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EFFICIENT WAY TO MEASURE THE OXYGEN IN WATER USING IOT DEVICES.

[1]PRAVEENA BAI DESAVATHU, [2]KADIYALA SUDHAKAR, [3]BALAJI TATA
[4]BALA PRASANTHI PAVULURI, [5]G.N.SOWJANYA, [6]G PRASANNA KUMAR,
[7]KURRA UPENDRA CHOWDARY

[13]Asst.Prof. Dept. of ECE, PVP Siddhartha Institute of Technology, Vijayawada, Andhra Pradesh, India.
[247]Department of ECE, R.V.R & J.C College of Engineering, Guntur, Andhra Pradesh, India.
[5]Department of CSE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P, INDIA
[6]Department of ECE, Vishnu Institute of Technology, Bhimavaram, Andhra Pradesh, India
Email: praveena.d@pvpsiddhartha.ac.in

ABSTRACT

Quality water is one the prime requirements of any living organisms and dissolved oxygen is one the essential parameter for ensuring the basic needs of aquatic life. Manually collecting samples for dissolved oxygen measurement in a given area is complex ,time consuming and the “number of samples required” are critical for accuracy. Sensor devices for dissolved oxygen level measurement forming cluster of wireless sensor networks (WSN) are providing solutions for such problems. These sensor devices connected to internet evolving Internet of Things network provides solutions for dissolved oxygen measurement in water. These features are exploited for this research and enhancements are made for collection of data from the gateway nodes of WSN transported through Long Term Evolution (LTE) mobile communication networks on to Cloud platform for computational purposes .Real time SMS trigger to stake holders and web based information flow from the cloud are the unique proposition. The innovative ideas facilitate in the transportation of data to cloud and on line computational analysis coupled with real time reporting will save time and energy in dissolved oxygen level measurements and also aims to prove information with accuracy on real time from any part of the world.

Keywords: *Water, Oxygen, WSN, LTE.*

1. INTRODUCTION

Soil, water, climate, natural vegetation, and landforms are key elements of the environment. Water is the utmost crucial element for human life among all these things. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is the need for public health . So it is necessary for us to maintain water quality . Otherwise, it would severely damage the health of the humans and at the same time affect the ecological balance among other species . Water pollution is a foremost global problem which needs ongoing evaluation and adaptation of water resource directorial principle at the levels of international down to individual wells. One of the reasons for consumption untested water is the ignorance of public and the lack of water quality monitoring system which makes serious health issues. IOT networks provide sensing properties from physical environment. These capabilities lead to real time water quality assurance methodologies and are smart enough to interpret data. Dissolved Oxygen is one of the basic parameters to measure oxygen levelin water.

2. PROBLEM STATEMENT

Traditional methods involve expensive laboratory testing and use manual sampling process. This require real time analytical methods and quick detection of abnormalities to minimize contamination. In manual and conventional method it is not possible to collect number of samples simultaneously and monitor the system on real time basis. This research aims to find a solution to this problem using IOT devices to detect anomalies in water quality in real time domain. Also there is a need for analyzing adequate set of samples for determining accuracy of results which is more complex in real time environment given the nature such as river ,ponds, lakes etc..

Formation of low bandwidth communication networks with dense coverage area and time critical data transport and measurements complicate the issues in achieving the goal.

3. PURPOSE

Water bodies like rivers, ponds, lakes etc are contaminated by unknown sources, and it is necessary to monitor remotely using the IoT devices. Using IoT enabled water monitoring system, remote water terrains that are not easily accessible can be easily monitored. So an IoT system for this purpose is proposed. A reliable cluster based wireless sensor networks is essential for the collection of adequate set of samples for study towards aiming for accuracy of results in real time domain in order to replace actual human sampling and laboratory analysis.

As society relies more and more on connected and autonomous devices, the evaluation of the reliability of such systems is imperative. Even more, from a sustainability point of view, the system should be designed to be energy efficient and robust so that sensors' batteries last as long as possible, keeping maintenance costs and human intervention to a minimum.

4. LITERATURE SURVEY

S. Geetha and S. Gouthami[1] present a detailed survey on the tools and techniques employed in existing smart water quality monitoring systems. Also, a low cost, less complex water quality monitoring system is proposed. The implementation enables sensor to provide online data to consumers. Chrysanthi Tziortzioti and et al [2] detail the challenges those occur in the deployment of Arduino kits and the problems encountered in the use of sensors. They have also enhanced the knowledge initiatives that will accrue in testing turbidity sensors malfunctioning.

Prasad .M.Pujar et al proposes system for water quality monitoring using different sensors for different parameters The sensing is done for only deviation and the difference from normal sets are collected through WIFI network for analysis.

