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***Abstract*—Smart agriculture uses advanced technologies like IoT, drones, AI, and data analytics to optimize farming practices. It improves resource efficiency, boosts crop yields, and promotes sustainability through precise irrigation, targeted use of inputs, and early pest detection. Automation reduces labour costs, while minimizing environmental impact by conserving water and reducing chemical use.**

I. INTRODUCTION

Agriculture is the unquestionably the largest livelihood provider in India. With rising population, there is a need for increased agricultural production. In order to support greater production in farms, the requirement of the amount of fresh water used in irrigation also rises. Currently, agriculture accounts 83% of the total water consumption in India. Unplanned use of water inadvertently results in wastage of water. This suggests that there is an urgent need to develop systems that prevent water wastage without imposing pressure on the farmers. Over the past 15 years, farmers started using computers and software systems to organize their financial data and keep track of their transactions with third parties information plays a key role in people's lives, agriculture is rapidly becoming a data intensive industry where farmers need to collect and evaluate a huge amount of information from a diverse number of devices (e.g., sensors, farming machinery etc.) in order to become more efficient in production and communicating appropriate information With the advent of open source Arduino boards along with cheap moisture sensors, it is viable to create devices that can monitor the soil moisture content and accordingly irrigating the fields or the landscape as an when needed.

An agricultural field is a piece of land that is used to grow crops or other high-value plant species Many farms have a field border, usually composed of a strip of shrubs and vegetation, used to provide food and cover necessary for the survival of wildlife. It has been found that these borders may lead to an increased variety of animals and plants in the area, but also in some cases a decreased yield of crops.

II. LITERATURE SURVEAY

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 productivity of agriculture and it offers more opportunities for jobs in rural areas. Farmers are facing problems related to watering system that how much water has to supply and at what time? Sometimes over-watering causes the damage to crops and as well as waste of water. Hence for avoid such damage we need to maintain approximate water level in soil. In this paper, humidity sensor, moisture sensor, temperature sensors placed in root zone of plant and gateway unit (ESP8266) handles the sensor information and transmit data to a android application. This application is developed for measure approximate values of temperature sensor, humidity sensor and moisture sensor that was programmed into a micro-controller to control water quantity. This paper presents a smart irrigation system designed to address water management issues in Indian agriculture, where about 35% of land is reliably irrigated, and around two-thirds of agricultural land relies on monsoon rainfall. The dependence on seasonal rainfall creates challenges for farmers, including crop damage from over- or under-watering, and it hinders food security, productivity, and rural employment opportunities. The proposed system uses various sensors, including humidity, moisture, and temperature sensors, placed in the root zone of the plants to monitor environmental conditions. These sensors are connected to a gateway unit (ESP8266), which gathers and transmits the data to an Android application. This application displays real-time readings from each sensor, allowing farmers to understand the optimal water requirements for their crops and avoid over-irrigation or under-irrigation. The application is programmed to communicate with a microcontroller, 10 Dept. of CS&E,JNNCE Smart Agriculture Farming which can adjust the water supply automatically based on the sensor readings, thus maintaining the desired water level in the soil. This solution aims to improve agricultural productivity by efficiently managing water resources and reducing reliance on monsoon rains, which can, in turn, contribute to increased food security and better employment opportunities in rural areas.

III .Methodology

Smart agriculture is a rapidly growing field with immense potential, driven by the need to optimize farming processes, increase productivity, and address challenges such as resource scarcity, climate change, and food security.

Hardware Implementation

1. Automatic water flow diagram

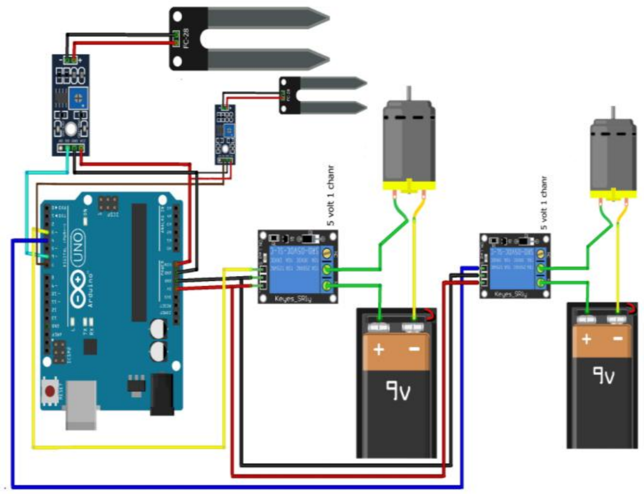

Fig 1 : Automatic water flow diagram

When the system is powered on, the NodeMCU initializes all the connected components, including the soil moisture sensor and the relay module. The NodeMCU begins by connecting to the local Wi-Fi network (if needed) to allow remote monitoring or control, though this step can be optional depending on whether you need IoT integration Soil.

