STM JOURNALS

Journal of
Water Pollution &
Purification Research

ISSN: 2394-7306
Volume 12, Issue 2, 2025
May–August
DOI (Journal): 10.37591/JoWPPR

https://journals.stmjournals.com/jowppr

Research JoWPPR

Water Quality and Level Monitoring System: Real-Time Detection of Biological Hazards

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Abstract

Water is essential for all life forms, yet its contamination poses serious risks> to human health, agriculture, and industry. Growing pollution, ecosystem disruptions, and the spread of biological hazards such as bacteria, viruses, and harmful algal blooms increasingly threaten global water bodies. This study presents the development of a Water Quality and Level Monitoring System aimed at real-time detection of biological hazards. The system employs a network of modern sensors, energy-efficient components, and wireless IoT technologies to continuously monitor key water quality parameters—temperature, pH, turbidity, dissolved oxygen, and biological indicators like E. coli and cyanobacteria. Deployed across varied water bodies including lakes, reservoirs, and water supply systems, the sensors relay data to a cloud-based platform using low-power communication modules. Advanced AI and machine learning algorithms analyze the collected data to detect contamination events and send alerts to relevant authorities when water quality standards are breached. The system's data is accessible via a website or mobile app, enabling both regulatory bodies and the general public to monitor water conditions in real-time. To enhance sustainability and usability in remote locations, the system integrates solar-powered sensors, minimizing maintenance costs and extending infrastructure lifespan. The design is scalable and can be adapted to cover wider geographic areas or integrate into existing water management systems. Beyond monitoring, the platform supports informed decision-making for policymakers, researchers, and environmental organizations, contributing to disaster preparedness, environmental protection, and public health initiatives. Ultimately, the research underscores the role of real-time, technology-driven monitoring in safeguarding water resources and enhancing community resilience.

Keywords: Water monitoring, ultrasonic sensor, turbidity sensor, PH sensor, cloud computing, internet of things, android App

INTRODUCTION

Water is important among all natural resources because it is necessary for the sustaining of life, ecosystems, and is a major input for agriculture, industrial activity, and human consumption. The quality of water affects the quality of health care, economic development, and environmental conservation within the area. In response to pollution, changes in climate, and industrialization leading to water contamination, protecting clean and safe water has become of top interest

internationally. Declining water quality leads to the spread of waterborne diseases, a declining

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Received Date: April 04, 2025
Accepted Date: April 13, 2025
Published Date: April 23, 2025

Citation: S.B. Jadhav, Thombare Sakshi Santosh, Khedkar Monika Dattatray, Pendhare Shruti Vijay, Pote Praniti Ganesh. Water Quality and Level Monitoring System: Real-time Detection of Biological Hazards. Journal of Water Pollution & Purification Research. 2025; 12(2): 52–61p.

condition of the environment, and reduced productivity in agriculture. Due to anthropogenic influences like industrial waste disposal, agricultural runoff, and inadequately managed waste disposal, pollution still affects a number of water bodies. Further, natural influences like floods and droughts, along with biological threats like harmful microorganisms and algae can compromise water quality. There is a growing demand for water for urban and rural areas which necessitates highly sophisticated and objective monitoring systems that can provide real time information 24 hours a day to ensure that water is monitored for safety and sustainability; which is otherwise impractical manually.

LITERATURE REVIEW

The article entitled "Water Level and Quality Monitoring System using Message Queuing," by Shaibu A. Juma, and Salome Chepchirchir, and writes about the poisonous nature of unsafe water which is a major health risk throughout the world. The authors state that "more than 3 billion people" do not have access to safe drinking water, and this water "can lead to microbial growth after extensive storage, which in turn cause disease such as flu and measles" [1, 2].

The article entitled "Prediction of Water Level and Water Quality Using a CNN-LSTM Combined Deep Learning Approach" with authors including Jingyi Wang was published in November 2020. The authors presented a hybrid deep learning model which is based on Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) neural networks to predict water level and water quality parameters such as total nitrogen, total phosphorous, and total organic carbon. They used data from the Nakdong River Basin for testing and training their model. Overall, it was useful in simulating the temporal variations of water pollutants in a high degree of accuracy. These findings showed that this combined hybrid approach could provide realistic, precise data for management and prediction of water resources [3].

