Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 4, April 2024

Comparative Study of Water Quality Assessment with IoT & Lab Test

Vaishnavi Shilwant, Prathmesh Mulik,
Roshan Kolap, Rutuja Tahkur.
Students of Civil Engineering department
JSPM's Imperial College of Engineering and Research
Wagholi, Pune, India.

Dr. K. B. Gurani
Professor, Department of Civil Engineering,
JSPM's Imperial College of Engineering and Research
Wagholi, Pune, India.

Abstract— **Water is the second most important factor after air for survival. Water pollution in recent times, one of the main risks as drinking water is getting polluted. Many researchers are trying to solve the problem by checking the quality of water. Current water quality assessment is a manual system with a long process and is very time-consuming. Smart solutions for assessment of water pollution are getting more significant these days with sensors, and Internet of Things (IoT) technology. In this paper we studied comparation with IoT sensors and Lab Test to assess water quality. Comparison study of water quality by IoT sensor device with Laboratory Test methods. The water quality parameters such as temperature, pH, Total Dissolved Solids (TDS), and Turbidity are assessed. For assessment, sensors are used such as, pH sensor, TDS sensor, Turbidity sensor and Temperature sensor along with ESP32.**

Keywords— **Water quality assessment, IoT, pH sensor, TDS sensor, Turbidity sensor and Temperature sensor, ESP32.**

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, but only 3% of freshwater is available for day-to-day use. The freshwater resources are lakes, ponds, wells, and rivers. These resources are getting polluted every day due to the contamination. [9]

To make sure that pure and safer water is gruelling due to overdue sources of chemicals and pollutants. Pollution of water can be instigated by multitudinous ways; one of the main reasons for pollution is artificial waste discharge and megacity sewage. Secondary sources of pollution are adulterants that enter the water from soils or from atmosphere via rain or from groundwater systems. [15]

Contaminated water supply declines the safety for human and directly influenced by drinking. Hence, Water-Borne diseases such as dengue, cholera, and malaria etc., are reduced for major health concerns. [7]

Traditionally, detection of water quality was done in laboratories by manually performed where water samples are obtained and sent for examination to the laboratories which is time taking process, cost and human resources. [2]

There are a lot of other parameters which can be found in water, but these three parameters turbidity, pH and temperature are crucial in determining the quality. These parameters are considered the main parameters for water quality testing. [1]

Today, the Internet of Things (IoT) is new technical development. An IoT-based sensor network is used in this study to track the physical and chemical characteristics of water such as pH, Temperature, TDS, and Turbidity. [3]

Internet of Things (IoT) as a platform in water quality monitoring and assessment. Wireless detector network and IoT surroundings are presently being used more constantly in contemporary times.[5]

To develop this project, we used pH sensor, Turbidity sensor, Temperature sensor, TDS sensor, and an ESP32 as IoT device. The pH sensor, Turbidity sensor, Temperature sensor, and TDS sensor are connected to ESP32. [10]

As a whole, this project contributes to determining the quality of water in a convenient, compact, and user-friendly method. [1] The primary goal is to assess the water quality.[11]

I. LITERATURE SURVEY

Varsha Lakshmikantha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted, Jagadeesh Basavaiah, Audre Arlene Anthony, [15] This paper proposes a cost effective and efficient IoT based smart water quality assessment system which monitors the quality parameters. The developed model is tested with three water samples and the parameters are transmitted to the cloud server for further action.

Mohammad Salah Uddin Chowdurya, Talha Bin Emranb, Subhasish Ghosha, Abhijit Pathaka, Mohd. Manjur Alama, Nurul Absara, Karl Anderssonc, Mohammad Shahadat Hossain, [8] stated that, Data collected at the apart site can be displayed in a visual format on a server PC with the help of Spark streaming analysis through Spark MLlib, Deep learning neural network models, Belief Rule Based (BRB) system and is also compared with standard values. If the acquired value is above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of our proposed paper is to obtain the water assessment system with high frequency, high mobility, and low powered.

Sathish Pasika, Sai Teja Gandla, [14] In this paper, the proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature, and humidity of the surrounding atmosphere. And also, the Microcontroller Unit (MCU) interfaced with these sensors and further processing is performed at Personal Computer (PC).

