International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Water Quality Assessment and Monitoring for river Malaprabha using the Internet of Things(IoT) system

Prasad. M. Pujar, Harish. H. Kenchannavar, Umakant. P. Kulkarni

Abstract: ***Water Technology is a new approach for assessing water quality. Water technology is the method by which the water quality can be improved so as to accept the water for a specific use. In this paper, an IoT based water quality assessment has been carried out. The IoT system consists of electronic devices and associated sensors to capture water quality. Experimental samples for water quality check were chosen from, river Malaprabha. The water samples are collected from a water quality monitoring station near Khanapur town, Belagavi district, in the state of Karnataka, India. The water quality parameters assessed here are temperature, pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Conductivity and Nitrate (NO3). The proposed IoT system collects the real-time water quality data at every regular time interval. The need for real-time assessment is because, in recent years the water is getting polluted at an alarming level, due to urbanization and industrialization, that results in pollutions like an Urban waste, industrial waste, and agricultural waste, etc... disposed into water. Thus making, the use of water even harder for day-to-day anthropogenic activities. The IoT system developed can be used to monitor and assess the water quality parameters.***

Index Terms: ***IoT, Sensors, pH, DO, TDS, BOD, temperature, Conductivity, and*** NO_3

I. INTRODUCTION

Water is one of the important resources for living beings. It is estimated that 71% of the earth surface is covered with the water in the form of oceans and seas, only 3% of freshwater is available for day-to-day use. The freshwater resources are lakes, ponds, wells, and rivers. These resources are getting scarce and polluted every day due to the contamination like industrial waste, agricultural waste, and urban waste. India is home to several rivers, which are considered as lifelines of country, the i.e. river provides the water for all-purpose anthropogenic use. But when it comes to the monitoring of the water quality of these rivers, India uses the slow costlier and non-real-time method. Thus the people are always unaware of the water quality.

Now with the advent of IoT, the things have started to change even in case of water quality monitoring and assessment. Using IoT we can have a real-time in-situ water quality check. For this purpose, different water quality sensors like pH, temperature, DO, BOD, Conductivity, and NO_3, etc…, are used to predict the accuracy of water quality in real-time. This helps the people to know the real-time quality of water they are using.

A. Related Work

The author in [1], propose a layered IoT framework. It consists of three layers namely; water quality information collection layer, processing layer, and communication layer to inform the concerned authorities in the form of alerts.

In [2], the author emphasizes on the use of big data techniques like C-mean clustering, Ant-colony, etc. and machine learning techniques like Artificial Neural Network(ANN), Radial Based Function Network(RBFN), Deep Belief Network (DBN), Decision Tree etc. in water quality monitoring which is essential for water quality evaluation in smart cities.

The IoT device in [3], was basically designed not only to sense the water quality but also to smell the odor of the water. The classification algorithms like Naive Bayes, Naïve Bayes-Multinomial, Logistics, etc. were used for carrying out analyses. Training and testing were done using neural network model 15-10-1with the accuracy of 95.12% (i.e. 15 attributes used, 10-fold cross-validation and accuracy, and 1 result).

The authors in [4], provide an IoT based water quality system based on four machine learning algorithms namely Support Vector Machine (SVM), K Nearest Neighbor (KNN), Neural Network (NN) and Deep Neural Network (DNN), and found that DNN was most effective algorithm followed by SVM with an accuracy of 93% and 90% respectively.

In [5], the authors focus on the use of IoT system for real-time monitoring of water quality by analyzing the pH value of the water. the recorded value will be messaged to the government authorities for appropriate action to be taken.

A real-time water quality monitoring IoT system using physiochemical parameters of water are analyzed in [6], by the authors. The physicochemical parameters include temp, pH, turbidity, and conductivity.

The authors in [7], propose a low-cost IoT system based on machine learning concept and cloud for storing data.

Revised Manuscript Received on 30 July 2019.

***** Correspondence Author

Prasad. M. Pujar*, Department of Computer Science and Engineering, KLS's Gogte Institute of Technology, Belagavi, India.

