IOT Based Smart Irrigation System

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***Abstract*— This work reports a design of SMART IRRIGATION system. This project uses ESP32 Wi-Fi module which connects the system to the internet. The system monitors moisture level of the field using soil moisture sensor. Based on the information received from soil moisture sensor, ESP32 module controls relays and solenoid valves for supplying water to the field. The moisture level data is acquired from sensor in real time and sent to the cloud based MQTT broker which can then accessed by the user. The system is monitored and controlled by an android application on user Smartphone.**

Keywords*— *MQTT (Message Queuing Telemetry Transport) protocol, IOT-Internet of Things, cloud, soil moisture sensor, ESP32 module.

I. INTRODUCTION

India is the country where agriculture performs key role in the country development. Fifty to sixty percent of Indian population is directly or indirectly depends on agricultural analogous activity and most of the agriculture is depends on monsoons which has inadequate water source. A farmer of small villages has to go to farm at odd hours or in the middle of night to check moisture level in the farm and to switch on and off the water pump. To alleviate this problem smart irrigation concept can used in agriculture field. In these concept a new system is designed that convert conventional agronomy into smart agronomy.

This paper aims to develop a simple system that controls water supply to farm by sensing the moisture level of soil with the help of soil moisture sensors and ESP32 module. The main objective of the system is to collect the information from soil moisture sensors and transmits this data to the user whenever the user wants to see the soil moisture status and water pump status. The ESP32 controller acts as gateway server for coupling to the internet. We used four soil moisture sensors which measures analog values, Four Channel Relay Module, ESP32 controller, four Solenoid Valves for our system.

In this system soil moisture sensors are situated into field for measurement of water content in the field and according to the moisture content water pump state will decide, so there is no need to turn the water pump switch on and off by being physically present at the field. The benefit of system is that farmer can control the switching of water pump automatically as well as manually through the mobile phone with internet connectivity.

In this project we used MQTT (Message Queuing Telemetry Transport) protocol for transmitting and receiving sensor data as MQTT is tremendously simple, lightweight, Publish/Subscribe messaging protocol with low bandwidth requirement. Depending on moisture status ESP32 module controls the action of water pump and displays relay state as well as soil moisture sensor data in mobile application. In this way simple, reliable, adaptable and economical system is evolved to solve the agriculture issues.

II. PROBLEM STATEMENT

1. Design and development of wireless sensor node for measurement of soil moisture levels and transmitting data to cloud based server.
2. Design user interface to check the moisture data and system status retrieved from cloud based server on client device to perform corresponding action.

III. OBJECTIVE

1. To design the data acquisition system to measure moisture level of soil in farm.
2. To accomplish wireless data transfer between the data acquisition system and cloud based server with the help of MQTT protocol.
3. To design and implement the software module for retrieving the soil moisture data from local or cloud based server on client device such as mobile phone.
4. To design and implement power supply unit using lithium ion battery as its prime power source and solar panel for charging the battery.

IV. SYSTEM DESIGN AND IMPLEMENTATION

Fig shows the block diagram of the entire system which implements using NODEMCU that act as heart of system, solenoid valves and relays, soil moisture sensors, power supply unit, cloud MQTT and user application.

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The soil moisture sensors measures moisture level of filed in analog form and the measured data is transmitted on user application through cloud. User can set moisture level and mode of operation through android application. In automatic mode, based on selected moisture level, system will automatically control the water pump action whereas in manual mode user have to control water pump action remotely through android application. According to received command from user, NODEMCU will monitor system function. The supply to the whole system is from solar source.

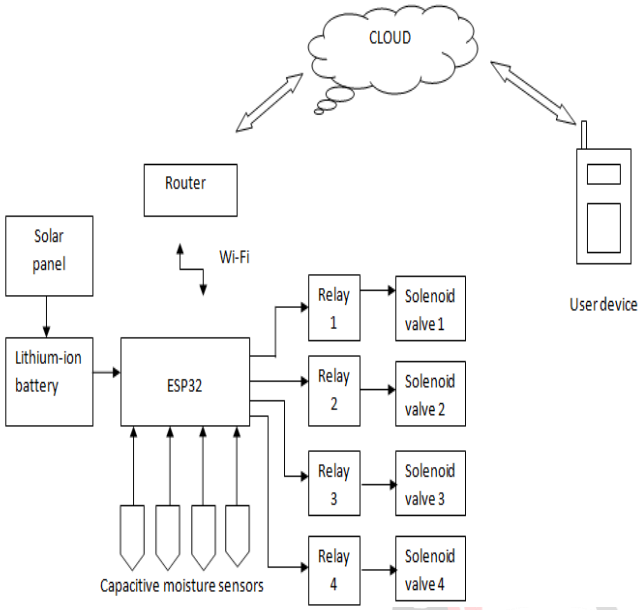

Fig 1. Block diagram of the system

A. **ESP32**:

ESP32 is powerful, cost effective, low power on chip microcontroller which has inbuilt Wi-Fi, 12 bit ADC and dual mode Bluetooth. It is improved version of ESP8266 microcontroller and available in both single/dual core variation. It is manufactured by Expressif system