According to Yaroshenko et. al, Data Collection (IOT Sensors): Install IOT sensors (e.g. pH, turbidity, temperature, dissolved oxygen, etc.) in water bodies to continuously measure water quality parameters in real-time. IOT sensors continuously record data on water quality parameters, including pH, turbidity, temperature, dissolved oxygen, and contaminants such as nitrates and heavy metals [4].

Problem Statement

Water contamination is an important public health, industrial process, and overall issue that is of great concern when it comes to environmental stability. One issue in water storage systems, particularly water tanks, which is often overlooked but is a notable concern, is the presence of biological hazards, such as dead animals, fungus, and harmful bacteria. Biological hazards can degrade water quality and present health risks associated with gastrointestinal infections, poisoning, and other forms of waterborne diseases. The traditional mechanisms of testing for contaminants involves either human inspection or chemical testing. These tests are often not only time consuming but also costly and inefficient, especially in real time.

Objective

1. *Real-time monitoring*: Allow for constant monitoring of water levels and quality parameters.
2. *Alerts and notificatio*ns: Provide instant notification of any water quality problems or low and highwater levels.
3. *Data logging and analysis*: Retain historical data to perform trend analysis and predictive maintenance.
4. *User accessibility*: Allow users to access data remotely to reduce response time to critical issues.

Scope

Objective The objective of the development of the Advanced Detection System for Dead Animals, Fungus, and Bacteria in Water Tanks is to contribute to a better solution for these problems through the creation of a real-time, automated monitoring system that ensures the quality and safety of the water. The system will include leading sensors, machine learning algorithms, and IoT-based remote monitoring for the detection, assessment, and reporting, of biological hazards in water storage systems.

The key objectives and scope of the project include:

1. *Detection of biological contaminants*: Employing smart sensors to detect dead animals, fungal growth, and bacteria in water tanks
2. *Real-time data monitoring and alerts*: Perform real-time and automated data acquiring and send alerts to a centralized dashboard and communications to mobile device
3. *IoT and artificial intelligence integration*: Identify opportunities to integrate artificial intelligence for predictive analysis and pattern recognition to maintain performance of the system proactively and minimize the risk of contamination.
4. *User-friendly access to data and alerts*: Development of a web and mobile app to allow users ease of access water quality and alerts
5. *Scalability and adaptability*: Implementation of the system across many different types of water storage facilities such as residential, industrial, and municipal water systems.
6. *Cost-effective and sustainable approach:* Implementation of a water quality monitoring program that minimizes labour or operational costs while providing an Open Access and environmentally sustainable monitoring effort.

This project will technologize the safety of water and hygiene to physically protect the public from water contamination while complying with water distribution and storage regulations.

Proposed System

- *Multi-sensor integration*: Combines sensors to monitor water quality with pH, turbidity, dissolved oxygen, temperature, odour, and water level.
- *Real-time data collection*: Continuously collects and processes data from sensors, identifying contaminants, changes in water quality in real time.
- *Automated alerts*: Sends SMS notifications or updates a dashboard if water quality is abnormal, and optionally water level is abnormal, or if there is a contamination accident.
- *IOT connectivity*: Enables remote monitoring and data access through a mobile app or web accessible dashboard.
- *Data analytics and ai (optional)*: Analyses data trends to improve detection accuracy, false positive alarms, and to mediate further issues.
- *Energy efficie*nt: Designed to be energy efficient with low energy requirements, with options for solar if necessary to monitor remote or off-grid locations.
- *User-friendly interface*: Dashboard provides real-time monitoring and historical data logging to more effectively monitor and manage water use (Figure 1)[5].

ARTWORK GUIDELINES

Overall Artwork Quality

- Time Management
- Communication
- Problem solving approach
- Team collaboration

Graphics & Icons

- *Water sensor icon:* A floating sensor in water transmitting wirelessly.
- *Detection*: A large water droplet with bacteria or biohazard symbol inside.
- *Real-time monitoring:* A digital dashboard depicting live water quality information.

- *Bacteria contaminant alert*: An alert symbol with water waves and exclamation mark.
- *Smart water monitoring*: A mobile phone showing water status updates.

