IoT and Cloud hinged Smart Irrigation System for Urban and Rural Farmers employing MQTT Protocol

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***Abstract*—A rapid change in the technologies can be seen in the fields of sensing, monitoring, communicating and actuating applications due to the evolution and development in the Internet of Things. Making use of this development in the era of polluted environment and evaporating agriculture, we designed a system to monitor the state of soil with sensors connected to Node MCU by analyzing and predicting the data with the help of the WEKA tool by using Raspberry Pi 3 as a broker for MQTT protocol. The key pay off of this system is to avoid human tampering with a low-cost design using IoT and MQTT to get Volumetric Water Content (VWC) in the soil. It is with the hope that this research can provide the current modernity in IoT for the most sophisticated research improvements.**

Keywords—sensors, internet of things, volumetric water content, raspberry pi 3, thingspeak cloud

I. Introduction

Agriculture is the main source of food in almost all countries [1] in the world. All these countries are still relying on labor work who doesn't know about the usage of specific pesticides for a specific crop. The hardest part to accept here is that labor is unaware of the amount of water to be used in a specific season. Here is the place where IoT acts as a kernel in watering the fields with the help of various sensors and antiquate data. With this, we can raise agricultural growth in the country gently. The communication between the IoT devices should be done by an IP address [2]. Nowadays, the world is associated with the internet around 5 billion objects. Almost 50 billion things or objects are connected to the web or internet in the year 2020. Fig. 1 illustrates the characteristics of IoT as shown below.

Fig. 1 Characteristics of IoT

II. Related Works

Vani et al. [4] have proposed in monitoring and measurement of agricultural parameters is vital in developing agriculture. The paper describes the design and development of the system for monitoring and measurement of soil moisture using the Android system and IoT Cloud and also the sensors for detection, Wi-Fi router for connection and a launchpad. The real-time data regarding the agriculture field is recorded by using Cloud technology and the Blynk app. The farmers can observe the field data anywhere and respond quickly depending upon the soil moisture. Rajeswari et al. [5] have explained to increase the better crop order and predict the crop yield based on the past crop order in the identical agriculture farm with the soil nutrients information (N, P, K) for the sustainable smart agriculture field. By keeping soil with health intact for minimizing the cost of fertilizer needs and improving crop production. Hence the expenses of agricultural products are controlled, and the farmers can access notifications in the form of current schemes for agriculture through mobile phones. Mekala et al. [6] have proposed Cloud computing with IoT technology. Li-Fi, when compared to Wi-Fi, provides good efficiency, security, and bandwidth. This paper describes two performance tasks like smart warehouse management which includes temperature and humidity maintenances. Warehouse management involves theft detection, spraying, weeding, animal, bird scaring, keeping vigilance, moisture sensing and so on. These activities are the remote-controlled process. Ali et al. [7] proposed a new Green IoT for real-time applications and economical based Precision Agriculture Monitoring System (PAMS) which is having less power consumption, less Green House Gas (GHG) emissions, and to help the farmers with an adaptable alliance. To monitor the changes in the parameters with their farms constantly from all over and anytime using their smartphones. Raikar et al. [8] proposed the amalgamation of Cloud computing (Cc) and the Internet of Things (IoT) for providing the finest solution to smart applications. With the help of wireless Sensor Networks (WSNs) and Raspberry Pi 3 are treated as one of the most essential peripherals in IoT and established a novel route of mature in the field of agriculture area. The increase in the performance of a smart irrigation system makes use of lightweight protocol like Message Queuing Telemetry Transport ((MQTT)) is to maintain effectively and protect the connection between the device/sensors and the users. Jino Ramson et al. [9] Explained on Sensor Networks based Water Quality Monitoring Systems for Intensive Fish Culture -A Review. This review describes the water quality monitoring in the all-inclusive fish culture concerns fostering fish in farms, tanks or some enclosures, it usually for food. With the help of Wireless Sensor Networks (WSNs) for monitoring the water quality monitoring parameters like temperature, pH, dissolved oxygen, electrical conductivity, etc and it was taken time to time measured and controlled for the proper growth of fish. By using various wireless technologies like Wi-Fi, Zigbee, GSM-based monitoring systems have been studied in this article.

