International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

Iot Based Water Quality Management System

Dr.T.Prakash, Kishor.R, Alvin Mathew Thoumas, Mohamed Abdullah. S, Ananda krishnan TU

Head of Mechatronics, Department of Mechatronics Engineering, SNS College of Technology Coimbatore, Tamilnadu, India

Student, Department of Mechatronics Engineering, SNS College of Technology, Coimbatore, Tamilnadu, India

Student, Department of Mechatronics Engineering, SNS College of Technology, Coimbatore, Tamilnadu, India

Student, Department of Mechatronics Engineering, SNS College of Technology, Coimbatore, Tamilnadu, India

Student, Department of Mechatronics Engineering, SNS College of Technology, Coimbatore, Tamilnadu, India

---

Date of Submission: 01-05-2023 Date of Acceptance: 10-05-2023

ABSTRACT: Water quality management is an essential aspect of ensuring public health and sustainable development. The IoT has emerged as a powerful tool in managing water quality. This technology can monitor, analysed, and control water systems in real-time, providing accurate and timely information for decision-making. IoT devices can detect changes in water quality parameters such as pH, temperature, turbidity, and dissolved oxygen levels. They can also detect leaks and other anomalies in the system. The data collected by IoT devices can be used to optimize water treatment processes, reduce operational costs, and ensure compliance with regulatory standards. The use of IoT in water quality management can lead to a more efficient, cost-effective, and sustainable water management system

Keywords: Water quality management, IoT, pH Sensor, Turbidity Sensor, temperature and humidity sensor, water level sensor

I. INTRODUCTION

Water is essential for both human and ecosystem health. Safe and clean water is necessary for drinking, cooking, sanitation, and hygiene, and is critical in preventing the spread of waterborne diseases. Water quality also impacts aquatic life and ecosystem health, as well as agricultural and industrial activities. Poor water quality can lead to contamination from harmful chemicals, pathogens, and pollutants, resulting in serious health and environmental consequences. Ensuring access to high-quality water is vital for public health, economic development, and the sustainability of our planet. Monitoring and managing water quality is crucial to protect both human health and the environment

Effective water quality management can help prevent contamination, reduce pollution, and conserve water resources. It also plays a crucial role in supporting sustainable development, protecting the environment, and promoting economic growth.

Using sensors and linked devices, an IoT-based system for managing water quality may track and control variables like pH, temperature, dissolved oxygen levels, and turbidity in real-time. The data collected by the sensors can be transmitted wirelessly to a centralized system for analysis and decision-making.

The system can detect and alert authorities of any anomalies in water quality, enabling them to take prompt action to mitigate potential risks to public health and the environment. Additionally, the system can enable water utilities to optimize their operations by identifying and addressing inefficiencies in the water treatment process.

II. LITERATURE SURVEY

Osei et al. (2019) explores the effectiveness of the water quality management system in Ghana. The study found that there were significant challenges in implementing the system, including limited resources and inadequate technical expertise.

Khan et al. (2019) presented water quality management systems worldwide. The authors highlight the need for sustainable water resource management and emphasize the importance of implementing effective water quality management systems.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

Wang et al. (2020) evaluates the effectiveness of the water quality management system in the Yangtze River Basin. The study found that the system had improved water quality in the basin, but there were still challenges in maintaining sustainable development.

Ahmed et al. (2018) investigates the challenges and opportunities in implementing water quality management systems in rural areas. The authors highlight the need for community involvement and capacity building to overcome the challenges.

Olawale et al. (2018) evaluates the performance of the water quality management system in Lagos, Nigeria. The study found that the system was inadequate in ensuring safe water supply due to poor governance, lack of resources, and inadequate technical expertise.

Ghimire et al. (2020) presents the design of a water quality management system for rural water supply in Nepal. The study emphasizes the need for a decentralized system with community involvement to ensure sustainability.

Patel et al. (2019) examines the effectiveness of the water quality management system in the Ganges River basin. The study found that the system had improved water quality and reduced the prevalence of waterborne diseases, leading to improved public health outcomes.

III. METHODOLOGY

A crucial role in ensuring that water is safe for drinking and other uses is water quality management. Technology advancements have made IoT a powerful tool for managing and monitoring water quality in real-time. Various sensors and gadgets are used in this system to track different elements of water quality and transmit the data to a centralized computer for analysis and decision-making. The detailed operation of an IoT-based water quality control system is displayed here:

Sensors and devices: Various sensors and devices are used to measure different water quality parameters such as pH, temperature, turbidity, dissolved oxygen, total dissolved solids (TDS), and conductivity. These sensors and devices are connected to a microcontroller or a gateway device, which collects the data and transmits it to the cloud server for analysis.