Icons Ideas

- *A water drop with a biohazard symbol*: Indicates a contamination alert.
- *Wireless signal over water*: Indicates real-time monitoring.
- *pH and chemical test tubes*: Indicates water quality analysis.
- *Bacteria and virus outline*: Denotes biological hazards in the water.
- *Alert notification symbol*: Indicates real-time hazard detection. (Figure 2)

UI components and Screenshots

- *User login panel*: A registration and sign-in screen for users to enter the system
- *User home page*: The landing page for users to access various features
- *Real-time monitoring of water*: Displays live data of water quality and levels.
- *Notification activity:* A section where users receive alerts regarding water quality.
- *Checkout history*: A historical log of water quality and level records [6].

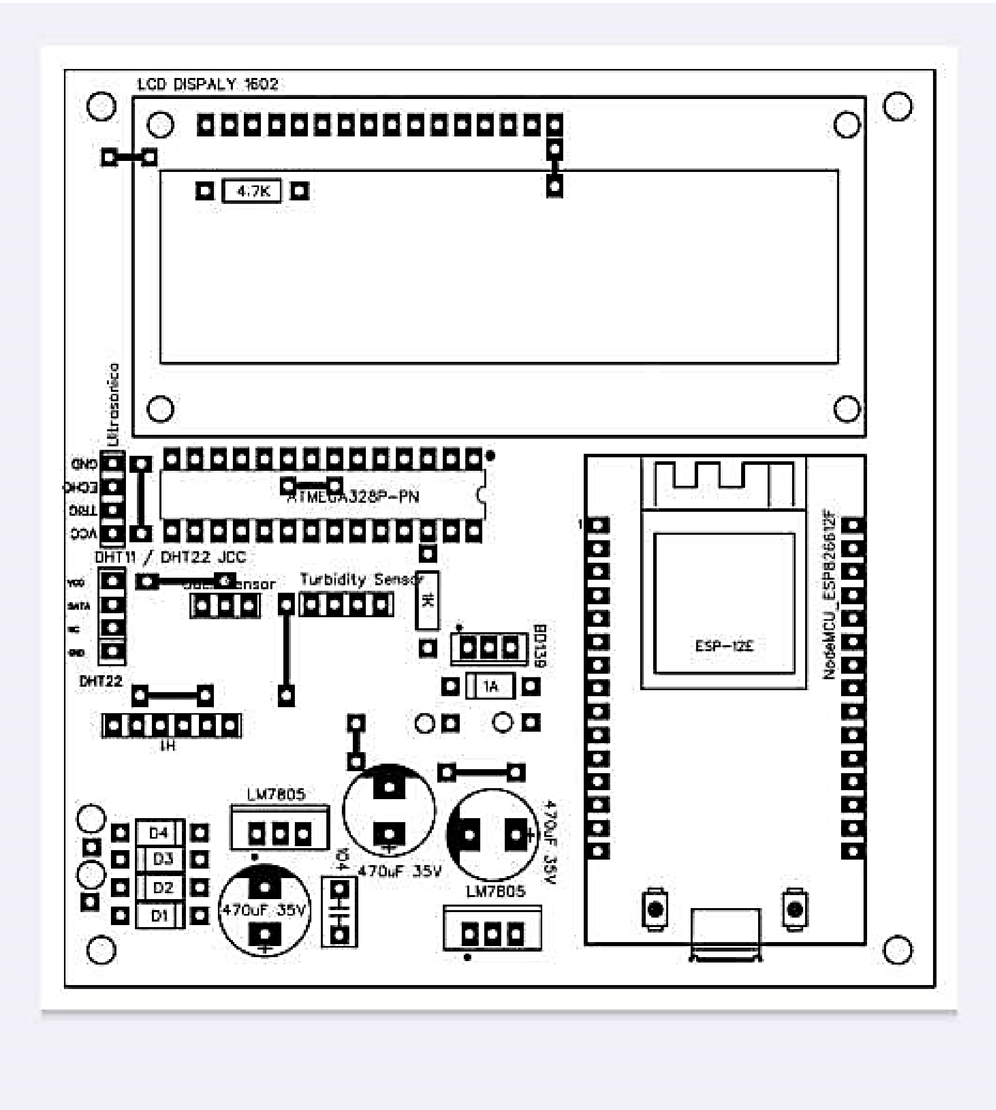


Figure 1. Block diagram of proposed system

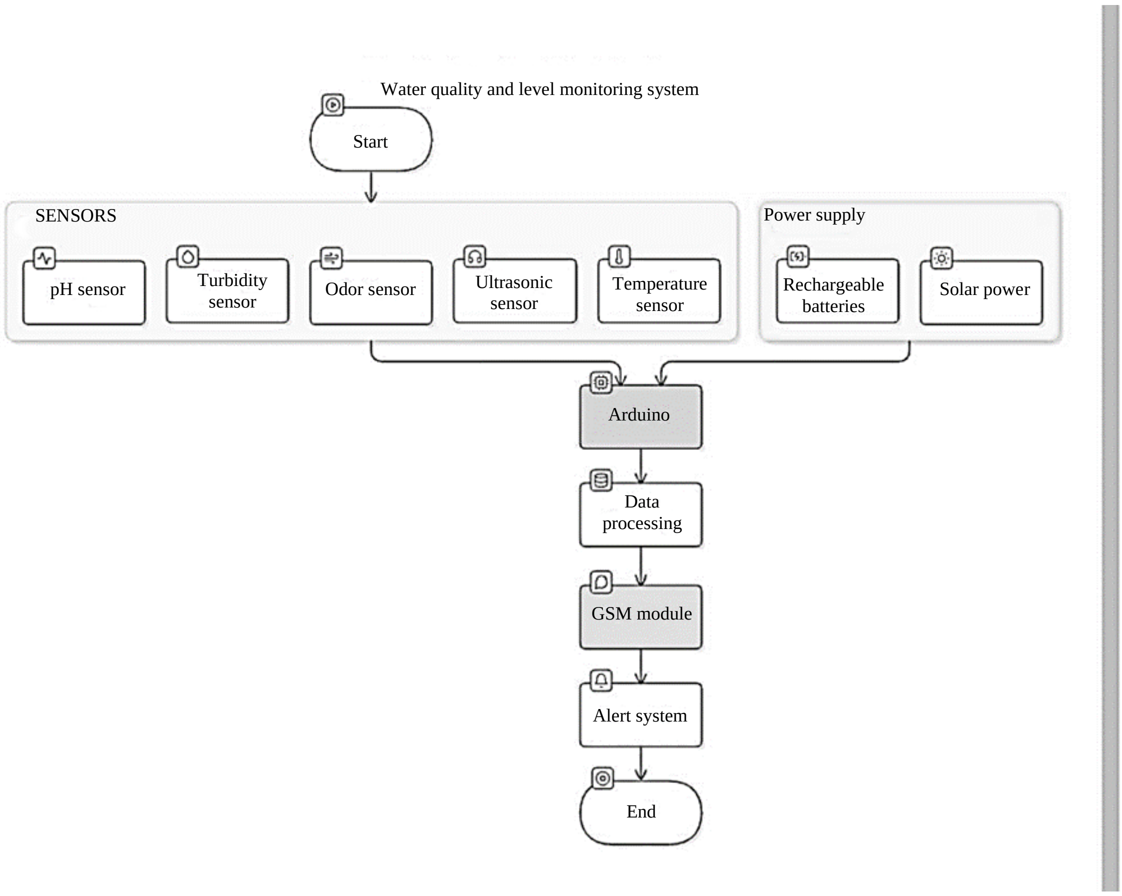


Figure 2<. Interaction overview diagram

RESULT AND DISCUSSION

The combination of several advanced technologies into water quality monitoring systems has enhanced the detection, analysis, and response to changes in water quality. Multi-sensor integration, which utilizes sensors for pH, turbidity, dissolved oxygen, temperature, odour, and water level to monitor water quality holistically. By integrating multiple sensors, the system can identify a wider variability of concerns, including contamination and changes in the environment. Real-time data collection allows for continuous gathering and processing of sensor data that enables the immediate detection of contaminants or other changes in water quality.