III. PROPOSED SYSTEM

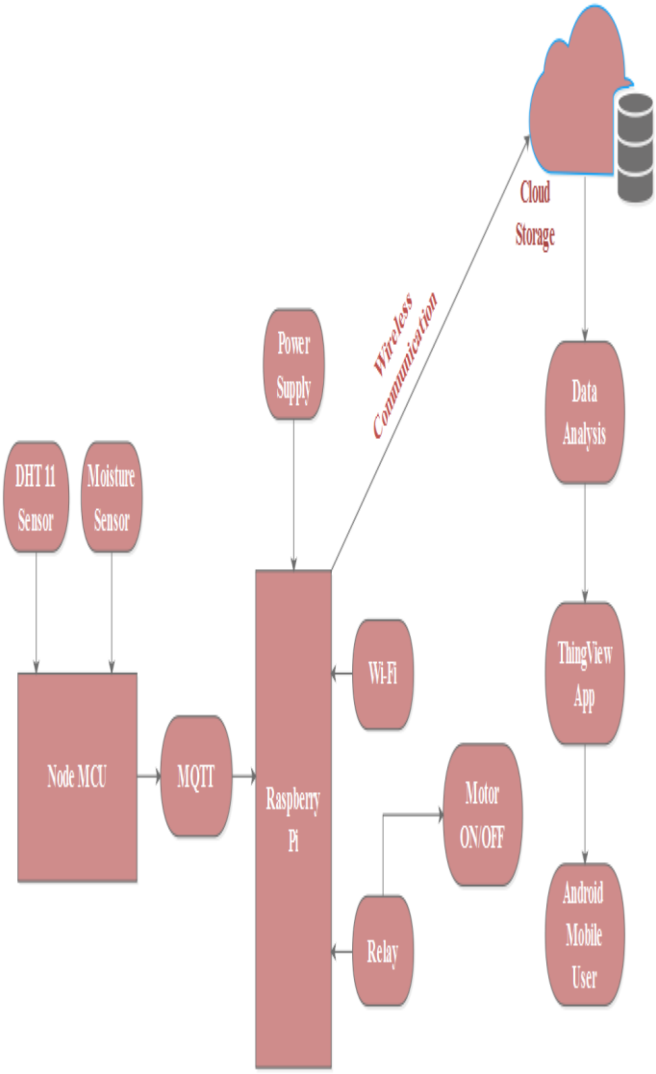

Fig. 2 Proposed System Architecture

In our proposed methodology, as shown in the above fig. 2. We connected DHT-11 and moisture sensor to Node MCU which acts as a client/subscriber of MQTT. The Raspberry pi [10] used in our system acts as a broker of MQTT through which the motor is switched on/off based on the prediction done by our data analysis tool. This tool named WEKA used in our proposed system accepts data from various sensors as training data and a model is generated which is later used as a model for testing the future data to predict the switching condition of the motor connected to the raspberry pi 3 and smart irrigation system schematic diagram as shown in the below fig 3.

