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An IOT Approach for Monitoring Water Quality Using MQTT Algorithm

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Abstract: ***The degradation of water resources has become a common problem. The conventional methods of water quality monitoring involves the manual collection of water sample from different locations. These water samples were tested in the laboratory using the rigorous skills. Such approaches are time consuming and no longer to be considered efficient. Moreover, the current methodologies include analysis of various kinds of parameters of water quality such as physical and chemical. The old method of water quality detection and communication was time consuming, low precision and costly. Therefore, there is a need for continuous monitoring of water quality parameters in real time. By focusing on the above issues, a low cost water quality monitoring system is developed and designed that can monitor water quality in real time using IOT. In the proposed system water quality parameters are measured by the different sensors such as pH, turbidity, dissolved oxygen and temperature for communicating data onto a platform via microcontroller system i.e. Arduino model. So in order to meet all these requirements, other technologies can be used such as MQTT (Message Queuing Telemetry Transport) which allows publishing and subscribing od data between the sensor and end device. Instead of using GSM network or any other technology, MQTT algorithm will be implemented to make the system feasible, modular, scalar and cost-efficient. Not only will this, with the help of MQTT algorithm there be simultaneous flow of data between the sensors and server.***

Keywords: Internet of Things, Arduino, MQTT, Raspberry Pi, Naive Baye's etc.

1. INTRODUCTION

With the introduction of IoT in the modern world, many problem have been solved. With the use of IoT in monitoring water quality, various issues such as data collection, communication, data analysis and early warnings are worked on .But in order to get this into picture, technologies and protocols are combined to get the desired output. Here the use of Message Queuing Telemetry Transport Protocol (MQTT) makes the whole procedure fast and reliable.

1.1 Purpose

The main purpose of using an Iot approach to monitor water quality using MQTT algorithm is to develop a system which provides the end user a useful data used. Conventionally, the water samples are collected from different places, and then tested by the scientist at their laboratory using many techniques to determine the water quality. This was a time consuming process but now the 'Internet of Things (IoT)' has the potential to modernize the water production, as more and more of its technology is connected to the web [1]. .So instead of monitoring the water quality using old ways, this technique is used which is way better, fast, cost friendly and easy to use

1.2 Background

The parameters for testing the water quality are monitored with the use of Global Messaging Service (GSM) technology but there are various limitations to this technology. First of all it by using GSM, the overall development cost increases. Not only this GSM faces security issues as the user identity confidentiality is violated by transmitting the identities in unprotected form.

During the transmission of data, it is sent one after another which creates a buzz and delay in transmission. However the data transmission should be simultaneous, fast and secure. So instead of using GSM network or any other technology, MQTT algorithm will be implemented in order to make the system feasible, modular, scalar and cost-efficient. Not only will this, with the help of MQTT algorithm there be simultaneous flow of data between the sensors and server.

1.3 Method of Investigation

In order to meet with the requirements for developing the system, some work has been done in the past to achieve the desired results. The system created earlier used sensors to gather the information regarding the water parameters. After that the information gathers was sent to Raspberry Pi, through which it was displayed to the computer or any other devices. After analysis of the data obtained, the communication part was carried out with the use of GSM technology. This system was helpful but had limitations as well such as expensive, no real time data could be generated and security issues.

1.4 Scope

So to overcome all these limitations, changes are done in this system with the help of Iot , a new water monitoring system is developed in which all the water parameters are inspected using sensors .

After that the useful data will be sent to the end user via MQTT algorithm. MQTT makes the communication and transmission of data reliable and fuzz free. Apart from this it makes the system cost friendly as the overall cost of the system decreases. The main advantage of using MQTT is that there will be simultaneous flow of data between the sensors and the sever. Thus making it an ideal choice in terms of connectivity

2. CHALLENGES

2.1. Security

Security at both the device and network levels is critical to the operation of IoT. The same intelligence that enables devices to perform their tasks must also enable them to recognize and counteract threats [4].

1. Secure booting: When power is first introduced to the device, the authenticity and integrity of the software on the device is verified using cryptographically generated digital signatures. In much the same way that a person signs a check or a legal document, a digital signature attached to the software image and verified by the device ensures that only the software that has been authorized to run on that device, and signed by the entity that authorized it, will be loaded Intentions.

