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REAL TIME APPLICATION OF IOT IN WATER QUALITY MONITORING SYSTEM: A PROTOTYPE MODEL

[1]Deepali Kothari, [2]Abhishek Dubey, [3]Teena Dubey

[1, 2,3]Assistant Professor

[1]Department of Electronics and Telecommunication Engineering, Shri G. S. Institute of Technology & Science, Indore, India,

[2]Department of Electrical Engineering, Shri G. S. Institute of Technology & Science, Indore, India

[3]Department of Computer Engineering, Shri G. S. Institute of Technology & Science, Indore, India

Abstract : Water is a precious resource that is essential for human survival, and monitoring its quality is crucial to ensure public health and safety. With the increasing popularity of the Internet of Things (IoT), water monitoring systems have become more sophisticated and efficient. The system proposed incorporates different sensors like pH, temperature, turbidity, conductivity to measure the quality of water. The data is updated in realtime on firebase through a device, displayed on LCD and later updated on app to notify the concerned. In this research paper, the use of IoT in water monitoring systems, including the benefits, challenges, and limitations of this technology is explored. The paper also review current research and developments in this field, and provide recommendations for future research.

IndexTerms **- IoT, Water monitoring, pollution, sensor, realtime.**

I.INTRODUCTION

Water is one of the most important resources for life, and it's essential to monitor its quality to ensure public health and safety. In recent years, the Internet of Things (IoT) has become increasingly popular in the water industry due to its ability to provide real-time monitoring and analysis of water quality data. In this paper, the use of IoT in water monitoring systems is reviewed.

Water monitoring systems are used to collect data on water quality parameters such as temperature, pH, dissolved oxygen, and other parameters. This data is crucial to ensuring public health and safety, as well as the proper functioning of water treatment systems. With the advent of IoT technology, water monitoring systems have become more efficient, accurate, and cost-effective. In this research paper, we review the use of IoT in water monitoring systems, including the benefits, challenges, and limitations of this technology.

1.1 Benefits of IoT In Water Monitoring Systems

The use of IoT in water monitoring systems offers several benefits. One of the main advantages is the ability to provide real-time monitoring and analysis of water quality data. This enables quick detection of water quality issues, such as chemical spills or leaks, which can be addressed before they become a significant problem. IoT systems can also be used to monitor the effectiveness of water treatment processes, ensuring that water quality standards are met.

Another advantage of IoT in water monitoring systems is the ability to collect data from remote locations. Low-power, wireless sensors can be easily deployed in hard-to-reach or hazardous locations, providing accurate data without the need for manual data collection. This reduces the risk of human error and increases the efficiency of the monitoring system.

1.2 IoT in Water Monitoring Systems

The network of devices that communicate with each other via internet is termed as IoT. These devices can be sensors, meters, or other devices that collect data and send it to a central server for analysis. In water monitoring systems, IoT devices are used to collect water quality data such as temperature, pH, dissolved oxygen, and other parameters.

The IoT devices used in water monitoring systems are typically low-power, wireless sensors that can be easily deployed in remote locations. They are designed to withstand harsh environmental conditions and can operate for long periods without the need for maintenance. The data collected by these sensors can be transmitted in real-time to a central server, where it can be analyzed and used to generate alerts or notifications.

II. LITERATURE REVIEW

The paper presented by Christos C. Anastasiou et al. [1] explains the need for a shift in the current monitoring paradigm and proposes the idea of monitoring the quality of water delivered to consumers, using low cost, low performance and sensors. This paper tells that the embedded system developed can also be used in the consumer-oriented manner. This paper presents the methodology and justification for the selection of water quality parameters to be monitored.

The Paper by Christos S. Sukaridhoto et al. [2] proposes the idea of monitoring the quality of water delivered to consumers using low cost, low power and portable sensors based on the Commercial off-the Shelf (COTS). The main contribution of this paper is the prototype of a low cost system that can be used at the site of consumption to continuously monitor qualitative water parameters, portable devices that are able to move or mobility.