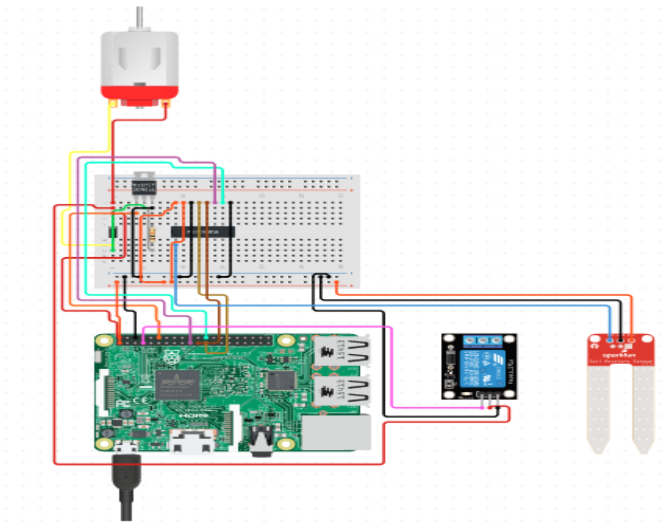

Fig. 3 Smart irrigation system schematic diagram

IV. WORKFLOW MODEL

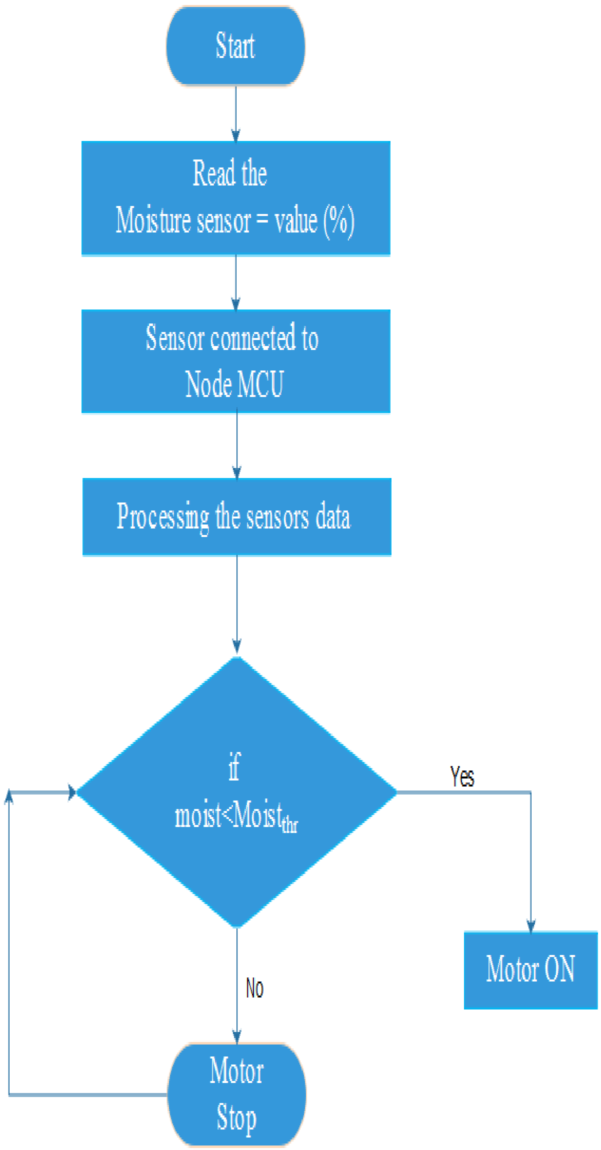

Fig. 4 Proposed workflow model

V. SENSOR DATA ANALYSIS

Digital data from DHT-11 giving temperature and humidity values along with Digital data from the in-built ADC of Node MCU connected to moisture sensor [11] are sent to cloud through Raspberry pi via MQTT a light-weight protocol and are analyzed for predicting the class switch on/off the motor connected to Raspberry pi with a relay. The prediction is done in the cloud or by a tool named WEKA locally.

VI. MQTT PROTOCOL

In our article, we use Raspberry pi as a MQTT broker as well as a server and Node MCU as an MQTT client subscribed to various topics on the publisher like data from moisture, humidity, and temperature sensor and is analyzed in the cloud and is visualized in ThingSpeak website and ThingView mobile application of our rural and urban farmers.

