International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 8 Issue 06 Series. I || June 2019 || PP 41-48

A Study on IOT Approach for Monitoring Water Quality Using MQTT Algorithm

Anvita Keni[1], Prof.Mangala Kini[2], Divya C H[3,],Deepika K V[4],Deepa[5]
Corresponding Author: Anvita Keni

Abstract *–Water is one of the essential part of life.Degradation of water resources has become a commonproblem.Theconventionalmethodsofwaterquality monitoring involves the manual collection of water sample from different locations. These water samples were tested in thelaboratoryusingrigorousskills.Suchapproachesaretime consumingandnolongerconsideredtobeefficient. 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 different sensors such as pH, temperature and dissolvedoxygen, turbidity, ultrasonic levelforcommunicatingdataontoaplatformvia microcontroller system. The Arduino model can be used as controller. The Wi-Fi module in the system transfers data collected by the sensors to the microcontroller, and transfers the data to the smart phone/PC. So in order to meet all these requirements, other technologies can be used such as MQTT (Message Queuing Telemetry Transport) which allows publishing and subscribingofdatabetweenthesensorandend device. And with the help of MQTT algorithm there will be simultaneousflowofdatabetweenthesensorsandtheservers. This paper presents a design of low cost system for real time monitoring of the water quality and quantity of water in IOT (Internet of Things).*

Key Words*: Internet of Things (IOT),Monitoring Temperature sensor,Wi-Fi(ESP8266),PH,Real-time Systems,MQTT, Raspberry Pi, Naive Bayes' theorem, Arduino etc.*

Date of Submission: 02-06-2019 Date of acceptance: 18-06-2019

I. Introduction

The rapid development of the society and numerous human activities speeded up the contamination and deteriorated the water resources. For above water quality monitoring is necessary to identify any changes in water quality parameters from time-to- time to make sure its safety in real time. The Central Pollution Control Board (CPCB) has established a series of monitoring stations on water bodies across the country which monitor the water quality on either monthly or yearly basis. This is done to ensure that the water quality is being maintained or restored at desired level.Water quality monitoring helps in evaluating the nature and extent of pollution control required, and effectiveness of pollution control measures.All the stations will operate in real time and central station can access data from any of the above stations using GPRS/GSM or3G cellular services. State pollution boards and CPCB zonal offices can also access data from central station. Large amount of data can help to take right decisions and also to implement in time accordingly [1],[2]. Since the time IOT has evolved a lot of problems have been solved in this world. The IoT is a collection of devices that work togetherinordertoservehumantasksinaefficientmanner. It combine computational power to send data about the environments. These devices can be in form of sensors, appliances, embedded systems, and data analysis microchips.Thispaperpresentalowcostwatermonitoring system,whichisasolutionforthewaterwastageandwater quality. Microcontrollers and sensors are used for that system.UltrasonicSensorisusedtomeasuringwaterlevel. The other parameters like pH, TDS, and Turbidity of the water can be calculated using different corresponding sensors.Thissystemusetheflowsensorwhichcanmeasure the water flow and if the necessary quantity of water flow through the pipe then water flow can be stopped automatically.By using IOT in this water quality monitoring system various issues such as communication, data collection, data analysis, early warnings have been workedon.Butinordertogetthisintopicture,technologies andprotocolsarecombinedtogetthedesiredoutput.Here the use of MQTT makes the whole procedure fast and reliable.

II. Problem Statement

Recent water quality sampling results from the watershed indicate low dissolved oxygen concentrations, high biological oxygen demand, and chemical oxygen demand ntrations, all water quality indicators for dissolves organic matter. The New River's two major sources of dissolved organic matter are: (1) NPDES facilities that discharge wastes, and(2)the municipality of Mexico, sewage.

