using data from the sensor [25]. Sometimes system merged other technologies to develop the system. In that case four different supervised Machine Learning (ML) methods to assess the performance of our irrigation model, and the Gradient Boosting Regression Trees (GBRT) approach for IoT solution [26].

A system that is reasonably priced was created using a soil moisture FC-28 hygrometer sensor that is well-matched with an Arduino Uno R3 and sends electrical signals based on voltage differences caused by an increase or decrease in soil water content [27] to the monitor via the Arduino [28] to decide whether to operate irrigation pumps [29]. The ground's moisture content can be determined using the hygrometer sensor. The soil hygrometer detection produces a high standard when the moisture content level is over a threshold level and vice versa.

The sensor can be combined with an Arduino-based module to create an automatic plant watering [30] system that does not require human oversight when watering plant [31]. The Ethernet Shield is utilized to quickly connect the Arduino to the internet. With an internet connection needed, the Arduino to send as well as receive data from anyplace in the world, that can be utilized for real-time applications [32]. Particularly in [33] paper this gadget should be able to water the plant automatically at a certain time. The entire system is run by an ESP-WROOM-32 module with an ESP32D0WDQ6 microprocessor. The users of this system are those with busy daily schedules. It is entirely useful for domestic use. The answer to eliminating human tasks in the watering plant is an automated plant watering system [33].

In different way authors pointed out irrigation system that were developed using robot technology. A remotely controlled robot that will run on solar power has been created. Through an application, the robot has been wirelessly controlled. The robot is equipped with a variety of a high-resolution camera and sensors to monitor crop health as well as assess soil quality. Different sectors will be created inside the field. The robot will travel over all areas for commercial reasons and feel the soil's condition before sending the information to the phone via the GSM module [34]. In some papers mentioned that they used mobile applications to connect the system. Using the mechanical switch on the module or even a mobile application created with Blynk [35], the user can operate the automatic plant watering module [36]. By performing many setups, the MQTT [37] dashboard is linked to the system through IOT [38] modem [39] as well.

III. LITERATURE REVIEW

This approach offers a clever way for managing facilities in dry places that makes use of temperature as well as soil moisture sensors that are occasionally priced. Wireless communication elements deliver the data knowledge gathered from each sensing element node to a centralized server which manages the facility. The farmer may get data from all systems.

Problem Definition

Water conservation is not taken into account while using a standard irrigation system. Because the water is applied straight to the soil, plants are put under a lot of stress by variations in soil moisture, which reduces plant look. Inadequate water control is the outcome of the system's lack of automated control. The population expansion, which is accelerating, is the main cause of these restrictions. As a result of the current worldwide water problem, managing water shortage has become a critical task. Countries with a lack of water resources and weak economies might observe this expansion. Therefore, this is a severe issue in the agricultural sector. In order to conserve water, we created a smart irrigation system based on Proteus software programming that uses an Arduino microcontroller to sense the soil's moisture.

3.1 Proposed Model

The Smart Irrigation System in this model is based on an Arduino microcontroller. The prototype has track of the soil's moisture content. Crops can change the soil moisture level from a predetermined value. The irrigation system is turned OFF/ON if the soil moisture differs from the predetermined range. This will turn on the irrigation system and start pumping water to irrigate the plants if the soil is waterless. The C programming language is the primary foundation of this project. Pins 2 as well as 3 are utilized as input pins for a DC motor as well as switch, respectively, during simulation. It is likely to use this approach extensively for farming, which may turn out to be much more helpful. Due to the present circumstances and the lack of water, the ideal irrigation schedules must be chosen, especially in farms, to preserve water.