Pratik More, Harcharan Singh Soman, Akheel Patel, Gaurav Shirke, Prof. Dhanashree Pannase, [10] reported that, in this paper, we present a design of real time water quality assessment system which is used for ease of mankind a

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

detailed review of the latest works that were implemented in the area of smart water pollution assessment systems is presented. The paper proposes a cost effective and efficient IoT based smart water quality monitoring system which monitors the quality parameters uninterruptedly. The developed model is tested with water samples and the parameters are transmitted to the cloud server for further action.

Sivaranjani S., Amitava Rakshit and Samrath Singh, [13] were stated, A water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. These indices utilize various physical, chemical, and biological parameters and have been resulted as an outcome of efforts and research and development carried out by different government agencies and experts in this area globally. This review paper includes the water quality assessment with water quality indices being used globally.

Vaishnavi V. Daigavane & Dr. M.A Gaikwad, [14] were stated, a design and development of a low-cost system for real time monitoring of the water quality in IOT. The system consist of several sensors is used to measuring physical and chemical parameters of the water. The parameters such as temperature, pH, turbidity, flow sensor of the water can be measured. The measured values from the sensors can be processed by the core controller. The ESP 32 model can be used as a core controller. Finally, the sensor data can be viewed on internet using WI-FI system.

Dinesh P.M, Shree Sapnaa K, Kiranisha A.J, Sabeenian R.S, Paramasivam M.E, Manjunathan A.,[3] this research suggests a system with sensors for water quality monitoring. A wireless sensor network (WSN) contains a micro-controller for data processing, a mechanism for communicating between and inside nodes and many (IoT). Using Spark flow analysis with Spark MLlib, deep on it. The agent will receive a warning SMS automatically if the detected value exceeds the threshold. Our plan to develop a high- frequency, high-mobility, low-power water monitoring system makes it special.

Kartik Maheshwari & Adrija Chakraborty, [6] were reported that, the proposed system was successfully implemented to determine the turbidity, TDS, flow rate and the level of water for a given sample. The data obtained from the sensors are uploaded to the Thing Speak dashboard for online monitoring purpose. Besides, an SMS alert is sent to the user whenever the turbidity and TDS values have crossed the threshold limit defined for good quality water. As per the obtained results, the proposed system can be considered as suitable water quality monitoring system. Our system has made water quality testing more economical, convenient, and reliable with timely feedback.

II. MATERIALS AND METHODOLOGY

A. Laboratory Test

a. Determination of pH of water.

Equipment’s Required: -

i. pH meter
ii. pH electrode filled with KCL solution.
iii. Buffer solutions of pH 4, pH 7 and pH 9.2.
iv. Clean beakers
v. Tissue papers

Procedure: -

i. Plug in the pH meter to power source and let it warm up for 5 to 10 minutes.
ii. Wash the glass electrode with distilled water and clean slowly with a soft tissue.
iii. Note the temperature of water and set the same on the pH meter.
iv. Place the electrode in pH 7 buffer solution and set the value of 7 on the pH meter turning the Calibrate knob on the meter.
v. Take out the electrode, wash with Distilled water and clean.
vi. Dip the electrode in the pH 4 buffer solution. Adjust the value on the pH readout meter by the Slope switch. Repeat with pH 7 and pH 4 buffers till a correct and stable reading is displaced.
vii. While moving and cleaning the electrode, put the selector switch on standby mode. Turn to pH mode for recording the pH.
viii. Now place the electrode in the water sample whose pH is to be determined.

b. Determination of Turbidity in a water.

Equipment’s Required: -

i. Turbidity Meter
ii. Sample Cells
iii. Standard flasks
iv. Wash Bottle
v. Tissue Papers

Procedure: -

i. Prepare the Sample.
ii. Calibrate the Nephelometer.
iii. Set up the Nephelometer.
iv. Insert the Sample.
v. Insert the Cuvette into the Nephelometer.
vi. Take the Measurement.
vii. Record the Results.
viii. Clean and Maintain the Nephelometer.

c. Determination of Total Dissolved Solids.