Communication protocols: To transmit the data from sensors and devices to the cloud server, different communication protocols such as Wi-Fi, Bluetooth, Zigbee, or LoRaWAN are used depending on the distance between the devices and the cloud server.

Cloud server: In a cloud server, the data collected from sensors and devices is kept for additional analysis and decision-making. The cloud server may be located on-site or with a provider of cloud services like Microsoft Azure or Amazon Web Services (AWS).

Data analysis: The data collected from sensors and devices is analysed to determine the quality of water. Various algorithms and ML models can be used to predict water quality based on historical data and other factors such as weather conditions, time of day, and water source.

Alerts and notifications: If the water quality is found to be below the acceptable levels, alerts and notifications are sent to the concerned authorities or users through email, SMS, or mobile apps. This enables quick action to be taken to resolve the issue.

Visualization and reporting: The data collected from sensors and devices can be visualized using various tools such as dashboards and reports. This helps in understanding the trends and patterns in water quality over time and enables informed decision-making.

Awater quality management system using IoT involves the deployment of various sensors and devices to measure different water quality parameters, data transmission using different communication protocols, data analysis using algorithms and machine learning models, alerts and notifications to concerned authorities, and visualization and reporting of data using various tools. This system enables real-time monitoring and management of water quality, which is crucial for ensuring safe water for consumption and other purposes.

A. ARDUINO

Arduino Uno is a microcontroller board that can be used as a component in a water quality management system using IoT. Here are the details of the main components of an Arduino Uno:

Microcontroller: The main component of an Arduino Uno is the ATmega328P microcontroller, which is responsible for controlling the board's functions. The microcontroller has 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM.

Analog-to-Digital Converter (ADC): The 10-bit ADC on the Arduino Uno transforms analogue sensor signals into digital signals that the microcontroller can process.

Digital I/O pins: The circuit board includes 14 digital input/output (I/O) pins that can be used to connect to a variety of devices like actuators, sensors, and more. Input or output functionality

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

can be assigned to each of these pins, depending on the requirements.

PWM pins: The Arduino Uno contains six pins that are referred to as pulse width modulation (PWM), which can be used to regulate the speed of motors, the brightness of LEDs, and a variety of other factors.

Serial communication: The board has a USB port that can be used for serial communication with a computer. This allows the board to be programmed and debugged using the Arduino Integrated Development Environment (IDE).

Power supply: Arduino Uno can be powered using a USB cable, a 9V battery, or an external power supply. The board has a voltage regulator that ensures a stable supply voltage to the microcontroller and other components.

The Arduino Uno can be used in an IoT water quality management system to gather data from sensors, process the data, and send the processed data to the cloud server using Wi-Fi, Ethernet, or other communication protocols. The Arduino IDE and numerous libraries for water quality sensors, including pH sensors, temperature sensors, and turbidity sensors, can be used to program the board. The data collected from the sensors can be stored in the board's memory or sent to the cloud server for further analysis and decision-making.

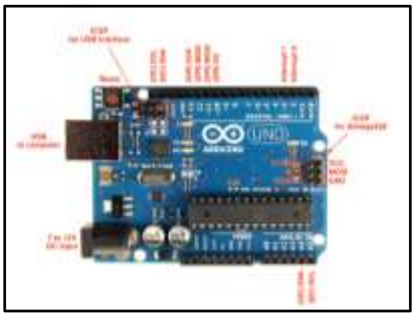

Fig 1: Arduino

B. PH SENSOR

Water quality management is crucial to ensure the safety of drinking water. A pH sensor is one of the most critical components of a water quality management system. It measures the pH of the water, which is an indicator of its acidity or alkalinity. pH sensors can be integrated into an IoT system, which allows for real-time monitoring and data analysis. ApH sensor can be used in the proposed system.

Firstly, pH sensors can be connected to IoT devices such as microcontrollers and single-board computers, which can be programmed to collect data from the sensor at regular intervals. The data can then be transmitted to a central server for storage and analysis. This allows for real-time monitoring of the pH levels of the water.

Secondly, Proposed systems can be equipped with an alert system that sends notifications to stakeholders when the pH levels of the water go beyond a set threshold. This allows for prompt action to be taken to address any potential issues, such as adding pH-adjusting chemicals to the water or identifying the source of the pH imbalance.

