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IOT Based Smart Plant Monitoring System

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Abstract: ***The IoT-based Smart Plant Monitoring System represents a transformative approach to modern agriculture by leveraging the power of the Internet of Things (IoT) to enhance the monitoring and management of plants in agricultural settings. This system integrates advanced sensor technologies, wireless communication, and data analytics to provide real-time insights into the health and environmental conditions of plants, thereby optimizing resource utilization and improving overall crop yield.***

The key components of the proposed system include a network of sensors strategically placed within the agricultural field to capture vital data related to soil moisture, temperature, humidity, light intensity, and nutrient levels. These sensors are connected through IoT-enabled devices, forming a cohesive network that continuously collects and transmits data to a centralized cloud-based platform. The cloud platform acts as a repository for the acquired data, where advanced analytics algorithms process the information in real-time.

I. INTRODUCTION

The Internet of Things (IoT) has emerged as a transformative force across various industries, and agriculture is no exception. In the context of modern farming, the integration of IoT technologies has given rise to innovative solutions aimed at optimizing crop management and resource utilization.

Traditional farming practices often rely on manual observations and historical knowledge to make decisions about irrigation, fertilization, and pest control. However, these methods can be imprecise and may not fully account for the dynamic and often unpredictable nature of environmental conditions.

A. Scope

An IoT-based smart plant monitoring system has a broad scope, offering several opportunities for development and innovation. The scope of such a project can encompass various aspects, including hardware design, software development, data analytics, and user interfaces.

II. PROBLEM DEFINITION

Farmers cannot precisely detect environmental condition around the plant. Farmers only know the wetness of soil, the humidity and temperature around the plant by feel it themselves. Nowadays, there is wireless technologies that being implement in many fields. The user need device that can send the condition of plant wirelessly. The user will get notification about the environmental condition around the plant.

Along the course of project completion, we encountered various problems and obstacles.Not everything that we had planned went smoothly during the project development span. Also, we had a limited amount of time for its completion so we were under a certain amount of pressureas well. We had to start from the research phase at the beginning and needed to gain knowledge on all the devices and components that we had intended to use for our project. Other phases of the project included coding, debugging, testing, documentation and implementation and it neededcertain time for completion so we really had to manage the limited time available to us and workaccordingly to finish the project within the schedule.

By this iot based plant monitoring system we can easily water the crops according tonecessity from where ever we are present.

Because we are watering and controlling the soil moisture using specific app in the mobile.

III. LITERATURE REVIEW

Automated plant watering system. Abhishek Gupta [1] They explain that the system consists of a soil moisture sensor, a water pump, and a microcontroller that controls the watering process. The article also discusses the advantages of using an automated system over manual watering, such as improved plant growth and reduced water waste.

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Overall, the article presents a useful solution for individuals who want to maintain healthy plants while minimizing their water usage. Smart garden monitoring system using IOT T. Thamarai Manalan [2]They explain that the system collects data on parameters such as temperature, humidity, soil moisture, and light intensity using sensors and sends the data to a cloud-based server for storage and analysis. The article also describes how the system can be accessed remotely through a mobile application.

Embedded based greenhouse monitoring system using microcontroller. Arul Jai Singh

[3] They presents a system designed to monitor and control the environmental parameters of a greenhouse using an embedded system based on a PIC microcontroller. The authors, Arul Jai Singh, Raviram, and Shanthosh Kumar, explain that the system measures parameters such as temperature, humidity, and light intensity using sensors and adjusts them to maintain optimal conditions for plant growth.

Iot based plant monitoring system. Miss. Prajakta Zodge [4] In India about 35% of land was under reliably irrigated. And the 2/3rd part of land is depending on monsoon for the water. Irrigation reduces dependency on monsoon, improves food security and improves productivityof agriculture and it offers more opportunities for jobs in rural areas. Farmers are facing problemsrelated to watering system that how much water has to supply and at what time? Sometimes overwatering causesthe damage to crops and as well as waste of water. Hence for avoid such damage we need to maintain approximate water level in soil.