S. Benedict et al. [3] in the paper designed a real time water quality analysis framework (WQAF). WQAF collected the water quality parameter from a few predefined water quality monitoring systems. This paper uses the application of random forest and linear regression algorithms to protect water quality parameters. Dr. Purnendu Shekar Pandey et al. [4] presents a paper which tells about low cost water quality monitoring system using emerging Technology such as IoT, machine learning and Cloud Computing this helps in solving problem of rural areas from various dangerous diseases such as chlorosis this proposed model also has a capacity to control temperature of water just model used hardware components like nodemcu turbidity sensor DS18B20, LM35 future scope for this project is to add more quality sensors which can detect other chemical and physical parameters.

The paper framed by G. Shenbagalakshmi et al. [5] explains about the development of real time in pipe smart contamination detection systems measuring the water quality parameters such as pH, temperature, oxidation reduction potential, conductivity and turbidity. The sensed data and the contaminated observed values are then processed and analyzed using a fuzzy inference system and transmitted wirelessly using Zigbee. The Paper introduced by O. P. Nautiyal et al. [6] works on how to extract water quality parameters through IOT and device an analysis technique for low cost automatic water quality assessment system based on computing Technology through different sensors, arduino uno, GSM module by installing various nodes in different location.

M. S. Kumaraswamy et al. [7] put together a research paper to explain how to overcomes the water quality problem like water pollution conductivity pH turbidity dissolved oxygen this paper uses multi-parameter sensors and GSM communication technology for communication between sensor node and server this paper contain architecture like data acquisition layer data transmission and processing this paper has future scope for the water quality analytics and Communication Technology.

C. Feng et al. [8] assembles all the work done in a paper in which a water quality monitoring system is designed in this paper to realize real-time monitoring and judgment of water quality parameters through pH sensor, turbidity sensor, electrical conductivity sensor and temperature sensor and then the parameters are transmitted to a smart phone for monitoring through Bluetooth after arduino processing.

III. CURRENT RESEARCH AND DEVELOPMENTS

There is a significant amount of research and development in the field of IoT water monitoring systems. One area of research is the development of new sensors and technologies that can collect more accurate data in real-time. For example, researchers are developing sensors that can detect and identify specific pollutants or contaminants in water, providing more detailed information on water quality.

Another area of research is the integration of IoT systems with other technologies, such as artificial intelligence (AI) and machine learning (ML). These technologies can analyze large amounts of data and provide insights and predictions on water quality trends and issues.

IV. CHALLENGES AND LIMITATIONS OF IOT IN WATER MONITORING SYSTEMS

While IoT has many benefits for water monitoring systems, there are also several challenges and limitations. One of the main challenges is the cost of implementing IoT systems, which can be high due to the need for specialized sensors and infrastructure. In addition, there are concerns about data security and privacy, as the data collected by IoT devices may be sensitive and require protection.

Another limitation of IoT in water monitoring systems is the potential for false alarms or errors. The sensors used in these systems may be affected by environmental factors, such as temperature or humidity, which can lead to inaccurate data readings. It is therefore essential to calibrate and validate the sensors regularly to ensure accurate data.

V. PROPOSED METHODOLOGY

The block diagram in Fig.1 shows the internal architecture of the device which has been proposed. The block diagram also depicts how multiple devices can be integrated with the microcontroller module for integrated communication with designated databases. The data read through sensor is uploaded on web and can be processed later. If the water quality is not up to the mark based on indications of sensors values, then alarming situation informs the concerned authority to be taken care of.

