Automated Smart Water System Using IOT

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***Abstract*— Smart pots with NodeMCUs offer a creative horticultural and technological mix in the realm of the Internet of Things. The ESP8266 WiFi module serves as the foundation for NodeMCU, an open-source, reasonably priced IoT platform that makes these smart pots an efficient and useful way to take care of your plants. Using a web or mobile application, NodeMCU is a device that can be installed into traditional plant pots to provide remote monitoring and control of significant environmental parameters including temperature, light intensity, and soil moisture. This clever system uses sensors for temperature, humidity, light, and soil moisture in addition to extra features like water pumps for automated watering. To link sensors and transmit data using Internet of Things connectivity, it is possible to write custom firmware for the NodeMCU and store it locally or on a cloud platform.**

I. INTRODUCTION

In the context of the Internet of Things, a smart pot driven by NodeMCU is an inventive combination of horticulture and technology. Through the utilization of NodeMCU, an open-source, cost-effective IoT platform built on the ESP8266 WiFi module, this project presents a practical and effective method of taking care of plants. Through the integration of NodeMCU into a conventional plant pot, important environmental parameters such as soil moisture, temperature, and light levels may be remotely monitored and controlled via a web or mobile application. In addition to optional elements like water pumps for automated watering, this intelligent system depends on sensors for soil moisture, temperature, humidity, and light. For the NodeMCU, users can create custom firmware, connect sensors to collect data, and use Internet of Things connectivity to send to a local server or cloud platform. Real-time monitoring and watering controls are made possible by an intuitive interface, which also makes plant maintenance more accessible and knowledgeable. Gardening aficionados may indulge their tech-savvy side while cultivating healthier and thriving plants by embracing this IoT-powered invention. Moreover, the NodeMCU smart pot project in the Internet of Things is a comprehensive undertaking that enables plant lovers to maximize their gardening practices. Users can easily access real-time sensor data and learn more about the health of their plants with the help of a specialized online or mobile application. This information helps monitor the plant's vital signs and makes it easier to set up customized alerts or notifications, which guarantees that no important care needs are overlooked. The automated possibilities of the system, especially for watering-based reduces the need for human maintenance based on soil moisture levels. This technology gardening assistant only needs to have routine maintenance performed to ensure that the sensor accuracy and NodeMCU capabilities are functioning properly. All things considered, a smart pot with NodeMCU at its heart not only adds a touch of future ease to gardening but also encourages a closer bond with the natural world by providing a more personal comprehension of each plant's distinct requirements.

II. REQUIREMENT SPECIFICATION: HARDWARE:

a) NODEMCU ESP8266

A well-liked development board built on the ESP8266 Wi-Fi module is the NodeMCU ESP8266. It is intended to make the process of developing Internet of Things (IoT) projects and prototypes simpler for enthusiasts and developers. The NodeMCU ESP8266's salient features are as follows:

1. *ESP8266 Board:* The Wi-Fi module, ESP8266, is the heart of the NodeMCU. An inexpensive WiFi chip with full TCP/IP stack and microcontroller functionality is the ESP8266. Its tiny size, low power consumption, and affordability make it a popular choice for Internet of Things applications.
2. *Development Board:* Based on the ESP8266 module, the NodeMCU board is a platform for development. It has GPIO pins for attaching sensors, actuators, and other electrical parts, along with a USB-to-serial converter for programming and debugging.
3. *Arduino Compatibility:* The ESP8266 Arduino Core may be used to program the NodeMCU, which has grown in popularity among the Arduino community, using the Arduino IDE. This makes it possible for programmers to write code in the well-known Arduino programming environment.
4. *Wi-Fi Connectivity:* The NodeMCU ESP8266 module has Wi-Fi connectivity, which makes it appropriate for projects requiring internet access. Sending and receiving data over the internet is made simple by its ability to connect to nearby Wi-Fi networks.
5. *GPIO Pins:* Sensors, LEDs, screens, and other hardware components can be connected to the General-Purpose Input/Output (GPIO) pins on the NodeMCU. You can interface with a variety of devices by using programming to control and read these pins.
6. *Power Supply:* The micro-USB port on NodeMCU makes it simple to connect it to a computer or a USB charger. It can also be powered by a battery or an external power source.
7. *Additional Features:* To make NodeMCU even more convenient for prototyping, certain variations have built-in LED indicators, reset buttons, and voltage regulators.
8. *Community and Libraries:* Users and developers of NodeMCU exchange projects, tutorials, and libraries within a large online community. Both novice and seasoned coders can benefit from this community help.