2. Access control: Next, different forms of resource and access control are applied. Mandatory or role-based access controls built into the operating system limit the privileges of device components and applications so they access only the resources they need to do their jobs. If any component is compromised, access control ensures that the intruder has as minimal access to other parts of the system as possible.

3. Device authentication: When the device is plugged into the network, it should authenticate itself prior to receiving or transmitting data. Deeply embedded devices often do not have users sitting behind keyboards, waiting to input the credentials required to access the network.

2.2 Sensor Network

A sensor network comprises a group of tiny, typically battery-powered devices and wireless infrastructure that monitor and record conditions in any number of environments -- from the factory floor to the data centre to a hospital lab and even out in the wild. The sensor network connects to the Internet, an enterprise WAN or LAN, or a specialized industrial network so that collected data can be transmitted to back-end systems for analysis and used in applications.

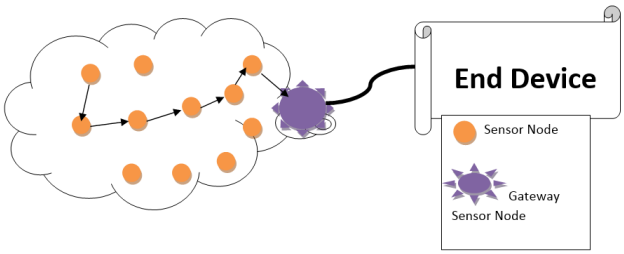


Fig a Sensor Network

2.3 Communication

Wireless communication system is the essential part of the IoT infrastructure, which acts as the bridge for dual directional communication for data collection and control message delivery. It can be applied to various IoT applications, including mission critical industries, such as power grid, oil field, and cases in our routine life like the smart city [10].We summarize the common challenges and issues on wireless communication for IoT applications:

- Huge volume of sensors with varied types and distributed sites need to be connected, managed and maintained
- High reliable communication will be required under the environment with lots of interfaces

- Available spectrum resources will be very limited for new IoT wireless network
- For harsh outdoor area, low power consumption and simple architecture will be required [5].

3. METHODOLOGY

- The first task is to determine which water parameters would provide a close indication for water pollution. Through extensive research the parameters are chosen to be composed of pH, turbidity, dissolved oxygen and temperature [4].
- The second step is the selection of locales that will provide useful data. The locations were narrowed down to industrial areas, sewer waste openings and city lines where human interference had a considerable impact. Various sensors where installed at such locations for testing.
- The third step is to transmit the data from the sensors onto the arduino kit for further processing.
- The transmission of the data obtained is done in the next step, from where MQTT comes in the picture. With the help of MQTT along with raspberry pi, the information obtained is passed onto the server and the end user.
- Finally data analysis is done on the acquired data set using naive bayes algorithm with the help of which the desired information is obtained.

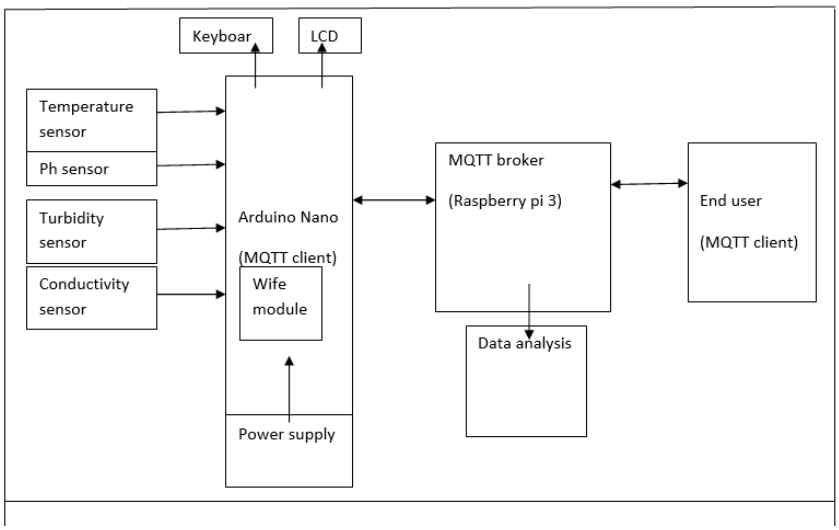


Fig b Overall Block diagram

4. INTRODUCTION TO MQTT

MQTT is a Client Server publish/subscribe messaging transport protocol. It is light weight, open, simple, and designed so as to be easy to implement. These characteristics make it ideal for use in many situations, including constrained environments such as for communication in Machine to Machine (M2M) and Internet of Things (IoT) contexts where a small code footprint is required and/or network bandwidth is at a premium. [7]