Harish. H. Kenchannavar Department of Information Science and Engineering, KLS's Gogte Institute of Technology, Belagavi, India.

Umakant. P. Kulkarni Department of Computer Science and Engineering, SDMCET, Dharwad, India.

Multivariable linear regression algorithm is used for controlling the temperature because the authors believe that by controlling the temperature, the users get suitable water according to the climate.

An android based IoT system for smart well monitoring is developed in [8], the authors use the parameters such as pH, turbidity and dissolved oxygen to assess the water quality. The system helps people to know, when water can be used for drinking and when to use it for other uses like agriculture etc. using the Android interface and cloud storage the data is collected and stored for further use.

The authors in [9], have come up with an IoT system for the bore wells. The motto here is to monitor regularly the quality of bore water and also to check that bore wells do not run dry. If any abnormality detected than report to the concerned authorities

The authors in [10], compare the effectiveness of modern water quality monitoring technology (i.e. IoT) over manual techniques. Further, the authors also discuss the various IoT systems available in the current scenario and compare them against communication techniques, energy management schemes, and data processing approach used for effective water quality monitoring.

An IoT system proposed by the authors in [11], is a low cost, low power, reliable water quality monitoring system, with the parameter such as pH, water level, carbon-dioxide (CO2), turbidity and temp are used to get the accurate real-time data from the remote location.

In [12], the authors have developed a prototype which consists of mainly the physicochemical parameters such as pH, temp, turbidity, DO and conductivity, to assess the quality of water in a pond.

The authors in [13], propose a real-time IoT system for water quality analysis of drinking water. An additional sensor called proximity sensor is deployed other than normal water quality sensors, in order to keep the officials, alert in case of deliberated contamination of water.

In [14], the authors have proposed a water quality monitoring IoT system for industrial application, this system analyzes the water quality by monitoring the following water parameters like pH, turbidity, temp, DO, etc. from various water sources. The system can be further extended for Smart city projects of water monitoring and management.

In [15], the authors discuss the various technologies that are already in use for real-time monitoring and also identify the gaps adhering to the current systems like a limited number of sensor, interdependency between parameters for the accurate real-time decision, heterogeneous communication platform and energy efficiency in use for water quality monitoring. Table 1 summarizes the research issues identified in the related study.

B. Study Area

The river Malaprabha is one of the tributaries of river Krishna it starts its journey at the place called Kankumbi in Khanapur taluka, Belagavi district, in the state of Karnataka at the following 15.702997N latitude and 74.215595E longitude and it unites with river Krishna at Kudalasangama in Bagalkot district in Karnataka. For the experimental purpose, the samples were taken only from the station near Khanapur as shown in table 2.

II. PROPOSED SYSTEM

Unmanned water bodies like rivers are an easy target of contamination, so it is best practice to remotely keep a watch on such water bodies using the IoT devices. Using IoT enabled water monitoring system, remote water terrains that are not easily accessible can be easily monitored. So we have proposed an IoT system for this purpose. The proposed IoT system consists of several water quality sensors, Data processing unit, Wireless module to transmit the data back to the data center. The following figure 1 shows the block diagram of the proposed system and figure 2 shows the actual testbed.

The IoT enabled water monitoring system is realized using Arduino mega 2560 microcontroller board, for the processing of the data collected from the different sensors such as pH, temperature, DO, TDS, BOD conductivity NO_3. The power supply and backup unit is used for a continuous supply of the power required for the working of all the modules in the system

The Wi-Fi module is used to transmit the data collected from all sensors at a remote location to the data center using the internet. The collected data at the data center can be further used for complete quality analysis of the water.

The sensors used for water quality monitoring are:

pH (Potential Hydrogen): This sensor is used to predict the water's one of the physical parameter i.e. pH. This parameter indicates the usage of the water i.e. we measure the pH in the range of 1-14 with a value range of 6.5-7.5 according to Central Pollution Control Board (CPCB) usually found to be normal, less than 6.5 termed as acidic and greater than 7.5 as alkaline.