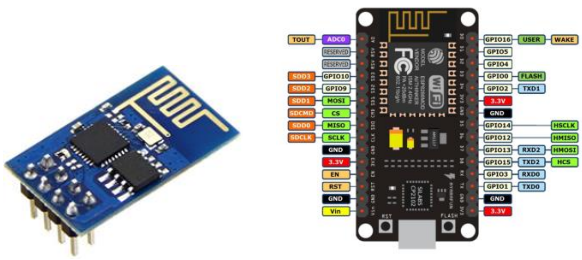

Fig.1. NodeMCU ESP8266.

b) DHT11 SENSOR:

A cheap digital temperature and humidity sensor is the DHT11. It is frequently used to measure and track ambient conditions in electronics projects and Internet of Things (IoT) applications. Here are some essential DHT11 sensor details:

i. Assessment Proficiencies:

1. *Temperature:* With an accuracy of ±2°C, the DHT11 can measure temperature between 0°C and 50°C (32°F and 122°F).
2. *Humidity:* With an accuracy of ±5%, it measures relative humidity between 20% and 80%.
3. *Digital Output:* The DHT11 has a digital output, which enables it to immediately provide humidity and temperature readings in a digital format that microcontrollers and other digital devices can read.
4. *Single-Wire Communication:* A single-wire protocol is used to communicate with the DHT11 sensor. This indicates that sending and receiving data from the sensor only requires one data pin.
5. *Operating Voltage:* The DHT11 can be used with a variety of microcontrollers and development boards because it usually runs at 3.3V or 5V.
6. *Library Support:* To make connecting to and receiving data from the DHT11 sensor easier, libraries are available for a number of microcontroller platforms, including Arduino, Raspberry Pi, and others.
7. *Applications:* The DHT11 is frequently utilized in applications that require simple temperature and humidity data, such as home automation systems, greenhouse monitoring, and DIY weather stations.

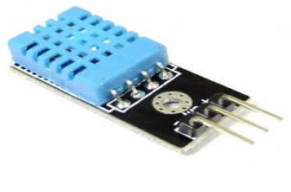

Fig.2. DHT11 Sensor.

c) BREADBOARD:

When creating makeshift circuits, a breadboard—also known as a plug block—is utilized. Because it makes it simple to remove and replace components, designers can benefit from it. For someone who wishes to construct a circuit to show how it works and then utilize the same parts in another circuit, it is helpful.

Fig.3. Breadboard.

d) JUMPER WIRES:

An electrical wire, or group of them in a cable, with a connector or pin at each end (or occasionally without them – simply "tinned") is called a jumper, jumper wire, or DuPont wire. It is typically used to interconnect the internal or external components of a breadboard or other prototype or test circuit without the need for soldering. The process of installing individual jump wires involves putting their "end connectors" into slots on a circuit board, a test piece of equipment, or a breadboard.

Fig.4. Jumping Wires.

e) RELAYS:

Relays are electromechanical devices that respond to signals by opening or closing contacts to control electrical circuits. Relays are crucial parts of many different applications, including as electronics, home automation, industrial automation, and more. The following describes a relay's main features and how it operates:

1. *Fundamental Function:* An electromagnet (coil) and a series of electrical connections make up a relay.
2. *A magnetic* field is created around the coil when an electrical current is introduced to it.
3. A movable armature or contact is drawn to the coil by this magnetic field and, in certain situations, repelled from it.
4. When the armature moves, it either closes (makes) or opens (breaks) a set of electrical contacts, depending on the type of relay.

Types of Relays: 1. *SPST (Single-Pole Single-Throw):* This type of relay has one normally open (NO) or normally closed (NC) contact. When the coil is energized, it either opens or closes the contact.

2. *SPDT (Single-Pole Double-Throw):* SPDT relays have one common terminal and two contacts one NO and one NC. When the coil is energized, it switches between the two contacts.