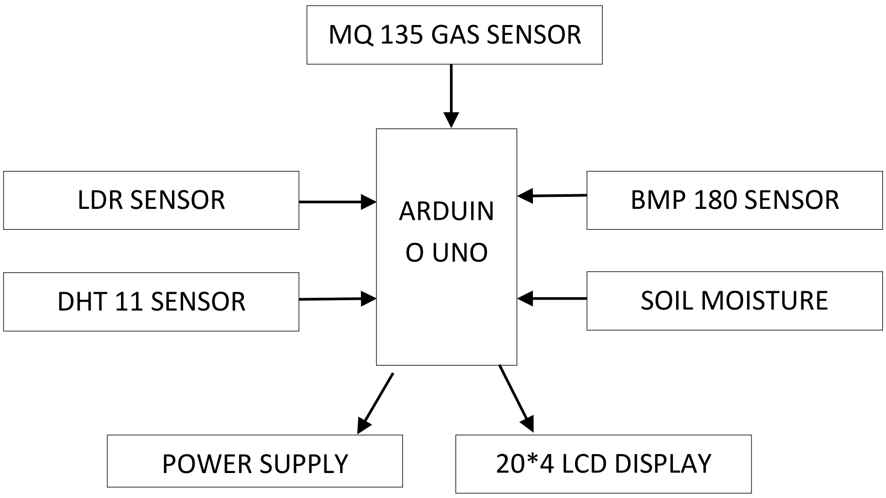

Figure1: Block diagram of the system

According to the basic block diagram of smart irrigation system each and every devices including sensors and actuators connected to the Arduino UNO. LDR sensor, DHT 11 sensor, BMP 180 sensor, MQ 135 Gas sensor and soil moisture sensor are connected to the Arduino UNO. Additionally we have to connect power supply to the system. Finally the output shows in 20*4 LCD display. In Arduino the output can view in virtual terminal.

Hardware Requirement

- Arduino UNO

An ATmega328p microcontroller is used in the Arduino Uno, a specific type of Arduino board that is made accessible as open-source hardware. Arduino Uno has a number of output as well as input analog and digital pins that are used to attach the board to other parts.

- **BMP180 Sensor**

High-precision sensor BMP180 was created for consumer applications. The force of air pressing on everything is what is known as barometric pressure. Air carries weight, also its pressure may be felt anywhere it is current situation. Especially, BMP180 sensor detects that pressure as well as outputs the data digitally. We need temperature-corrected pressure reading because the temperature influences the pressure. The BM180 also features a decent temperature sensor as a makeup.

- **DHT11 Sensor**

A low cost digital sensor for sensing temperature as well as humidity is the DHT11. To promptly detect temperature and humidity, this sensor may be simply interfaced with any microcontroller, including Arduino. The DHT11 temperature and humidity sensor is offered as a sensor and a module. The pull-up resistor and a power-on LED distinguish this sensor from the module. A relative humidity sensor is the DHT11. This sensor employs a capacitive humidity sensor and a thermistor to detect the ambient air.

- **LDR Sensor**

One form of resistor, called an LDR, changes in resistance accordance to the quantity of light that hits its surfaces. The resistance alters as light strikes the resistor. Numerous circuits where the need to sense the presence of light exists, these resistors are frequently employed. The resistance as well as uses of these resistors are varied. For example the LDR may be used to turn ON a light when it is in the dark or to turn OFF a light when it is in the light. A typical light-dependent resistor has a resistance of 1 MOhm in darkness and a resistance of a few K Ohms in daylight.

- **MQ135 Gas Sensor**

Air quality MQ135 Gas Sensor Module with Analog and Digital Output. The MQ135 gas sensor's sensitive component is SnO_2, which has a reduced conductivity in clean air. Its conductivity of the sensor rises along with the concentration of the target flammable gas when it is present. The MQ135 gas sensor is very sensitive to hazardous gases including smoke and ammonia, sulphide, and benzo steam. It is low-cost and suitable for multiple uses.

- **Soil Moisture Sensor**

One type of inexpensive electrical sensor used to measure soil moisture is a soil moisture sensor. The volumetric content of water in the soil may be determined with this sensor. Sensing Probes and the Sensor Module make up the majority of this sensor's components. The probes enable current to flow through the soil, and they subsequently calculate the resistance value based on the soil's moisture content. Sensor Module receives data from the sensor probes, analyzes it, and outputs the result as either a digital or analog signal. Consequently, the soil moisture sensor may produce both digital output (DO) also analog output (AO).