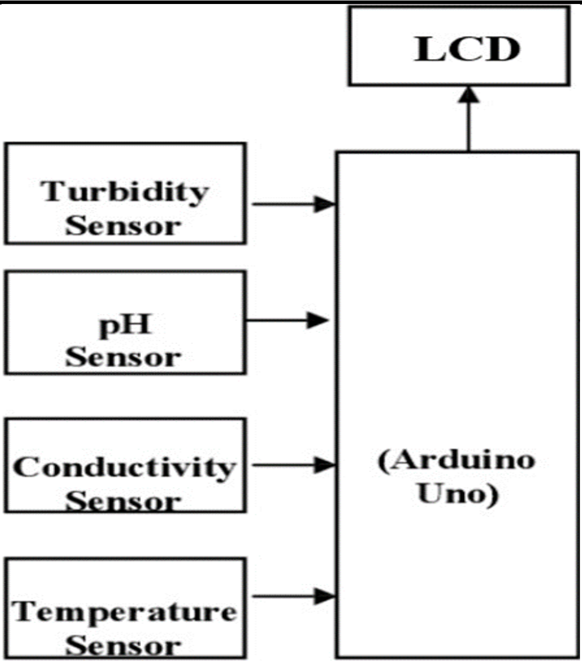

Fig.1. Block Diagram of proposed Water Quality Monitoring System

The flowchart in Fig. 2. indicates the algorithm flow of the proposed system. It depicts how the sensors are going to be activated just when there is flow of polluted water detected, thus resulting in lots of power saving as well. The data can later be processed, and the concerned authorities can be alerted to the pollution level. The data fetched will be uploaded on firebase through Arduino code and later updated on the app.

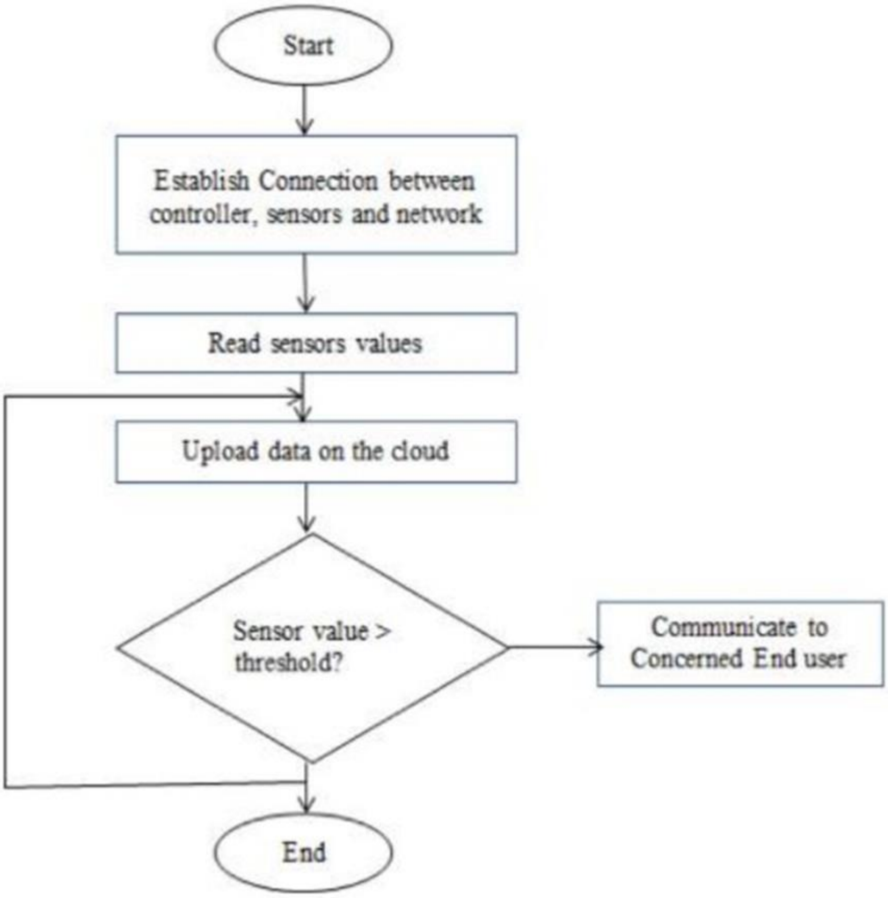

Fig. 2. Flowchart for proposed Water Quality Monitoring System

5.1 Power calculation

Using all the information that has been researched regarding the best suitable sensors for the use case, calculation of the overall power consumption of the proposed device. This power consumption value was optimized by us by modifying the operational time of the device using a smart observation. The standard Li-Ion Battery could now power this device for up to 7 months in the best-case scenario.

