An IoT-based Irrigation Monitoring and Control System

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***Abstract*— The main goal of this effort is to modernize the conventional agricultural system and improve present agricultural practices by utilizing cutting-edge technologies. Saving time in the field, cutting costs, and reducing danger are all possible with remote irrigation monitoring and control. "Irrigation Monitoring and Control System based on IoT." This is a very helpful project that allows the user to monitor and manage the water supply from a distance. This system makes advantage of the IoT concept (Internet of Things). Therefore, for our project, we use a Wi-Fi module to link our approach to the internet. The Arduino Uno board is used to transmit the control signals. Using a moisture sensor, the circuit continuously monitors the soil's moisture content, and updates the "Moisture level". The user can then remotely check the moisture content of the soil and manage the water delivery. The user must switch the status from "ON-OFF" or "OFF-ON" to accomplish this; the "water pump" will then be "turned ON" or "turned OFF" in accordance. As a result, the "soil moisture" is measured and the "water supply" is manageable. Therefore, the user should not be concerned that his plants or crops may suffer from "water-logging" or "drought".**

Keywords*— *IoT-based, irrigation monitoring, agriculture, moisture sensor, Arduino Uno, remotely.

I. Introduction

In the past Farmers used to determine the soil's maturity and manipulate suspicions to determine what kind of yield to produce. Firstly, they failed to consider the climate conditions that are increasingly harmful to farmers, such as humidity, water levels, and temperature. Through a wide variety of tools, the Internet of Things (IoT) is revolutionizing the agricultural industry and empowering farmers.

Secondly being a low-water stress country is a cause to rejoice for Bangladesh, where Persistent drought, heat, electrical brownouts, and overconsumption caused the demand for water to go up day by day therefore the land of water, Bangladesh faced water stress throughout the years thus making the proper management and distribution of water a necessity.

For every 100 liters of water, farmers use 35% for required irrigation and the remaining **65%** is wasted. Our goal in this research is to help these farmers by designing and manufacturing a remote-control system that runs and shuts down irrigation pumps through modern technology and IoT. IoT refers to various IoT devices having unique identities and capabilities to perform remote sensing, activating, and live monitoring of specific data. It includes a microprocessor/ microcontroller, I/O units, storage devices, RAM/ROM, and networking components. We will be using sensors for the physical layer, a cloud storage system for data collection as the network layer and The user-facing layer is responsible for delivering specific services to the user.

We start by getting information on the fertility of the soil and then measuring the moisture level in the soil. In this system water pumps are placed in water and soil moisture sensors are placed at the root of the plant near the module. So for our project, we connect our system to the internet using a Wi-Fi module. Through the use of a moisture sensor, the circuit continuously monitors the soil's moisture content and updates the website's "Moisture level" information. The user can then monitor the current moisture level and manage the water supply from a distance. The user just needs to change the "Motor status" from "ON-OFF" or "OFF-ON" to accomplish this; the "water pump" will then be "switched ON" or "turned OFF" as necessary. Thus, by just switching the "Motor status," the "soil moisture" is monitored and the "water supply" is managed.

We use an Arduino Uno board to send the control signals and to connect to our desired website.

On the website, two things are displayed:

a) Motor status and b) Moisture level

While it may not be possible for a person to be constantly present in his or her garden, this project can be used to maintain track of "soil moisture" and assure the correct water supply even from a distance. This technique can also be helpful for persons with small gardens.

II. Proposed System Topology

This project is driven by a variety of sensors, which are input into it and then processed by an Arduino Uno according to the project's requirements. First, the moisture sensor needs to assess the soil's condition. You can have either dry or wet soil. There is a water pump connected to this sensor. The pump will automatically turn on when the soil's dry level is high in such a situation, and this information is saved and stored in an online server. In the meantime, the user will receive information about the pump's status and the detection the soil moisture as well as water level.

Second, the water flow can be measured with a water level sensor. This pump must be turned off after a certain amount of time. The condition of the moisture sensor and water level when the pump is turned off will be moderate. Additionally, the user's notification bar displayed the notification that the pump had been turned off. It will provide the user with additional temperature and humidity information.