N.Vijayakumar and R.Ramya [4] use Raspberry PI and IOT module with WIFI for monitoring water quality and view the data through cloud. Vaishnavi V. Daigavane et al[5] are attempting an implementation model by using ATMEGA 328 with Wi-Fi module. Inbuilt ADC and Wi-Fi module connects the embedded device to internet. Sensors are connected to Arduino UNO board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated. The sensed data will be automatically sent to the web server, when a proper connection is established with server device. Nguyen Thai-Nghe et al [6] propose deep learning with Long Short Term Memory models for forecasting water quality indicators using System Architecture for Shrimp/Fish Pond Monitoring with conventional sensor data collection techniques

.Arun.V et al [7] tries to measure the determinants of water pollution with sensor devices and web interface without the underlying complicated details of Dissolved oxygen. Simitha K M [8] et al present a system having a low cost, low power, long range and scalable approach for water quality monitoring using LoRa module based on LoRaWAN protocol which is Low-Power Wide Area Network (LPWAN) technology. In this project, Temperature - DO dependency relation is used for the calculation of DO of the water sample. Mohammad Salah Uddin Chowdury et al[9] propose a system with real-time data access which can be done by using remote monitoring and Internet of Things (IoT) technology. Data collected at the site can be displayed in a visual format on a server PC. If the acquired value is above the threshold value automated warning SMS alert will be sent to the agent.

5. IMPORTANCE OF PROPOSED RESEARCH

In this research work relating to Internet of Things basically the following elements are important for the effective apportionment of correctness of the data collected for dissolved oxygen in water.

a) Selection of appropriate sensor devices for the objective measurement.
b) Design of robust and reliable wireless sensor networks for the data spread and consequent accuracy of results.
c) After in-network processing of data ,the design of gateway network and selection of suitable communication topologies for error free and latency controlled transmission of data.
d) Instead of collecting dissolved oxygen data from a single sensor device formation of clusters of wireless sensor networks for optimized data collection for more accuracy and data integrity.
e) Pushing methodology of data to the

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cloud and data processing for data integration.

f) Web interfacing techniques and real time transfer of critical information on to the hand held mobile device for networked environmental analysis.

g) Microcontroller and mobile cloud integration using SIM module and programming interface for sending SMS trigger to the stake holders for exception reporting and management functions.

In this paper a comprehensive analysis have been made and Dissolved oxygen cluster based Wireless sensor network with source and sink sensors having gateway processing capability have been chosen with Raspberry PI programming environment for micro controller using Python Language which will be an effective tool as the same is robust as compared to Arduino boards.

This proposal is unique in the above selection of network elements and is very important since this is going to have a robust LTE communication network (Long term Evolution 4G communication) for backhauling.

In view of the exclusivity of design on account of the above points, this research is important because of real time monitoring of dissolved oxygen and cluster based approach for data accuracy and integrity

6.GENESIS OF THE PROPOSAL

Dissolved oxygen refers to the level of free, non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water . It is a major parameter in determining the quality of water. Too large or too small DO level can cause damage to aquatic life and degrades the quality of water. High level of turbidity, increase in water temperature and salinity, all leads to the reduction of dissolved oxygen level of water bodies

The Dissolved Oxygen (DO) levels in water are also dependent upon atmospheric pressure, temperature and salinity. The most influencing parameter on dissolved oxygen content is the temperature of the water body. We can use DO meters, Winkler's Azide modification technique based on APHA reagents or use the temperature dependency relation on DO. The DO level is expressed in mg/L. Good dissolved oxygen level is 7.3mg/L to 9.5mg/L.

7.PROPOSED PLAN

Smart Water – Dissolved Oxygen Sensor can be used for this project. This is a galvanic cell sensor that can measure Dissolved Oxygen in the range 0-20mg/L with an accuracy of ±2%. The sensor produces a voltage proportional to the dissolved oxygen in the solution. This reference voltage will be input to the microcontroller board for conversion into data.

Alternatively, Optical Dissolved Oxygen and Temperature sensor(OPTOD) probe can be used. The OPTOD probe uses luminescent optical technology that is better suited to long- term or remote IoT monitoring of dissolved oxygen. The OPTOD probe is highly accurate, even in low-flow water systems or with low concentrations of dissolved oxygen.

The overall block diagram of the project proposal is given Figure 2. Raspberry PI will be used as a core controller. Raspberry Pi3Model B runs on Linux kernel based operating systems. It boots and runs from the SD card. It does not have any internal memory other than the ROM. It has an SD card slot which is capable of reading up to 32 GB. The GPIO pins of the Raspberry Pi3 Model B are programmed using Python programming language. The I/O devices like sensors are given to GPIO pins whenever needed. The core controller will be accessing the sensors values and processing them to transfer data through internet. The sensed physical values are converted into data by Raspberry PI module and sent to IOT gateway to a communication network for cloud computing and processing for interpretation computed results

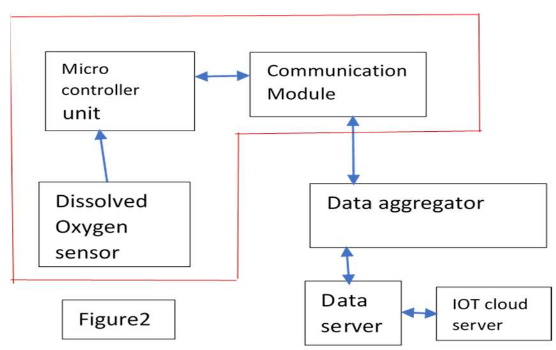

Fig1. Block diagram.

