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An Android based Automatic Irrigation System for Home Gardening

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***Abstract*—The Internet of Things (IoT) is a system that connects devices, either directly or indirectly, to the internet. These devices can be controlled remotely. IoT systems can be used in irrigation for sustainable growth and development of plants. In this paper, we introduce an Internet-of-Things-based smart plant watering and monitoring system. This equipment comes with a soil moisture measurement sensor that serves as a benchmark for determining soil moisture levels. Watering of plants is done when the soil moisture is below desired range. An Android-based application's screen will display information as long as the gadget is turned on. In this project, we use a soil moisture sensor, and an ultrasonic sensor. These sensors are combined with a well-established android application as a wireless sensor network.**

***Index Terms*— IoT, Android, Sensor, irrigation.**

I. INTRODUCTION

Agriculture contributes significantly to the Indian economy, yet food costs are steadily rising as production rates drop. There are several factors that are responsible for this, like waste of water, insufficient soil moisture, fertilizer overuse, climate changes, etc. It is important to develop effective interventions in agriculture and one solution is IoT Integration with wireless sensors. IoT is a method of connecting everything to the internet. It is important to develop effective interventions in agriculture. It is used to connect objects or things such as (Cars, homes, and Electronics devices). The primary purpose of IoT is to ensure the delivery of Triple "R" Means (Right Information to the Right People at the Right Time). Home gardening and harvesting of various vegetables and fruits are getting popular in modern societies. Rooftop places and small home plots are used to harvest many vegetables and fruits which can be consumed by individual families. There are many obstructions related to this kind of harvesting. Monsoon rainfall and excessive sunlight are unpredictable and uncertain. Another disadvantage of such irrigation is the unavailability of full-time monitoring mechanism of the whole system. Home-based systems are often lack of physical manpower to observe. In the Automatic Plant Watering system, we use predefined values to active the pump and to turn off the pump. The pump can also be readily automated utilizing controllers, and no need for labor to turn it on and off physically. It also saves energy and natural resources and is also cost effective. It's a precise irrigation system and a useful tool for controlling soil moisture in highly specialised greenhouse crop production. It saves time and eliminates human error when regulating available soil moisture levels.

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II. LITERATURE STUDIES

On smart agriculture monitoring system using IOT by Dr. Sanjay N Patil et al. [1], used the rain sensor, soil moisture sensor, temperature sensor, and humidity sensor where data are stored in Arduino. After that, the data will be sent to the web application using the Internet. On smart e-agriculture monitoring based on Arduino using IoT by Prof. Caroline El Fiorenza et al. [2], worked on soil moisture, temperature, camera, humidity sensor, and GSM modem technology where data are first moved to Arduino. After that, it will move to the wireless node to the web application. In a research paper on smart agriculture using IoT by Ritika Srivastava et al. [3], used soil moisture sensors and water level sensors where data are first stored in Arduino. After that, it will be sent to the web application. An automatic irrigation system using android by Souvanxay Lorvan leuang et al. [4], used a temperature sensor and soil moisture sensor where data are stored in raspberry pi. After that, it will be sent to the android app using the Internet. An automatic plant watering system using android by Ridwan Siskandar et al. [5], worked on soil moisture sensors, RTC DS3231 and DTH11 where the sensor data are stored in Node MCU after that the data will be displayed using an LCD screen.