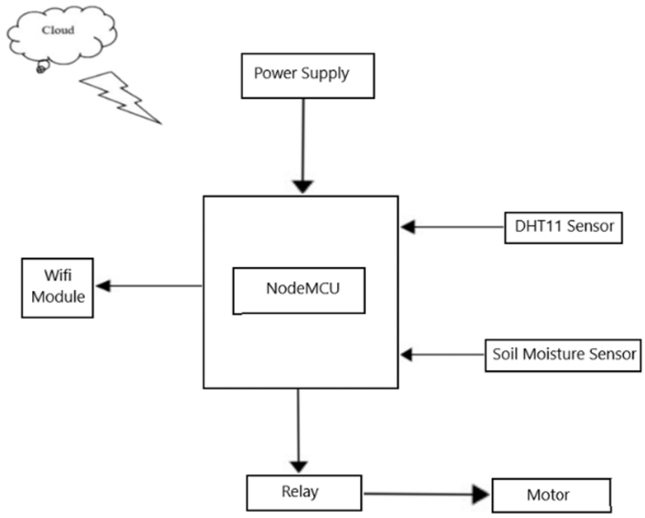


Fig. 1. The Block Diagram of the proposed system

We can use soil moisture sensor or DHT11 sensor, but for this we've only used soil moisture sensor.

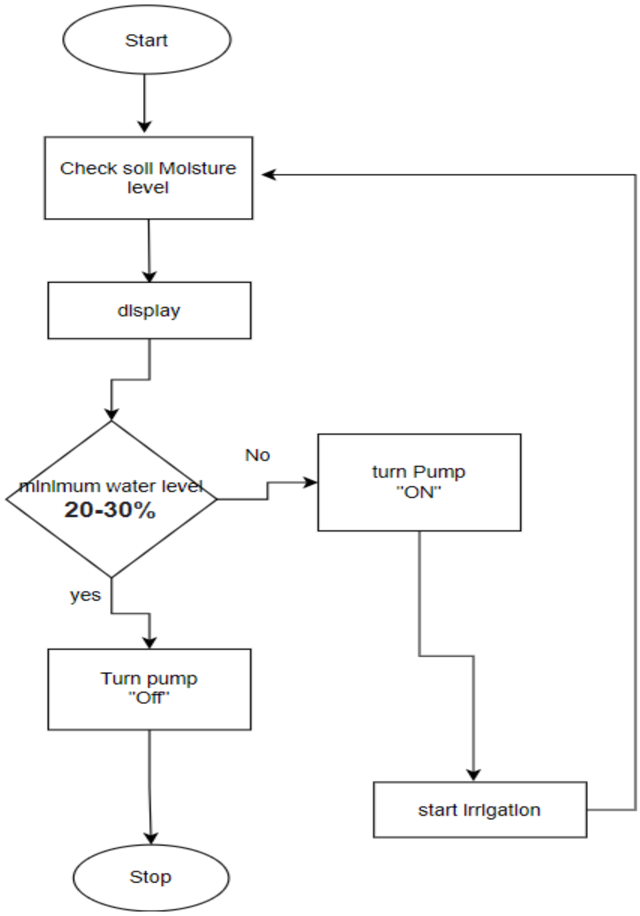


Fig. 2. The workflow system

We start by getting information on the fertility of the soil and Displaying it, if the water level crosses the minimum requirement then the pump will be turned "OFF" again if the moisture level is below the minimum then the pump will be turned "ON" and start the irrigation later on measuring the moisture level in the soil it will be displayed and then restart the process. In this system water pumps are placed in water and soil moisture sensors are placed at the root of the plant near the module.