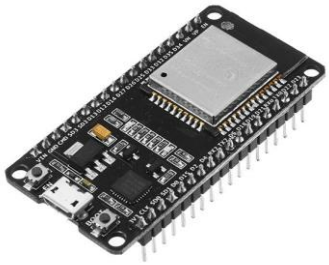

Fig 2.ESP32 module

Name	Specification
CPU	Xtensa (single or dual core) 32bit microprocessor whose operating frequency is 160MHz to 240MHz.
Power	3.3V DC
Memory	448KB ROM, 520KB SRAM, 4MB Flash
Peripheral interfaces	12bit SAR ADC up to 18 channels 2x8bit DACs
Data rate	Up to 150 mbps

Table1. Features of ESP32 module

B. **Soil moisture sensor**:

Soil moisture sensor measures water content in soil and gives moisture level as its output. As the sensor can give both analog as well as digital output it can be used in both analog and digital mode. It is low power device which operates in the range of 3.3V - 5V.The module has potentiometer to set the threshold value and then threshold value is compared by LM393 comparator. The output LED will turn on and off depend on threshold value. In this proposed system, we used soil moisture sensors in its analog mode.

Resolution of ADC

Output=sensor value x 5/4096

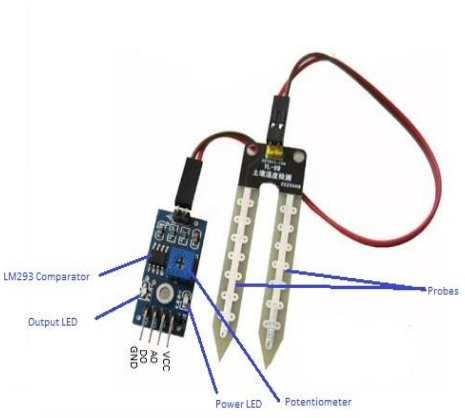

Fig 3. Soil Moisture sensor

Moisture value	Meaning
4096	Zero moisture value
3500	Threshold moisture value
1700	Maximum moisture value

Table2. Moisture levels

Name	Specification
Operating voltage	3.3V – 5V
Input current	30mA (max)
Output signal	Analog / digital
Power indicator	Red LED
Digital output indicator	Green LED

Table3.Features of soil moisture sensor

C. **Four channel relays**:

Basically relay is switch that operates electrically. In this project 5V, four channel relay interface board is used to turn the four solenoid valve on and off. Each channel requires 15 to 20 mA driving current.

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Fig 4. Four channel relay

Name	Specifications
No. of channel	4
Driving current of each relay	15 – 20 mA
Maximum output of relay	DC 30V / 10A AC 250V /10A
Operating voltage	3.3V-5V

Table 4. Features of Four channel relay module

D. **Solenoid valves**:

Solenoid valve is device that uses electric current to produce magnetic field to handle mechanism that controls opening and closing of water flow in valve. The valve has solenoid coil which operate with 12V DC supply. It is normally closed, it opens the liquid flow as soon as power is on and blocks flow when there is no supply voltage. Life of solenoid valve is depend on the parameters such as temperature, pressure and voltage

Fig 5. Water solenoid valve

E. **Solar panel**:

As solar panel absorbs sunlight as energy source to produce electricity so that we decided to use solar energy as primary supply to the system. 10W/12V polycrystalline solar panel is perfect for this system as it has a compact size and easier portability.

Fig 6. Solar panel

Name	Specification
Model name	10W/12V Polycrystalline panel
Max power (Pmax)	10Wp
Max power voltage (Vmp)	19.25V
Max power current (Imp)	0.52A
Short circuit current (Isc)	0.55 A
Open circuit voltage (Voc)	22.5 V

Table 5. Features of solar panel

F. **Lithium ion battery (12V/5AH):**

A lithium ion battery is rechargeable kind of battery which has high energy density and low self-discharge and most important they are safe.

Fig 7. Lithium ion battery

G. **MQTT**:

Message Queuing Telemetry Transport (MQTT) is ISO standard messaging protocol that basically fallows publish-subscribe messaging pattern. It is very simple, lightweight protocol specially designed for low bandwidth and high latency network. The system has three main important parts they are Publisher, Broker and Subscriber. System consist of many clients that are connected to server, client can be either publisher or subscriber.