Power consumed by various sensors are -

- pH sensor ~ 0.5 Watts
- Turbidity Sensor ~ 0.15 Watts
- Conductivity sensor ~ 0.75 Watts
- Temperature sensor ~ 0.05 Watts

Total wattage = 0.775 watt
10* Battery capacity = 10*2.5 = 25 volt
Assumed 100% efficiency between the battery and the appliance for purposes of this discussion.
Power Last: 25 / 0.775 = 32.258 Hours
Let's assume that the device is going to be activated flow sensor and temperature sensor to be activated ½ of an hour and turbidity and pH sensor to be ⅙ of an hour (based on the flow sensor readings).
So total lifetime = 32.2 * 2 * 2 * 6 * 6/24 = 193 ~= 200 days (Approx. 7 months)

VI. HARDWARE AND SOFTWARE REQUIREMENTS

The proposed model uses pH sensor, turbidity sensor, temperature sensor alongwith other circuit components. Software part uses programming through Arduino IDE and displays results on serial monitor, LCD and also updates the result on web in real time.

6.1 pH sensor:

- Input Supply Voltage: 5V DC
- Range: 0-14 pH
- Accuracy: ± 0.01 pH
- Temperature: 0-50℃
- Response Time: <=1 min

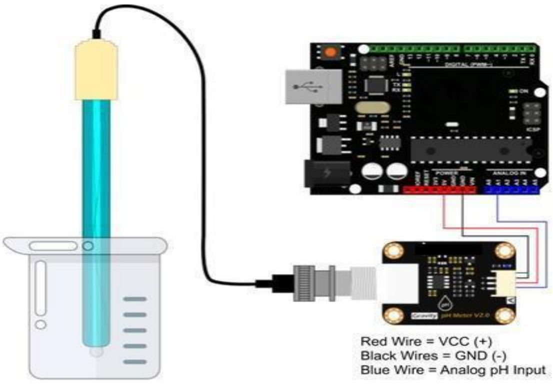

Fig. 3. pH Sensor

6.2 Turbidity sensor:

- Working Voltage: DC5V
- Working Current: 30mA(max)
- Response Time: <500 msec
- Operating Temperature:-30 ~ +80
- Range: 0 ~ 1000 NTU

Fig. 4. Turbidity Sensor

6.3 Temperature sensor:

- Usable temperature range: -55 to 125°C (-67°F to +257°F)
- 9-to-12-bit selectable resolution
- Uses 1-Wire interface
- ±0.5°C Accuracy from -10°C to +85°C

Fig. 5. Temperature sensor

6.4 Conductivity sensor:

- Output Voltage: 0-2.3V
- Working Current: 3-6mA
- TDS Measurement Rate: 0-1000 ppm
- Connection interface: Grove 4 – pin/XHB 2.54mm 2p.

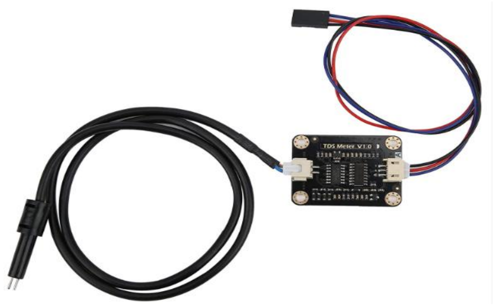

Fig. 6. Conductivity sensor

The circuit implementation is as shown in Fig. 7. For software requirements, to run all the connected hardware, a sketch is written on Arduino IDE and uploaded on microcontroller. Dashboard displays the sensors data in real time. Consequently, based on the sensor values, LCD displays the water quality.