- **20x4 LCD Display**

To show the data, a 20x4 LCD screen will be used. For the I2C bus, we'll utilize a PCF8574 remote 8-bit I/O expander. It will enable I2C compatibility for the display. With the aid of the I2C protocol, we can control the LCD using just 2 pins.

- **PCF8574 remote 8-bit I/O expander for the I2C bus**

I2C bus to 8-bit parallel bus IO expander IC, PCF8574. It offers easy, affordable GPIO extension for a large number of microcontrollers. This IC's interface is I2C (or I2C), which uses the SDA (Data) and SCL (Clock) lines.

- **Breadboard**
- **Jumper wires**
- **Power supply**

Battery is used for the power supply.

Software Requirement

- **Simulation**

Proteus 8 Professional Software.

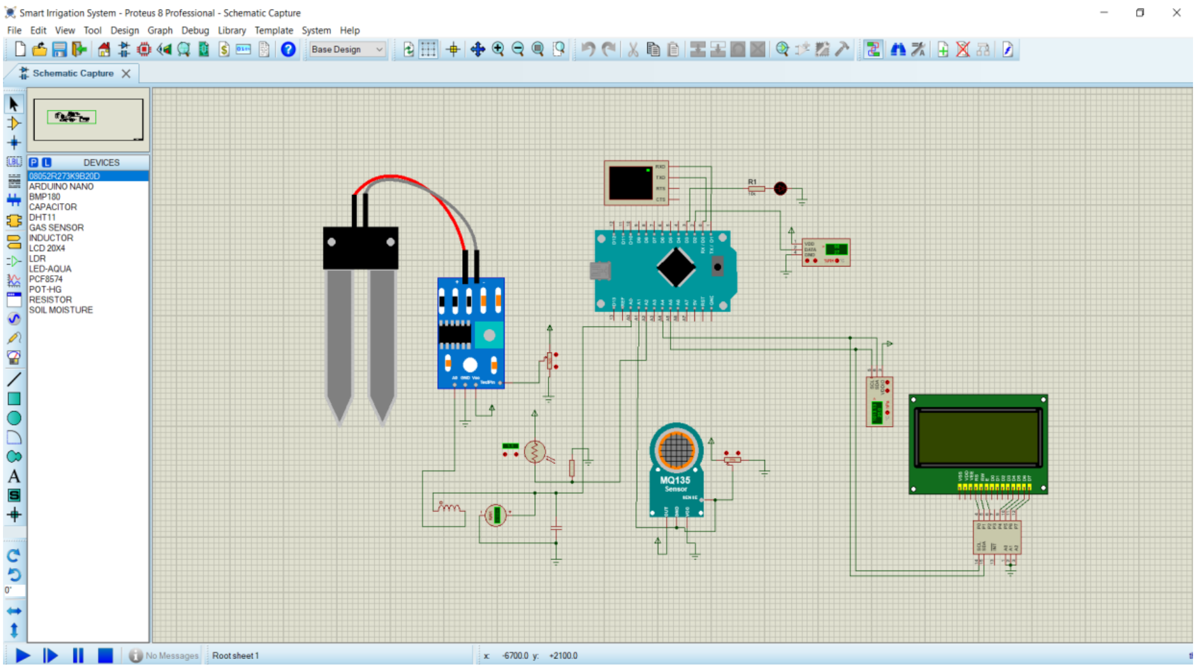

Figure2: Virtual Simulation for the proposed system

Table 1: Pin connected with components of the system

No	Components	Pins connected
1	MQ135 Gas Sensor	Arduino/Out - A1
2	Soil Moisture Sensor	Arduino/Data - A0
3	BMP 180 Pressure Sensor	Arduino/SDA-SDA Arduino/SCL - SCL
4	DHT 11 Sensor	Arduino/Data - 2
5	LDR Sensor	Arduino/LDR-Resistor Junction - A2
6	LCD Screen	Arduino/SDA - SDA Arduino/SCL - SCL

IV. RESULT AND DISCUSSION

The aforementioned automatic plant watering system is used to reduce human work required for maintaining in plant area such as home garden, farm etc. Industrial greenhouses would find it very helpful since keeping a controlled water supply level is essential for enhancing plant life.