Water can be polluted any time. So the water we reserve in the water tank at our roof top basement in

our society or apartment may not be safe. Still in India most of the people use simply water purifier that is not enough to get surety of pure water. Sometimes the water has dangerous particles or chemical mixes and general purpose water purifier cannot purify that. And it's impossible to check the quality of water manually in every time. So an automatic real-time monitoring system is required. It can warn us automatically if there is any problem with the reserved water . And we can check the quality of the water anytime and from anywhere.

III. Literature Survey

The available water resources are getting depleted and water quality is deteriorated due to the rapid increase in population and need to meet demands of human beings for agriculture, industrial, and personal use. The quality of ground water is also affected by pesticides and insecticides. The rivers in India are getting polluted due to industrial waste and discharge of untreated sewage. In order to eliminate problems associated with manual water quality monitoring, CPCB has planned to go hi-tech and plans to establish 'Real Time Water Quality Monitoring (WQM) Network' across Ganga Basin. Stephen Brosnan, 2007 [3] investigated a wireless sensor network (WSN) to collect real time water quality parameters (WQP). Quio Tie-Zhn, 2010 [4] developed online water quality monitoring system based on GPRS/GSM. The information was sent by means of GPRS network, which helped to check remotely the WQP. Kamal Alameh, 2011[5] presented web based WSN for monitoring water pollution using ZigBee and WiMAX networks. The system measured various WQP. It collected, processed measured data from sensors, and directed through ZigBee gateway to the web server by means of WiMAX network to monitor quality of water from large distances. System was capable of monitoring water pollution in real time. Dong He, 2012 [6] developed WQM system based on WSN [7]. The remote sensor was based on ZigBee network. WSN tested WQP and sent data to Internet using GPRS. With the help of Web, information was gathered at remote server. Kulkarni Amruta, 2013 [8] created solar powered WQM utilizing remote sensor network. The Base station (BS) gathered information from distant remote sensors. The BS associated with ZigBee module was powered by sunlight baseboard (Energyharvesting).

3.1Purpose

The main purpose of using IOT approach to monitor water qualityusingMQTTalgorithm istodevelopasystemwhichprovidestheenduserausefuldataused.Conventionally,thewatersamplesarecollectedfromd ifferentplacesandtested rigorously by scientists in the laboratory using many techniques to determine the water quality. Therefore older methodsweretimeconsumingprocessbutnowtheIOThas the potential to modernize the waterproduction,asmoreandmoreofitstechnologyisconnectedtotheweb.ThisIOTapproachisfarbetterthanconventio nalmethodssinceitis cost friendly, faster and easy touse.

3.2Background

Poor water quality spreads disease,causes death and hampers socio-economic progress. Around 5 million people die due to waterborne diseases around the world(Water Resource Information System India, 2017). Fertilizers and pesticides used by farmers can be washed through the soil by rain, to end up in rivers. Industrial waste products are also washed into rivers and lakes. Raising the temperature of the water lowers the level of dissolved oxygen and upsets the balance of life in the water. All the above factor make water quality monitoringessential.TheparametersfortestingthewaterqualityaremonitoredwiththehelpofGSM(GlobalMessagingS ervice)technology but there are various limitations to this technology. First of all by using GSM over all development cost increases. Not only this, GSM faces security issues as well since the user identity confidentiality is violated by transmitting the identities in unprotectedform.

Duringthetransmissionofdata,itissentoneaftertheotherwhichcreatesabuzzanddelayintransmission.Howev erthe 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 will be simultaneous flow of data between the sensors andserver.

3.3.Method ofinvestigation

Inordertomeettherequirementsfordevelopingthesystem someworkhasbeendonepriortoachievethedesiredresult. Thesystemcreatedearlierusesensorstogatherinformation regarding the water parameters. After that the information gathered was sent to raspberry pi, through which it was displayed to the computer or any devices. After analysis ofthedataobtained,thecommunicationpartwas carried out withtheuseofGSMtechnology.Thissystemwashelpfulbut had limitations as well such as expensive, no real time data could be generated and securityissues.