DO (Dissolved Oxygen): This sensor is used to predict the oxygen content in the water which is essential for the aquatic life. It is usually found that the contents of DO in water should be greater than or equal to 4mg/l according to CPCB.

Temperature: This sensor is used to predict how warm or cold the water is. This is essential because it directly affects the living of aquatic eco-system. It is measured in either Celsius or Fahrenheit.

BOD (Biological Oxygen Demand): This sensor is used to predict the amount of oxygen used by aquatic organisms to break down the organic materials present in the water. It is usually measured as mg/l and it ranges between 3-5 ppm according to CPCB.

Conductivity: This sensor is basically used to check how easily the heat and current can be passed through water. It depends upon the hardness of the water caused due to the dissolved salts and ions. It is measured as Siemens per meter (S/m) or milliohms' per centimeter (mmho/cm) should not exceed 300 mmho/cm according to CPCB.

NO_3 (Nitrate): This sensor is used to predict the amount of nitrogen present in the water. If the amount of nitrogen is low or high, it affects the aquatic plants. It is measured as mg/l and it should not exceed 1mg/l according to CPCB.

Another parameter which can be assessed using conductivity is TDS i.e. TDS is always 0.64 times of conductivity.

The parameters like DO, BOD, NO3, Conductivity are all dependent on temp. As the temp varies correspondingly there is a variation in the described parameters. Thus it affects the aquatic ecosystem.

Table 1: Different issues identified.

Reference No	Research Issues: Need for More Sensors (Physio-Chemical or Biological)	Need for Real-Time Monitoring	Need for Big Data Analytics / Machine Learning, Deep Learning Capabilities	Need for Sharing of Information, Finding Exact Location, and Deployment Coverage	Need for Decision Support System	Need for Data Safety, Security, Data Aggregation and Processing	Need for Communication, Underwater Communication, and Energy Harvesting
[1]		✓	✓	✓			
[2]		✓	✓			✓	
[3]		✓	✓				
[4]		✓			✓		
[5]	✓	✓					
[6]	✓	✓					
[7]	✓	✓					✓
[8]	✓	✓		✓			
[9]	✓	✓		✓			
[10]		✓				✓	✓
[11]		✓		✓			
[12]	✓	✓					
[13]		✓	✓				
[14]	✓	✓					
[15]	✓	✓	✓				

Table 2: Location of sample collection.

Station Code	Location	Coordinates
1187	Malaprabha at Downstream of Khanapur Town.	15.633944N, 74.510519E.

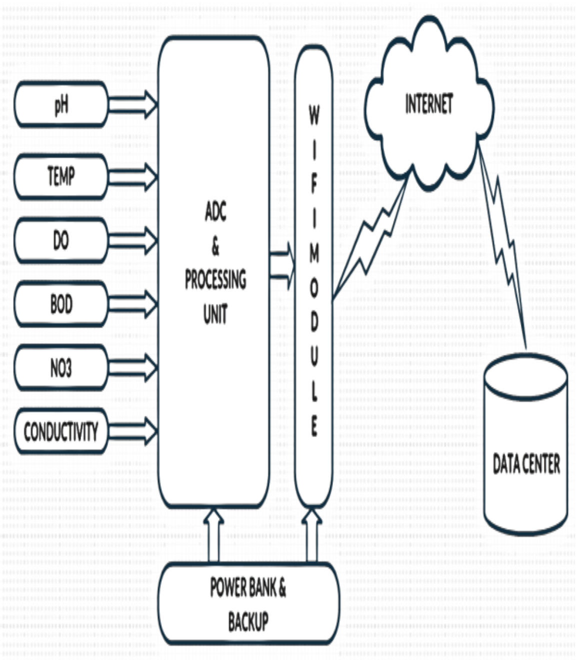


Figure 1: The block diagram of the proposed system.