8.METHODOLOGY

The main levels of the IoT architecture in water monitoring system will be sensor, communication,

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management and application, terminal and user level. The sensors in water sources are smart sensor, or "edge device," sits on the outer edge of the IoT network. The proposed system consists of several water quality parameter sensors, Raspberry PI B+ core controller and an IoT module. These devices are low cost, more efficient and capable of processing, analyzing, sending the data to the gateway node called "sink nodes"

Each Sink sensor node for a cluster has connectivity to a number of source sensor nodes to be deployed in a specific demarcated area of water where the dissolved oxygen level is to be measured. The sink nodes look for the data containing physical change in oxygen level in water .The source nodes responsible for collecting the physical change in oxygen level

and convert them into electrical signal and hand over to sink nodes after performing in-network processing such as filtering and aggregation of data. The sink node upon pre-processing the data, encapsulates the IP address in the header and transports to data server after aggregation

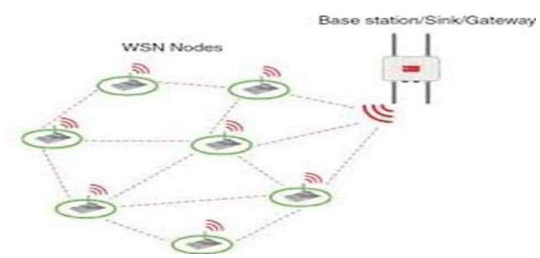

Figure2. Communication Link

The communication link (Figure 2)between source nodes and source nodes to sink nodes will have the design of LoRa WAN technology depending on the coverage area. The attributes of LoRa WAN includes transfer rate of 300bps to 50kbps, low power and low duty cycle, this makes LoRa WAN best suited for IoT applications. The operating frequency of LoRa is 433 MHz. The data from the sensors are transmitted to the gateway using LoRa module. It provides long-range coverage of about 8 kilometers in semirural areas and up to 3 kilometers in dense urban areas and up to 30 kilometers range in line of sight measurements

The gateway is responsible for data analysis and forward sensing data to the remote server. The UDP packets produced at the gateway encapsulate sample data to be sent to windows based remote server. The server collects sample data by receiving the UDP packets containing sample data from the IoT module and gateway and store in database. By using a separate IP address we can view the sensor data anywhere in the world through mobile communication (LTE) (Figure 3)network. The processing of data can be done either in remote server or cloud server and the processed information and analytical reports can be seen through web interface with URL. Also SMS trigger can be initiated from the web interface from the Sink node micro controller interface in case the unprocessed data has to be critically seen on real time.

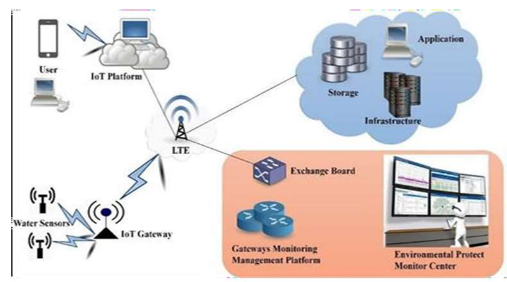

Figure3. Network.

9.RESEARCH OUTCOME

A big area like ponds or lakes can be covered by the use of cluster based wireless sensor networks having dissolved oxygen measurement sensors as edge devices of the IOT network thus formed. Irrespective of geographical limitation the cloud processing can be done by collecting data transported through Long Term Evolution based 4G networks. The computed dissolved oxygen level and its limits can be sent through SMS alert message to the stake holders. This research will prove to be good test bed to ascertain the suitability of the water environment for the best healthy living conditions of aquatic organisms. Application of Optical Dissolved Oxygen and Temperature sensors (OPTOD), clustered Wireless sensor networked environment for accurate interpretation of results and cloud based processing of data , web based and SMS alert mechanism in real time domain are specific research outcome

10. CONCLUSION AND FUTURE SYSTEM

The objective was the design and evaluation of a solution for finding out the dissolved oxygen level detection in an IoT networked system where both local computing and transmission resources are limited and the mandate will be accomplished with scope for future research. The implementation enables the system to provide online data to

consumers. The android based mobile applications can be further developed and interfaced with this IOTnetwork for real time monitoring of data.
The future system can take off from these concepts to build prediction based system using Machine learning and Artificial Intelligence taking into consideration of all parameters of water quality such as pH value ,Turbidity, Conductivity and Temperature. The experimental setup can be improved by incorporating algorithms for anomaly detections in water quality

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