4.1 Features of MQTT

- MQTT stands for Message Queuing Telemetry Transport .It is described as a machine-to-machine (M2M) / IoT connectivity protocol.
- This protocol is so lightweight that it can be supported by some of the smallest measuring and monitoring devices, and it can transmit data over far reaching, sometimes intermittent networks.
- MQTT is a publish/subscribe messaging transport protocol that is optimized to connect physical world devices and events with enterprise servers and other consumers.
- MQTT is designed to overcome the challenges of connecting the rapidly expanding physical world of sensors, actuators, phones, and tablets with established software processing technologies.
- Therefore, the MQTT protocol represents an ideal messaging protocol and is able to provide routing for small, cheap, low power and low memory devices in vulnerable and low bandwidth networks.

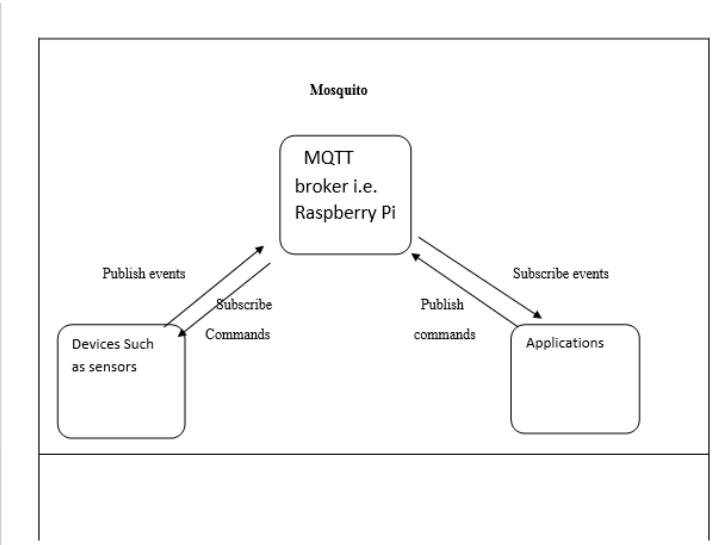


Fig c Working of MQTT algorithm

Functionality of MQTT

- MQTT algorithm consists of Broker, publish and subscribe.
- The MQTT messages are delivered asynchronously **("push")** through publish subscribe architecture.
- The MQTT protocol works by exchanging a series of MQTT control packets in a defined way.
- Each control packet has a specific purpose and every bit in the packet is carefully crafted to reduce the data transmitted over the network.
- A MQTT topology has a MQTT server and a MQTT client. MQTT client and server communicate through different control packets.

5. NAIVE BAYE'S THEOREM

Inorder to analyze the data obtained from the sensors to the MQTT, Nive Baye's theorem is used. Here with the help of this classifier, a particular or combined parameter of water quality is checked unrelated to the other attributes or it can be said that every feature being classified is independent of the value of any other feature. In simpler words the naive baye's theorem can be formulated as:

$$P(a/b)=\frac{P(b/a)P(a)}{P(b)}$$

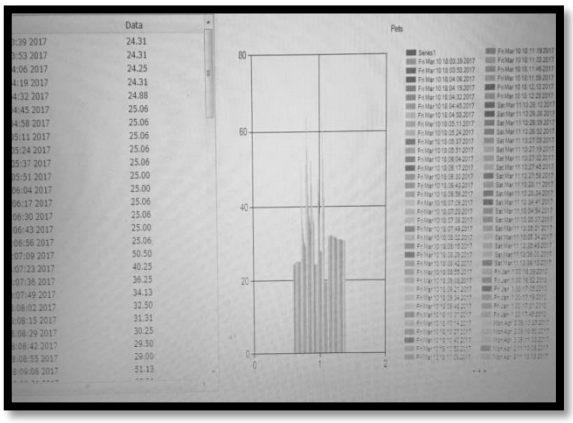
6. APPROACH

The very first step is to determine the water parameters used for determining the condition of the water quality. In this case the chosen parameters are temperature, turbidity, ph and dissolved oxygen. Secondly the collection of data for analysis is done which is the water from taps and lakes is taken the sensors are installed at these locations for testing

To transfer the data obtained from the sensors, a setup is created which consists of an arduino nana as microcontroller, a wifi router, lcd to display the values along with the sensors. All the devices are interconnected with each other. The wifi module creates a connection between the sender and receiver.