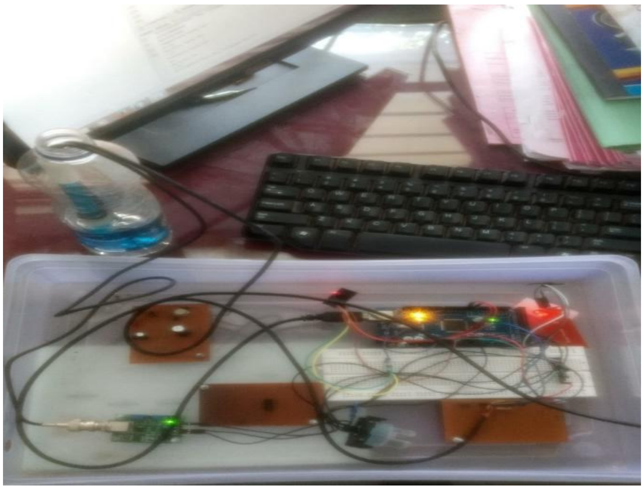


Figure 2: The testbed.

III. ANALYSIS

The following flow chart in figure 3 shows, the analysis carried out for checking the water quality using different parameters.

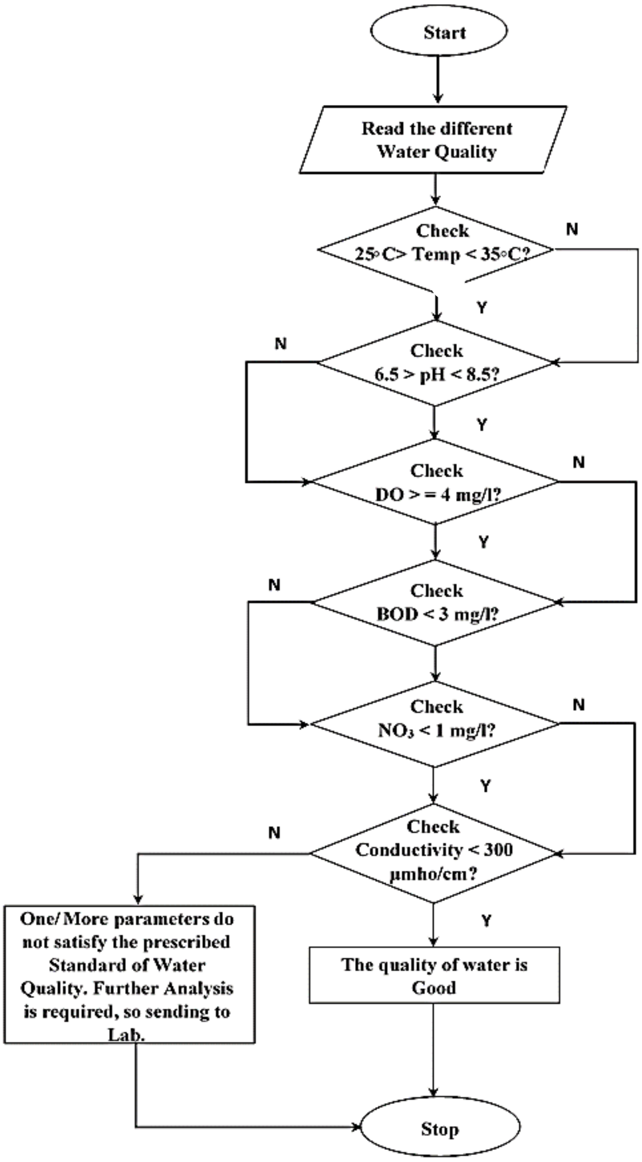


Figure 3: Water Quality Analysis process.

The following steps are carried out for water quality assessment.

A. Algorithm: Water Quality Analysis

1. Collect the water sample.
2. Check the temp for Value between 25◦C-35◦C? if within range then proceed to step 3. Otherwise, go to step 3.
3. Check the pH for Value between 6.5-8.5? if within range then proceed to step 4. Otherwise, go to step 4.
4. Check the DO for Value greater or equal to 4 mg/l? if within range then proceed to step 5. Otherwise, go to step 5.
5. Check the BOD for Value less than 3mg/l? if within range then proceed to step 6. Otherwise, go to step 6.
6. Check the NO3 for Value less than 1mg/l? if within range then proceed to step 7. Otherwise, go to step 7.
7. Check the Conductivity for Value less than 300 µmhos/cm? if within range then proceed to step 8. Otherwise, go to step 9.
8. Declare that the water quality is good for daily use.
9. Send the sample to a lab for further detailed analysis.

