IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, June 2025
Impact Factor: 7.67

Water Quality Monitoring System Based on IoT

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Abstract: *Water pollution is one of the biggest fears for the green globalization. In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. In this paper we present a design and development of a Low-cost system for real time monitoring of the water quality in IOT (internet of things). Keyword: pH sensor, Turbidity sensor, TDS sensor, Microcontroller ESP32 model, WI-FI module. The system consist of several sensors is used to measuring physical and chemical parameters of the water. The parameters such as turbidity, PH, TDS sensor of the water can be measured. The measured values from the sensors can be processed by the core controller. The ESP32 model can be used as a core controller. Finally, the sensor data can be viewed on internet using WI-FI system.*

Keywords: pH sensor, Turbidity sensor, TDS sensor, Microcontroller ESP32 model, WI-FI module

I. INTRODUCTION

Water plays a vital role in the creation of human beings and other natural phenomena. About 80% of diseases in the developing country are caused by the consumption of polluted water. As we all know, water is not only used for drinking purposes, it has other uses too such as; economic aspects, industrial sites, agriculture, fishing, and other constructive activities. The quality of water is mainly affected by physical, chemical, and biological aspects.

The main sources of water are lakes, rivers, glaciers, groundwater, rainwater, etc. Water is available in every part of the earth whether it is polluted or not. About 80 percent of Earth's land is covered by water. In our day-to-day life water plays one of the most important roles for living beings on earth. [1.] Quality of water is getting very serious attention in our generation. So, to live a healthy and prospective life, checking the water quality is very important.

In the past, water quality has been measured by taking the water samples and sending them to the laboratories, and examining them, which is very costly, time-consuming, and involves more human resources. [2.] This process will not provide real-time data and lead us to the impure quality of water. The proposed water quality monitoring systems consisting of a microcontroller with common sensors are compact and very useful for pH, turbidity, conductivity, water level detection, temperature and humidity of As per increase in water pollution there is need of controlling pollution in water is finished by monitoring water quality. Our system consists of various sensors which will compute the standard value is 6.5 to 8.5 of water in real time for effective action and is accurate and only less manpower required

II. LITERATURE REVIEW

Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.

Jayti Bhatt, Jignesh Patoliya entitled "Real Time Water Quality Monitoring System". This paper describes to ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists some sensors which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller and this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.

Michal Lom, Ondrej Pribyl, Miroslav Svitek entitled "Industry 4.0 as a Part of Smart Cities". This paper describes the conjunction of the Smart City Initiative and the concept of Industry

4.0. The term smart city has been a phenomenon of the last years, which is very inflected especially since 2008 when the world was hit by the financial crisis. The main reasons for the emergence of the Smart City Initiative are to create a sustainable model for cities and preserve quality of life of their citizens. The topic of the smart city Water Quality Monitoring System Based on IOT

cannot be seen only as a technical discipline, but different economic, humanitarian or legal aspects must be involved as well. In the concept of Industry 4.0, the Internet of Things (IoT) shall be used for the development of so–called smart products. Subcomponents of the product are equipped with their own intelligence. Added intelligence is used both during the manufacturing of a product as well as during subsequent handling, up to continuous monitoring of the product lifecycle (smart processes). Other important aspects of the Industry 4.0 are Internet of Services (IoS), which includes especially intelligent transport and logistics (smart mobility, smart logistics), as well as Internet of Energy (IoE), which determines how the natural resources are used in proper way (electricity, water, oil, etc.). IoT, IoS, IoP and IoE can be considered as an element that can create a connection of the Smart City Initiative and Industry