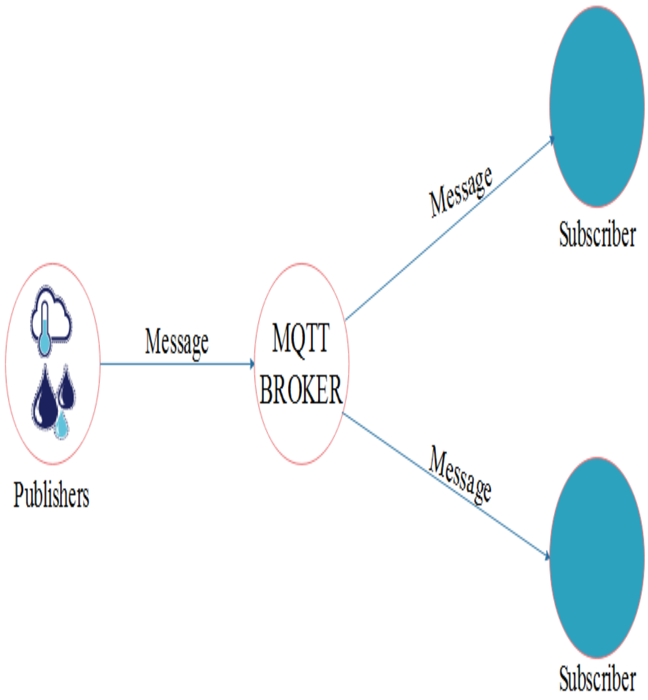

Fig. 5 Workflow of MQTT Protocol

VII. SIMPLE ALGORITHM

1. ALGORITHM:

λ_1- min (Threshold)
λ_2- max (Threshold)
n- Total no sensed values
i- 0 to n and i-i+1
Input: Sensor data (x)
Output: Status of sensor data (x)
If (x[i] $\geq \lambda_1$and x[i] $\leq \lambda_2$)
Print ("Moisture is good")
Else
Print ("Moisture is bad")
End if
End

VIII. SYSTEM LAYER ARCHITECTURE

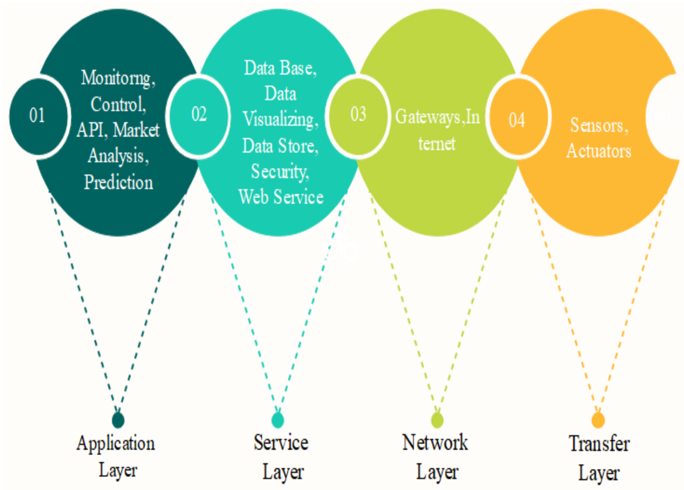

Fig. 6 IoT Layer Architecture

Different IoT devices connected over a network through above mentioned four layers as shown in fig 6. A four IoT System [12] Layer Architecture (SLA) consists of four layers such as Transfer Layer (TL), Network Layer (NL), Service Layer (SL) and Application Layer (AL). These layers are carried out the data from the sensors to end-users. This architecture gives insight into different agricultural fields.