The integration of multiple advanced technologies within water quality monitoring systems has improved the ability to detect, analyse, and respond to changes in water quality. For example, multi-sensor integration is where sensors for pH, turbidity, dissolved oxygen, temperature, odour, and water level are deployed in a holistic approach. With multiple sensors, one system can detect a broader range of variability, including contaminants as well as changes in the environment. Real-time data collection allows continuous gathering and processing of sensor data that facilitates immediate detection of contaminants or other changes in water quality (Table 1) (Figure 3).

Data Analytics and AI (Optional)

Evaluates trends in data to improve detection accuracy, minimize false alarms, and predict potential problems. By evaluating previous data and identifying recurring patterns, the system can more accurately determine potential issues, such as pollution spikes, system failures, and service interruptions. Energy Efficiency: Designed to minimize power usage, but with options for solar power that allow the system to support remote or off-grid locations. The virtualized component for solar power supports the system to continue working in off-grid locations, making it very adaptable. In addition, decreased power consumption helps to lower operational expenses, making it practical for long-term monitoring with clear sustainability benefits. User-Friendly Interface: Provides a simple and intuitive dashboard for real-time monitoring, historical log of data, and alerts that makes management and analysis easy. It has an interface ensuring users can navigate the system easily to monitor water quality data, access logs, and respond to alerts (Figures 4 and 5) [7-13].