Equipment’s Required:

i. Balance
ii. Beaker

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 4, April 2024

iii. Measuring Cylinder
iv. TDS Meter

Procedure:

i. Filter your water sample through a Whatman Filter paper.
ii. Collect the filtrate (liquid) and rinse water in a flask.
iii. Take the weight of empty container (ceramic dish/ evaporating Dish). Make sure the container should be dried.
iv. Add the filtrate to the container and allow the sample to stay in the oven at 103°C for 24 hours. If possible, increase the temperature of the drying oven to 180°C and allow the sample to dry for up to 8 hours.
v. Remove the container - Remember it is very hot. After removing from the drying oven, the sample should be placed in a desiccator to cool in a dry air environment for at least 3 to 4 hours.
vi. After the container cools, reweigh the container at least three times.
vii. Subtract the initial weight (in grams) of the empty container from the weight of the container with the dried residue to obtain the increase in weight.
viii. Then do the following:

A- Weight of clean dried container (gm)
B- Weight of container and residue (gm)
C- Volume of Sample (ml)

Concentration(mg/L) = ((B - A)/ C)*(1000 mg/g)*(1000 ml/L)

B. IoT Sensors

Hardware Description: The proposed system consists of four sensors such as pH, Temperature, Turbidity, and TDS are connected to ESP32. The ESP32 access all the data from the sensors and once the data is retrieved from the sensors the ESP32 sends the data to the application which is Blynk cloud application.

i. ESP 32: It is a single chip 2.4 GHz Wi-Fi and Bluetooth combo chip designed with TSMC ultra-low power 40 nm technology. It is designed and optimized for the best Power Performance, RF Performance, Robustness, Versatility, Features, and Reliability, for a wide variety of applications, and different Power Profiles. It is also Secure Boot and Flash Encryption.
ii. Green LCD: LCD impede is a flat brace electronic exhibit power and finds in a countywide orbit of applications. A 16x4 LCD demo is the fundamental power and is rattling commonly victimised in varied devices and circuits. These modules are desirable over heptad segments and otherwise multi-segment LCDs.
iii. pH Sensor: The pH of a solution is the measure of the acidity or alkalinity of solution. The pH scale is a logarithmic scale whose range is from 0 to 14. The normal range of pH is 6.5 to 8.5. Values from 7 to 14 indicate a basic or alkaline solution and values from 0 to 7 would indicate an acidic solution. The pH value of neutral water is 7. To get the correct value of pH, we must calibrate the sensor.
iv. Turbidity Sensor: Turbidity is indicating the degree at which the water loses its transparency. The more the turbidity level of water means a greater number of particles accumulated in water. So, it is useful to check the water if any impure particles are present in water or not.
v. Temperature Sensor: Temperature sensor is used to measure the temperature of water. The sensor which is selected for this project is DS18B20. It indicates how hot or cold water is. The range of DS18B20 temperature sensor is -40 to +120°C. This temperature sensor gives accurate reading.
vi. TDS Sensor: TDS Sensor is an Arduino-compatible. TDS sensor is used for measuring TDS value of the water. It can be applied to domestic water, hydroponic and other fields of water quality testing. This product supports 3.3 ~ 5.5V wide voltage input, and 0 ~ 2.3V voltage output, which makes it compatible with 5V or 3.3V control systems or boards.
vii. Power Supply: We have to just plug it into the sockets of your ESP 32, and we're set. The power supply shield can be charged using a simple micro-USB cable. It outputs a steady current supply, that you can use to power up your ESP 32. We use the USB B cable supply. You simply connect the + end of your USB cable to ESP 32 Vin and the – end to ESP 32 ground.

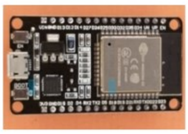

Figure 1: ESP 32

Figure 2: Green LCD

Figure 3: pH sensor.

Figure 4: Turbidity Sensor.

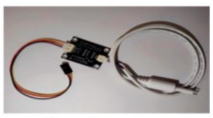

Figure 5: TDS Sensor.

Figure 6: Temp. Sensor.

III. IMPLEMENTATION

We preferred method for programming the ESP32 is using C++ with the Arduino core. Connect the ESP32 to the computer with the help of USB cable. Once the setup of ESP32 is completed according to our requirements we can connect our sensors the ESP32 Connect pH, turbidity, TDS and temperature sensors to the ESP32. The pH sensor is used to find out the pH value of the water (from 0 to 14) & its accuracy is $^{+}_{-}$ 0.1pH. Turbidity sensor can find cloudiness in the water. Temperature sensor in the system is used to find the temperature of water up to 100^{0} C. Each of the sensors will be connected to ESP32 with different pins of VCC & GND, then after that we will be able to take values from different sensors.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 4, April 2024

To connect the sensors with the ESP32 it needs jumper wires where we use all this M-M, F-F & F-M wires. Using this jumper wire, the sensors are connected to different ports. If the pH is connected to the pin on the ESP32 only on ADC, then that pin cannot be used to connect any other sensors.