IX. RESULTS AND DISCUSSIONS

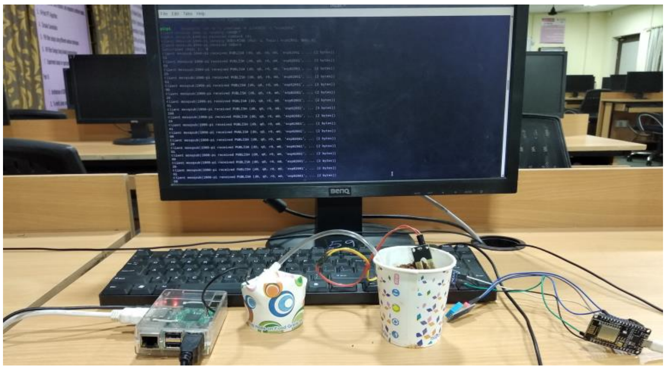

Fig. 7 Implementation of hardware

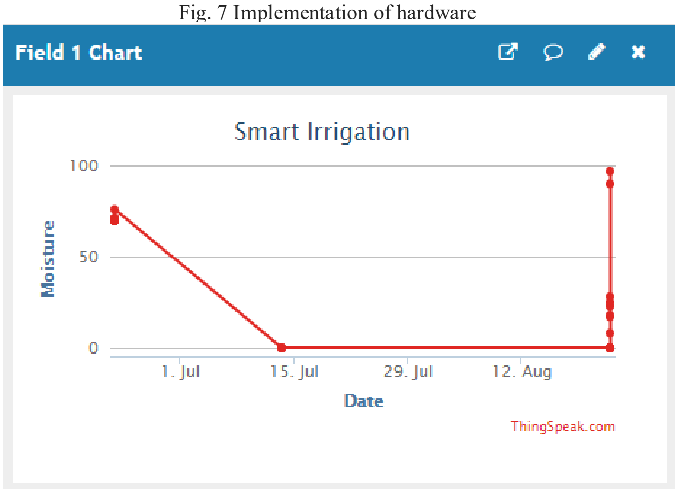

Fig. 8 ThingSpeak output for moisture level 72%

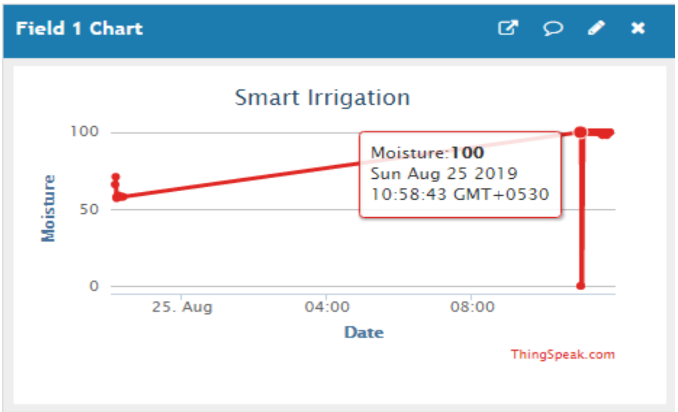

Fig. 9 ThingSpeak output for moisture level 100%

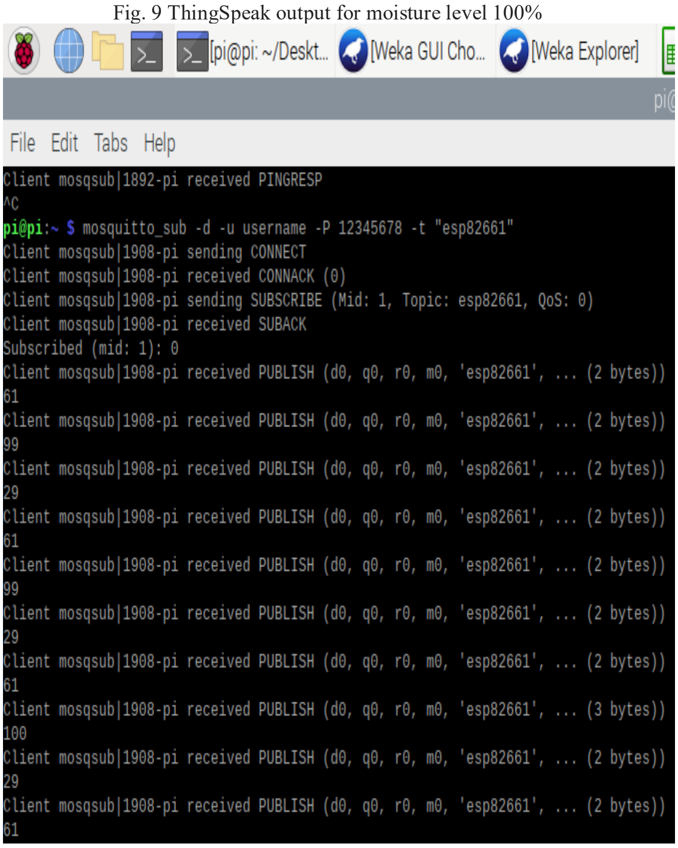

Fig. 10 Sensor data received at MQTT broker

Fig. 11 Training and testing data from Node MCU to MQTT broker

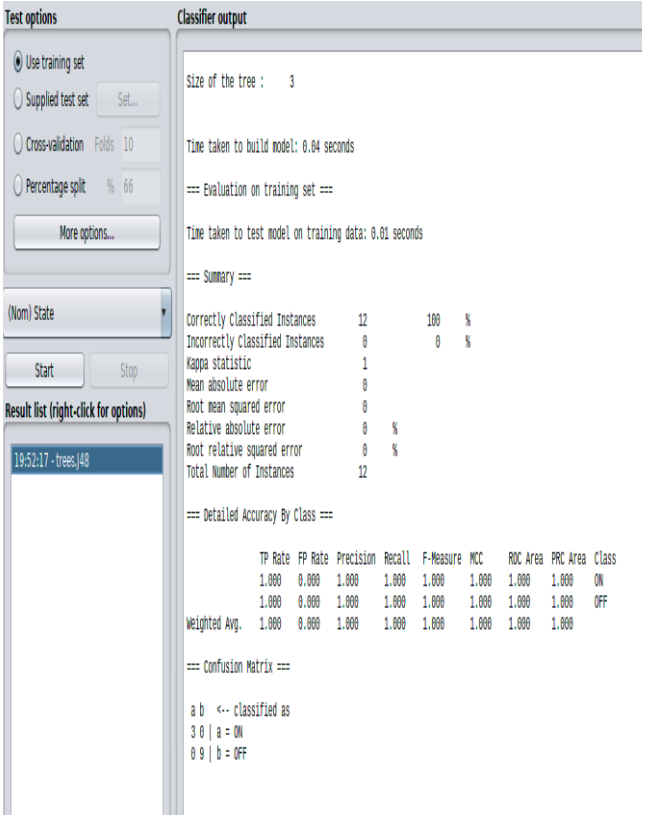

Fig. 12 After applying testing dataset to WEKA tool

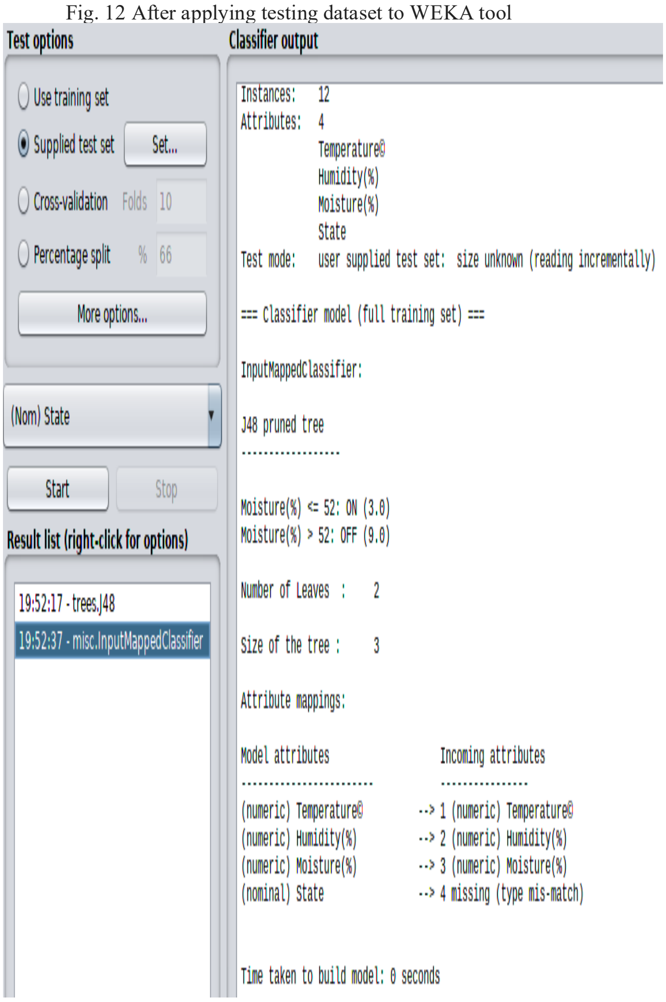

Fig. 13 After applying testing dataset to WEKA tool

X. CONCLUSION

In the present era, everyone is focusing on interfacing the basic need of people which is sustainable irrigation and technology. The main idea of this article is to interface the raspberry pi 3 and the sensors connected to Node MCU through MQTT protocol for tracking the agriculture needs of the farmers especially water, through this, we will be able to validate the above comments. The moisture sensor's data connected to Node MCU is analyzed at the cloud or with the WEKA tool locally which is the best part of our paper provided with the least cost possible.

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