3. *DPST (Double-Pole Single-Throw):* DPST relays have two separate single-pole contacts that operate together. They are used for controlling two independent circuits.

4. *DPDT (Double-Pole Double-Throw):* DPDT relays have two separate single-pole doublethrow contacts. They can be used for controlling two circuits with both NO and NC option.

Fig.5. Relays.

f) SOIL MOISTURE:

The moisture content and humidity of soil are measured by soil moisture sensors. Since the removal, drying, and coefficient of a sample are required for the direct hydrometric measurement of free-soil wetness, soil wetness sensors indirectly measure the water content of the soil by using another property of the soil, such as an electrical phenomenon, non-conductor constant, or interaction with neutrons, as a stand-in for the wetness content.

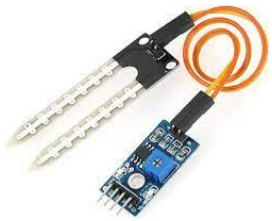

Fig.6. soil moisture sensor.

g) BATTERY:

To power electrical gadgets like flashlights and electric cars, an electric battery is a device made up of one or more electrochemical cells with external connections. The positive and negative terminals of a battery are known as the cathode and anode, respectively, when the battery is producing electricity. Electrons that are sent toward the positive terminal by an external electric circuit originate at the terminal designated as negative. When an external electric load is linked to a battery.

Fig.7. Battery.

h) DC MOTOR:

An electrical motor that is powered by direct current (DC) is known as a DC motor. Fig.8. DC motor typically consists of two main parts: an indoor rotor that is connected to the output shaft and produces a second rotating flux, and an outside stationary stator coil with coils that are supplied with DC to produce a rotating flux. Other methods of creating the rotor flux include reluctance hitting, permanent magnets, and DC or AC electrical windings.

Fig.8. DC Motor.

i) PIPE:

Here it is used as a water channel, and pipe has been used for watering plant.

Fig.9. Pipe.

j) ARDUINO IOT CLOUD:

An online platform called **Arduino IoT Cloud** makes it easier to connect and manage Internet of Things (IoT) devices. With an intuitive smartphone app or online interface, you can remotely monitor and control your linked devices and construct secure, easy-to-manage Internet of Things projects. The Arduino IoT Cloud typically operates as follows:

i. *Device Setup:* Our first step involves configuring your Internet of Things (IoT) gadget, which might be an Arduino board fitted with different sensors, actuators, or connectivity modules (such as the Arduino MKR WiFi 1010 or Arduino Nano 33 IoT).

ii. *Arduino IoT Cloud Account*: To manage your devices and data online, you must first register for an account on the Arduino IoT Cloud platform.

iii. *Arduino Cloud Library*: The Arduino IoT Cloud Library is included. In your Arduino IDE sketch, use the cloud library. This library makes it easier for your Arduino board and the IoT Cloud platform to communicate.

iv. *Device Configuration:* You can specify the characteristics of your Internet of Things (IoT) device in the Arduino IDE. These features include the actuators (like LED controls) that you want to manage remotely and the variables (like sensor readings) that you want to monitor.

v. *Upload Code*: You upload our written Arduino sketch to your Internet of Things device, which enables it to read sensor data and control actuators.

vi. *Device Connection:* An IoT device uses its built-in Wi-Fi or other available connectivity methods to establish a connection with the Arduino IoT Cloud.

vii. *Data Synchronization:* Your IoT device and the cloud are constantly synchronizing data thanks to the Arduino IoT Cloud platform. Device sensors send out data.

viii. *Security:* To safeguard your data and device control, Arduino IoT Cloud offers secure connectivity between your devices and the cloud platform.

All things considered, Arduino IoT Cloud makes it easier for makers, enthusiasts, and developers without a lot of experience with IoT to create, connect, and manage IoT projects. It provides a comprehensive ecosystem for developing Internet of Things applications involving automation, control, and data monitoring.

k) ARDUINO IDE:

To develop and add code to Arduino boards, utilize the Arduino IDE, an open-source software. The IDE tool is suitable for unique operating systems that include Linux, Mac OS X, and Windows. Programming languages like Cand C++ are supported by it. IDE stands for Integrated Development Environment in this context. The code describing the microcontroller program and the code describing the LCD application make up the two main parts of the Sensor Interface software design. The microcontroller programming oversees controlling the linked sensors and the data they provide. Choosing the sensor ports to read from, along with allowing the user to add, remove, and modify the properties of sensors, it should show details about every sensor that is linked to the microcontroller.