Publisher: A publisher can be a sensor that senses the information and transmit this information or data to the broker on particular topic.

Broker: Broker is basically a bridge between publisher and subscriber. It transmits received information to subscriber.

Subscriber: Subscriber can be a client which is connected to the broker. Subscriber has to subscribe the particular topic on which publisher is publishing the data. If new data is arrived on the subscribed topic broker will notify to the subscriber about new data.

V. PCB DESIGN

In this project, we used proteus design suit software tool for PCB design. It is windows application for schematic, simulation and PCB layout design. It has auto router, PCB

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layout module gives automatically connectivity information in net list form from the schematic.

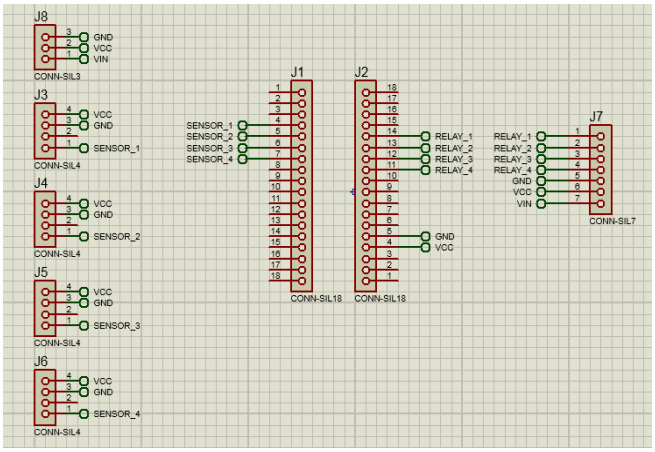

Fig 8. PCB design

VI. FLOW CHART

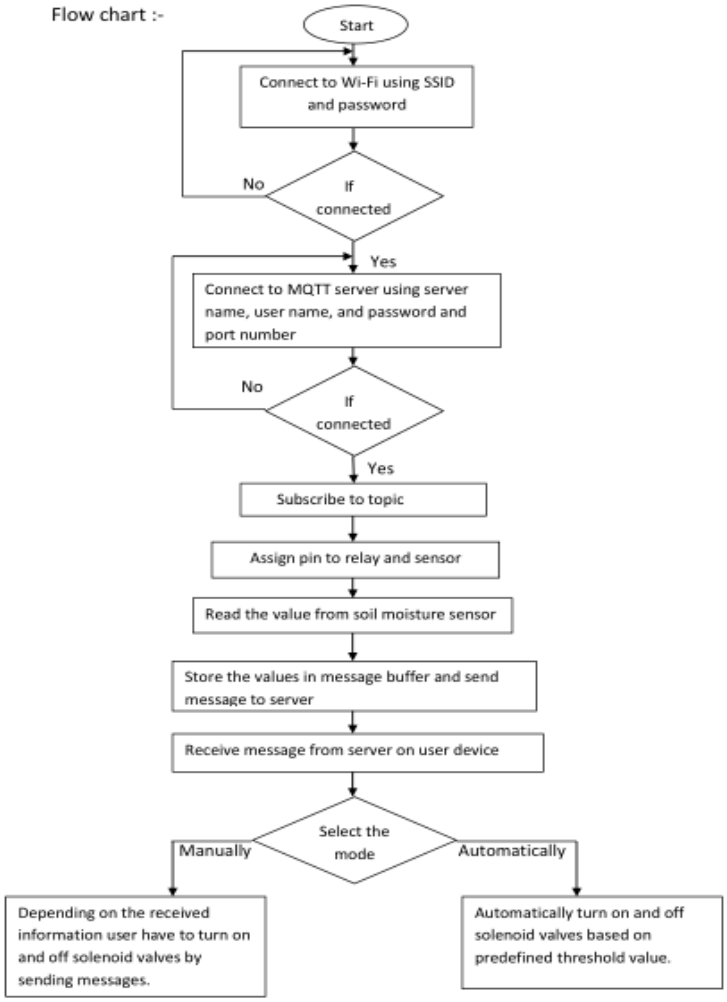

Fig 9. Flow chart

Above flowchart shows flow of the system operation which involves the following steps;

1. Connect the system to Wi-Fi as well as cloud with SSID and Password.
2. Read the sensor value in analog form and transmit through cloud on user android application.
3. Select mode of operation and moisture level through user application.
4. If operation mode is automatic system will automatically control water pump action based on moisture level.
5. If mode of operation is manual then user will control water pump action through user application.
6. Based on received commands NODEMCU will monitor the function of solenoid valves.

