LoRa BASED WATER QUALITY MONITORING SYSTEM

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Abstract —

The introduction of the Internet of Things (IoT) enabled the development of various real-time applications. In reality, IoT has facilitated the remote monitoring or sensing. A variety of networked sensor nodes can be deployedtoprovideaperiodicorcontinuousmonitoring data, that can be used further evaluation. In this paper, we demonstrate the use of IoT for water quality monitoring using LoRa as communication system. The water body is used for aquaculture, and manyaquaticorganismsareobservedandstudied to improve aquaculture ecosystem. LoRaisalow-power wide area modulation technique, that consist of a base station for the collection of real-time data from the sensors in the water body and a user interface/Dashboard is designed for better visualization of data for information analysis. We conduct some performance tests to determine the reliability and efficiency of the system, and the results are alsopresented.

Keywords —, base-station,IoT, LoRa, Sensor, Water Quality

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I. Introduction

The key purpose of the botanical garden is to conserve flora's biodiversity, i.e. to save endangered species and to ensure plant protection. Consider a botanical garden, where a pool is present for aquatic species. Hence, it is necessary to consider the quality of water quality. Water quality can be defined as a function of the water concentrationandstateoforganicandinorganiccontent,as well assomeofthewater'sphysicalcharacteristics [1]. Themain aim of water quality monitoring system is to measure and analyze the samples for future research and assessment of the findings. This method has many limitations such as:

- Manual errors that occur while collecting the samples for further analysis, like container used may change the quality of the sample.
- There is a failure to perform pattern examination dependent onchronicledinformation, asdatamightnotbeanalyzedoften sufficiently and additional information can be misplaced at any time because of the manual methods concerned in recording.
- Since the condition of water change in very short amount of time, it is difficult to collect the sample in short intervals and send it to lab for quality checking.
- The outcome of the experiments on a collected sample of water is legitimate just for the spot and time of examining.

Given all these limitations, there is a need for more reliable approach for collecting water parameters for measure the water quality. This paper comprises the following sections, which will guide you through step by step to the research and findings. These are:

1. Research Elaborations
2. Results or Finding
3. Conclusions

II. Research Elaboration

Why is checking water quality is so important? Due to humannegligenceinkeepingthewaterbodiesclean, andtons of waste being discarded into water, it is very difficult for aquatic life to survive in such conditions. Hence, keeping a checkonqualityofwaterisveryimportant. Variousmethods are used to detect any changes that occur in water bodies over a period of time. Such innovations can be short-term. Regular monitoring of water quality is an essential part of identifyingcurrentorfutureproblems. For example,thedata was used to show that changes in fertilizers used in food have increased global nitrogen emissions in rivers by 20 percentagesoverthelastfewyears.Therefore,itisimportant to monitor water quality to maintain the biodiversity of botanical gardens or any watersource.

Inpaper[3]asystem called

SWQMwaspresented,which uses IoTbased smart water quality monitoring system for measuring the water quality. that assists in continuous water condition measurement based on four physical parameters i.e. dissolved oxygen, temperature, pH value, electricalconductivity, turbidity and nitrogen.The foursensors are connected to arduino-uno board to sense and detect the water quality. The SWQM system can effectively analyzes water constraintsby using the "Fast Forest" binary classification to categorize whether the test water is suitable for drinking based on the measuredresult.

The paper [4] stress on Smart City initiatives with the help of IoT and wireless sensor network to improve the efficient management ofassetsandresources.

The water we use todaygetscontaminateddueto industrialization, fertilizer and pesticide use, urban growth, etc. So, we should have a robust control system for maintaining water quality.TheproposedschemeusesIoTandwireless sensor network, toprovides sample data onwaterquality inreal-time,sothattheauthoritycanmanage efficiently and control/preserve precious water supplies. The smart water control and management are attainable with the help of IoT and WSN. The proposed system in this paper,helps tomakecityservicesmoreefficientandkeep the citizens informed well in advance. The architecture consists ofa embedded microcontrollerintegrationwithsensors,LoRa wireless module for transmitting and receiving sensor values and the ThingSpeakIoT cloud framework for the analysis and visualization of uploaded water quality sensorvalues.