These are the aims of the testing:

i) A successful test is one that has a high probability of identifying an error.

ii) Testing is the act of running the program with the intention of finding an error.

iii) Testing cannot demonstrate that there are no defects.

l) TEST TYPES:

Unit testing primarily concentrates on the software design unit's verification work. To guarantee that information enters and exits the modules under examination properly, each

module's interface is tested. Conditions around borders are examined. Integration testing is a methodical approach to building a structured software while simultaneously doing condition tests to find interface-related problems. Data loss is possible when using an interface. When merged, one service module subsidiary function might not produce the intended principal function, global data models could lead to problems, and one subsidiary function might negatively impact another. Localizing mistakes that are found during integration testing is the primary challenge.

System testing: Following integration testing, the program is put together in its entirety as a package, and any interface problems are found and fixed. System testing entails assembling all the modules and doing a comprehensive software review. It is helpful in determining whether the intended output is produced for the supplied input. This makes it possible to verify if every independent path in a module has been used at least once.

Acceptance testing: A crucial stage of any project, user acceptance testing necessitates substantial involvement from end users.

III. THE PROPOSED HARDWARE SYSTEM

There are two output pins on the soil moisture sensor module that is being used: an analog output and a digital output. A LM393 comparator is used to compare the moisture sensor's probe's output to a reference value. The potentiometer in the module can be turned to alter the reference value. When the earth is wet, the digital pin produces an active low output. Here, we are connecting the module's analog output to one of Node Mcu's analog pins to use it. The program itself allows for the setting or adjustment of the wet detection value while using the analog output. A float switch is attached to one of the analog pins of the NodeMCU, as indicated by the circuit diagram, and a 1K Ohm resistor is utilized. to raise the line. Node Mcu's analog pins can also be utilized as digital inputs. The output of the float switch can be used to determine the tank's state. Node Mcu detects the water level in the tank by measuring the voltage dropped across the pull-up resistor. A pair of LEDs are attached to Node Mcu's second and third pins, respectively, to display the moisture and tank states. Additionally, the fourth pin connects to the base of a BC547 transistor, which powers a 12 V DC motor.

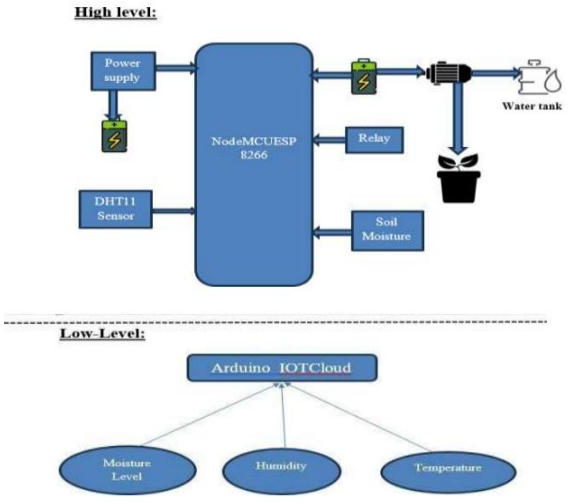

Fig.10. System flow.

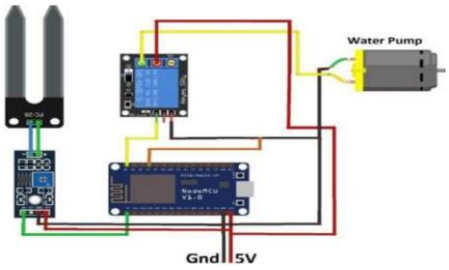

Fig.11.Hardware Connection.

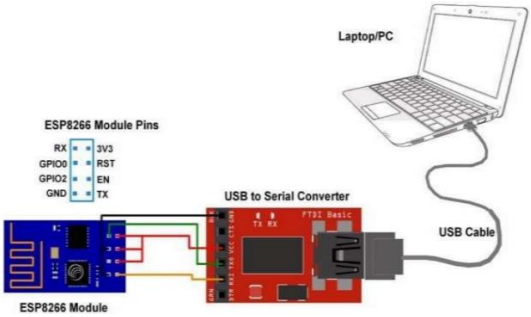

Fig.12.The connection to check and testing the NodeMCU to Port.