3.4. Scope

To overcome these limitations, changes are done in this systemwiththehelpofIOT,anewwatermonitoringsystemisdevelopedinwhichallthewaterparametersareinspected

usingsensors.
After that the useful data will be sent to the end user via MQTT algorithm. MQTT makes the communication and transmissionofdatareliableandfuzzfree.Apartfromthisit makes the system cost friendly as the overall cost of the systemdecreases.ThemainadvantageofusingtheMQTTis that there will be simultaneous flow of data between the sensors and the server. Thus making it an ideal choice in terms ofconnectivity.

IV. Motivation

Water pollution and water scarcity is global problem, which requires ongoing modification of water resource guiding principle at the levels of international down to individual wells. It has been surveyed that water pollution is the leading cause of diseases worldwide. The records show that more than 10000 people die daily worldwide. In India predictable 500+ people die of water pollution related problems everyday. Research has shown that after few years the quantity of useful water will be goes down to minimum level. In many developing countries, dirty or contaminated water is being used for drinking without any proper former using it. One of the reasons for this happening is the unawareness of public and administration and the lack of water quality monitoring system which creates serious global issues. Also nature effects such as volcanoes, algae tints, and earthquakes also change the quality and ecological status of water.

V. Proposed System

The main aim here is to develop a system for continuous monitoring of water quality at remote place using wireless sensor network with low power consumption, low cost and high detection accuracy. Following are the objectives of idea implementation [12]:

- To measure water parameters such as pH, dissolved oxygen, turbidity, water level, etc using available sensors at remote place.
- To collect data from various sensor nodes and send it to base station by wireless channel.
- To simulate and analyze quality parameters for quality control. (Graphical and numerical record using MATLAB)
- To send to an authorized person authorized person automatically when quality detected does not match the preset standards, so that, necessary actions can be taken.

5.1.SystemOverview

In this, we present the theory on real time monitoring of waterqualityandquantityusingIoT.Thesystemconsistsof Arduino,microcontroller,differenttypeofsensorslikewater flowsensor,pHandturbiditysensorandultrasonicsensor. The Arduino is the main processor of the system which control and process the data generated by thesensors.

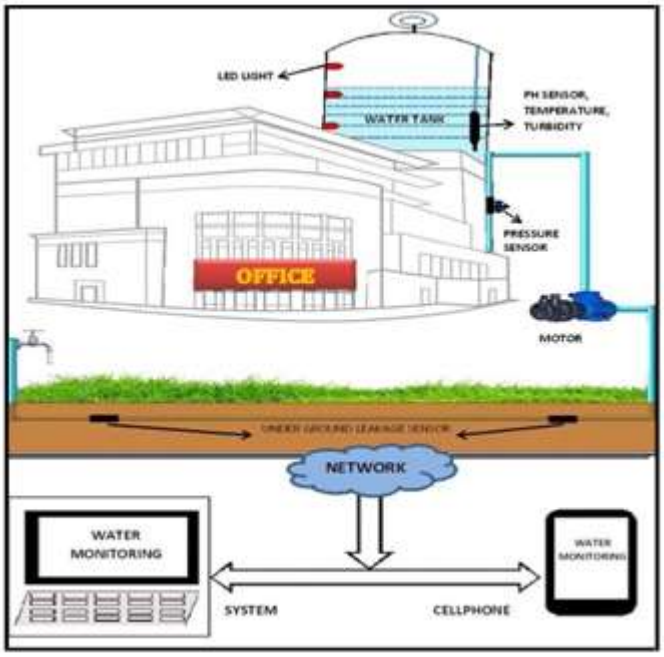

Fig-1: Water monitoring system

A Wi-Fi module is connected to the Arduino device which help to transfer the data to the cloud over internet. The ultrasonicsensorhelpstomeasurethewaterlevelwhenthe water flow reach certain level then the water flow can be stoppedautomaticallybyturningthemotorofforclosethe water flow in pipe by the help of Arduino. Thewaterflowsensormeasurethequantityofwaterflowthroughthepipeinagiventime,thisdatawillbesenttocloudforstorageand analysis purposes. The other sensor like temperature, pH andturbiditysensormeasurethewaterqualityandhelptodetermine whether the water is useful for drinking or any agricultural purposes.

