An Agricultural Irrigation Management System Based on the Internet of Things With MQTT Protocol

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Abstract: There are several factors upon which the yield of a crop depends. Water, external temperature, humidity, the fertility of the soil, etc. Among these, water is a vital and scarce resource, and thereby more human attention is needed. When and how to water the plants are the two important things to consider in agricultural irrigation! Modernizing agriculture with the help of smart technologies is a promising solution. This project presents an automated irrigation system for agriculture-based out of several low-cost sensors that monitor and maintain the soil moisture based on real-time data from the field with very low form factor compared to the existing systems. This automated system is a combination of low-cost hardware, IoT, and cloud server. The ESP8266 MCU installed in the field will collect all the sensor data from the crops and send it to the cloud server, thingSpeak, for storage via Wi-Fi. The farmers can monitor the stored or real-time data on their mobile or in a web portal. They can also check the status of the pump at any time from anywhere. The amount of moisture required for a specific type of crop is predetermined and saved in the system thereby human presence can be decreased and can effectively make the system automated.

Keywords: Water pump, Siphon, IoT, Sensors, MQTT, HTTP

1. INTRODUCTION

For the proper economic development of a country, all the challenges and issues concerning agriculture should be addressed effectively. One of the important challenges that needs to be addressed is the proper usage of water. Nowadays IoT has a huge impact on many industries due to digitization and advanced technologies. The agriculture sector is one of them. This project proposes a real-time field monitoring system. Temperature, humidity, and soil moisture are the properties that are monitored by our system. The major advantage of the proposed system is that it can control many operations of the field remotely from anywhere, anytime. All this is made possible with the help of IoT and low-cost hardware. It is an advanced technology which is clubbed with the existing technologies to offer a futuristic way of life. Due to that, an individual can control his electronic devices using a smartphone from anywhere. The protocol we have used for the system implementation is MQTT - Message queue telemetry transport protocol. This is a lightweight messaging protocol that is ideal for emerging M2M or IOT connected devices, in which bandwidth and battery power are at a premium. Here we have adapted the same technology to the area of agriculture. There is a large variety of equipment available in the market for water resource management. But most of them are costly. As a major portion of the farmers in India is still small and marginal, buying this equipment for their farm is still not economically viable. The cost always matters in the agriculture sector. Our paper had considered both these cost and water management issues with great priority.
1.1 BASİCS Of IoT

The Internet of Things or IoT is an architecture that comprises specialized hardware boards, Software systems, web APIs, protocols which together creates a seamless environment which allows smart embedded devices to be connected to the internet such that sensory data can be accessed and control systems can be triggered over the internet. Also devices could be connected to the internet using various means like Wi-Fi, Ethernet and so on. Furthermore devices may not need to be connected to the internet independently. Rather a cluster of devices could be created (for example a sensor network) and the base station or the cluster head could be connected to the internet[1]. This leads to more abstract architecture for communication protocols which ranges from high level to low level. Most interestingly, these devices must be uniquely discovered. For unique discovery of the devices in a Network, they need to have a unique IP address. IoT devices essentially have IPv6 addressing schemes. All these devices have either fixed or Subnet masked IP addresses of type v6. Unique IP addresses makes IoT devices discoverable in the internet as an independent node. This is the most important concept to have in mind to understand IoT[7].

2. LİTERATURE SURVEY

Various researchers had put forward many plans and proposals in order to effectively utilize the existing irrigation system. [1] Importance of IoT is well explained and how to create a smart environment in irrigation is analyzed. IoT architecture consists of 3 layers [2]. The collection of data from the sensors or things is done by the first layer. The second layer supports the transfer of collected sensor data and the third layer which stores those transferred sensor data. MQTT and HTTP are the application layer protocols. Whereas Zigbee, bluetooth, Wi-Fi, etc are the network protocols. The importance of smart agriculture [3] is well explained on the basis of the selection and utilization of wireless sensor technology for communication. Many problems related to storage, reduction of cost of resources, and availability of data are well addressed on the basis of integration of cloud computing with IoT. [4] Different protocol comparison and [5] use of different sensors like temperature, moisture, humidity sensor to collect data is done in a detailed manner along with data collection. On the basis of collected data, systems can take appropriate action due to environmental changes. The choice of effective messaging protocols for IoT systems: MQTT, CoAP, and HTTP is well explained by the author [6].