Figure 6: Observation of Various parameters graphs

IV. RESULTS AND OBSERVATIONS

The system was put into operation at the station 1187, and the following observations were recorded during the summer season. The figure 4 shows the data acquisition by the IoT kit and figure 5 shows the output window of the GUI.

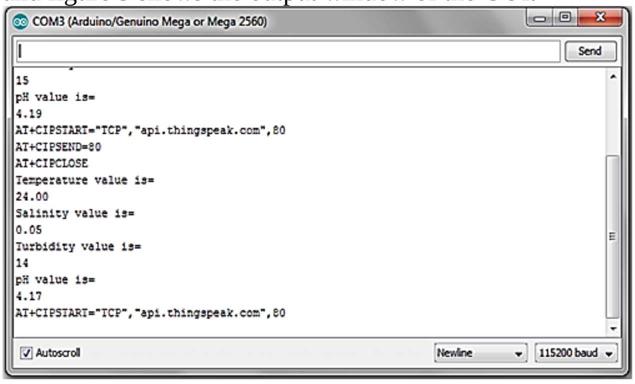


Figure 4: Arduino output

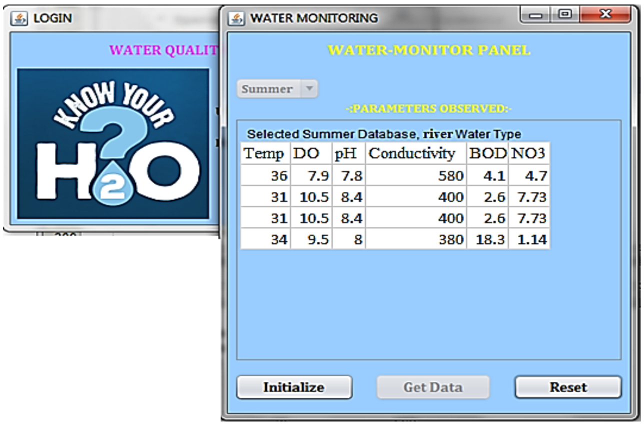


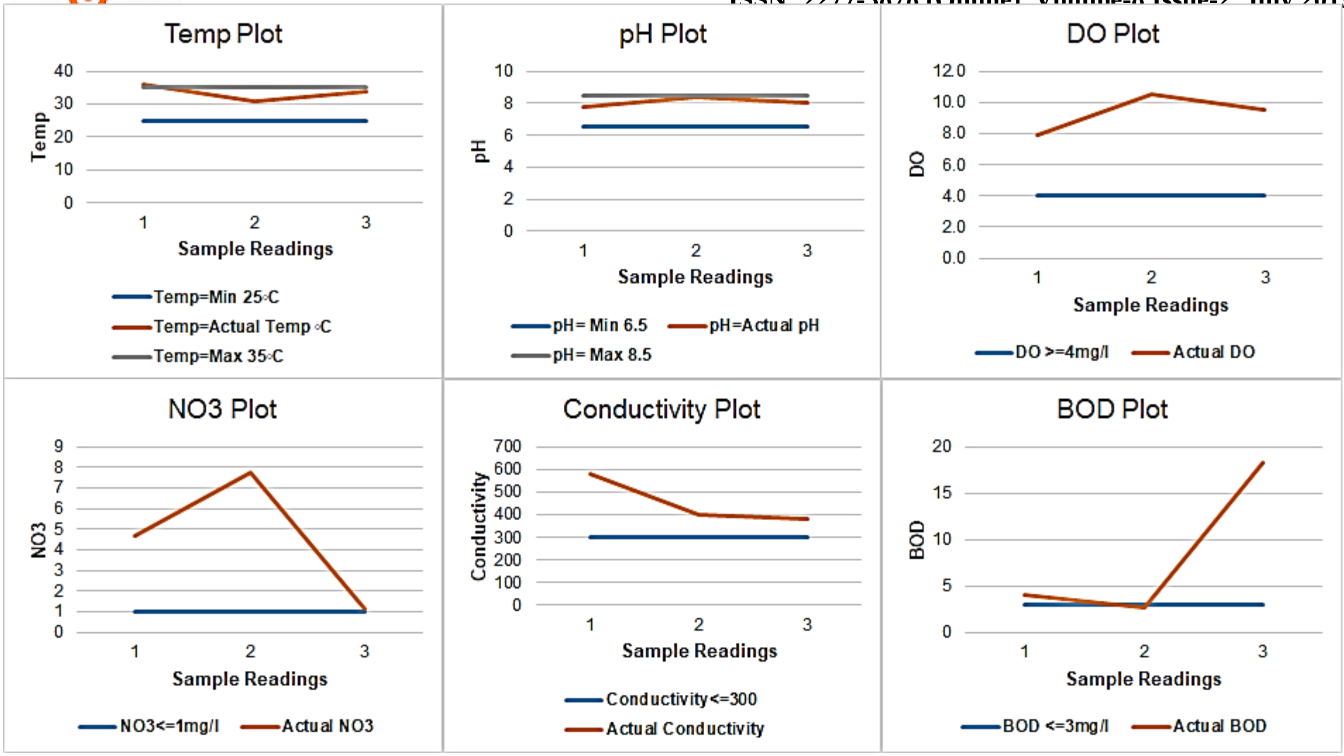
Figure 5: Data acquisition into the database.