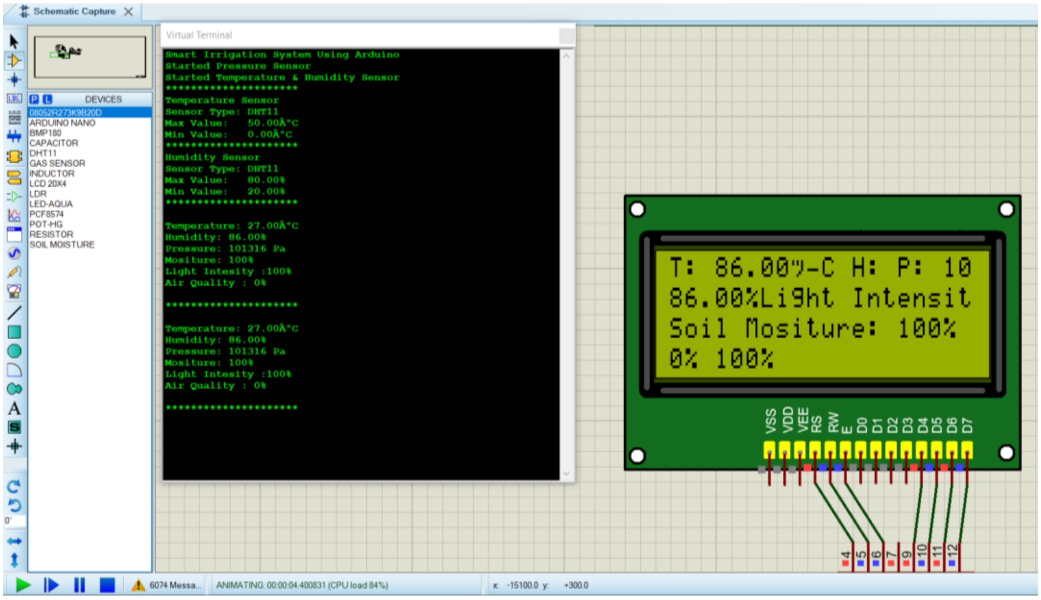

Figure3: Proteus Simulation output for proposed system

According to the figure 3, the virtual terminal and LCD displays the output of the sensors. In the Proteus simulation, this potentiometer controls the quantity of water in the soil. The circuit displays 0 volts across the voltmeter when the resistance at the test pin is at its highest. This indicates that the sensor is either in waterless ground or has been removed from the ground, providing a zero moisture value for the water content. The circuit will display the maximum voltage across the voltmeter when resistance is zero, indicating that the sensor is put in a moist ground or that the water content of the soil is too high. This is crucial. We have an LC filter linked to the output pin. Real hardware implementation does not call for this filter. We only need it for Proteus Simulation since Proteus provides the peak-to-peak value, which we must translate into Vrms. This LC circuit is not necessary if you are working on a genuine sensor. Similar to the gas sensor, when the potentiometer is increased in a simulation, it denotes improved air quality. The LCD displays the details.

The information from the sensor is shown on the virtual terminal initially in this simulation and project. Following that, each sensor transmits data that is organized and simple to understand to the terminal. The LED turns on in accordance with the code when the value of the soil moisture sensor falls below a threshold value. This indicates that the valve will open when the earth becomes dry and the crops will receive water. This is in figure 4.

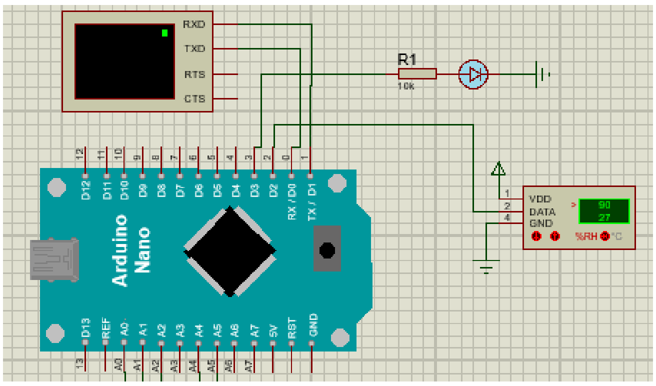

Figure4: Valve open

Moreover the terminal and the LCD provide the details of the smart irrigation with respectable sensor names. Accordance to these details a farmer or the responsible person for the irrigation can easily identify the temperature, humidity, pressure, moisture, light intensity and the air quality of the soil and plant. The farmer can easily decide the watering time and level of water for the plant as well.