5.2.SystemArchitecture

Takingaboutthisproposedsystem,itisclearlyshownthatit has several component which help to build a water monitoring system. The essential component of the system of smart home automationare:

- **Arduino Uno:** Arduino is a microcontroller board based on the ATmega328P. It has 14 digital input and output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a resetbutton.

Fig-2: Arduino

It contains everything need to support the microcontroller. Arduino Software (IDE) were the referenceversionsofArduino,nowevolvedtonew releases.TheUnoboardisthefirstinaseriesofUSB Arduino board, and the reference model for the Arduinoplatform.

- **Wi-fi module:** The ESP8266 Wi-Fi Module is a self SOCwithintegratedTCP/IPprotocolsthatcangive any microcontroller access to your Wi-Finetwork.

Fig-3: Wi-fi module

TheESP8266iscapableofhostinganapplicationor offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module come pre-programmed with an AT commandsetfirmware.TheESP8266moduleisan extremely costeffective.

- **Flowsensor:**sensorisusedtomeasuretheflowof water.

Fig-4: flow sensor

This sensor basically consists of a plastic body, a rotor and a sensor. The pinwheel rotor rotates when water / liquid flows through the pipe and its speedwillbedirectlyproportionaltotheflowrate. The Hall Effect sensor will provide an pulse with every revolution of the pinwheelrotor.

- **Cloud-Based Server**: Cloud goes about as a database to store every data generated by the sensors installed in the home. This cloud server helptosendemailalertaboutdifferentsituationin home to theclient.
- **Sensors**:Asensorisaelectronicdevicethatdetects and responds to some type of input from the physical environment. In this different type of sensors are used like temperature sensor, pH sensor, turbidity sensor, ultrasonic sensor which detect the change in environmentalphenomena.
- **Ultrasonic sensor**: Transmitters convert signal into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can both transmit and receive ultrasound. This helps to measure the waterlevel.

VI. Network Architecture

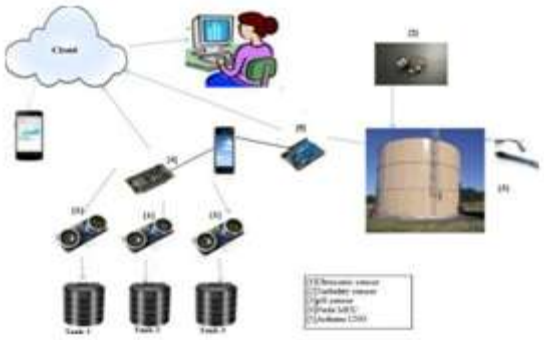

Fig-5: Architecture diagram

HOW TO USE CLOUD?

This system is using Wi-Fi module (Esp8266) to send the sensordatatothecloud.Allthesensorsareconnectedwith Wi-Fi module. Wi-Fi module needs the internet. So here MobiledataorWi-Fiistheaccesspointfortheinternet.And after all this data sends to the cloud. The following figure show the data stored incloud

Fig-6: Data of ultrasonic sensor

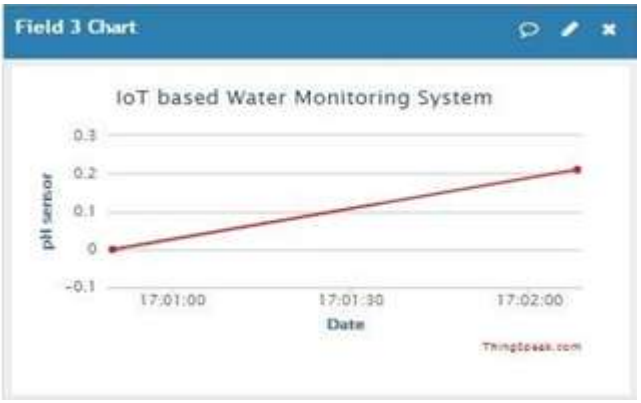

Fig-7: Data of pH sensor

VII. Challenges

Therearebasicallythreecommonchallengesthissystem faces they are security, sensor network and the communication.