In the next phase, raspberry pi acts as a mqtt broker which collects the data from the sensors to the server. The Raspberry pi is running Mosquitto which is a open source message broker running MQTT protocol. The whole process takes place in real time making it simultaneous and fast. The communication between the server and the end user.

The data is saved in the database ie the ms excel for further analysis. The data analysis if done with the help of naive bayes algorithm. Here the limit of the values is given, which whenever crossed gives a variation in the graph. In case of temperature the highest value is set as 40 degrees. The sample is collected from 3 different sources for 2 hours and then analysed . if the threshold value of water temperature has crossed 40 degree more times than the water is not fit for consumption . Same is the case for other parameters.



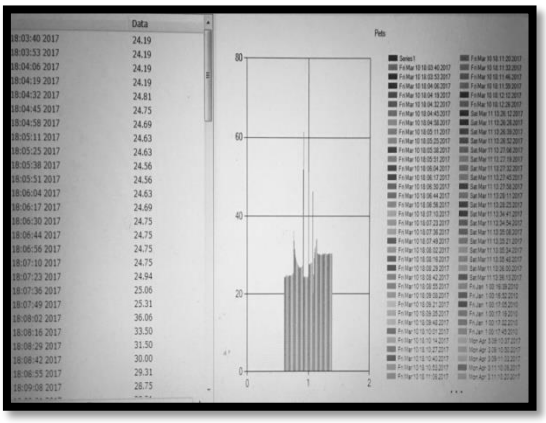


Fig d Threshold of temperature for interval of 2hours **Fig e. Threshold of Temperature at different location for another 2 hours**

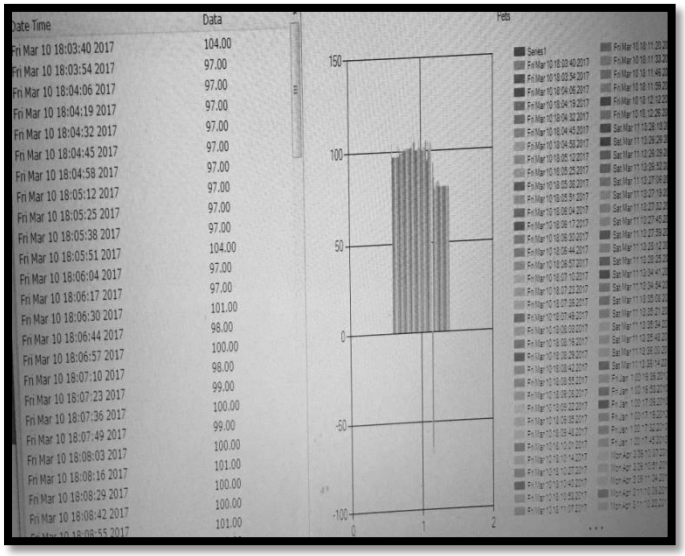


Fig f. Threshold of turbidity for 2 Hours

CONCLUSION

During the transmission of data, it is sent one after another which creates a buzz and delay in transmission. However, the data transmission should be simultaneous, faster and secure.

So in order to meet all these requirements, other technologies can be used such as MQTT (Message Queuing Telemetry Transport). Instead of using GSM network or any other technology, MQTT algorithm will be implemented to make the system feasible, modular,

scalar and cost-efficient. Not only will this, with the help of MQTT algorithm there be simultaneous flow of data between the sensors and server. A large amount of data is sent continuously without any hurdle, thus making it an efficient mode of communication.

In future the system can be implemented on a larger scale with the help of availability of various resources. Other water quality determining sensors can be used for analysis for more précised and accurate data**.**

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