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IOT Based Smart Water Telemetry System Using MQTT Protocol

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***Abstract* - In this research paper, we are developing the Internet Of Things (IoT) based Smart Water Management System by using MQTT (Message Queuing Telemetry Transport) protocol which is a lightweight, publish-subscribe, machine to machine network protocol for transferring data between various IoT devices and through our safe, secure and reliable flutter based mobile application user can manage their water system. We are discussing about the water management system through the use of our 3 IoT based devices i.e. Single Tank Motor Controller, Dual Tank Motor Controller and Level Indicator which completely automates the tank filling process in our homes, providing real time updates of water flow, tank level, machine status. Through device scheduling, alerts and notifications it let the user to control their devices as they want. The results of the proposed design and its evaluation are described in this paper.**

Keywords: IoT, DTMC, STMC, LI, MQTT, AI, ML, WMS, management.

I. INTRODUCTION

Pakistan being the most populous country in the world of approx 225 million people reside in an area of 796,095 km². So it's important to get the best livelihood. Everything should be properly managed and try to minimize the wastage of resources. Water is one of the most important resources in the world and water management has an impact on a number of important aspects of human life, including the environment, water usage, food production, purification, irrigation, and energy balance etc. but due to lack of management a high portion of the water is wasted, or it may not provide to the max no. of users.

By introducing Internet of Things (IOT) in this modern world a lot of problems have been solved such as water management, water quality monitoring etc. With the use of IOT in water management systems various issues such as: excessive loss of water due to not indicating the level of water in the tank, water missed due to late night supplies, checking water supplies manually which causes the motor to dry run, electricity wastage etc. can be solved. But in order to get this picture, technologies like IOT and the use of protocol i.e. MQTT (Message Queuing Telemetry Transport) are combined together to get the desired output.

The paper is divided into 7 sections. Section 1 presents a brief introduction, objectives and the purpose of developing WMS. Section 2 presents background information, the problem statement that is the need of developing WMS. Section 3 describes the system architecture of our mobile application and the communication of IoT devices with the MQTT protocol. Section 4 describes the process flow of how the device gets the real time data and logs into the mobile app. Section 5 presents an overview of the related work in the same domain. Section 6 presents future enhancement of WMS. Section 7 provides the conclusion.

- To build a modular & intelligent cloud platform for IOT device management & monitoring.
- To provide a product that helps or facilitate users regarding water management issues.
- To track water usage both at home and city level.
- To provide real time updates of water flow, tank level, data analytics and machine status.
- To avoid checking water supply manually and to completely automate the tank filling process in our homes.

In our product i.e. Smart Water Management Using IOT devices which let users to completely automate their tank filling process and optimize the use of human power by using our app. It will check water supply, fill both underground & overhead tanks and display the status of water level of the tank in real time. So, we can know tank level, machine status, and can control our motors i.e.(on, off and use option auto) through a single click. Therefore, the problem of water wastage, electricity consumption can be reduced to a great extent.

Also, users will schedule their own device by using alerts configuration, push notifications so that they can update or use their device accordingly. Water is managed by the users manually which causes a lot of problems, one of the main issues we are facing is excessive loss of water. Oftenly we have seen that when the tanks get full there is an excessive amount of water flowing outside which is the wastage of

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water. On the other hand, In many areas we have seen that water is missing because it comes in the late night. In many areas, water has not been supplied for weeks and weeks ago and some areas have a normal supply of water. So it's important to track so that higher authority takes an immediate action. Checking water supply manually causes the motor to dry run and wastage of electricity as well.