7.1.Security

Securityisanessentialfactorforanysystem.Securityat boththedeviceandnetworkleveliscriticaltotheoperation of IOT.

a. Secure booting: When power is first introduced to the device, the authenticity and integrity of software on the device is verified using cryptographically generated digital signatures.

b. Access control: Next the different form of resource and access control are applied. Mandatory or roll based accesscontrolbuiltintotheoperatingsystemlimittheprivilegesofdevicecomponentsandapplicationssotheyaccess onlythe resources they need to do their jobs. If any component is compromised,accesscontrolensuresthattheintruderhasa minimal access to other parts of the system aspossible.

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

7.2.SensorNetwork

Asensornetworkcomprisesofgroupsoftiny,typically battery powered devices and wireless infrastructure that monitor and record conditions in any number of environments from the factory floor to the data center to a hospital lab and even out in the wild. The sensor network connects to the internet, an enterprise WAN or LAN, or a specializedindustrialnetworksothatcollecteddatacanbe transmitted to back end systems for analysis and used in applications.

7.3.Communication

Wireless communication system is the essential part of the IOT infrastructure, which acts as a 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 smartcitywesummarizethecommonchallengesandissues on wireless communication for IOTapplications.

- Huge volume of sensors with varied types and distributed sites need to be connected, managed and maintained.
- Highreliablecommunicationwillberequiredunder the environment with lot ofinterfaces.
- Available spectrum resources will be very limited for new IOT wirelessnetwork.
- For harsh outdoor area, low power consumption and simple architecture will berequired.

VIII. Methodolgy

- The first task is to determine which water parameter would provide a close indication of water pollution. Through extensive research the parameter are chosen to be composed of pH, dissolved oxygen andtemperature.
- The second step is selection of locales that will provide useful data. The location were narrowed downtoindustrialareas,sewerwasteopeningsand city lines where human interference has a considerableimpact.Varioussensorswereinstalled at such locations fortesting.

- The third step is to transmit the data from the sensorontotheArduinokitforfurtherprocessing.
- Thetransmissionofdataobtainedisdonethenext step, from where MQTT comes in the picture.With the help of MQTT along with raspberry pi, the informationobtainedispassedontotheserverand the enduser.
- Finally data analysis is done on the acquired data set using Nave Bayes' algorithm with the help of which the desired information isobtained