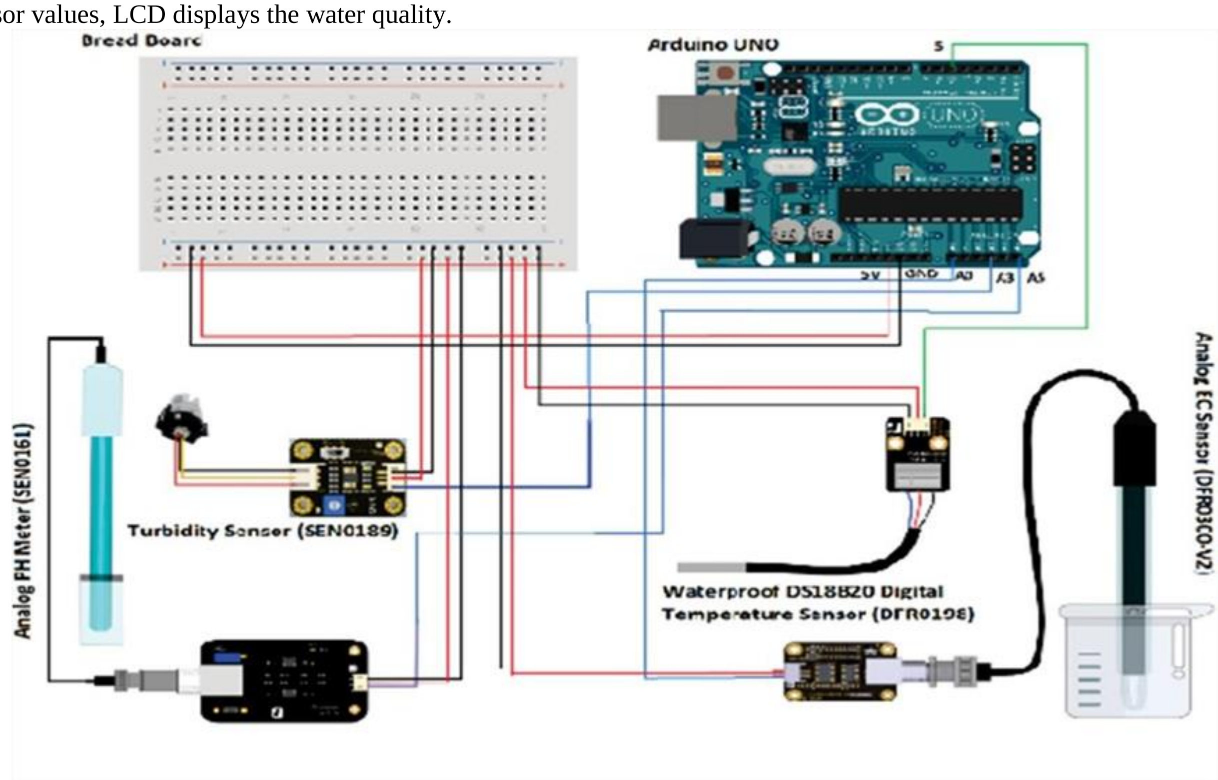

Fig. 7. Circuit Implementation of Proposed Model

VII. EXPERIMENTATION AND RESULTS

The proposed hardware was made and tested under different environmental conditions to get the results close to actual value. The entire assembly of components is made to sustain various conditions for practical implementation of model. Fig. 8 shows the hardware implementation for the proposed model.