Thirdly,ML techniques can be used to analyze the pH sensor data to find patterns and trends in the water quality. This can be used to develop predictive models that can help anticipate potential water quality issues before they occur.

Lastly, the use of IoT-based water quality management systems can help reduce the cost of monitoring and maintaining water quality. By providing real-time data and automated alerts, it eliminates the need for manual testing and reduces the risk of human error.

In conclusion, pH sensors are an essential component of the proposed system. They provide real-time data, automated alerts, and predictive modelling capabilities that can help ensure the safety of our drinking water, aquatic life, and the environment. With the increasing importance of water quality management, the use of IoT-based systems is likely to become more widespread in the future.

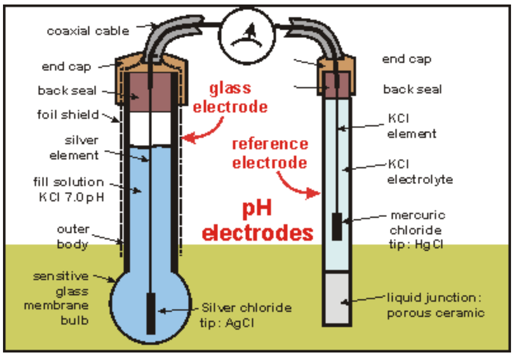

Fig 2: pH sensor

C. TURBIDITY SENSOR

A turbidity sensor is an essential component in water quality management systems, especially in monitoring the clarity and cleanliness of water. Sediment, algae, or other organic or inorganic materials could make up these particles.

In the proposed system, a turbidity sensor can provide real-time and continuous measurements of the turbidity levels in the water. The sensor is usually placed in the water source, and its readings are transmitted wirelessly to a cloud-based server for analysis.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

The system can be programmed to alert the authorities or the relevant stakeholders if the turbidity levels exceed the safe limit. This early warning system can help prevent water contamination and ensure that the water is safe for human consumption or other uses.

Moreover, an IoT-based turbidity sensor system can offer several benefits, such as cost-effectiveness, convenience, and accuracy. Additionally, IoT-based turbidity sensors can provide accurate and consistent data, allowing for better decision-making in terms of water quality management

Fig 3: Turbidity sensor

D. DHT11

It is a temperature and humidity sensor that can be used in the proposed system. In this system, the DHT11 can be used to monitor the temperature and humidity levels of the water in real-time, providing valuable data for ensuring the quality and safety of the water.

One of the main advantages of using the DHT11 in this system is its low cost and ease of use. The sensor is relatively inexpensive and can be easily integrated with other IoT devices, making it an ideal choice for water quality monitoring in areas with limited resources.

In addition, the DHT11 is a reliable and accurate sensor, providing precise measurements of temperature and humidity levels. This data can be used to detect changes in water quality, such as contamination or the presence of harmful chemicals, and trigger alerts to prompt immediate action.

The proposed system can also be designed to automatically adjust the water temperature and humidity levels based on the data collected from the DHT11 sensor. This can help to ensure optimal conditions for aquatic life and prevent the growth of harmful bacteria and other organisms.

Overall, the DHT11 is a valuable sensor that can play a critical role in the proposed system. By providing real-time data on temperature and humidity levels, it can help to ensure the safety and quality of water.

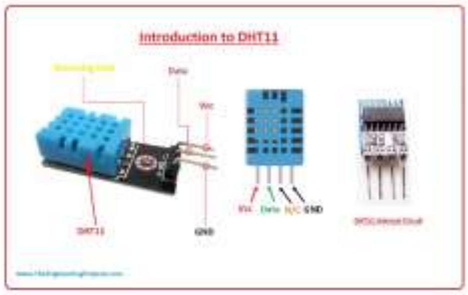

Fig 4: DHT11

E. WATER LEVEL SENSORS

A water level sensor is an important component of water quality management systems that use Internet ofThings (IoT) technology. The sensor is designed to measure the level of water in a tank or other container, and can be used to monitor water usage, detect leaks, and ensure adequate water supply.

In the proposed system, the water level sensor is connected to a wireless network, which allows for real-time data collection and analysis. The sensor can send data to a central hub, where it can be monitored and analysed by water management professionals.

Reducing water waste is one of the key advantages of utilizing a water level sensor in an IoT-based system. Water management experts can detect leaks and other problems early on and take corrective action before sizable volumes of water are wasted by monitoring water levels in real-time.