III. PROPOSED MODEL

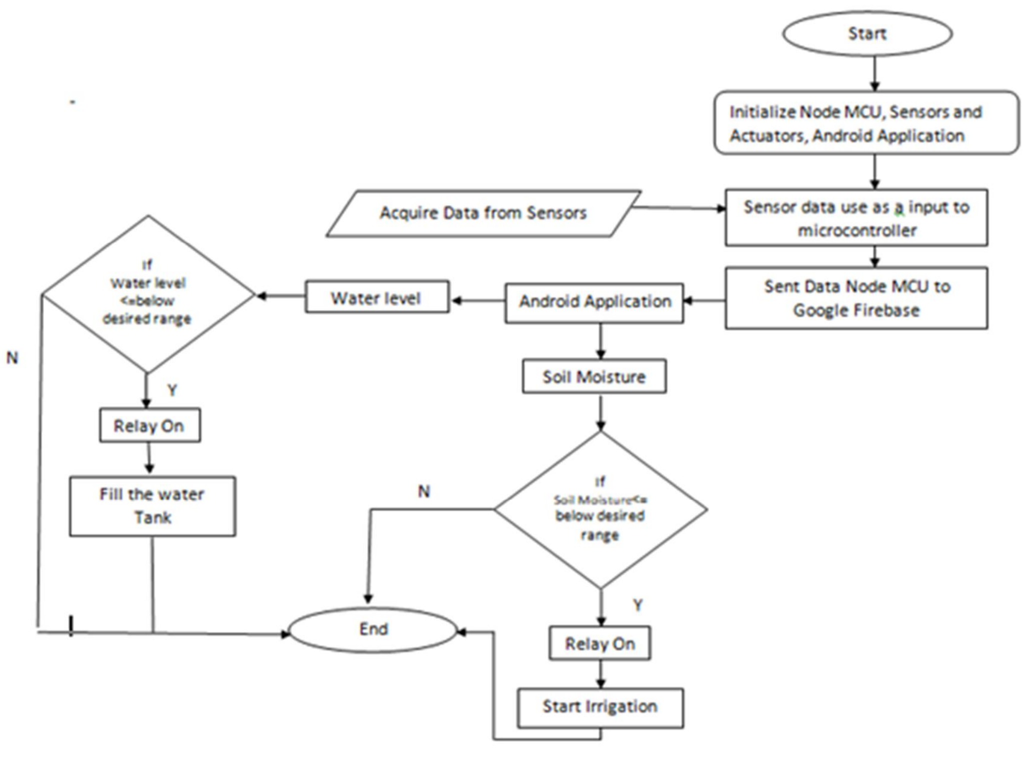

Figure 1. Note how the caption is left aligned

In process flow diagram “Fig.1” we can see there are two sensors one is a soil moisture sensor and another one is a ultrasonic sensor for determine the Water level in water tank. Here we use a capacitive soil moisture sensor and ultrasonic sensor as water level sensor. We use a relay as a switch and we use two pumps one is for plant irrigation and another one is used to fill the water tank. A capacitive soil moisture sensor was put on the ground. When we power up the system then all devices are active. The soil moisture sensor gets the moisture value from the soil and sent it to Node MCU. The Node MCU sent the data to the Google Firebase through the internet. After that our Android Application receives the data from the Google firebase and displays the soil moisture value on the Android Application. An ultrasonic sensor is mounted on top of the water tank to determine the amount of water level in the water tank. Then the sensor sent the data to Node MCU. The Node MCU sent the data to the Google Firebase through the internet. After that our Android Application receives the data from the Google firebase and displays the water level on the Android Application.

IV. METHODOLOGIES

Our proposed system works seamlessly both in manual mode and automatic mode. In this system there are three soil moisture levels a) Dry Soil: 0% - 10%, b) Moist Soil: 20% - 50%, c) Wet Soil: 60% - 100%. And three water Tank levels on our system a) Low: 15 CM, b) Medium: 8 CM, c) High: 2 CM

The Moisture Tab “Fig.2” Shows the Moisture value. The user sees the percentage of soil moisture. In the event that the soil is dry, then the user clicks the ON button to turn on the irrigation pump. And when the soil is moist soil or Wet soil then the user turns off the pump using the “PUMP OFF” button.

The Water level tab “Fig.3” displays the current water level in the water tank. The user can see the Water level. If the water level is low then the user clicks the “PUMP ON” button to fill the water tank. And when the water tank is full then the user turns off the water tank pump using the “PUMP OFF” button.

Our proposed system is an Android-based system that anyone can control from anywhere through Smartphone. In this system there have two modes: - One is automatic another is manual. First, you have to install the soil moisture sensor put in the soil. In Manual Mode user open the Application and can choose their desired plants like fruits, flowers, vegetables, etc. where it can measures the moisture which is present in the soil. In our Application users get a notification in “Fig.4” about the soil moisture and water requirement. On the notification user can see that the plant needs water, and then the user clicks on the notification. After clicking it will redirect to the Soil Moisture page. Where user can get two buttons one is a “PUMP ON” another is “PUMP OFF”. The user clicks on the “PUMP ON” button to start the irrigation. On the notification user can see that the water level in the water tank is low then the user clicks on the notification. After clicking it will redirect to the water tank level page. Where user can get two buttons one is “PUMP ON” another is “PUMP OFF”. The user clicks on the “PUMP ON” button to fill the water tank. In Automatic Mode, if soil moisture level is below 10% then the irrigation pump starts automatically and when the soil moisture level is 50% then the irrigation pump turns off automatically. If water level is 15 cm then the water pump starts automatically and when the water level is 2 cm then the water pump turns off automatically. By using our app our users can get a hassle-free environment to take care of their gardens and can provide necessary water to their plants.