Thepaper[5]providesideasonmonitoringwaterquality, its distribution, and the detection of chemical leaks in rivers usingM2M-LoRa. Thesystemmonitorsthe level and qualityof water in all storage tanks on a regular basis and displays status at a centralizedlocation, from this location theentirewaterdistributionsystem canbecontrolled.Thedistributionsystem saveswater and regulatestheflowofwastewaterthroughthe monitoring system. Finally, it deals with smart meter for controlling the waterdistribution.

The authors in paper [6] Water supply is sporadic with low levels of service in most of the Indian cities. The low qualityofservicecanbeduetolimitationsonthewaterand energy available, insufficient instrumentation, inadequate system activity and poor network maintenance. Sensors should be installed in appropriate locations to track and manage these geographically dispersed networks, and manual valves should be automated and adequate contact between the devices need to be permitted. The approach proposed includes, real-time water level monitoring of storage reservoirs in water distribution networks (WDN) and remotevalveactuationusingtheIoT. In order to track and manage the water distribution networks, a low-power wireless sensor and actuator network is built and deployed in the IIT Madras water distribution network. The network consists of electrically actuated valves with low cost water level measurement module that serve as remote nodes, relay nodes and gateway nodes. LoRa is used for communication among nodes. A gateway based on raspberry pi is being built that gathers the water level data from all remote nodes. The gateway sendsthe data to a local server and also sends the actuator control signals. Grafana is used for data visualization,andisalsousedasa human machineinterface to remotely manipulate thevalve for water control.

With the development of technology, the authors in paper[7] proposed a real-time system for improving and monitoring water quality control by using the IoT.At Dong Hwa NationalUniversity,DongLake is selected asatestareato measure dissolved oxygen, temperature, conductivity, turbidity andpH values. These parameters are transmitted to the remote server via the wireless transmission medium. The transmission technology usedhere is a low-power wide-area network (LPWAN) and a long distance broadband network (LoRaWAN) to transmit data for long distance over a geographical area. The solar panel has been adapted to charge the battery to extend the life of the devices.

A. Problem Statement

Water supply is uneven with low levels of service in most of the Indian cities. The low service levels can be due to limitations on the water and services available, insufficient instrumentation, inadequate system operation, poor network maintenance etc. Monitoring the quality of water is another issue for balanced aquacultureecosystem. Use of IoT with Sensors and communication system, we can monitor water quality at various locations over geographical area. The proposed method includes real-time water quality monitoring system for botanical garden using IoT. In order to track and manage the water quality, low-power sensors and communication system is built and deployed in the garden.

ResearchObjectives

The key objective of the proposed system is as follows:

- The framework ofwireless sensor network for water quality monitoring system consists of a variety of networked sensor nodes and communication system.
- The water parameters likedissolved oxygen, temperature, pH level and turbidity are collected in real-time by the sensors and sentit to server or base-station or control station.
- Since monitoring is done at remote location,in a restricted access areas, wireless transmission of signal/data is done from the sensor unit to the server.

The collected water quality data/parameters are analyzed and results are plotted on the graph.

IV. Design

A. ArchitecturalDesign

The architecture design has two parts, transmitter and receiver. The transmitter part of the model consist of turbidity, pH, conductivity and temperature sensor and LoRa transmitter which is connected to the arduino. The receiver part of the model consists of LoRa receiver which is connected to Node MCU which sends the data to the thingspeak cloud server.

LoRa is a lower-level physical layer technology that can be used in an applications distributed across wide geographical area. It uses license-free radio frequency bands ranging from 865 MHz to 867 MHz in india. LoRa enables long-range transmissions with low power consumption and can achieve data rates between 0.3 to 27 kbits per seconds depending on the spreading factor.