IV. PROJECT DESCRIPTION

The IoT-Based Smart Plant Monitoring System is an innovative project aimed at revolutionizing traditional agriculture by incorporating Internet of Things (IoT) . Implement a network of sensorsto capture crucial plant and environmental data, including soil moisture, temperature, humidity, light intensity, and nutrient levels. Develop an IoT-enabled infrastructure for seamless communication and data transfer between the deployed sensors and a centralized cloud-based platform. Design a user-friendly interface (e.g., mobile application or web portal) for farmers to access real-time data, receive alerts, and interact with the Smart Plant Monitoring System. Utilize advanced analytics algorithms for real-time data processing, trend analysis, and the generation of actionable insights to support decision-making. Integrate mechanisms for remote control of irrigation systems based on real-time soil moisture data, optimizing water usage. Implement an alerting system to notify farmers of potential issues such as plant stress, diseases, or suboptimal environmental conditions.

A. Proposed Structure

In the field section, various sensors are deployed in the field like temperature sensor, moisture sensor and PIR sensor. The data collected from these sensors are connected to the microcontrollerthrough RS232. In control section, the received data is verified with the threshold values. If the data exceeds the threshold value the buzzer is switched ON and the LED starts to blink. This alarm is sent as a message to the farmer and automatically the power is switched OFF after sensing. The values are generated in the web page and the farmer gets the detailed description of the values. In manual mode, the user has to switch ON and OFF the microcontroller by pressing the button in the Android Application developed. This is done with the help of GSM Module. In automatic mode, the microcontroller gets switched ON and OFF automatically if the value exceeds the threshold point. Soon after the microcontroller is started, automatically an alert must be sent to the user. This is achieved by sending a message to the user through the GSM module. Other parameters like the temperature, humidity, moisture and the PIR sensors shows the threshold value and the water level sensor is used just to indicate the level of water inside a tankor the water resource.

B. Assumptions and Dependencies

The system assumes a stable and reliable internet connection for data transmission andcommunication with the cloud platform.

The sensors used for monitoring plant parameters are assumed to be accurate and calibrated forprecise measurements.

Continuous and reliable power supply is available for both the IoT devices and sensorsdeployed in the plant monitoring system.

Standard security measures (encryption, access controls, etc.) are assumed to be effective insafeguarding the data and system from unauthorized access.

Users are assumed to have basic technical knowledge for system setup, troubleshooting, andinterpretation of monitoring data.

The system assumes that the environmental conditions, such as weather and external factors, will not significantly impact the hardware and sensor performance.

The system assumes compliance with relevant regulations and standards for data privacy,environmental monitoring, and IoT device deployment.

Timely and reliable supply of sensors from the chosen supplier is a dependency for thesuccessful implementation of the monitoring system.
The stability of the local power grid is a dependency for ensuring continuous power supply tothe IoT devices and sensors.
Approval from relevant regulatory bodies is a dependency for compliance with legal andenvironmental standards.
The mobile application's compatibility depends on timely updates and support from mobile operating system providers (iOS, Android).

V. REQUIREMENTS

1) Hardware Components:
- Sensors (Moisture, DHT11)
- NodeMCU
- Relay
- Motor

2) Language Used:
- JAVA
- PHP 3.JavaScript4.HTML 5.CSS

3) Database:
- MySQL

4) Host:
- 000webhost.com

5) Software components:
- PhpMyAdmin
- Android Studio
- Visual Studio Code

A. Hardware Requirements

1) Moisture sensor: Soil moisture sensor is used to detect the moisture of the soil. This sensor is made up of two pieces: the electronic board at the right, and the probe with two pads, that detects the moisture content of soil.



Fig5.1.1 Moisture Sensor

2) DHT 11 (Temperature and Humidity): DHT11 consist of both humidity and temperature sensor. For measuring humidity there are two electrodes with moisture holding substrate between them. So when the humidity changes, the resistance between these electrodes changes and conductivity of the substrate changes.



Fig 5.1.2 DHT 11 3.2

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3) *Node MCU:* The NodeMCU is a low-cost open-source IoT platform based on the ESP8266 WiFi module. It integrates the ESP8266 with a USB interface and a voltage regulator, making it a compact and convenient development board for building IoT projects.



Fig 5.1.3 Node MCU

4) *RELAY:* The relay is used to switch ON/OFF the water pump. It's connected between the "NO" (normallyopen) terminal and the circuit ground.



Fig5.1.4 Relay

5) *WATER PUMP:* DC 5V Mini Submersible Noiseless Water Pump is a low-cost, small size Submersible Pump. Itcan take up to 150 liters per hour with a very low current consumption from 300mA to 1A max. The water pump works using water suction method which drain the water through its inlet and released it through the outlet.