The author [7] developed an irrigation system with minimal usage of water by measuring the irrigation rate in the field. Due to the development of wireless sensor networks, the monitoring and control of the parameters in the agriculture field were made possible [8]. Here the author proposes such a system that collects the sensor data from the field and sends it to the main base station via a Global Positioning System. The major advantages of such a system were the cost and the precise remote control of irrigation systems [9]. A similar method of monitoring greenhouse was proposed by the author [10] which was based out of GSM-SMS in order to control the system and remote measurement. It consists of several base stations that measure the values of parameters which include air temperature and air humidity. GSM module is the channel through which the central station receives and sends messages. Many studies begin to apply the IoT concept in research [11]. The researchers created a smart classroom by using a combination of various sensor nodes. These sensor nodes were distributed evenly and connected to a microcontroller. Here the role of microcontroller was not only controlling the data but also acted as a provider of measured data and reading from the sensors. These sensor data can be accessed, analyzed anytime by any computers connected to the computer networks. In order to process and store the data, researchers have used a mini-computer. This mini-computer serves two purposes, one is monitoring and the next is automating the air condition devices and monitoring system.
3. EXISTING SYSTEM

Existing approach is a remotely sensing environment or direct inspection. Spatial goal of pictures taken by satellite imaging is hard to recognize watered fields and may cover just critical pieces of the land. In light of the weighty cover in otherworldly marks, it is difficult to distinguish inundated fields from non-flooded parts in muggy conditions. Planning exactness may diminish if there is a cover from the overflowed inundated fields with common wet territories. In Humid tropical and sub-tropical environment, optical information accessibility is very fragile with continuous overcast cover. Perceptions are not generally amassed at ideal occasions, for example, reaping period, thusly the assortment of distantly checked information is fixed[4].

3.1 Issues In Irrigations

- Lack of funding
- Insufficient material infrastructure
- Meager agricultural practice
- Limited admittance to valuable agriculture inputs
- Over depending on rain
- Insufficient production as well as after-harvest technologies.
- Insufficient consciousness of farmers on meticulousness farming techniques

4. PROPOSED SYSTEM

Dissimilar to traditional sensor organizations, the utilization of the sensor information can be shipped off the cloud to moderate the information where it is put away in a specific information base and once it arrives at a specific limit in soil boundaries like temperature, stickiness and dampness. The regulator can finish up how much water is required for the harvests and it additionally screens the over flooding boundary by finding the level of water level in the dirt. The wished-for framework's goal is mostly to gather the information on or after the sensors along with send this information to the client at whatever point the client needs to check the necessary soil moisture and water siphon status. The Esp8266 NodeMCU-12E goes about as gateway for associating with the Internet. It goes about as a little organization having power above the sensing element which provide the information updating of the soil dampness esteems, water siphon state and the status of the parts progressively. The information is made sure about utilizing security Protocol (secure Socket layer). We include utilized a dirt dampness sensor (which estimates both simple and computerized values) and a two Channel Relay Module (5V, 10A) for our undertaking. Besides, the information is put away ceaselessly in MQTT Server. The bunching of the information is likewise done utilizing different versatile fluffy rationale. The benefit of utilizing MQTT convention and transport layer security (TLS) cryptographic convention is that no vague information is put away alongside the necessary information. Going on the equipment part, sensing element as DHT11/22, soil dampness sensing element are recognized and totalled. Solenoid valves and engines are utilized for water system purposes. In this manner just a fitting measure of water is shipped off yields subsequently controlling the wastage of water.