Accordingly, the remaining sensors are connected to the board. The C++ with the Arduino core is used to program the ESP32 to take values from the sensors. The code is implemented and make sure that there are no errors in it. Once the compilation has finished, the code is loaded to the ESP32. When the codes are uploaded, the ESP32 will be able to take values from the sensors. To avoid this, we must ensure the pins on the sketch and on the board.

For correction in the programme to read the values from the sensors, it should be dipped in the different water to read pH, turbidity, TDS & Temperature. They sense the water and gives the output to the ESP32. These values are defined if the water is polluted or not. Once the readings from all the sensors are obtained the next step is to show them on Blynk cloud platform with the help of Wi-Fi which is in-build in ESP32 module we will be able to connect to the Wi-Fi.

ESP32 is a microcontroller with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 takes the readings, and they show on LCD, and they are sent to blynk cloud. The blynk cloud shows the analysis report of the sensors. Further the readings and the Analytic reports from the blynk application will be easy to access in remote area also. This app will be developed in such a way that the user will receive all the values and readings that will be collected from sensors by the ESP32. The whole project design of the system is based mainly on IOT which is newly introduced concept in the world of development.

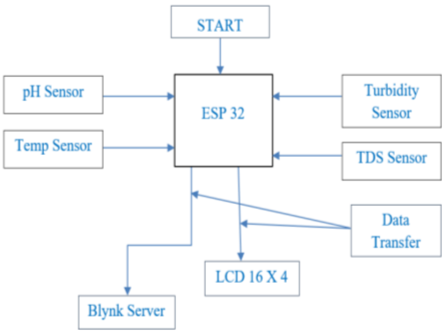

Figure 7: Block diagram of the entire system.

RESULT

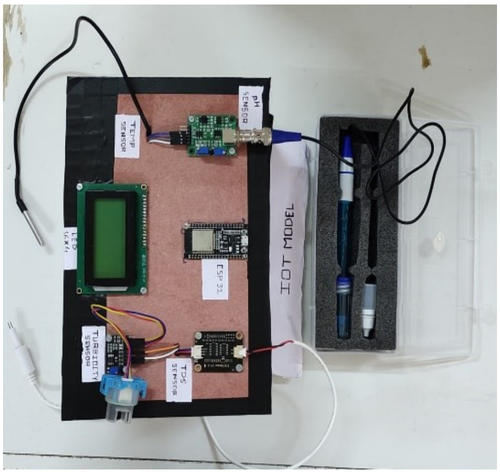

Figure 8: Prepared Model.

The various sample as distilled water, filter water, tap water & wastewater were analyzed in laboratory as well as IoT sensors the comparative readings given below.

i. pH Test: According to the laboratory test analysis & IoT sensors the following pH readings obtained where IoT sensors gives accurate readings than laboratory analysis. The following readings and comparison graphs were listed below.

Table 1: pH Test Readings.

Sr. No.	Sample	Lab Test	IoT Sensor
1	Distilled Water	7.1	7.2
2	Filter Water	7.5	7.3
3	Tap Water	8.2	8.5
4	Waste water	9.4	9.7

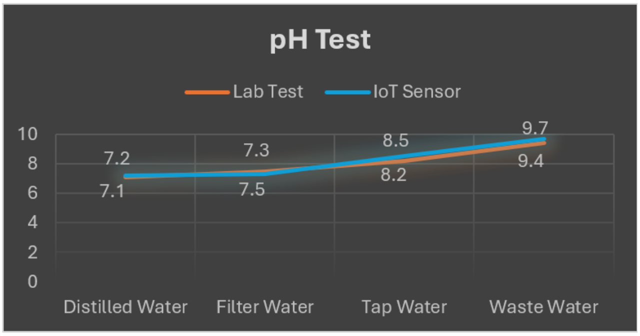

Figure 9: Graph showing variation of pH test.

ii. Total Dissolve Solids Test: According to the laboratory test analysis & IoT sensors the following total dissolve solids readings obtained where IoT sensors gives accurate readings than laboratory analysis. The following readings and comparison graphs were listed below.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 4, April 2024

Table 2: Total Dissolve Solids (TDS) Test Readings.