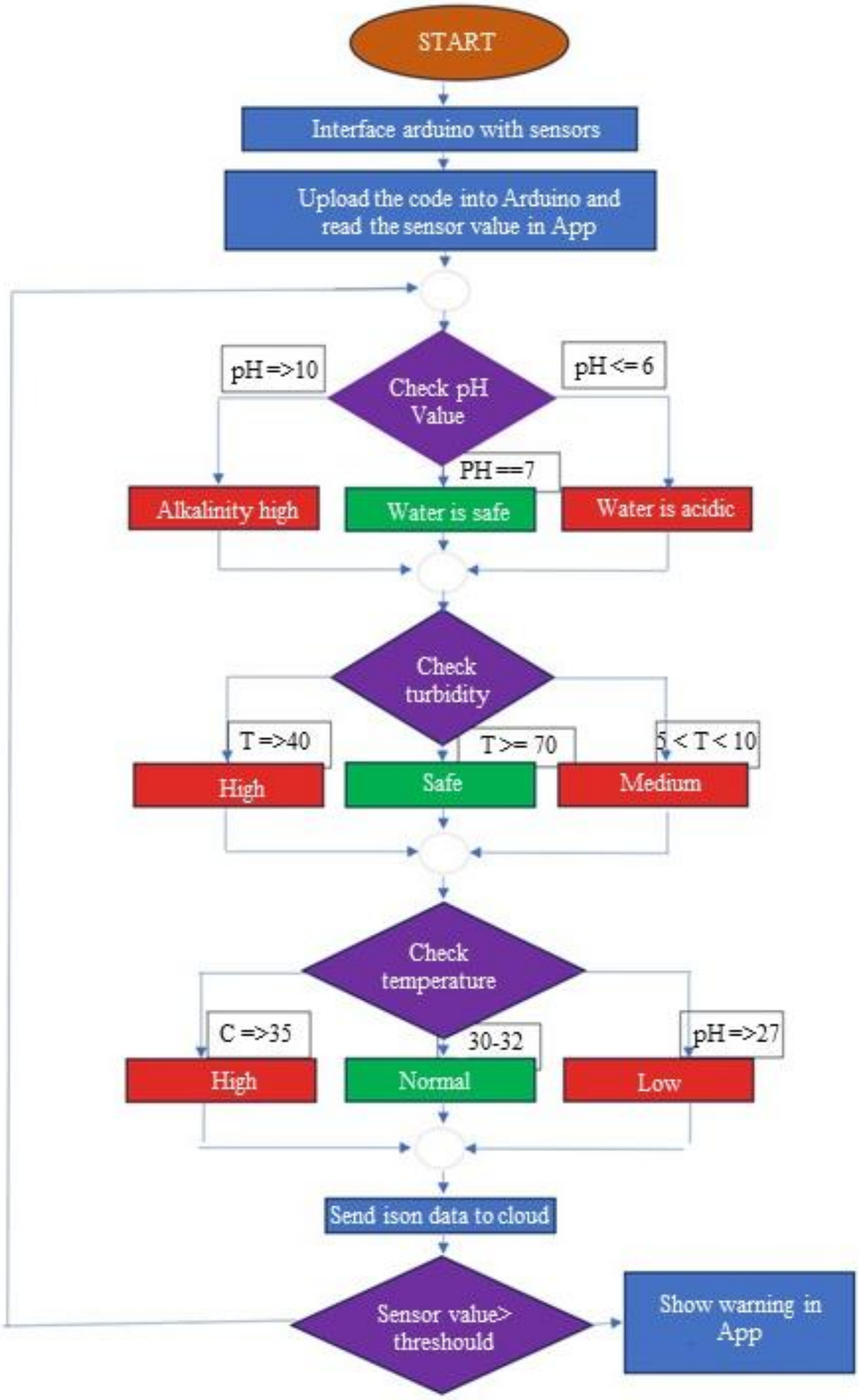


Figure 3. Flow diagram.

Table 1. Values of various parameters measured by the monitoring system.

Parameter	Measured value	Safe range	Detected issue	Action taken	Location	Time
PH	5.5	6.5 – 8.5	Acidic Water	Alert sent, treatment advised	LASALGAON	12:25
Turbidity	20 NTU	< 5 NTU	High Contamination	Filtration system recommended		