4.1 Proposed System Architecture

Water pump based farming is scheduled with the regulator on/off and Esp8266 NodeMCU12E using the MQTT convention. Esp8266 NodeMCU12E is associated with the sensor and transfer of soil dampness. The MQTT worker is then associated with Esp8266 NodeMCU12E, which is used for the showcase function. The dirt dampness sensor tests the information and sends the information through the MQTT worker to the customer. There are basically two areas for the given undertaking. The key section consists of the sensor and handoff, and the following region consists of the MQTT specialist and the results have been seen. The Esp8266 NodeMCU12E used as an organisational entryway is associated with soil dampness sensor and wired association switch in the primary field. Testing and checking of the dirt dampness sensor, handoff and Esp8266 NodeMCU12E are the main part of the venture. The client initially performs the critical MQTT specialist technique in the subsequent
perspective. The customer introduces the Mqtt agent library in Arduino IDE and it is tested and reviewed by simple built-in models and also checks that the message being sent and received is correct between the distributor and the endorser variable. So at whatever point the data is calculated by the dirt dampness sensor, the information is sent to the Esp8266 NodeMCU12E. The customer will now be able to see the subjects the customer has purchased including the estimation of the dirt dampness sensor, water syphon state using the technique previously described. The Thingspeak.io phase has built in security conventions for security purposes for example, TLS and SSL. The last stage involves taking care of the information base, a presentation of logging techniques by creating a username (user id) and a secret key to access the data. We may also strengthen the whole MQTT system by using these measures, which makes it tempting to use these measures.

![System Architecture](image)

Figure 1. System Architecture

5. RESULTS AND DISCUSSION

The system we created is a combination of low-cost hardware, IoT, and cloud server. The proto board is developed by using a dot PCB, ESP8266 Node MCU module, moisture sensitivity control unit, relay circuitry, temperature sensor, humidity sensor, and other hardware locally available in the market. The sensors are installed near the plant and powered by using an external power supply. We also made a setup to pump water to the soil with the help of a submersible pump which is always immersed underwater. Then a channel named smart irrigation system is created on the web portal by using ThingSpeak, which is an open-source Internet of Things application and API to store and retrieve data from things using the MQTT protocol over the Internet or via a Local Area Network. Inside this channel, we have created three subfields and each field represents the collected sensor data from the plant pot to obtain a graphical as well as a numerical representation of the real-time sensor value and status of the pump. As expected, the ESP8266 MCU installed near the plant pot collects all the sensor data from the soil and sends it to the cloud server, thing speak, for storage via Wi-Fi. The system also irrigates water with the help of a submersible pump and maintains the soil moisture based on real-time sensor data and also the signals from the ESP8266 nodemcu. All these activities are monitored on the channel which we created on the web portal and also on a mobile application from thing speak. The sensor
data will be updated every ten seconds. In order to cross verify the result, we have serial monitored the

events happening in the proto board by using a USB interface on Arduino IDE. We thereby

successfully built, tested the proposed system, and monitored the stored or real-time sensor data on our

mobile and also in the web portal.

Figure 2. Real Time Testing Setup

Figure 3. Protoboard Developed

Figure 4. Real Time Monitoring on APP
6. CONCLUSION

Currently, farmers irrigate their fields manually at a systematic period which in turn results in high amounts of water loss and more human effort. The proposed system prevents the wastage of water and conserves water usage up to 45-50% from conventional irrigation. Our proposed system can not only save water resources but also money, human effort, an increase in crop yield rating, plant quality, and productivity. Here we have successfully implemented an irrigation system based out of IoT and MQTT protocol which will help the user to monitor, analyze, and control various parameters in the field from anywhere and anytime using a smart phone. Thereby the system becomes efficient in cost, power consumption, and size. The major highlight of the proposed system is that it is easy to use for anyone with a smart phone and does not require maintenance once setup. The addition of a few more sensors with more data analysis can be done as a future work of this paper in order to limit human interaction in the farming field. Also, an addition of LPWAN technologies like LORA, NB IoT, SIGFOX to the proposed system in the future will make the system more suitable for any terrain and climatic conditions.

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