II. RELATED WORK

Researchers draw the attention to make water management and distribution systems more efficient by reducing human intervention and completely automate the preservation and delivery of water, and implement regulations to reduce water wastage. In their research authors examine water deficiency level in many rural areas of India so they deployed their water distribution system there also water management is very necessary as in their research when the authors compare the water availability, they found some villages receive water throughout the year while some villages are not.[1]

A lot of research work has already been done in the field of water quality monitoring by using Internet Of Things (IOT) technology that proposes a cost effective IOT based solution which monitors the quality parameters such as: turbidity, pH, water level in the tank, humidity, condensation and temperature of the water.[2]

MQTT is a low-cost, low-power message transmission protocol that connects commercial servers with various subscribers and actual devices, actions, and activities. In their proposed model Author Susmit Vartak, Kaviraj Poojary uses Naive Bayes theorem in order to examine the data collected by different sensors to the MQTT. By using this theorem each and every attribute or parameter of water quality examines independently of others.[9]

III. SYSTEM ARCHITECTURE

The proposed system consists of four different layers which are described below:

Presentation Layer

This layer contains all the logic related to UI (User Interface).The HTTP requests are handled by the presentation layer, which also converts each JSON argument to object, verifies the request, and sends this to the business layer. In essence, it is made up of views, or the front-end. This layer is responsible for rendering the static templates however, the dynamic data comes from the Business Layer through Rest APIs. This is the top most tier and the main function is to translate tasks and result to something that the user can easily understand. For frontend, we have used React JS in our admin panel and in flutter app use Dart.

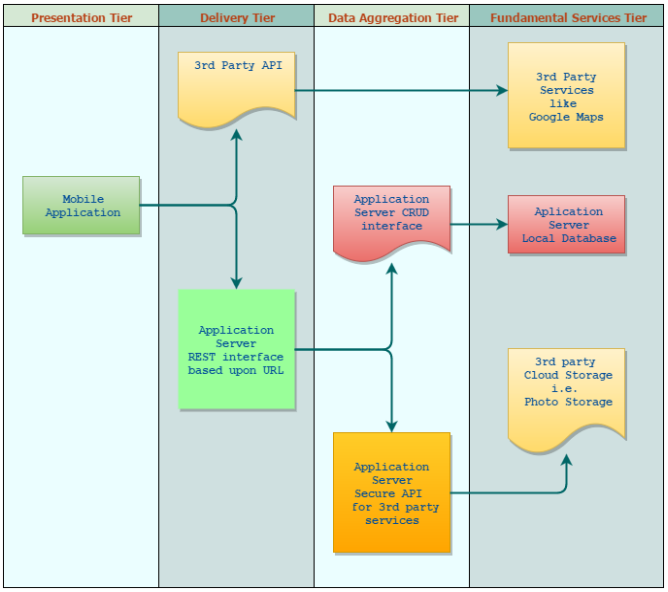

Figure 1:4-tier architecture

Business Logic Layer

Business Layer contains business logic, validation and authorization. All business logic is managed by the business layer. It utilizes resources offered by data access layers and is made up of service classes. It also carries out verification and permission. e.g. Roles and Permissions, only admin allowed to view certain modules etc. In short, this layer coordinates the application, processes commands and makes logical decisions.

Persistence Layer

The storage logic is entirely contained in the persistence layer, which also converts business objects into and out of database rows.

Database

Database where all the data is stored which is going to be utilized by our admin panel and flutter app. In the database layer all the CRUD (Create, Read, Update, Delete) operations are performed. In our product, we have used the MongoDB database which is an open source NoSQL database management system. NoSQL databases are used in place of conventional relational databases. Through this architecture, we get a lot of benefits such as scalability in the future. If we want to extend our product and add different modules we can easily do this. A Lot of other advantages such as Data Integrity and reusability.

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IV. PROCESS FLOW

The whole process flow of how the mobile application connects through the MQTT and get a real time data are as follows:

There are 3 types of IoT based devices which connect to the user's motor and then through our flutter based mobile application user can control and monitor their device activity and automate the tank filling process.