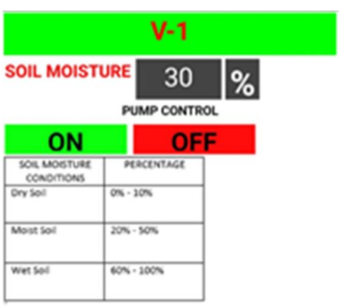

Figure 2. Soil Moisture Page

Figure 3. Water tank Page

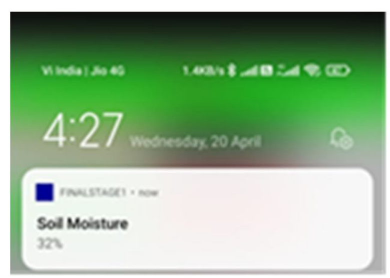

Figure 4. Notification

V. HARDWARE USED

Figure 5. Node MCU ESP – 8266

Figure 6. Ultrasonic Sensor HC– SR04

Figure 7. 5 V 1Channel Relay

The Node MCU ESP 8266 “Fig. 5” is a development board that comes with ESP- 12E module and it is used for multiple input-output devices with Wi-Fi functionalities. In this development board, we see there are 16 GPIO pins (General Purpose Input Output) and one analog pin A0, one +3.3 v pin, vin pin, and three GND pins are there. The development board works on +5v dc power supply [8]. And in our project, we use this board for controlling all sensors and actuators.

An ultrasonic sensor “Fig. 6” is a sensor that uses ultrasonic sound waves to measure the distance to an object. A transducer is used in an ultrasonic sensor to send and receive ultrasonic pulses. In this Module there are echo and trig, echo sent the ultrasonic sound wave and trig receives the reflected waves. The sensor is installed on top of the water tank and connected with the node MCU.

The relay module “Fig. 7” is an electrically operated switch that can be turned on or off deciding whether to let the current flow through or not. This module is to be operated with low voltages like +3.3 v to +5v and it is familiar with ESP 32, ESP 8266, and Arduino. Three of the five pins on this relay are high voltage terminals (NC, COM, and NO), which are connected to the device you want to operate. The common (COM) terminal is where electricity enters the relay. The condition of the normally closed (NC) and normally open (NO) terminals is determined by whether the device is turned on or off. Two of the remaining pins are attached to an electromagnet coil. The electromagnet becomes charged and activates the switch when current flows through the coil. The normally open (NO) terminal is connected to the common (COM) at this moment, while the normally closed (NC) terminal is disconnected. When the current in the coil stops flowing, the internal contact reverts to its original condition, with the normally closed (NC) terminal connecting to the common (COM) and the normally open (NO) terminal reopening. [7].

The soil moisture sensor [15] detects the amount of moisture in the soil. It works on the principle of open and short circuits. When the soil is dry, no electricity can pass through it, resulting in an open circuit. When the soil becomes wet, electricity passes from one terminal to the other, causing the circuit to short and the output to be

Figure 8. Capacitive Soil Moisture Sensor

Figure 9. Resistive Soil Moisture Sensor

zero. Soil moisture sensors are divided into two types: resistive soil moisture sensors and capacitive soil moisture sensors. A resistive soil moisture sensor “Fig. 8” measures soil moisture levels by utilising the link between electrical resistance and water content. Two probes are put directly into the soil sample. The sensor measures the resistance of the soil between the probes by sending an electrical current from one to the other. Electrical conductivity occurs when the water content in the soil is high. As a result, the resistance reading is lower, indicating high soil moisture. When the amount of water in the soil is low, electrical conductivity become poorer. As a result, the resistance reading is higher, indicating low soil moisture. The change in capacitance is measured using a capacitive soil moisture sensor “Fig. 9”. Capacitance is a term that describes how much electrical charge may be stored across an electrical potential. A capacitive soil moisture sensor typically consists of a positive and negative plate separated in the middle by a dielectric medium. The soil is the dielectric medium in this situation, and its capacitance varies with moisture content. we obtain an analog voltage from the sensor that can be read with an Arduino board [9] [10].

VI. Result and Performance Analysis

The power supply for all of the components are either +5v or +3.3v. Table 1 show the overall test results when the automatic conditions are applied. The test results in Table I indicate that the system is performing properly in accordance with the irrigation plan. If the soil moisture level is dry or below 10%, the irrigation pump will switch on.