Sr. No.	Sample	Lab Test	IoT Sensor
1	Distilled Water	15	13.35
2	Filter Water	16.82	14.64
3	Tap Water	20.92	22.72
4	Waste water	594	641.60

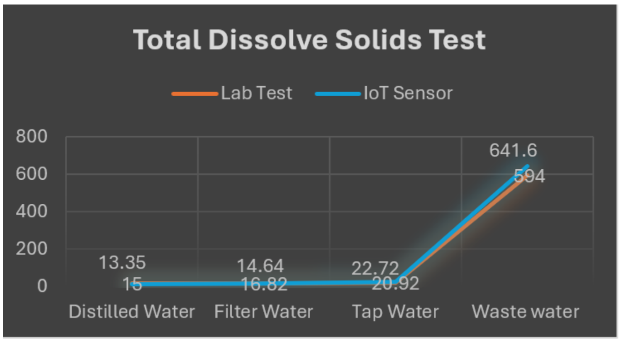

Figure 10: Graph showing variation of Total Dissolve Solids (TDS) test.

iii. Turbidity Test: According to the laboratory test analysis & IoT sensors the following Turbidity readings obtained where IoT sensors gives accurate readings than laboratory analysis. The following readings and comparison graphs were listed below.

Table 3: Turbidity Test Readings.

Sr. No.	Sample	Lab Test	IoT Sensor
1	Distilled Water	0	1
2	Filter Water	1	1
3	Tap Water	2	2
4	Waste water	7	8

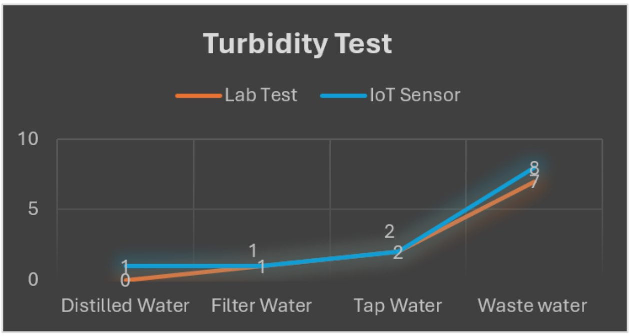

Figure 11: Graph showing variation of Turbidity test.

iv. Temperature Test: According to the laboratory test analysis & IoT sensors the following Temperature readings obtained where IoT sensors gives accurate readings than laboratory analysis. The following readings and comparison graphs were listed below.

Table 4: Temperature Test Readings.

Sr. No.	Sample	Lab Test	IoT Sensor
1	Distilled Water	23.9 ^{0}C	24.21 ^{0}C
2	Filter Water	26.32 ^{0}C	26.2 ^{0}C
3	Tap Water	28.85 ^{0}C	28.32 ^{0}C
4	Waste water	30 ^{0}C	29.82 ^{0}C

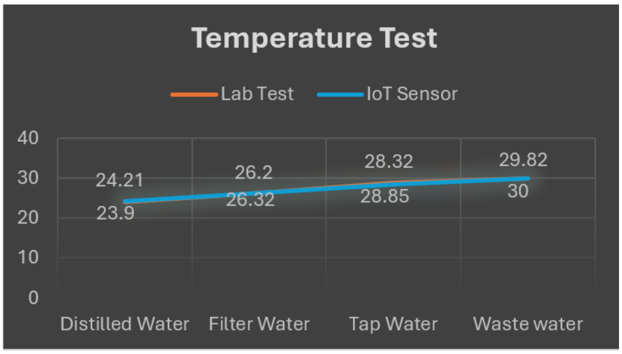

Figure 12: Graph showing variation of Temperature test.

IV. CONCLUSION

1. The proposed system is an efficient solution for water quality assessment.
2. The system can assess water quality automatically, in low cost and does not require people on duty. So, the testing is like economical, suitable, and fast.
3. As per our requirement by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters.
4. The operation is simple.
5. It has widespread application and extension value.