2. *Measuring soil moisture, temperature and humidity*

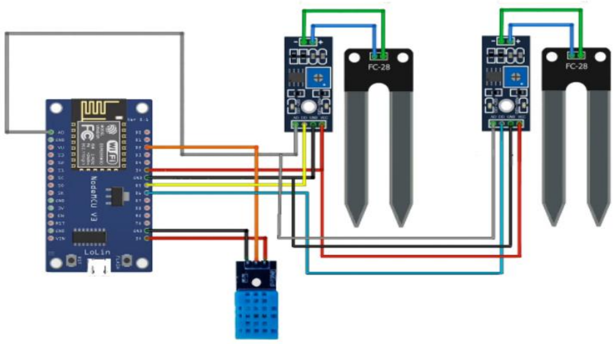

Fig 2: Measuring soil moisture, temperature and humidity

Monitoring soil moisture using a NodeMCU and controlling or displaying the data via the Blynk application is a popular IoT project. Here's an explanation of how the setup works.

3.NodeMCU

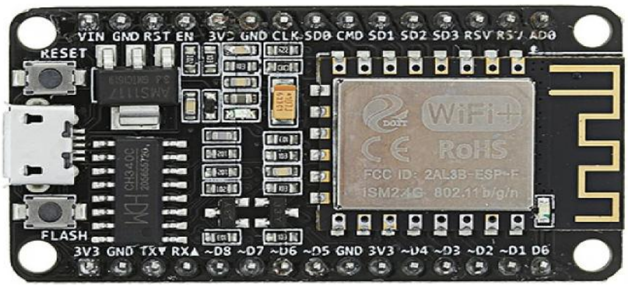

Fig 3: NodeMCU ESP8266

The ESP8266 NodeMCU CH340 board has ESP8266 which is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

4. Soil moisture sensor

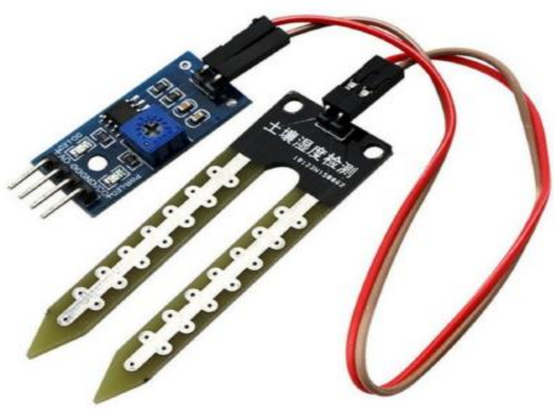

Fig 4:Soil moisture sensor

In this proposed system the soil moisture sensor is one part of the wireless sensor unit. Used to measure the moisture content of the soil. It helps monitor soil conditions, ensuring optimal water levels for agriculture, gardening, and landscaping. The sensor typically works by measuring the electrical resistance or capacitance of the soil, which changes with moisture levels. Data from these sensors can be used to automate irrigation systems, reducing water waste and improving crop yields. The Copper electrodes are used to sense the moisture content of soil.