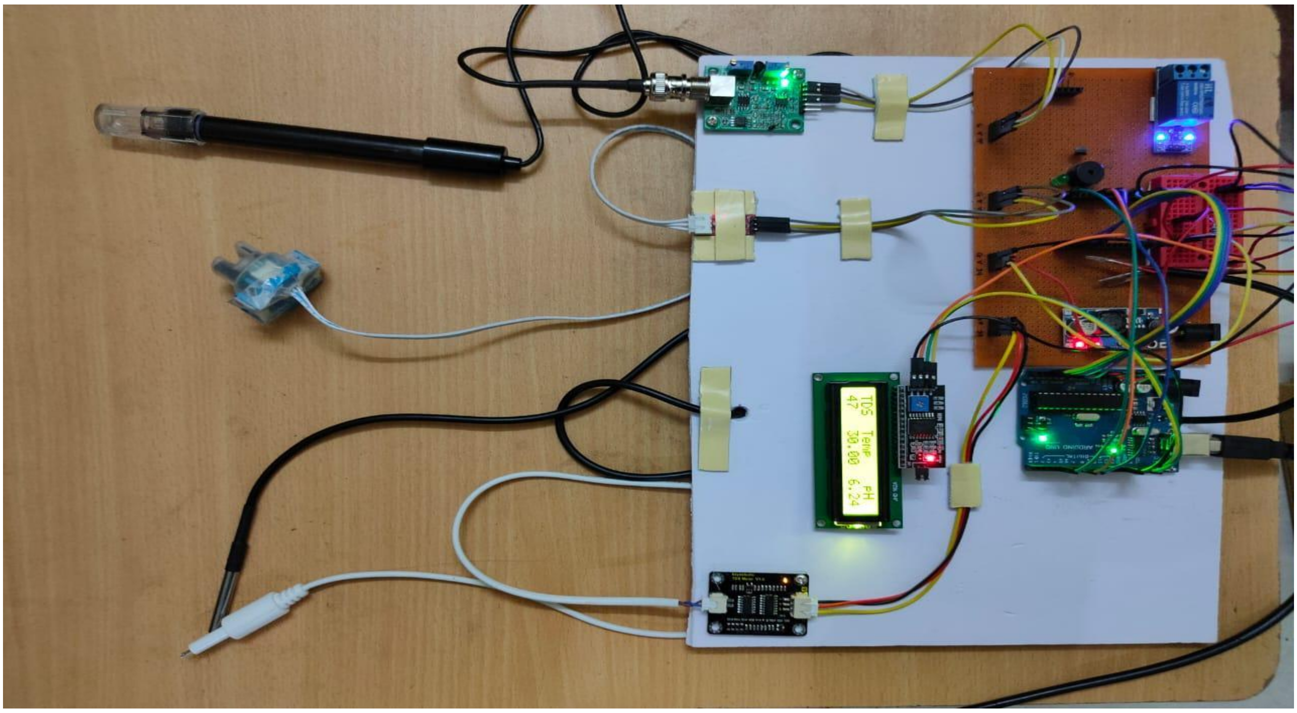

Fig.8. Hardware Implementation of Proposed Model

Features of the final model:

- The device is working as expected and all the sensors are working under all test cases.
- All the other sensors namely – pH, temperature and turbidity sensors are activated whenever any flow is detected.
- Whenever the flow is detected, all the sensor values are updated on a real time database in firebase
- The app developed is also working fine by fetching the data from firebase and showing it in the UI.