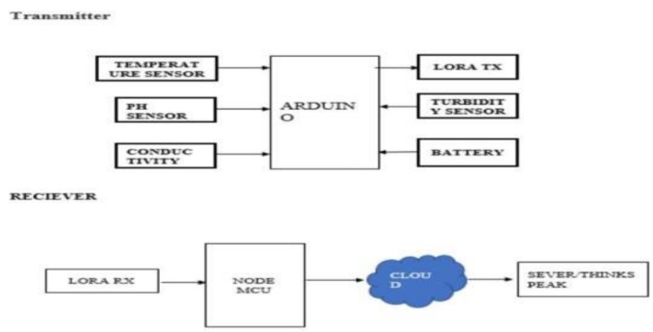

Figure 1: Picture illustrates of the architecture design

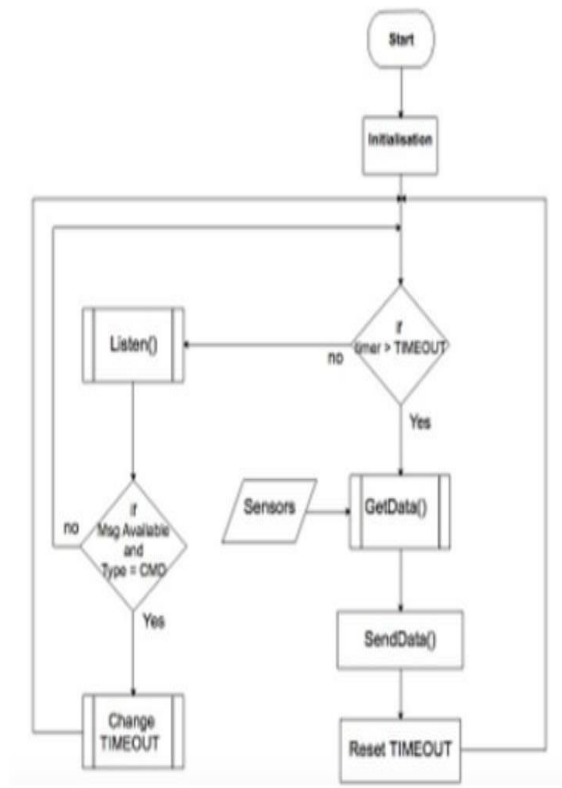

Figure 2: Picture illustrates the dataflow in the model

B. Dataflowdiagram

V. Implementation

A. *Methodology*

Methodology generally is a set of approaches, strategies, systems, techniques, procedures, and laws. Methodologies are precise, stringent in project management and normally include a sequence of phases and activities for every step of the life cycle of the project.

- We have to connect the sensor to the microcontroller and power up.
- Then the LoRa module is connected to the

micro- controller, there will be two LoRa modules one is the transmitter and other is the receiver.

- Then the values of the sensors are sent through LoRato Node MCU module at the receiver side.
- The values are sent to cloud server calledthinksspeak.

VI. Results

IoT-based solution that uses LoRa to monitor and control the water distribution network. Our LoRa-based nodes demonstrate excellent coverage, energy efficiency, and reliabilitywhilereducingimplementationandmaintenance costs. Adding pressure and flow sensor readings can be easilyadjusted.Toensureconstantmonitoringandcontrol, GSM is used as a backup network. The results of the initial implementation are encouraging; all remaining OHSR, UGSRandmanualvalveswillbeusedtobuildanintelligent water distribution system.

Figure 3: Graph of Ph level

Figure 4: Graph of Temperature level

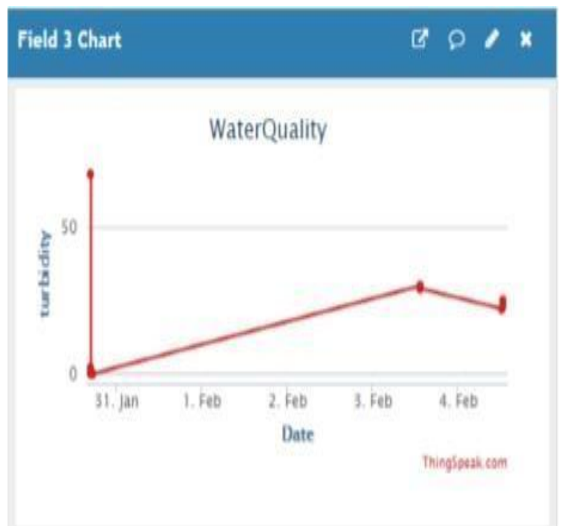

Figure 5: Graph of Turbidity level

VII. Conclusion

We implemented and tested measuring station with real-time data visualization, at our botanical garden. We displayed all the virtual components in the setup at the central place for easy control and also visualized the collected data in the form of graphs as shown in the above figures. As a future research work, we are planning to enhance this framework considering a broad range of water parameters in physic-chemistry and bacteriology. We also intend to develop machine learning based risk assessment algorithms to combine the various sensors to determine the risk of contamination of the water. It will then permits us to set up an aquatic disease epidemiological observation.

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