5. Relay Module

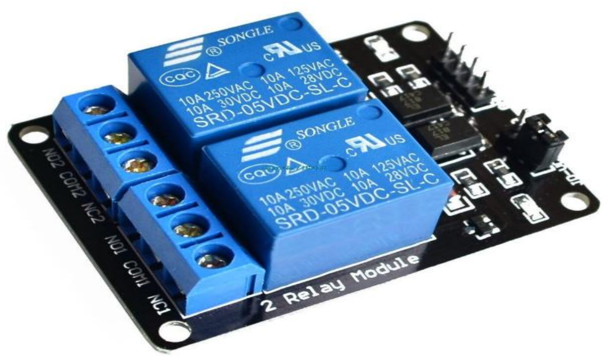

Fig 5: Relay Module

2-Channel 5V Relay Module is a relay interface board, it can be controlled directly by a wide range of microcontrollers such as Arduino, AVR, PIC, ARM and so on. It uses a low level triggered control signal (3.3-5VDC) to control the relay. Triggering the relay operates the normally open or normally closed contacts. The relay has two outputs-normally open and normally closed (NO and NC). When the IN1 or IN2 pin is connected to ground, NO will be open and NC will be closed, and when IN1 or IN2 is not connected to ground the opposite occurs. ... A microcontroller can also be used to control IN1 and or IN2 and cause the relay to trip. Since the relay has 5V trigger voltage we have used a +5V DC supply to one end of the coil and the other end to ground through a switch. ... The purpose of the diode is to protect the switch from high voltage spike that can produced by the relay coil.

6.DC 3-6 V Mini Micro Submersible Water Pump

Fig : DC 3-6 V Mini Micro Submersible Water Pump

Micro DC water pump is a low cost, small size Submersible Pump Motor which can be operated from a 3-6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Mini water pumps have diverse applications, including household uses (drainage, water circulation, aquarium filtration), agriculture (irrigation, livestock watering, pond management), and industrial uses (cooling, lubricating, liquid transfer). The operator connects the DC water pump to a power source and switches it on. Electricity flows through the motor, causing it to turn.

7. DHT11

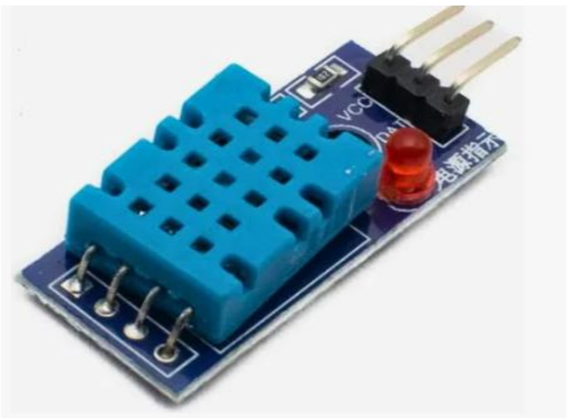

Fig : DHT 11

DHT11 is a digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc… Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

IV. Implementation details

1. *Blynk Cloud Application:*

Blynk Cloud is the backbone of the Blynk IoT Platform, facilitating seamless communication between IoT devices and the Blynk application. It allows developers and users to interact with their hardware projects remotely using the internet.

Key Features of Blynk Cloud

- Device Connectivity:
  Acts as a central server where IoT devices (like NodeMCU, ESP32) send data. Devices can also receive commands from the app via the cloud.
- Real-Time Communication:
  Provides instant synchronization between the device and the Blynk app for real-time data visualization and control.
- Virtual Pins:
  Enables flexible and structured data handling. Virtual pins are used to send and receive data between the device and app widgets.
- Cross-Platform Access:
  Accessible from smartphones (iOS and Android) and web dashboards for monitoring and managing devices.
- Scalability:
  Handles multiple devices and projects simultaneously. Suitable for individual DIY projects or large-scale IoT deployments.
- Notifications and Automation:
  Configurable notifications based on triggers (e.g., when a sensor reading crosses a threshold).Supports automation logic for controlling devices based on conditions.
- Blynk API for Customization:
  Allows users to build more advanced features or create custom apps that communicate with their IoT devices over the Blynk cloud or private server.
- Blynk Server (Local/Private Option):
  Blynk Server: You can run your own **Blynk server** locally, which gives you full control over data storage, security, and device management.

2 .Arduino UNO Language:

Arduino programming is based on C/C++ with additional functions and libraries provided by the Arduino API to simplify hardware interaction. It is written in the Arduino IDE, which makes coding and uploading sketches (programs) to Arduino boards straightforward.