4.0 – Industry 4.0 can be seen as a part of smart cities

Zhanwei Sun,Chi Harold Li,Chatschik Bisdikian,Joel W.Branch and Bo Yang entitled "QOI- Aware Energy Management in Internet-of-Things Sensory Environments". In this paper an efficient energy management frame work to provide satisfactory QOI experience in IOT sensory environments is studied. Contrary to past efforts, it is transparent and compatible to lower protocols in use, and preserving energy-efficiency in the long run without sacrificing any attained QOI levels. Specifically, the new concept of QOI-aware "sensor-to-task relevancy" to explicitly consider the sensing capabilities offered by an sensor to the IOT sensory environments, and QOI requirements required by a task. A novel concept of the "critical covering set" of any given task in selecting the sensors to service a task over time. Energy management decision is made dynamically at runtime, as the optimum for long-term traffic statistics under the constraint of the service delay. Finally, an extensive case study based on utilizing the sensor networks to perform water level monitoring is given to demonstrate the ideas and algorithms proposed in this paper, and a simulation is made to show the performance of the proposed algorithms.[

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III. PROBLEM STATEMENT

Problem Statement 1:

In many areas, people use water without knowing if it is clean or safe. Traditional water testing methods are slow, costly, and not available everywhere. There is a need for a real-time, affordable system that can check water quality instantly and alert users if the water is unsafe.

Problem Statement 2:
Access to clean and safe water is still a challenge in many parts of the world. Water may contain harmful chemicals or particles, but users cannot detect this with the naked eye. Without regular monitoring, using such water can lead to serious health problems. There is a lack of a simple system that can test water quality easily and regularly.

Problem Statement 3:
Water pollution is increasing due to industrial waste, poor sanitation, and environmental damage. Manual water testing is time-consuming and often ignored. A smart and automatic solution is needed to check important water quality parameters like pH, turbidity, and TDS in real time.

Problem Statement 4:
Most existing water quality monitoring systems are expensive and not suitable for homes or small communities. There is no low-cost, user-friendly solution that provides real-time monitoring and alerts for water quality changes. This creates a risk of using unsafe water unknowingly.

Problem Statement 5:
People cannot tell the quality of water just by looking at it. Clear water may still contain harmful substances. Traditional lab testing methods are not practical for daily use. There is a need for a digital solution that continuously monitors water quality and informs users immediately.

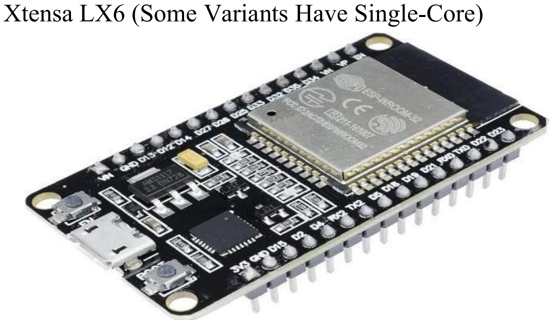
IV. METHODOLOGY

Module 1. Unit Testing

In unit testing, select an individual sensor like turbidity and then establish the connection using jumper wires. First connect the filter kit to the sensor and then connect the filter kit to the microcontroller. Three wires are used. One is the signal to take the data input. The second is the vcc to supply voltage to the sensor. Then the last one is the ground to control the high voltage. After connecting the installed sensor to the microcontroller, the next process is to establish a new connection with the microcontroller to the laptop using a USB cable to upload the code. Then the next process is to open the Arduino software, then click on the file option, select the preference option, open and select the additional board option and then cross the json file link of esp32 and then click on OK. Then click on the tools option, select the board option from the list, then open the board manager and find the eps32 board and installed, after completing the installation process click on the tools option again and select the board option from the list, then select the eps32 board and select the port com 7 and click on the OK button. After all this process is done, write the code for individual sensor testing on Arduino software, then upload the code and take a water sample and check the sensor placed on the water and check if it is working properly or not and check if it is not showing reading. Do the same process for other components for unit testing and check if its sensor is working properly.