To activate the ESP8266 in flash mode, connect it only to a PC or laptop after making the connections shown in the above figure between the ESP8266 and the USB to Serial converter. Remember to connect the GPIO0 pin to ground. Next, select the START tab in the ESP8266 download tool and allow it to finish. Once the flash procedure is complete, unplug the ESP8266 module from your laptop or PC and cut the ground connection at the GPIO0 pin.

How can I begin using NodeMCU?

The NodeMCU Development board has serial communication protocols, analog and digital pins, and Wi-Fi functionality. It must first learn how to develop or obtain NodeMCU firmware for NodeMCU Development Boards before we can begin using NodeMCU for Internet of Things applications. And before to that, this NodeMCU firmware will be updated in accordance with our prerequisite. It easily obtains our customized NodeMCU firmware by using the online NodeMCU custom builds that are available.

IV. RESULT AND ANALYSIS

In summary, a notable step toward more effective and knowledgeable gardening techniques is the incorporation of IoT technology into a smart pot for the purpose of monitoring and controlling plant health. Through the measurement of vital characteristics like temperature, humidity, and moisture content, this device enables gardeners to make informed decisions and provide ideal growing environments for their plants. In addition to giving real-time access to the plant's status, storing this important data in the Arduino IoT Cloud also makes remote monitoring and control convenient. Solutions such as the smart pot show how IoT advancements can improve our relationship with nature, promote sustainability, and grow healthier and more vibrant plants as technology continues to collide with agriculture. This convergence of IoT sophistication with green thumb expertise lays the path to a more intelligent and environmentally friendly gardening and plant-care future.

Fig.13. Monitoring the moisture level, Humidity, Temperature when switch is in OFF and ON state in Mobile Visualization.

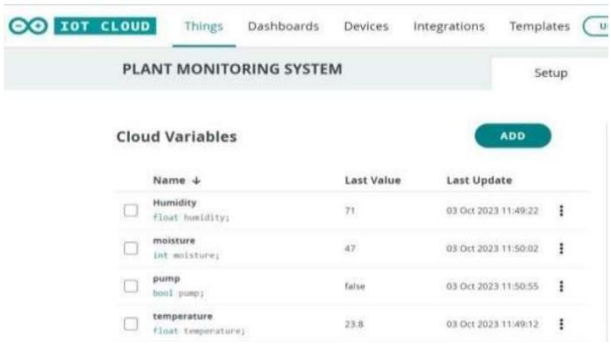

Fig.14. Parameters of plant monitoring system.

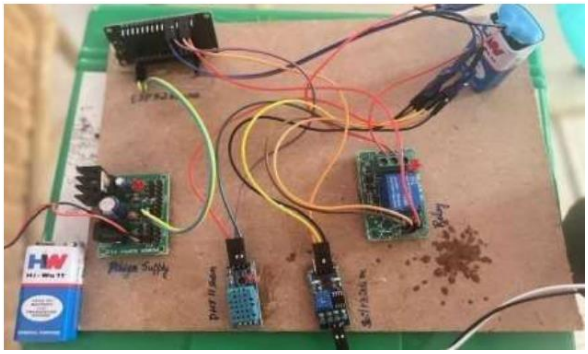

Fig.15. Live Demonstration.

Fig.16. The connections with running status.

V. CONCLUSION

Soil moisture using Node Mcu has been successfully constructed and tested. It was created by integrating the features of every piece of hardware that was utilized. Each module's inclusion has been thoughtfully chosen and arranged to enhance the unit's functionality. As a result, the Node Mcu Based Automatic Plant Watering System has undergone successful testing and design. The system's ability to operate automatically has been evaluated. The various plants' moisture levels, or water contents, are measured by the moisture sensors. The moisture sensor alerts the Node Mcu board, which turns on the water pump and supplies water to the appropriate plant, if the moisture level falls below the set and desired level. When the appropriate moisture level is reached. The water pump is shut off and the system stops on its own. As a result, the system's overall functionality has been thoroughly evaluated, and it is considered to operate satisfactorily.

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