III. Proposed System Design and Simulation

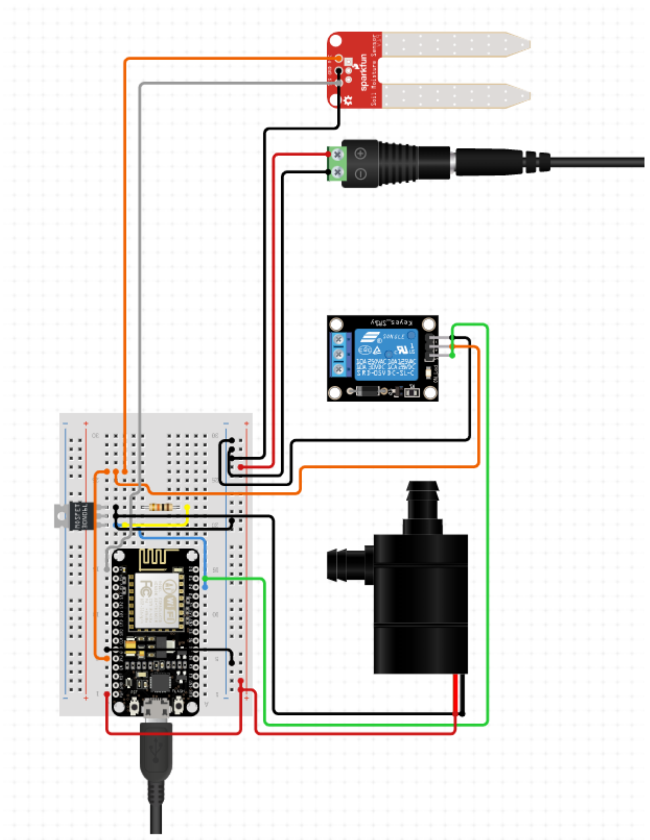


Fig. 3. The simulation of the proposed system

A software simulation is conducted before the hardware development and testing. Here the pin connections will remain the same as that of the hardware, power is supplied through a 5V Female DC power adapter.

For the project's internal system, the prototype uses a pump that turns on and off using relays. The NodeMCU ESP8266 is a microcontroller that has built-in programmable 2.4GHz wi-fi and is used to control electronic equipment. It also allows for the creation of an environment for developing applications on hardware using open-source software (SoC). For the project demonstration, this module has been used to make the system work wirelessly and enable the controlling of the irrigation system.

IV. Hardware Development and Testing

A proper circuit connection was built between Arduino Uno, the relay module, the wifi module for making it IoT-based, a submersible water pump, and Rtc the real-time clock with male-female jumper wires.
Pin connections with NodeMcu based on ESP8266 wifi module:

Moisture sensor
VCC to adapter positive end
GND to adapter negative end
A0 to NodeMcu A0

Relay module
VCC to adapter positive
GND to adapter negative
IN to D4 of Nodemcu

Vin pin to +ve end adapter
-ve end of Adapter to GND pin

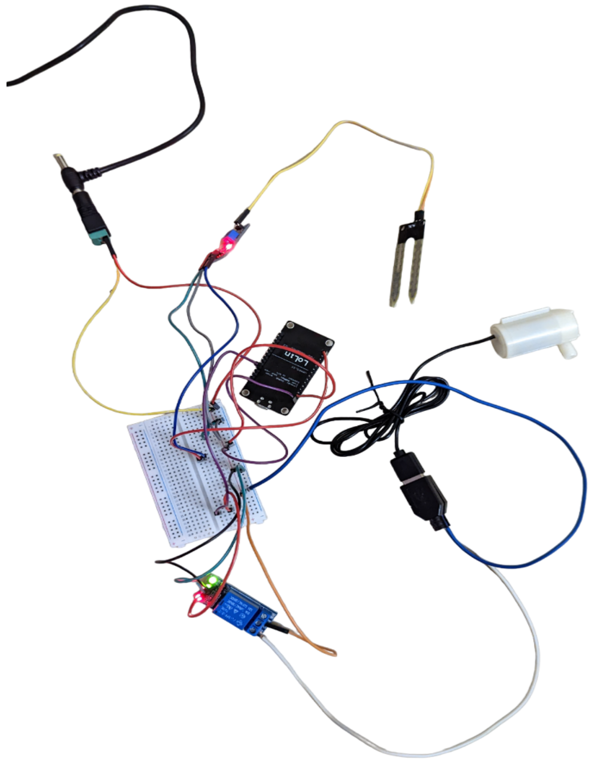
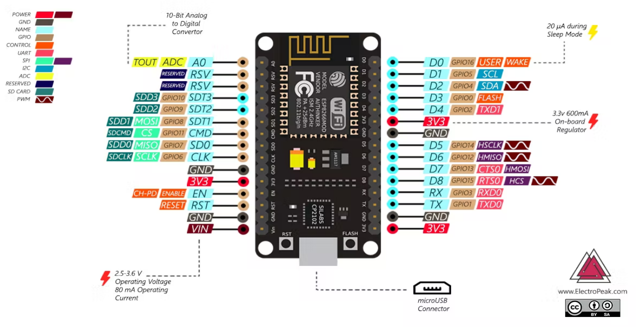