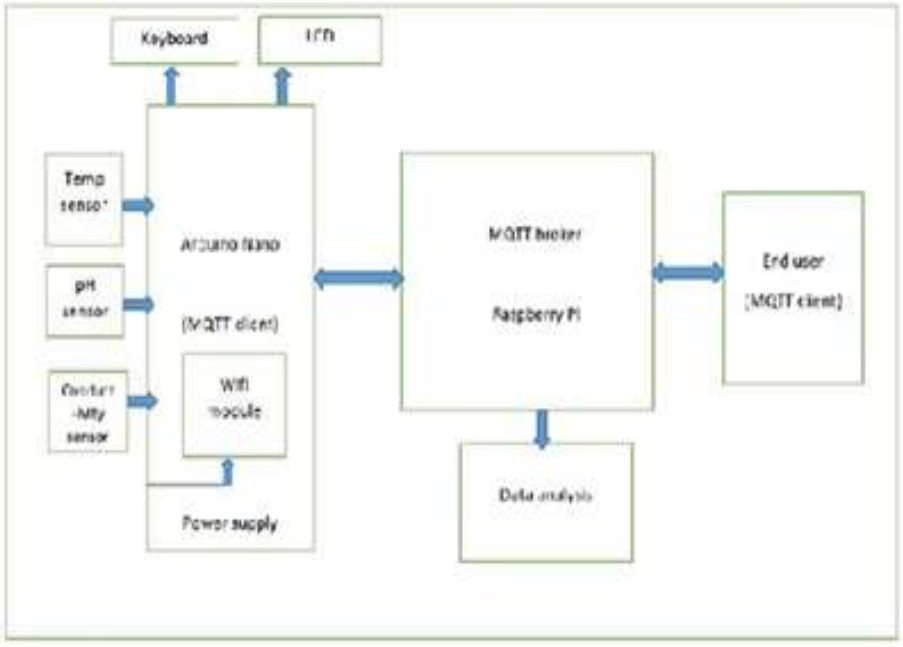

Fig -1: Block Diagram

IX. Naive Bayes'theorem

In order to analyze the data obtained from the sensor to the MQTT, Naïve Bayes' 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 simple word the Naïve Baves' Theorem can be formulated as:

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

X. Conclusion

During the transmission of data, it is sent one afteranother whichcreatesabuzzanddelayintransmission.Howeverthe datatransmissionshouldbesimultaneous,fasterandsecure. So in order to meet all these requirements, other technologies can be used such as MQTT (Message Queuing TelemetryTransport).InsteadofusingGSMnetworkorany other technology, MQTT algorithm will be implemented to makethesystemfeasible,modular,scalarandcostefficient along with this it makes communication of data between sensorsandserverssimultaneouslyflow.Alargeamountof data can be sent without facing anyhurdle. Infuturethesystemcanbeimplementedonthelargerscale with the help of availability of various resources. Other water quality determining sensors can be used for analysis of more precise and accuratedata.

References

[1]. Pavan NR and Dr. M.C. Padma, "Design of Low Cost System for Real Time Monitoring of Water Quality Parameters in IOT Environment", International Journal of Advanced Research in Computer Science and Application Volume 4, Issue 5, May 2016.
[2]. A.N.Prasad, K.A. Mamun, F.R. Islam, H. Haqva,"Smart Water Quality Monitoring System",IEEE,2015.
[3]. N Vijayakumar,R Ramya,"The Real Time Monitoring of Water Quality in IOT Environment", International Conference on Circuit, Power and Computing Technologies, IEEE,2015.
[4]. Young Hua Ling Jiabin Tang. Qing Yang Chao Zui, "Wireless Communication for IOT",IBM Research. Accessed December 17,2016.
[5]. Wind River,"SECURITY IN THE INTERNET OF THINGS –Lessons from the past for the Connect futer"2015. Accessed Dec 17.2016.
[6]. Design Spark,'1 1 Internet of Things Protocols you need to know about",Accessed December 10,2016.
[7]. OASIS-MQTT Version 3.1.1 plis Errata 01.Accessed November 7,2016.[8] NivitYadav, "CPCB Real time Water Quality Monitoring", Report: Center for Science and Environment,2012
[8]. Tuan Le Dinh, Wen Hu, PavanSikka, Peter Corke, L. Overs, Stephen Brosman, "Design and Development of a Remote Robust

Sensor Network:Experiences from Outdoor Water", 32nd IEEE Conf.on Local Computers,pp 799-806,Feb.,2077
[9]. Quio Tie-Zhn, Song Le, "The Design of Multiparameter On line Monitoring System of Water Quality based on GPRS", Report: Advanced Transducers and intelligent Control System Lab, Taiyuan Technical Univercity. Taiyuan, China,2010
[10]. N Vijaykumar ,R Ramyas, "The real time monitoring of water quality in IOT environment",IEEE sponsored 2nd international conference on innovation in information,embedded and communication system(Iciiecs)2015.
[11]. Saima Maqbool , Nidhi Chandra, "real Time Wireless Monitoring and Control of Water System using Zigbee802.15.4"5th International conference on Computational Intelligence and Communication Networks., 2013

Anvita Keni" A Study on IOT Approach for Monitoring Water Quality Using MQTT Algorithm" International Journal of Engineering Science Invention (IJESI), Vol. 08, No. 06, 2019, PP 41-48