Another benefit of using the proposed system with a water level sensor is that it can help to ensure that there is an adequate supply of water. Water level sensors can be used to track the amount of water in a reservoir, for example, and alert water management professionals when levels get too low. This can help to prevent shortages and ensure that there is enough water for all users.

Overall, the use of water level sensors in the proposed system can help to improve water efficiency, reduce waste, and ensure an adequate water supply. With the increasing need for sustainable water management practices, the integration of IoT technology and water level sensors can play a critical role in achieving these goals.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

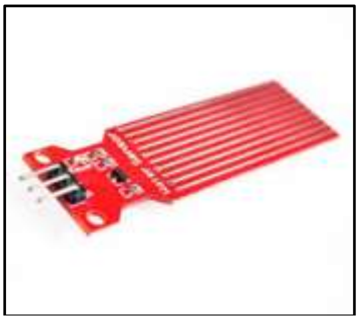

Fig 5: Water level sensor

F. Node MCU:

Node MCU can be interfaced with various sensors that measure these water quality parameters and send the collected data to a central database using Wi-Fi connectivity. The collected data can then be analysed and used to make informed decisions about water quality management. For example, if the temperature of a water body increases beyond a certain threshold, it could indicate the presence of pollutants, and immediate action could be taken to prevent further damage to the ecosystem.

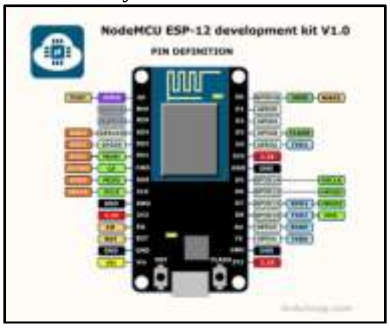

Fig 6: Node MCU

G. GSM:

GSM, or Global System for Mobile Communications, is a widely used cellular network technology that enables wireless communication between devices. In recent years, the use of GSM in water quality management systems has gained popularity with the rise of the IoT technology which exchange data and information with each other, enabling smart and automated decision-making processes. GSM technology can be integrated with IoT devices to facilitate the transmission of water quality data to a centralized database or a control room. This enables water quality managers to remotely monitor the water quality parameters and take appropriate action in case of any abnormalities.

The integration of GSM and IoT technology in water quality management systems offers several benefits. First, it enables real-time monitoring of water quality parameters, allowing for timely action in case of any issues. Second, it reduces the need for manual monitoring, which is time-consuming and expensive. Third, it enables better decision-making, as water quality managers can access data and information from remote locations.

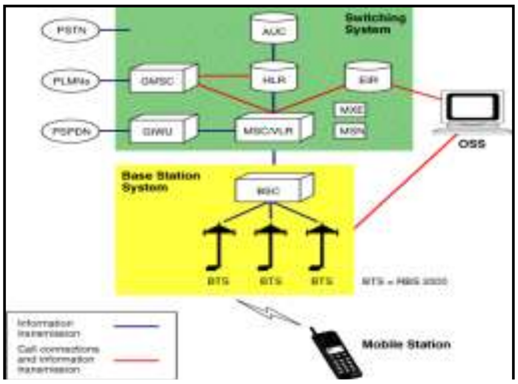

Fig 7: GSM

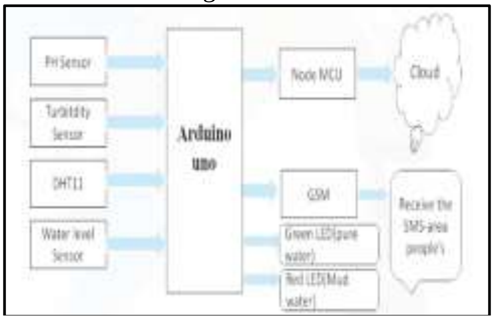

Fig 8: Block Diagram

The functional block diagram of the system hardware is shown in the image. The system is set up to accept a variety of inputs for the PH Sensor measurement parameters. The sensors' inputs are combined and processed. The Serial Monitor and Thing talk cloud both show the findings. The user interface of the application enables a report on the person's present state. Data is immediately updated on the screen once the user is linked to the receiver device. On the display, value is shown. Since the design is modular, adding additional sensors for measuring and monitoring other parameters is rather simple and straightforward. The micro controller board is then updated with sensor values.