Table II Summaries all the recent related works with their advantages and disadvantages. None of these methods were using Android-based Mobile application. They also did not use waterproof sensors, and are not fully automated. In our Project, we use Capacitive Soil Moisture Sensor because this type of sensor is corrosion-free. And we make this sensor waterproof for better performance. In this sensor there are many electronic parts are

TABLE I .TEST RESULTS WHEN IN AUTOMATIC MODE

Time	Soil Moisture Percentage	Water Pump	Water Tank Level (CM)	Water Tank Pump
08:00 A.M	16	Off	3	Off
10:00 A.M	10	On	5	Off
12:00 P.M	30	Off	13	On
2:00 P.M	9	On	2	Off
4:00 P.M	46	Off	15	Off
6:00 P.M	36	Off	15	Off
8:00 P.M	37	Off	15	On
10:00 P.M	33	Off	15	Off
12:00 P.M	30	Off	15	Off

attached with it, so we cover the electronic parts by using the heat shrink sleeve to make a waterproof capacitive soil moisture sensor. And here we can also control our system using an Android Application from anywhere in the world.

TABLE II. PROPOSED WORK COMPARISON WITH RELATED PROJECTS

Paper	Working Principles	Advantages & Disadvantages
Smart Agriculture Monitoring System Using IoT (Dr. Sanjay N. Patil, *et al.*,2019) [1]	Provide Water Tank Level, Rain Detection, Soil detection, Web Application,	• Using Resistive Soil Moisture Sensor for Sensing the Moisture of the Soil but the life of the sensor is not long. The sensor is not Water Proof, • No Android Application used.
Smart E-Agriculture Monitoring Based On Arduino Using IoT (Prof. Caroline El Fiorenza, *et al.*) [2]	Provides SMS service, measure temperature and humidity.	• No Android applications. • Not fully automated • No water level detection in water tank.
A Research Paper On Smart Agriculture Using IoT (Ritika Srivastava, *et al*) [3]	Provide soil Moisture detection, Water Level in the Water tank, Display Data on The LCD Screen	• No Android applications • No Web applications
Smart Farming: IoT Based Smart Sensors Agriculture Stick for Live Temperature and Moisture Monitoring using Arduino, Cloud Computing & Solar Technology (Anand Nayyar, Er. Vikram Puri) [6]	Provide soil Moisture detection, Provide Temperature, Display Data on The LCD Screen.	• Use water proof Temperature sensor, • Using Resistive Soil Moisture Sensor for Sensing the Moisture of the Soil but the life of the sensor is not long. The sensor is not Water Proof, • No Android applications • No Web applications • No water level detection in water tank.
Automatic Irrigation System Using Android (Souvanxay Lorvanleuang, Yandong Zhao) [4]	Provide Soil Moisture, Temperature, Provide Android Application, but it is not Low Cost	• Using Resistive Soil Moisture Sensor for Sensing the Moisture of the Soil but the life of the sensor is not long. • The sensor is not Water Proof • Costing is competitively high.
Internet of Things: Automatic Plant Watering System Using Android (Ridwan Siskandar, *et al.*) [5]	Provide soil Moisture detection, Display Data on The LCD Screen, No android or PC Web applications	• Using Resistive Soil Moisture Sensor for Sensing the Moisture of the Soil but the life of the sensor is not long. • The sensor is not Water Proof • No water level detection in water tank.
• Proposed Work	Provide soil Moisture, Water level in the water tank, Android Application	• Use Capacitive Soil Moisture Sensor for Better Performance and the sensor is corrosion-free and waterproof. • Provide Automatic irrigation when the soil moisture is low. When the water tank's water level is low, the tank automatically replenishes. • Easy Android based application for remote monitoring and operations.

VII. Conclusion and Future Work

As a result, this technique prevents over- and under-irrigation, top-soil erosion, and water waste. The main advantage is that the behavior of the system can be changed in response to changing circumstances (crops, weather conditions, soil, etc.). Agricultural, horticultural, parks, gardens, and golf courses can all be irrigated using this technique. This approach is also less expensive and more effective, when compared to the others. In the future high sensitivity sensors can be used for large-scale applications. Vast swaths of agricultural land monitoring activities should be comprehensive in scope, encompassing not only farmland but also urban areas. Not only in terms of production and productivity, but also in terms of natural resources**.** In future we can also make a reusable water management system. In the future, this system could be a more intelligent system that forecasts user activities, plant nutrient levels, harvest time, and so on. More advancements can be made in the future with Machine Learning algorithms, which will benefit farmers greatly and cut water use in agriculture.

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