The data as shown in figure 5 was taken for the summer season. It can be extended to other seasons too.

Table 3: Parameter wise readings of the water sample.

Parameter	In Range	Out of Range
Temperature	✓	✓
Dissolved Oxygen (DO)	✓	
Potential Hydrogen (pH)	✓	
Conductivity		✓
Biological Oxygen Demand (BOD)	✓	✓
Nitrogen (NO_3)	✓	✓

The following table 3 shows the readings obtained by the IoT system. According to the table information the temperature was found to be in range as well as out of range, DO was completely within range, pH was too within the prescribed range, Conductivity was the only parameter which was completely out of range this is due to the low water level and high mixture of salts and ions into water, BOD was almost found within range except for one reading which was out of range, NO3 was almost out of range except for one reading. Figure 6 shows the result in graphical form.



V. CONCLUSION AND FUTURE WORK

In this paper, the design and development of the IoT system for water quality monitoring are presented. The proposed system uses different water quality sensors like temperature, pH, DO, BOD, Conductivity, and NO_3 to monitor the water quality of the river Malaprabha. The sensed data is then analyzed for any deviation from the normal set of values. If there are any then the values are sent to the data center through the Wi-Fi module for the further analyses.

The future work of the proposed system is that we can include biological sensors for more effective analyses of water quality. Further, the monitoring area can be increased by employing deployment strategies. One more important future work on the proposed system is that we can apply some machine learning algorithms to make the system intelligent.