H. SYSTEM ARCHITECTURE

Embedded systems are typically designed to interact with their surroundings by gathering data from sensors and acting on that data with actuators, as was discussed earlier. In order to accomplish this, embedded systems must operate at environment speed.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

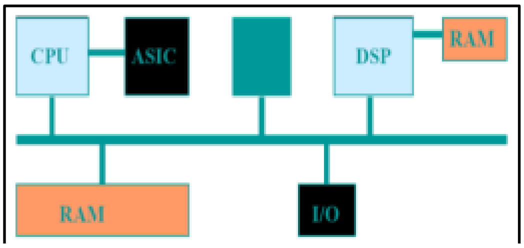

Fig 8: System Architecture

"Reactive" describes this feature of embedded systems. Reactive computing refers to the process of a system (most often a software component) operating in reaction to outside stimuli. External events can either be recurring or not. It is simpler to arrange processes to ensure performance when periodic events occur. Periodic occurrences are more challenging to plan. To account for worst-case scenarios, the maximum event arrival rate must be estimated. The majority of embedded systems contain a sizable reactive component. A major role in the entire process is played by the signal being sent to the PLC, which then produces the output based on our ladder program before being fed to drive the DC motor, which only requires the pulses. This is one of the greatest obstacles for embedded system designers. The signal to the monitoring area will be collected from the PLC, and we will have certain display arrangements to monitor the entire procedure here.

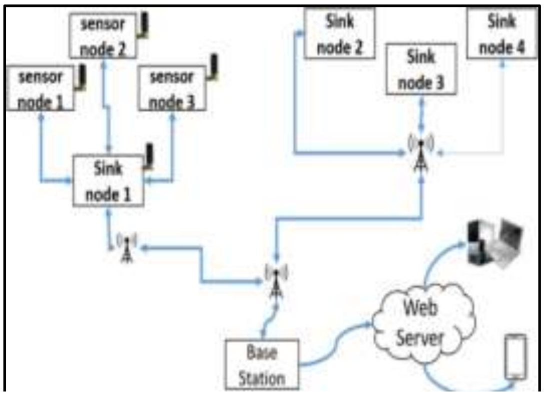

Fig 9: Working model

Advantages

- Real-time monitoring: Real-time data on water quality, allowing for timely detection and response to any issues that arise.
- Cost-effective: Over time,IoT-based water quality monitoring systems have the potential to be more economical than conventional monitoring techniques because they don't require as much manual labor and can be automated to gather and process data.
- Accurate data: The sensorsprovide more precise information than traditional monitoring methods.
- Remote monitoring: Remotely allowing for data to be collected from hard-to-reach locations, reducing the need for on-site visits and saving time and resources.
- Easy integration: The proposed system can be easily integrated with other systems, such as water treatment plants or environmental monitoring networks, providing a comprehensive view of the water system.

IV. SIMULATION RESULTS

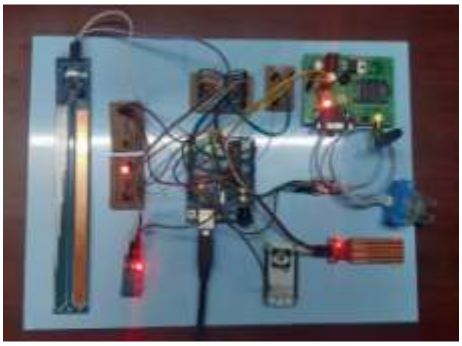

Fig 10: Proposed IoT-based water quality monitoring system

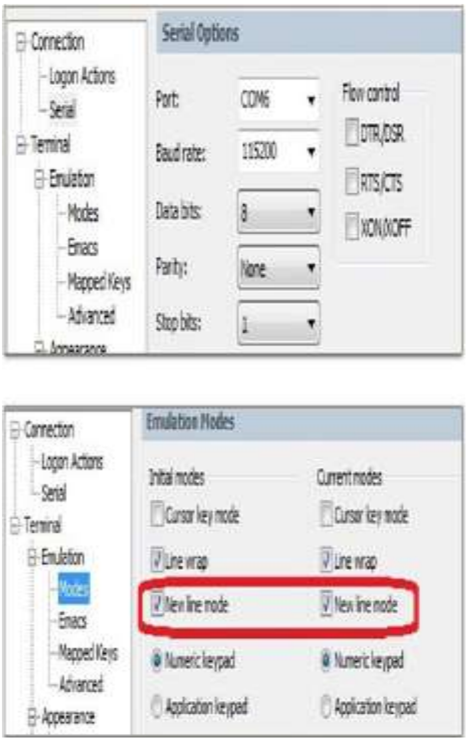

Fig 11: pH sensor

DOI: 10.35629/5252-0505346353 |Impact Factorvalue 6.18| ISO 9001: 2008 Certified Journal