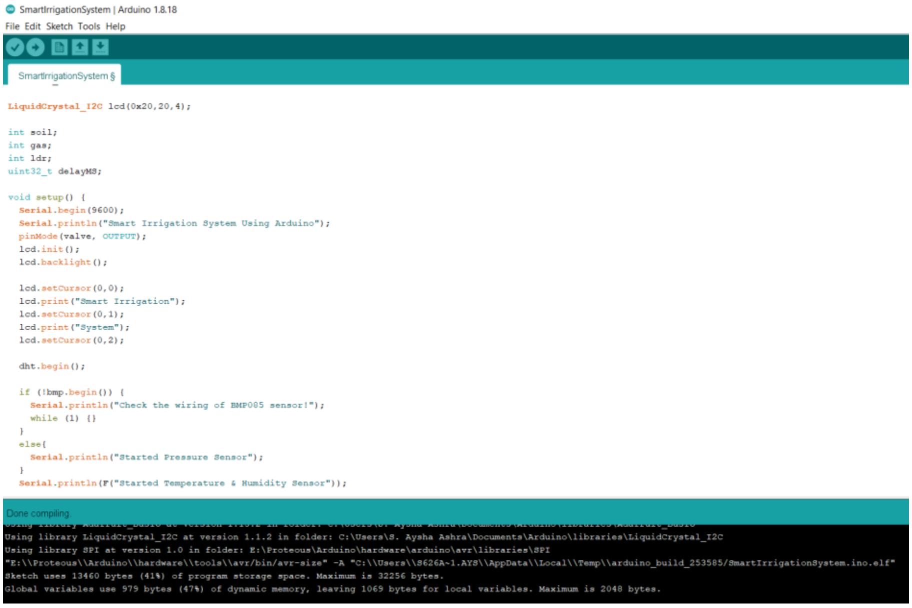

Figure5: Codes for the system in Arduino IDE

V. CONCLUSION

Since the advancement of information technology reduces suffering in customers' daily lives worldwide, the irrigation business now needs to apply this knowledge. Due to the world's constantly expanding population and the resulting exponential increase in the demand for food, the current area under cultivation must be increased (Josephine et al., 2021).

In our system, the terminal and LCD provide information about the smart irrigation system with appropriate sensor names. A farmer or the person in charge of irrigation may quickly determine the soil and plant's temperature, humidity, pressure, moisture content, light intensity, and air quality based on this information. The farmer may easily choose the plant's watering schedule and volume. In this simulation and project, the sensor's data is initially shown on the virtual terminal. The terminal then receives data from each sensor that is well-organized and understandable. When the worth of the soil moisture sensor downs below a threshold value, the LED illuminates in accordance with the code. This means that when the ground becomes dry, the valve will open, allowing water to reach the crops.

Finally our system implemented to help farmers in irrigation. The implemented system developed using IoT and its technologies and sensors. With the help of the Arduino and Proteus software we implemented to make ready to real world implementation. This technology is both practical and reasonably priced. In areas with a lack of water, this irrigation technique is also beneficial and increases sustainability. Additionally, it may be changed based on the kind of crops that need to be watered.

5.1 Future Scope

The use of the aforementioned technique may also be expanded to zoos and gardens, where the main objective is to further horticultural and botanical research. In order to reap its advantages, ornamental garden areas in business buildings or public parks can also adopt the aforementioned method. In order to facilitate the best maintenance schedules at cricket stadiums, football fields, and golf courses, where typically a timer-based sprinkler system is utilized to carry out the watering operation at a given preset interval of time, the module's applicability may be scaled up. Provisions can be included to administer nutrients in a similar way with fully customizable discharge control, facilitating the development of plants.

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