REFERENCE

1. S. Lokuliyana, A. Jayakody, N. B. R. P. Bandara, J. W. P. Deshapriya, P. C. Kavinda, and T. L. Wijewickrema, "A survey: IoT enable framework for water quality measurement and distribution," 13th Int. Conf. Comput. Sci. Educ. ICCSE 2018, no. Iccse, pp. 693–698, 2018.
2. G. Kang, J. Z. Gao, and G. Xie, "Data-driven water quality analysis and prediction: A survey," Proc. - 3rd IEEE Int. Conf. Big Data Comput. Serv. Appl. BigDataService 2017, pp. 224–232, 2017.
3. C. Lowongtrakool and P. Lorwongtrakool, "IoT Based Water Quality Measurement Using Hybrid Sensors and Data Mining," Proceeding 2018 3rd Int. Conf. Inf. Technol. InCIT 2018, pp. 1–6, 2018.
4. U. Shafi, R. Mumtaz, H. Anwar, A. M. Qamar, and H. Khurshid, "Surface Water Pollution Detection using the Internet of Things," 2018 15th Int. Conf. Smart Cities Improv. Qual. Life Using ICT IoT, HONET-ICT 2018, pp. 92–96, 2018.
5. N. R. Moparthi, C. Mukesh, and P. Vidya Sagar, "Water quality monitoring system using IOT," Proc. 4th IEEE Int. Conf. Adv. Electr. Electron. Information, Commun. Bio-Informatics, AEEICB 2018, pp. 1–5, 2018.
6. K. Gopavanitha and S. Nagaraju, "A low cost system for real time water quality monitoring and controlling using IoT," 2017 Int. Conf. Energy, Commun. Data Anal. Soft Comput. ICECDS 2017, pp. 3227–3229, 2018.
7. N. Kumar Koditala and P. Shekar Pandey, "Water Quality Monitoring System Using IoT and Machine Learning," Proc. 2018 3rd IEEE Int. Conf. Res. Intell. Comput. Eng. RICE 2018, pp. 1–5, 2018.
8. K. Soni, D. Waghela, R. Shah, and M. Mohan, "Smart Well Monitoring System," 2018 Int. Conf. Smart City Emerg. Technol. ICSCET 2018, pp. 1–5, 2018.
9. K. Poornisha, M. R. Keerthana, and S. Sumathi, "Borewell water quality and motor monitoring based on IoT gateway," in 2018 International Conference on Communication, Computing and Internet of Things (IC3IoT), 2018, pp. 514–518.
10. K. S. Adu-Manu, C. Tapparello, W. Heinzelman, F. A. Katsriku, and J.-D. Abdulai, "Water Quality Monitoring Using Wireless Sensor Networks," ACM Trans. Sens. Networks, vol. 13, no. 1, pp. 1–41, Jan. 2017.
11. C. Z. Myint, L. Gopal, and Y. L. Aung, "Reconfigurable smart water quality monitoring system in IoT environment," Proc. - 16th IEEE/ACIS Int. Conf. Comput. Inf. Sci. ICIS 2017, pp. 435–440, 2017.
12. N. Vijayakumar and R. Ramya, "The real time monitoring of water quality in IoT environment," in 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015], 2015, pp. 1–4.
13. B. Das and P. C. Jain, "Real-time water quality monitoring system using the Internet of Things," 2017 Int. Conf. Comput. Commun. Electron. COMPTELIX 2017, pp. 78–82, 2017.
14. P. Salunke and J. Kate, "Advanced smart sensor interface in the internet of things for water quality monitoring," 2017 Int. Conf. Data Manag. Anal. Innov. ICDMAI 2017, pp. 298–302, 2017.
15. G. S. Menon, M. V. Ramesh, and P. Divya, "A low cost wireless sensor network for water quality monitoring in natural water bodies," GHTC 2017 - IEEE Glob. Humanit. Technol. Conf. Proc., vol. 2017-Janua, pp. 1–8, 2017.

AUTHORS PROFILE

Mr. Prasad. M. Pujar. is an Assistant Professor in Department of Computer Science and Engineering, He has completed his M. Tech. from KLS GIT, Belagavi currently pursuing Ph.D. under the guidance of Dr. Harish. H. Kenchannavar, He is the life member of ISTE.

Dr. Harish. H. Kenchannavar. is a Professor and Head in the Department of Information Science & Engineering at KLS Gogte Institute of Technology, Belagavi, Karnataka, INDIA. He has completed his Ph.D. from Walchand College of Engineering, He is present, guiding 06 Ph.D. research scholars. He is a member of ISTE, CSI, ACM, and IEEE.

Dr. Umakant. P. Kulkarni. is a Professor and Head in the Department of Computer Science & Engineering at SDM College of Engineering and Technology, Dharwad, Karnataka, INDIA. He has completed his Ph.D. from Walchand College of Engineering, He has guided 08 and presently, he is guiding 06 Ph.D., research scholars. He is a member of ISTE, CSI, and NCSSS.