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 346-353 www.ijaem.net ISSN: 2395-5252

V. CONCLUSION

In conclusion, the proposed systemoffer several advantages over traditional monitoring methods, including real-time monitoring, cost-effectiveness, accurate data, remote monitoring, easy integration, early warning system, and sustainability. While there are some potential disadvantages to consider, such as high initial investment costs, maintenance requirements, and security concerns, the future scope of the proposed system is promising. With the integration of advanced technologies such as AI, blockchain, and smart cities, IoT-based water quality monitoring systems can be used in a wide range of applications, from precision agriculture to disaster management and space exploration, helping to ensure the availability of clean water for all.

VI. FUTURE SCOPE

- Artificial Intelligence (AI) integration: IoT-based water quality monitoring systems can be integrated with AI algorithms to improve data analysis, pattern recognition, and predictive modelling, enabling more accurate and timely responses to water quality issues.
- Blockchain technology integration: Blockchain technology can be integrated with IoT-based water quality monitoring systems to enhance data security and transparency, providing a secure and tamper-proof record of water quality data.
- Smart cities: As cities become smarter, IoT-based water quality monitoring systems can be used to create intelligent water management systems, enabling better water resource management, reducing water waste, and improving overall water quality.
- Precision agriculture: It can be used in precision agriculture to monitor water quality in irrigation systems, enabling more efficient use of water and reducing environmental impact.
- Health monitoring: It can be used to monitor water quality in hospitals, ensuring that water used for patient care is free of harmful contaminants.
- Disaster management: Itcan be used in disaster management to monitor water quality in the aftermath of natural disasters or other emergencies, providing timely information to authorities to ensure that clean drinking water is available.
- Space exploration: Itcan be used in space exploration to monitor water quality in closed environments such as spacecraft or space stations, enabling astronauts to safely consume clean water.

ACKNOWLEDGEMENT

I would like to acknowledge the contributions of various experts and researchers who have contributed to the development and implementation of IoT-based water quality monitoring systems. Their dedication and hard work have helped to advance this field, and their insights have been invaluable in shaping our understanding of the advantages and challenges associated with these systems. Additionally, I would like to thank the organizations and individuals who have funded and supported research in this area, as well as the countless water quality professionals and stakeholders who are committed to ensuring the availability of safe and clean water for all.

REFERENCES

[1] Nikhil Kedia, Water Quality Monitoring for Rural Areas- A Sensor Cloud Based Economical Project, in 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India, 4-5 September 2015. 978-1-4673-6809-4/15/$31.00 ©2015 IEEE
[2] Jayti Bhatt, Jignesh Patoliya, Iot Based Water Quality Monitoring System, IRFIC, 21feb,2016.
[3] Michal lom, ondrejpriby&miroslavsvitek, Internet 4.0 as a part of smart cities, 978-1-5090-1116-2/16/$31.00 ©2016 IEEE
[4] Zhanwei Sun, Chi Harold Liu, ChatschikBisdikia_, Joel W. Branch and Bo Yang, 2012 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), 978-1-4673-1905-8/12/$31.00 ©2012 IEEE
[5] SokratisKartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann, 2016 IEEE First International Conference on Internet-of-Things Design and Implementation, 978-1-4673-9948-7/16 © 2016IEEE
[6] MithailaBarabde, shruti Danve, Real Time Water Quality Monitoring System, IJIRCCE, vol 3, June 2015.
[7] Akanksha Purohit, Ulhaskumar Gokhale, Real Time Water Quality Measurement System based on GSM , IOSR (IOSR-JECE) Volume 9, Issue 3, Ver. V (May - Jun. 2014)

[8] Eoin O'Connell, Michael Healy, Sinead O'Keeffe, Thomas Newe, and Elfed Lewis, IEEE sensors journal, vol. 13, no. 7, July 2013, 1530-437x/$31.00 © 2013 IEEE
[9] Nidal Nasser, Asmaa Ali, Lutful Karim, Samir Belhaouari, 978-1-4799- 0792-2/13/$31.00 ©2013 IEEE
[10] Niel Andre cloete, Reza Malekian and Lakshmi Nair, Design of Smart Sensors for Real-Time Water Quality monitoring, ©2016 IEEE conference.