V. FUTURE SCOPE

1. In future, more sensors can be added to measure other parameters of the water.
2. The system can monitor other factors that pollute the environment by adding more specific sensors to the system.
3. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on.

ACKNOWLEDGMENT

This project report on, is present form is not a singular effort. We would like to acknowledge the help and guidance given by our guide Dr. K. B. Gurani, our H.O.D. Prof. Y. R. Suryawanshi and project coordinator Mr. A. N. Bhirud for great effort and help in our project. Without their help, this project work of ours would have been an uphill task. It has been made possible through necessary guidance and help from different quarters.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

REFERENCES

[1] Bharati Sengupta, Soham Sawant, Mayuresh Dhanawade, Shubham Bhosale, Mrs. Anushree Prabhu., "Water Quality Monitoring using IoT", (IRJET), Volume: 06 Issue: 06 | June 2019.

[2] Das, Brinda, Jain, P.C., 2017. "Real-time water quality monitoring system using the internet of things". Int. Conf. Comput. Commun. 78–82.

[3] Dinesh P.M, Shree Sapnaa K, Kiranisha A.J, Sabeenian R.S, Paramasivam M.E, Manjunathan A., "IOT Based Real Time River Water Quality Monitoring and Control System", E3S Web of Conferences 399, 04013 (2023), ICONNECT-2023, https://doi.org/10.1051/e3sconf/202339904013

[4] He, Donge, Zhang, Li-Xin, 2012. The water quality monitoring system based on wireless sensor network. In: Report: Mechanical and Electronic Information Institute, China University of Geo Science, Wu Hen, China.

[5] Joshua O. Ighalo, Adewale George Adeniyi, and Goncalo Marques., "Internet of Things for Water Quality Monitoring and Assessment: A Comprehensive Review", publication at: https://www.researchgate.net/publication/344158165

[6] Kartik Maheshwari, Adrija Chakraborty., "Water Quality Monitoring System Implemented with IoT", International Journal of Emerging Trends in Engineering Research, ISSN 2347 – 3983, Vol.9. July 2021.

[7] Manoharan.S., Sathiyaraj.G., Thiruvenkadakrishnan.K., Vetriselvan. G., V. Praveenkishor., "Water Quality Analyzer using IoT", (IJITEE) ISSN: 2278-3075, Volume-8, Issue-8S, June 2019.

[8] Mohammad Salah Uddin Chowdurya, Talha Bin Emranb, Subhasish Ghosha, Abhijit Pathaka, Mohd. Manjur Alama, Nurul Absara, Karl Anderssonc, Mohammad Shahadat Hossain, "IoT Based Real-time River Water Quality Monitoring System" Procedia Computer Science 155 (2019) 161–168.

[9] Prasad. M. Pujar, Harish. H. Kenchannavar, Umakant. P. Kulkarni., "Water Quality Assessment and Monitoring for river Malaprabha using the Internet of Things (IoT) system" (IJRTE) ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019.

[10] Pratik More, Harcharan Singh Soman, Akheel Patel, Gaurav Shirke, Prof. Dhanashree Pannase, "IoT Based Real Time Water Quality Monitoring System", Journal homepage: www.ijrpr.com ISSN 2582-7421.

[11] Sahana R, Sneha K, Syeda Heena Kausar, Dr. C Vidya Raj, Vatsala BR., "WATER QUALITY MONITORING SYSTEM USING IOT" Volume:04/Issue:09/September-2022, e-ISSN: 2582-5208. www.irjmets.com

[12] Sathish Pasika, Sai Teja Gandla, "Smart water quality assessment system with cost-effective using IoT", Heliyon 6 (2020) e04096.

[13] Sivaranjani S., Amitava Rakshit and Samrath Singh, "Water Quality Assessment with Water Quality Indices" International Journal of Bioresource Science. Vol 2 · January 2015.

[14] Vaishnavi V. Daigavane and Dr. M.A Gaikwad, "Water Quality Assessment System Based on IOT", ISSN 0973-6972 Volume 10, Number 5 (2017), pp. 1107-1116.

[15] Varsha Lakshmikantha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted, Jagadeesh Basavaiah, Audre Arlene Anthony, "IoT based smart water quality monitoring system" Global Transitions Proceedings 2 (2021) 181–186.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)