Water Level	30%	50% – 90%	Low Water Level	Notification to refill tank		
Temperature	28°C	10°C – 25°C	Slightly High	Monitoring continued		
Biological Hazard	Bacteria Detected	None	Contaminated Water	Urgent alert, disinfection required		

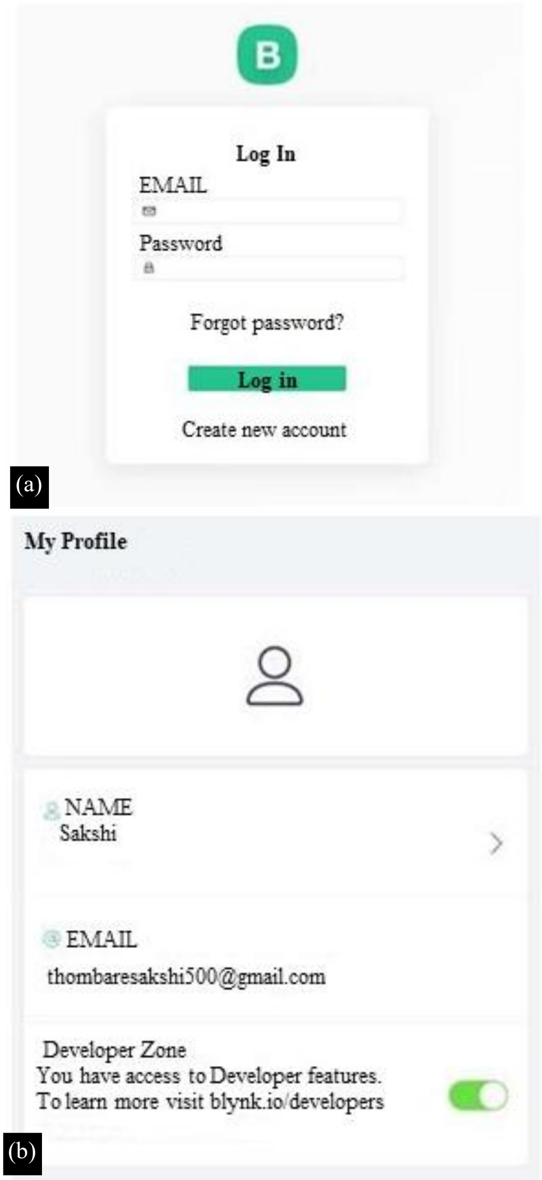
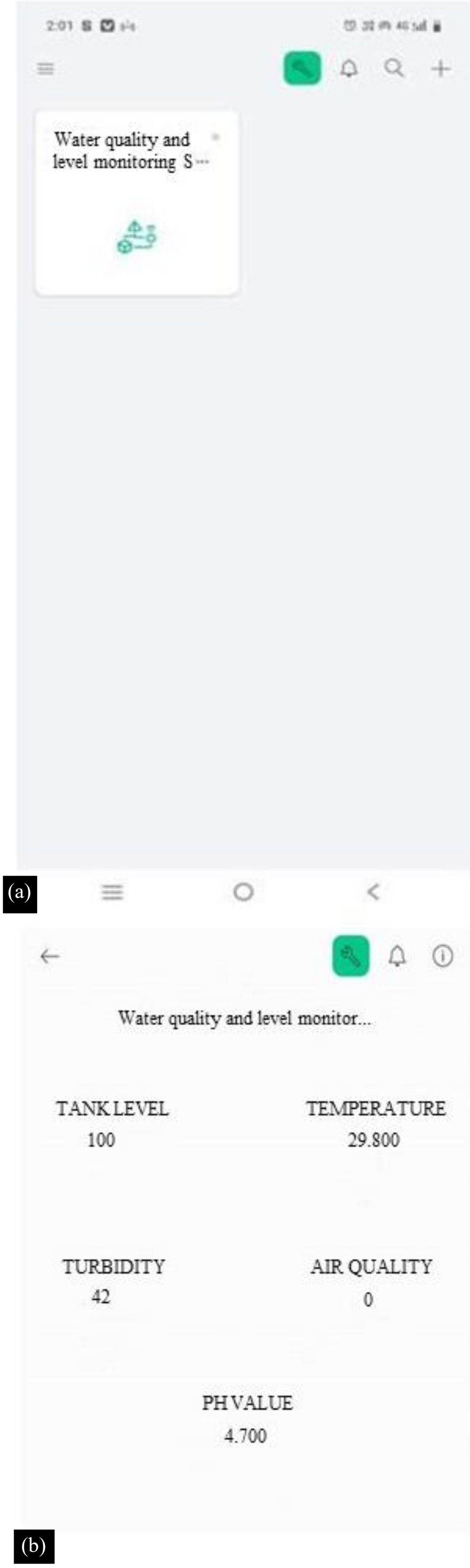