Dual Tank Motor Controller

Dual Tank Motor Controller (DTMC) manages both the overhead and suction pump of our house i.e. manages and controls the underground and overhead tank. Check for the water supply and if the user has turned on the device then it automatically fills water in the tank, if the user has selected the option of Auto then the device turns on and when water fills in the tank it automatically turns off. It helps to stop the motor from dry running and also monitor the energy used by the motors.

Single Tank Motor Controller

Single Tank Motor Controller (STMC) manages or controls either the overhead tank or underground tank of our house. This device mainly checks for water supply, fills either underground or overhead tanks, stops motors from dry running, it also monitors energy used by motors.

Level Indicator

Level Indicator (LI) monitors the level of any tank either it is upper or lower tank. This device also lets us know how much water you have, how much water you have used, when you have to call the tanker, Low water level and high consumptions rate alerts.

When the user purchased the device, they get a unique device id which they add into the mobile app and get all device data by subscribing to the mqtt topic. MQTT is the middleware platform for the communication between hardware devices and software components (Apps). All IOT devices are connected with MQTT Broker and MQTT broker is sending that real time data to both mobile and web apps. Both Apps are also bidirectionally connected with backend server which is built on MongoDB can sending and receiving data. In mqtt, when we subscribe the topic we get a json response that contain the following attributes and values. In our mobile app, we provide numerous feature to our user to automate their tank filling process such as: OTP verification to provide safe, secure and most reliable app to our users, device management, device authentication through OTP, separate dashboards for all the devices that contain real time data through MQTT, alerts configuration, push notifications.

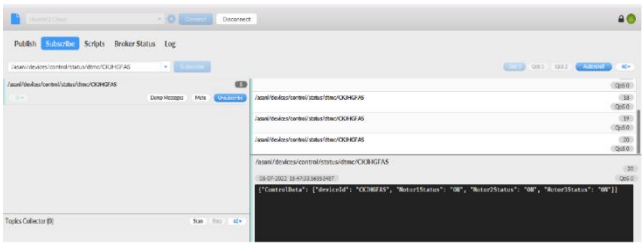

Figure 2: MQTT response of DTMC device

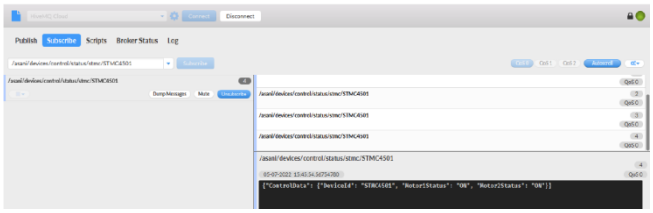

Figure 3: MQTT response of STMC device

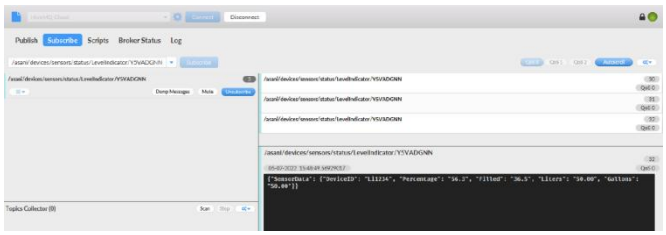

Figure 4: MQTT response of LI device

So the user set it accordingly according to their choice, payment integration so if the user wants to buy another device they can easily purchased online through our mobile app, data logging in which we log the user's data and show it in the form of a bar graph. The corresponding Deployment Diagram, Context diagram, Sequence diagram, and Use case diagram pertaining to IoT based system are:

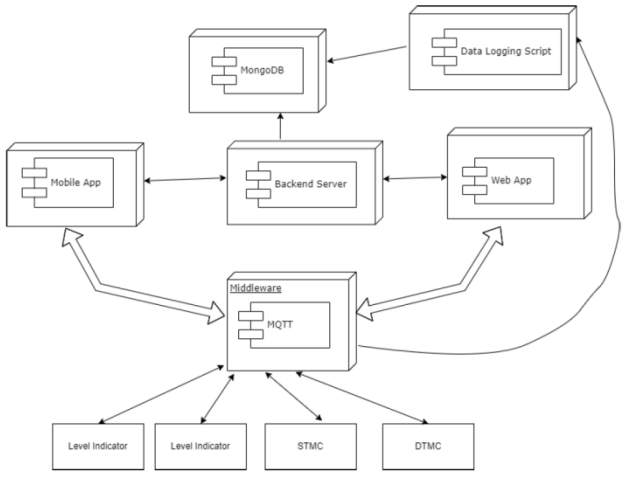

Figure 5: Deployment diagram

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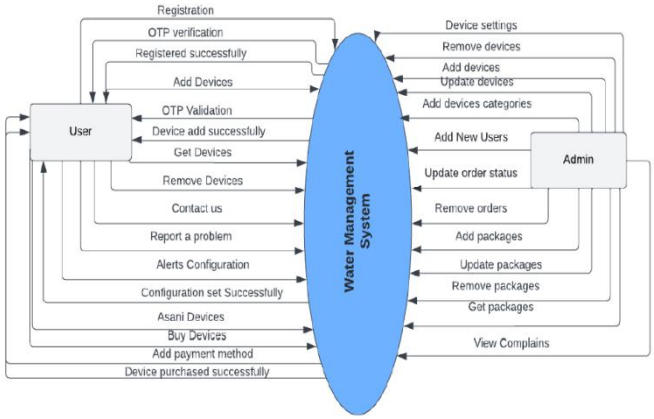

Figure 6: Context diagram

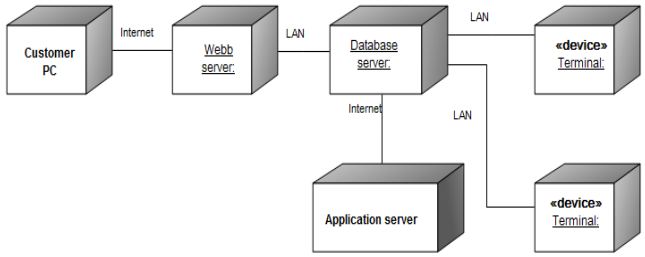

Figure 7: Deployment diagram 2

V. FUTURE ENHANCEMENT

In future, we can add another device i.e. modbus gateway whose main job is to: Get data from Industrial Sensors/Meters and other devices and send the data to the cloud for further processing and analytics. Monitors industrial process, alerts on set level readings, analysis data for process optimization.

We will also work towards water quality monitoring so when a user tries to manage their water resource through IoT, we will also make sure the quality of water should be maintained through IoT. So, before the user fills the water in the tank we make certain quality parameters such as: water's PH value , turbidity, temperature and humidity of the atmosphere by using different sensors such as: PH sensor, turbidity sensor, temperature and humidity sensor.[3]

In the future, we want to integrate Artificial Intelligence and Machine Learning for predictions, data analytics, distribution of water etc. If devices have been installed on a particular area, commercial buildings then through their devices we log the data. We will work on Data Analytics to completely log user's data for all the devices i.e. DTMC, STMC and LI that they are using, their usage, know about when water will come on a particular area, what are water distributions?

VI. CONCLUSION

An IoT based smart water management system i.e. proposed in this research paper is a highly efficient, inexpensive real time water management system that is built by using 3 IOT devices i.e. DTMC, STMC and LI. To make the system workable, modular, scalable, and affordable, MQTT protocol will be created as opposed to the GSM network or other technologies.[4]. The MQTT protocol enables simultaneous data transfer between the server and the sensors. Being able to transfer more data constantly and without interruption makes this form of communication effective.

Our smart devices will replicate human processes involved in water management and remove hassle. This proposed model is highly efficient and completely automates the tank filling process for both overhead and underground tanks, and the major issues regarding the water management i.e. water missed due to late night supplies, checking water supplies manually which cause the electricity wastage and dry running of motors.

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