Fig5.1.5 Water Pump

VI. METHODOLOGY

The IoT-based Smart Plant Monitoring System is designed to monitor and maintain the growth and health of plants. The system works by collecting data from various sensors and then sendingthat data to a mobile application through the internet. The system starts by collecting data from the DHT11 sensor, which measures the temperature and humidity of the environment. The data is then sent to the Arduino microcontroller, which processes the data and sends it to the Blynk app through the ESP8266 Wi-Fi module. The Blynk app then displays the temperature and humidity data in real time. If the temperature or humidity falls outside of a specified range, the Arduino sends a notification to the user's mobile device or computer. The user can then adjust the settings on the app to optimize the environment for the plants. The solenoid valve is controlledby the Arduino based on the data from the sensors.

VII. DESIGN AND IMPLEMENTATION

An important factor such as temperature and humidity of the environment Can be monitored using DHT 11 The control on the temperature is done using DC motor which acts as cooling mechanism. Temperature and the humidity will be sensed by DHT11 sensor digitally. The CO2 gas will be sensed by the MQ135 sensor and Other MQ sensors is also provided for the knowledgeof the different atmosphere released gasses of that surrounding.The ESP8266 microcontroller is used to send all the monitored parameter and different gasses on IoT Cloud using Wi-Fi. And to monitor a moisture in soil the moisture sensor is used and also relay for controlling water pump to maintain the moisture sensor of the soil.

All the sensors are interfaced with ESP8266 micro- controller and regulated DC power supply is used. The water level in the soil is detected using the soil moisture detector and further actions are taken accordingly.

A. Block Diagram

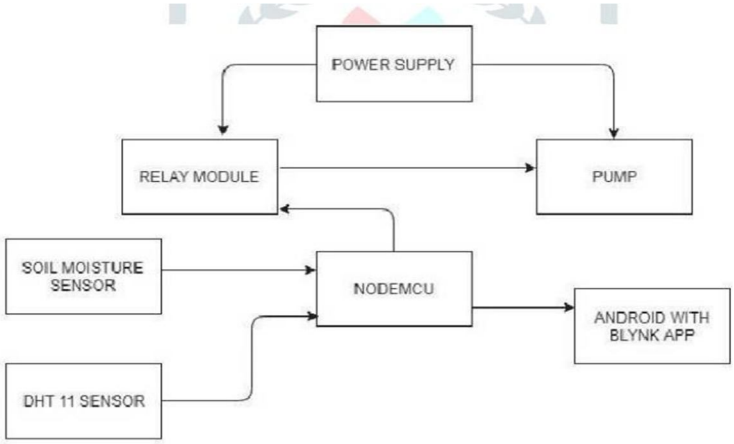


Fig 7.1: Block Diagram

The Physical Description of project can be represented by the above Fig 7.1. All Sensors are connected to the NodeMCU and DC Pump and Relay module is connected to Power Supply. Herewe use the power supply as Battery. The Output can be shown in Blynk App. This app is used toMonitor and Control our Hardware project and Display the parameters in Web Dashboard of Blynk App.

B. Circuit Diagram

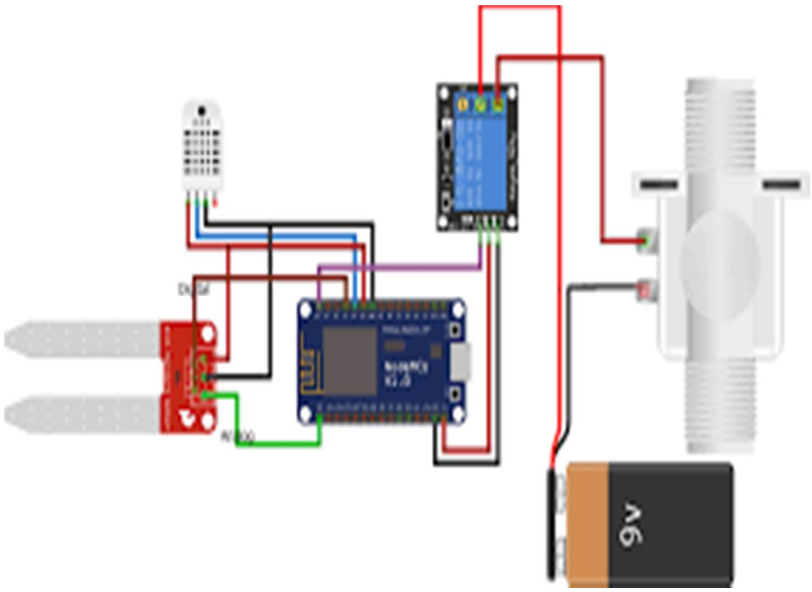


Fig -7.2: Circuit Diagram.