Figure 4. (a, b): User-friendly interface.


2:01
Water quality and
level monitoring S ···
(a)
Water quality and level monitor...
TANK LEVEL
100
TEMPERATURE
29.800
TURBIDITY
42
AIR QUALITY
0
PH VALUE
4.700
(b)

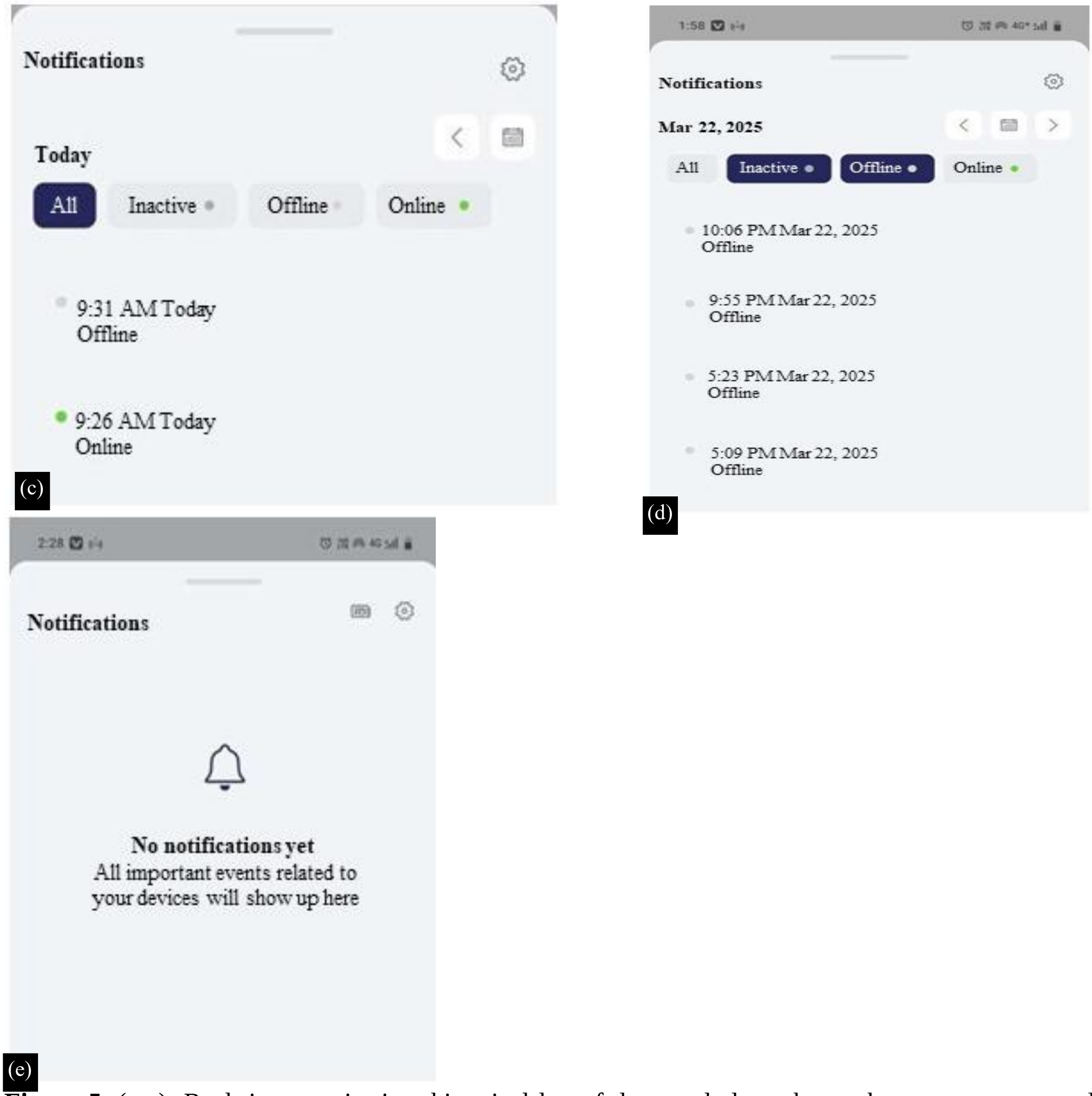


Figure 5. (a-e): Real-time monitoring, historical log of data, and alerts that makes management and analysis

CONCLUSION

Monitoring of Water Quality and Level

Real-Time Detection of Biological Hazards. An advanced detection system of dead animals, fungus and bacteria in water tanks could significantly improve water quality management. The inclusion of new sensor technologies that enable real-time monitoring could enhance the capability to detect contamination in early stages, ensuring safe and quality water supplies. Water is one of the maxi or most important basic needs for all living beings. according to Wikipedia, 97% of the world's water is in Seas and Oceans. That would leave only 3% of the world's water as fresh water.

Out of this three%, only 1% of water is accessible for use, however a large amount of this water is being wasted due to excessive use, or more specifically, the unsustainable exploitation of the resource. There are other automated water level monitoring systems available, but most of these methods have shortcomings in the real-world. Therefore, we attempted to address these shortcomings and create a relatively simple, efficient automated water level monitoring and controlling system. The object of our study was to develop a versatile, inexpensive, easily configurable, and most importantly, a portable device that widely resolves some of the problems of water wastage. In our project we used Raspberry pi, Ultrasonic sensor, Turbidity sensor and pH sensor which all provide significant cost savings and make it affordable. Furthering, this research does not require special exclusive tank, therefore any existing water tanks may be used. To conclude, this advanced monitoring and detecting system provides safer drinking quality water and promotes better management and the sustainability of our water use and rehabilitation.

In the future, the technology will be further improved, adapted for new uses, and tested in field trials to confirm its effectiveness in multiple settings. Live monitoring of quality indices such as pH, turbidity, and conductivity provides information to assure safe water consumption and helps eliminate health risks. Further, early detection of water quality shortens costly treatment and maintenance of poor quality water. In sum, the project supports sustainable water management, while factoring in human health and advances technologies in environmental monitoring.

Disclosure of Interest

A disclosure of interest in a research publication is a statement in which authors disclose any potential conflict of interest financial, personal, or professional that could influence their work. This is important for transparency and to foster research integrity.

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