VII. RESULTS

Result is displayed on Android application dashboard.

1. An android application dashboard shows the current soil moisture level through different colours (red for dry field, green for wet field, yellow for medium moisture field).
2. User can set the mode of operation and moisture level through corresponding switch on dashboard.
3. In Auto mode, operation is automatic and user does not need to control water pump action. User can set the moisture level (in percentage form) through slide button and based on set moisture level operation is performed automatically. Four switches shows the current moisture level through corresponding colour code.
4. In manual mode, user has to control water pump action remotely. User will switch on/off water pump through touch button based on current moisture level.
5. The status of the entire system can be checked serially on laptop terminal screen also.

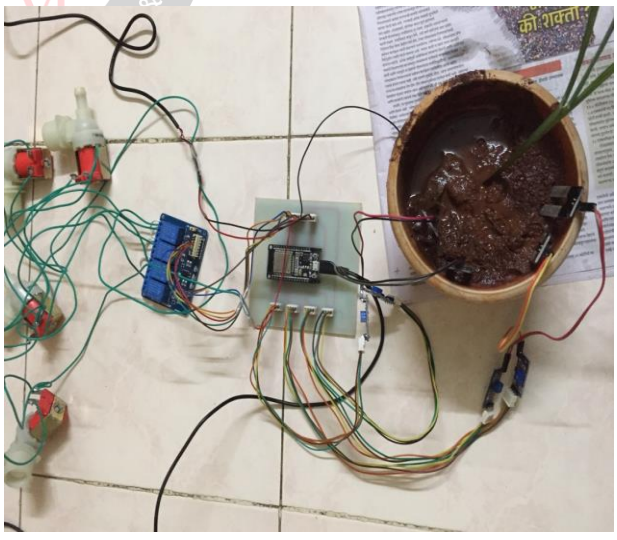

Fig 10. Circuit connect of system

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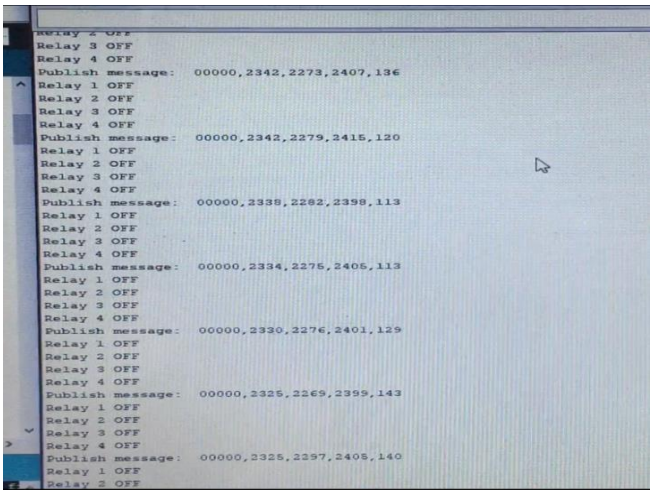

Fig11. System status in automatic mode on serial port

The above fig shows the status of system displayed on serial port of laptop when operation mode is automatic. Fig shows the current moisture levels of field and current status of relays.

Fig12. Manual mode of operation with moisture level 35%

The above figure shows that the selected operation mode is manual and the moisture level is set to 35%. Currently four switches indicates the filed is completely dry.

Fig13.Auto mode of operation with moisture level 35%

The above figure shows that the selected operation mode is automatic and the moisture level is set to 35%. The green switches shows the corresponding field is completely wet and red switch indicates corresponding field is completely dry

Fig 14.Manual mode of operation with moisture level 35%

The above figure shows that the selected operation mode is manual and the moisture level is set to 35%. The green switches shows that the corresponding field is completely wet the red switch indicates the field is completely dry and yellow indicates the field has average moisture level.

VIII. CONCLUSION

This report addresses the design and development of simple soil moisture controller. As ESP32 is low cost, small size controller and has low power consumption which make the system more relevant for given application. The accurate soil moisture sensors give analog readings, so we can perfectly measure value of soil in field. The obtained data from system transmitted to the user device with the help of cloud MQTT. Eventually we displayed moisture value of soil and status of controlling relays in mobile application and control them. By using this water monitoring system we can easily prevent water wastage by maintain required moisture level in field and reduced human effort in farm by controlling the system remotely.

IX. FUTURE SCOPE

We can modify the system by adding humidity and temperature sensor for green house use. The entire system is solar based without use of secondary supply in critical conditions and hence self contained. We can make the system more reliable, fast and accurate with highly precise sensors and strong internet connectivity. Instead of solenoid valves we can use sprinklers so that the system will become more effective and can implement in garden and parks.

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