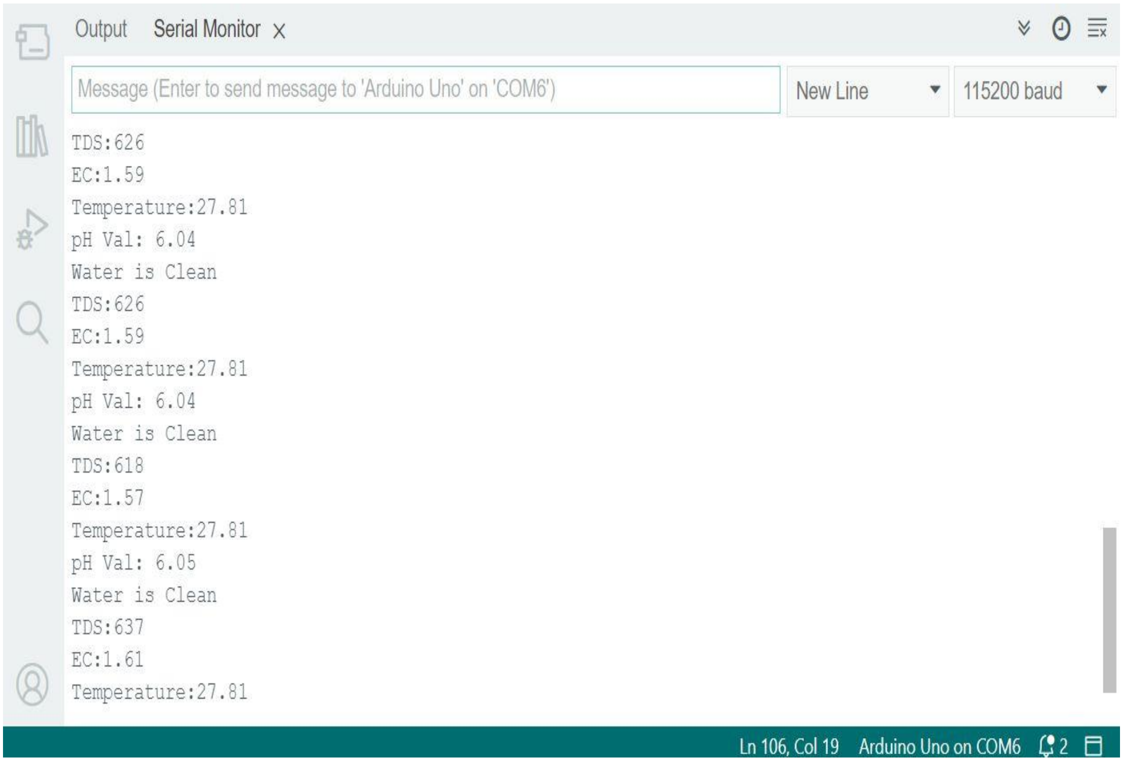

Fig. 9. Snapshot of serial monitor showing different sensor values in realtime

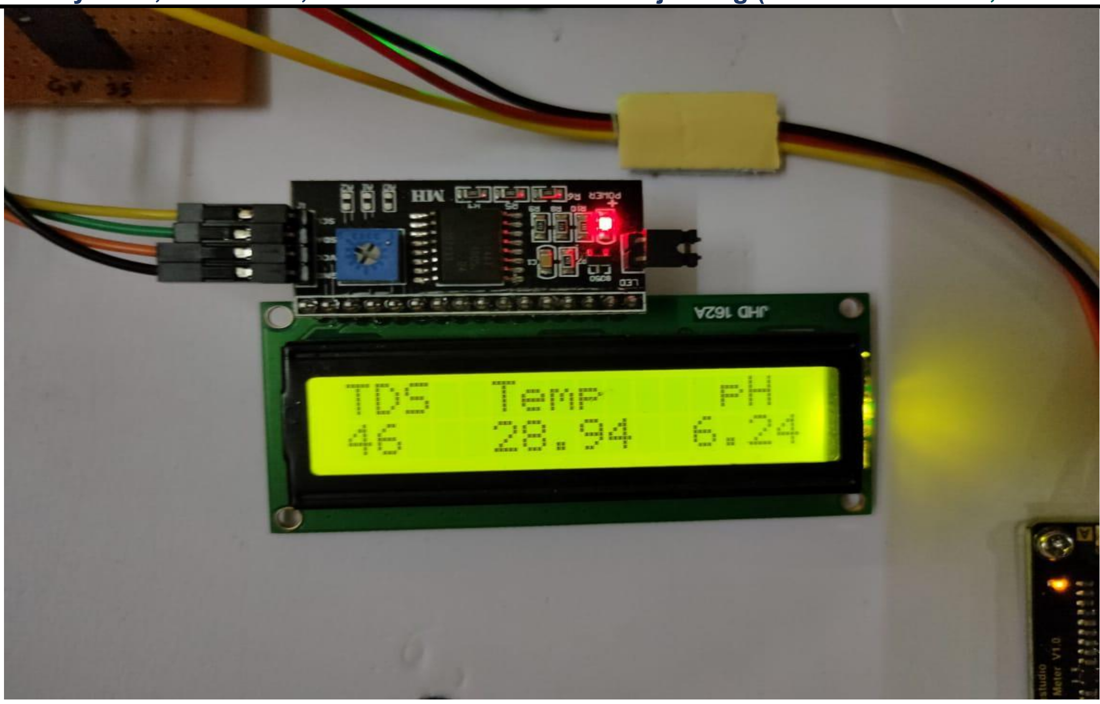

Fig. 10. Snapshot of LCD showing different sensor values

Fig. 11. Snapshot of LCD indicating purity of water

VIII. RECOMMENDATIONS FOR FUTURE RESEARCH

To further advance the use of IoT in water monitoring systems, several areas of research need to be addressed. One area of research is the development of low-cost, scalable IoT systems that can be easily deployed in remote locations. This would increase the efficiency and accessibility of water monitoring systems, particularly in developing countries or areas with limited resources.

Another area of research is the improvement of data security and privacy in IoT water monitoring systems. Researchers should investigate ways to ensure the protection and integrity of data, particularly in systems that collect sensitive or confidential information.

IX. CONCLUSION

The use of IoT in water monitoring systems has many benefits, including real-time data analysis and early detection of water quality issues. However, there are also challenges and limitations that need to be addressed, such as the cost of implementation, data security, and accuracy of data readings. Overall, IoT has the potential to revolutionize water monitoring systems and improve public health and safety by providing accurate and timely data on water quality. For better analysis, models can be incorporated with AI and ML technologies.

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