The connections of circuit are explain in above as shown in above Figure:7.1. In NodeMCU we use D3, D2,D5 and A0 along with VCC and GND Pins.DTH11 Sensor consist of Three pins the data pin is connected to D3 of MCU and Supply and Ground pin is connected to VCCand GND respectively. Soil moisture sensor signal pin is connected to A0 and remaining twopins one is connected to supply and another is ground. LED positive is connected to D2 whereas negative is grounded. Relay Module data pin is connected to the D5 and Supply andGround is connected to VCC and GND Respectively. DC pump Operates based on the Relayand Battery. When we give Power Supply to NodeMCU 5V or 9V then the user program in flash memory is enables and display the outputs.

VIII. EXPERIMENTATION

1) The experimentation starts by assembling the components required (WIFI chip, sensors, battery, motor, jumper wires, etc.) in the breadboard.
2) Then we connect the USB cable to our laptop or monitor where we can set up the codes and run the codes in a free application named Arduino IDE which helps in operating various MCUs.
3) In the website we can setup the required criteria such as temperature, moisture, etc and connect it to the specific code segment that is going to track the values.
4) The interface is then created showing us the criteria that we inserted and is displayed in a meter like image showing the exact calculations below it.
5) Then we can put the sensors in agricultural soil sample and operate the system.
6) Once we are sure that the system has no problems whatsoever and is tracking the required data smoothly we can connect the system data to our mobile application that is BLYNK app, leading to monitoring and operating the system with our mobile device.

IX. DELIVERABLES

Through the integration of various sensors such as humidity, temperature, soil moisture, light intensity, and even nutrient levels, the system offers a comprehensive view of the plant's environment.

This data is then collected and transmitted to a centralized platform or application, which can beaccessed by users from anywhere at any time.

The benefits of such a system are numerous:

Optimized plant growthResource efficiency Remote monitoring Early detection of issuesData-driven insights Education and research

However, it's important to acknowledge some potential challenges:

Data security: given that the system relies on data transmission and storage, ensuring data securityand privacy is crucial to prevent unauthorized access or breaches.

Technical expertise: users may require a certain level of technical knowledge to set up andmaintain the system effectively.

Reliability: the system's reliability depends on stable internet connectivity. Any disruptions inconnectivity could hinder real-time monitoring and intervention.

X. RESULT AND DISCUSSION

The previous work on the monitoring system was automatically switching on the pump taking theother detected factors in account but here in this paper the detection of the hazardous gases is alsodone where one can get detail information about the atmosphere nearby. As we are aware of the occupations in India, one of the most important occupation is Agriculture which is very time consuming also water requiring occupation. This proposed system is basically used to monitor the important factors of the crops under the unfavorable conditions including the atmospheric conditions. The sensor used will result in giving the values of the important factors including thehumidity, temperature, gases of the surrounding which will be taken into consideration in order to reduce the damage to the crop. This will effectively increase the production having quality assurance thus reducing the manpower required.

XI. ACKNOWLEDGEMENT

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CODE:

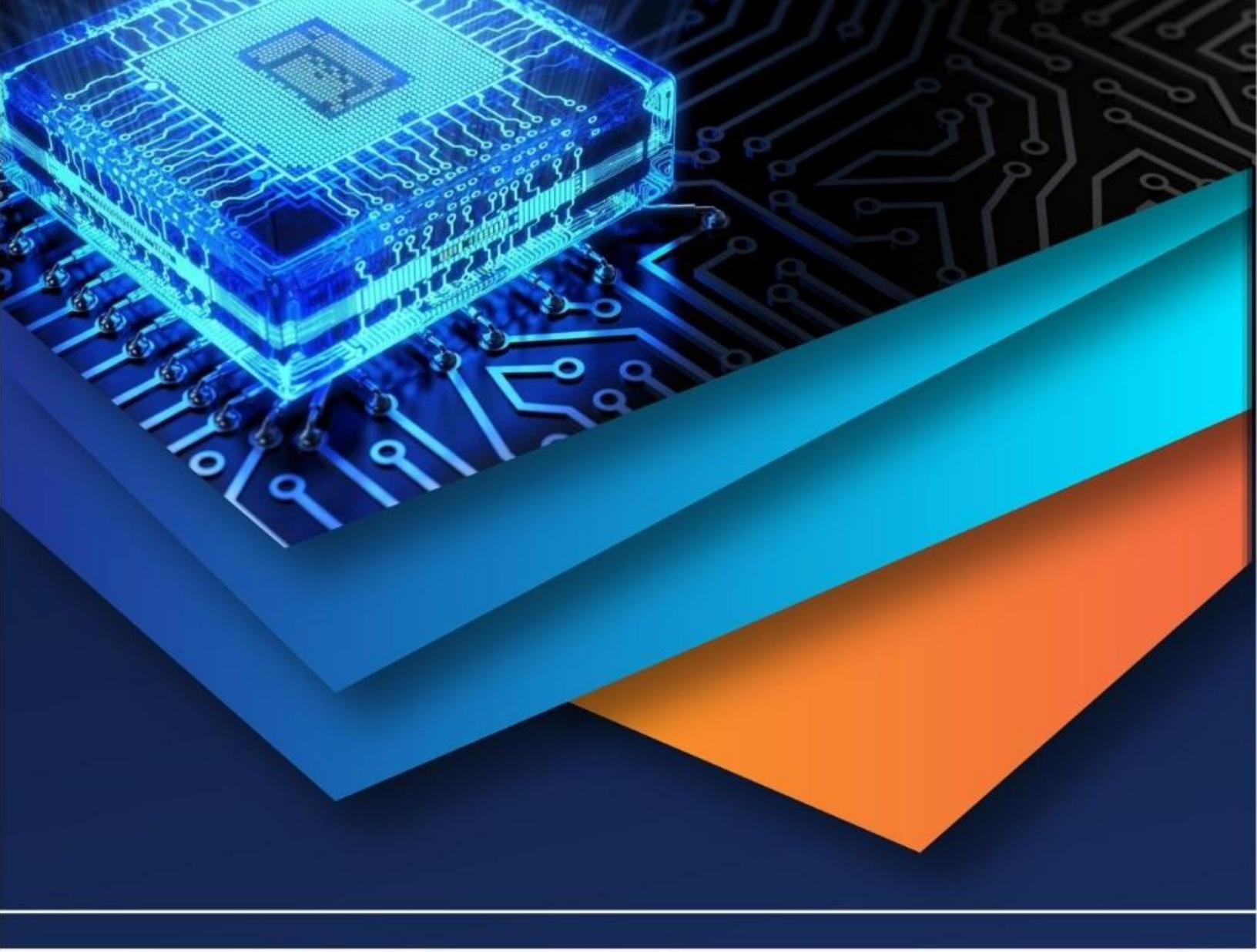
```
#define BLYNK_PRINT Serial
#include <SPI.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <SimpleTimer.h>
#include <DHT.h>
#define BLYNK_PRINT Serial
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS D2
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
char auth[] ="----------------";            //Authentication code sent by Blynk
char ssid[] = "-------";                    //WiFi SSID
char pass[] = "-------";                    //WiFi Password
#define sensorPin D3
int sensorState = 0;
int lastState = 0;
#define DHTPIN 2
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
SimpleTimer timer;
void sendSensor()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
   Blynk.virtualWrite(V5, h);  //V5 is for Humidity
  Blynk.virtualWrite(V6, t);  //V6 is for Temperature
}
void setup()
{
```

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```
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
   pinMode(sensorPin, INPUT);
  dht.begin();

  timer.setInterval(1000L, sendSensor);
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
   sensors.begin();
}
int sensor=0;
void sendTemps()
{
sensor=analogRead(A0);
sensors.requestTemperatures();
float temp = sensors.getTempCByIndex(0);
Serial.println(temp);
Serial.println(sensor);
Blynk.virtualWrite(V1, temp);
Blynk.virtualWrite(V2,sensor);
delay(1000);
}
void loop()
{
  Blynk.run();
  timer.run();
  sendTemps();
  sensorState = digitalRead(sensorPin);
Serial.println(sensorState);
if (sensorState == 1 && lastState == 0) {
  Serial.println("needs water, send notification");
  Blynk.notify("Water your plants");
  lastState = 1;
  delay(1000);
//send notification
      }
  else if (sensorState == 1 && lastState == 1) {
    //do nothing, has not been watered yet
  Serial.println("has not been watered yet");
  delay(1000);
  }
  else {
    //st
    Serial.println("does not need water");
    lastState = 0;
    delay(1000);
  }
    delay(100);
}
```

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