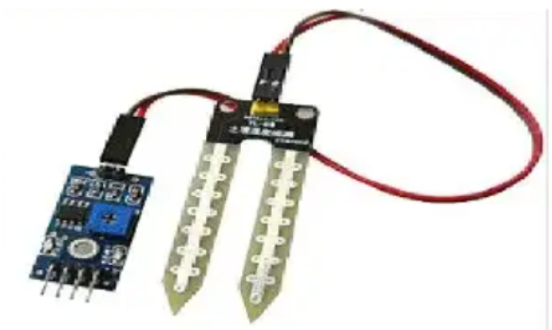
Fig. 4. The Developed Hardware and it's testing

NodeMCU is an open-source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, etc, it can solve many of the project's needs alone.



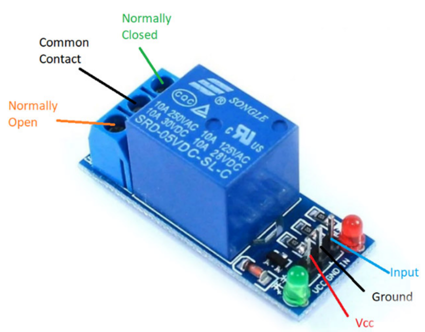
1. The NodeMcu and pin details

The Soil Moisture sensor is used to determine the soil's moisture level. If the sensor detects the soil moisture value above the threshold point, the digital output will be low level (0V) and, if it is below the threshold level, the digital output will be high (5V). The present soil moisture value is read explicitly using the wireless button to see whether it is above a threshold.



2. Soil Moisture Sensor

Relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single-channel relay module is much more than just a plain relay, it comprises components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.



3. Relay Module

These pumps are cheap and useful for prototyping but they won't last very long under an intensive workload, so they are good for prototyping and projects that require watering from time to time and not a continuous water flow.

4. Submersible water pump

V. Result and Performance Analysis

Several standard performance evaluation metrics were proposed to evaluate the accuracy of prediction results, such as the coefficient of determination (R2), mean squared error (MSE), root mean square error (RMSE), mean absolute percentage error (MAPE), and mean absolute error (MAE).

The coefficient of determination (R2) is considered one of the important measures for verifying the performance of predicting models, which has an approximate value from 0 to 1. The closest (R2) value to 1 is indicated as the best performance result, and it can be defined as in Equation (1)

$$R^2 = 1 - \frac{\sum_{i}^{n} (y_i - f_i)^2}{\sum_{i}^{n} (y_i - \bar{y}_i)^2} \quad (1)$$

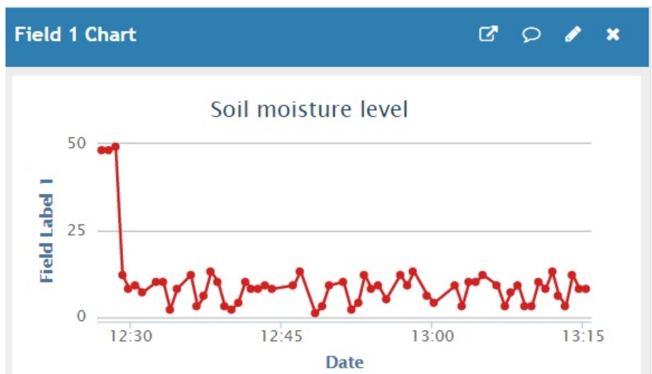


Fig. 5. Predicted Result and Performance Analysis

For Field, Label - 1 collected data of soil moisture level gradually falls from 50 of the day 1 starting from 12:30 pm till 13:15 pm and with each fall of the soil moisture the pump is turned on to maintain the required moisture level of the soil.