Key Features of Arduino Language:

- Arduino Sketch: Each program is called a "sketch. Contains two main functions:
  setup(): Runs once at the start of the program, used for initialization (e.g., setting pin modes).
  loop(): Runs continuously after setup() to execute the main logic.
- Simplified Syntax:
  Pre-built functions like digital Write(), analog Read(), and delay() make it easy to interact with hardware.
- Predefined Libraries:
  Libraries like Wire, Servo, and LiquidCrystal.h extend functionality, supporting various sensors and modules.
- Pin Mapping:
  Arduino provides abstractions like pin Mode() to configure pins as input/output and easily control connected devices.
- Input and Output Pins**:**
  i.14 Digital I/O Pins: These can be used for both input and output, with 6 of them capable of **PWM** (Pulse Width Modulation) output.
  ii.6 Analog Inputs: These pins allow you to read analog signals, useful for sensors.
  iii. 1 Serial Communication Pin (UART**)**: For serial communication with other devices.
- Open Source:
  Arduino Uno's hardware and software are open-source, making it easy for developers and hobbyists to modify and customize the board to suit their needs.

V. RESULTS

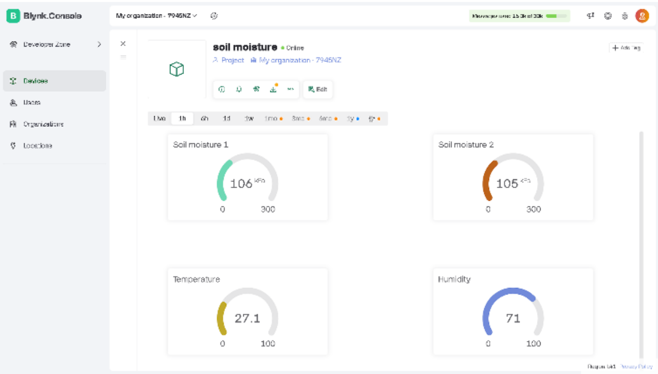

Fig 2: Temperature and moisture analysis

In Fig 2 In **Blynk Software**, displaying **temperature** and **moisture** data is an essential feature for real-time monitoring and analysis of environmental conditions. The platform provides an intuitive and customizable interface for visualizing this data, making it easy for users to monitor key metrics such as temperature fluctuations and moisture levels from anywhere using a mobile app or web dashboard.

Fig 3: smart agriculture model

In Fig 3 **smart agriculture farming**, **plants** are at the heart of the ecosystem, and leveraging technology to monitor, manage, and optimize plant health and growth is essential for maximizing yields, minimizing resource usage, and promoting sustainability. The integration of **IoT** (Internet of Things), **sensors**, **data analytics**, and **automation** systems has revolutionized the way plants are cultivated, ensuring precise care and efficient farming practices.

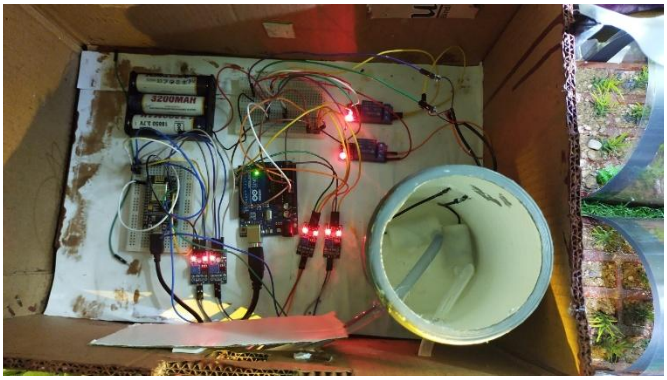

Fig 4**:** Control room

In Fig 4 The **Arduino** and **DHT11** sensor can be connected in a simple circuit to monitor **temperature** and **humidity**. The DHT11 sensor has a **single data line** for communication, and you only need a few basic components to set up the connection.

Below is a detailed description of the circuit connections between an **Arduino** board (e.g., Arduino Uno) and the **DHT11** temperature and humidity sensor.

VI. CONCLUSION

The implementation of smart agriculture demonstrates the potential to transform traditional farming practices through the integration of advanced technologies such as IoT, artificial intelligence, data analytics, and automation. By leveraging these tools, farmers can optimize resource utilization, improve crop yield, and reduce environmental impact. Smart agriculture systems enable precise monitoring of soil health, weather conditions, and crop requirements, allowing for real-time decision-making and efficient resource management.

Additionally, automated systems reduce manual labour, save time, and enhance overall productivity.

This project highlights that smart agriculture is not just a pathway to achieving sustainable farming but also a critical response to challenges such as climate change, water scarcity, and the growing demand for food. Future work should focus on making these technologies more affordable and accessible to small-scale farmers, ensuring widespread adoption and global agricultural resilience.

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