For calculating the soil moisture content:

$$SMC = \left(\frac{Depth\, m^3}{Volume\, m^3} \right) \times 100 \qquad (2)$$

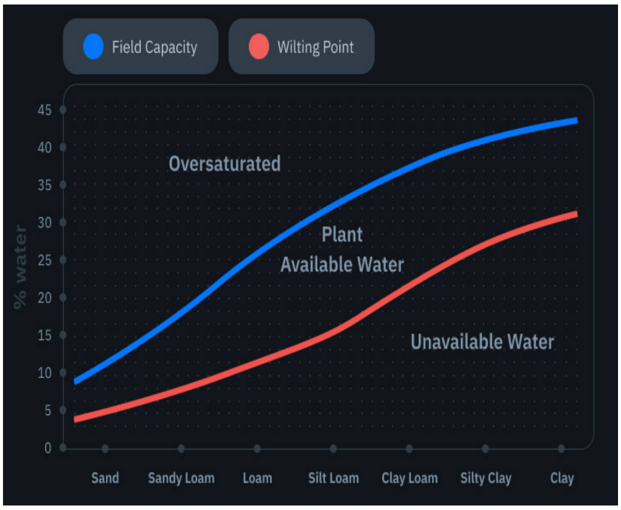


Fig. 6. Moisture requirement for different soil

The required soil moisture will vary on the basis of which type of soil it is thus making moisture requirements for various crops different as well. Sandy soil requires less water while clay requires the maximum of it.

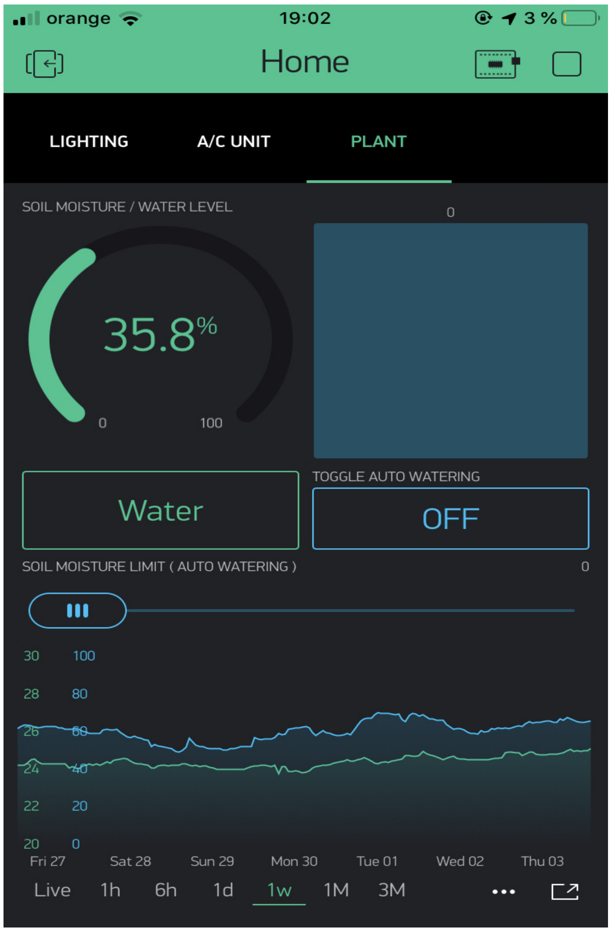


Fig. 7. BLYNK app interface

For user interface, android version of Blynk app with custom designed layout and buttons was used to facilitate monitoring and controlling various connected things.

Fig. 8. Final Project

VI. Conclusion

Agriculture computerization by the emergence of various technical innovations like the Internet of things (IoT) and cloud computing offers a substantial opportunity to implement advanced solutions aimed at improving rural infrastructure for the benefit of smart irrigation. In particular, the combination of IoT technology and cloud computing used for agricultural applications, through the automation and digital control of all farm production. The major challenge faced by the irrigation process is saving the wasted water. In this paper, we proposed an IoT based approach automatic irrigation system for controlling the agriculture pumps, and remote monitoring system. The Sensors are connected to the network, acquire and transfer data to the cloud. The system allows for better incorporation of the real environment with computer-based structures resulting in increased economic benefits. Tests to show the efficacy of our proposed project performed using the BLYNK platform.

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