Esp32 Microcontroller

Processor: Dual-Core Tensilica Xtensa LX6 (Some Variants Have Single-Core)



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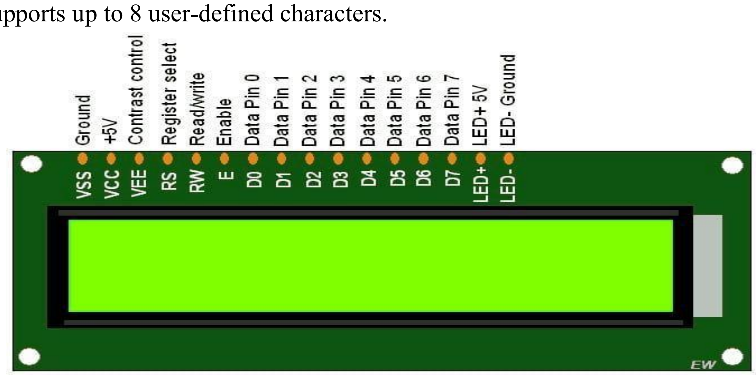
Clock Speed: Up To 240 Mhz RAM:Typically 520 KB
SRAMROM: 448 KB
External Flash: Up To 16 MB Wi-Fi: 802.11 B/G/N
Bluetooth: V4.2 (Classic And BLE) SPI,I2C,UART, I2S
PWM , ADC (12-Bit), DAC (8-Bit)
Operating Voltage: 2.2V – 3.6V (Typical 3.3V)
Ultra-Low-Power Coprocessor: For Sensor Readings During Sleep.

Lcd Display

Character-based display (not graphical).Each character is displayed in a 5x8 pixel matrix.
Backlight: Usually includes LED backlight (white, blue, green, etc.). Contrast control: Via a potentiometer on V0 pin.
Custom characters: Supports up to 8 user-defined characters.



Ph Sensor

Neutral pH: 7 Acidic: pH < 7
Measurement Range: pH 0 to 14
Alkaline (Basic): pH > 7
Accuracy: Usually ±0.1 to ±0.2 pH units
Temperature-sensitive: Readings affected by temperature

Turbidity Sensor

Voltage Range: Typically 0–5V or 0–3.3V (for microcontroller compatibility)
Low Power: Suitable for battery-powered systems Submersible Probe: Can be placed directly in water
Calibration: Usually needs to be calibrated with known NTU samples

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TDS Sensor
Measures: Concentration of dissolved substances (salts, minerals) in water
Unit: ppm (parts per million) or mg/L
Working Principle: Measures water electrical conductivity to estimate TDS
Output: Analog voltage (converted to TDS in microcontroller)
Typical Range: 0–1000 ppm (some up to 5000 ppm) Power Supply: 3.3V – 5V

MODULE 2. Integrating IOT components on board

In Module 2, we will integrate the IoT components on the board by following the block diagram of the project. First, we will connect the sensor to the esp32 microcontroller using jumper wires. To install the sensor, we will use the IoT components. In this process, three wires are used: signal, VCC and GD, which are ground. The signal wires are used to provide data to the sensor. Taking input and sharing it with the microcontroller. VCC is the supply current to the sensor. The microcontroller uses GD to control the high voltage to safely damage the sensor. The pH sensor data pin is D27 and VCC and GD. The turbidity sensor data pin is D30. The VCC and GD. The TDS sensor data pin is 24. VCC and GD. All the sensors are installed with the microcontroller. Then the LCD display is installed with the microcontroller. The power supply is also connected to the microcontroller. The filter kit is used to convert each sensor input voltage and information to low frequencies and to high frequencies and to remove noise.

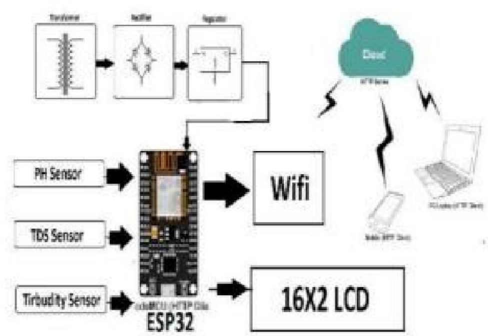

Fig.1 Block Diagram

MODULE 3. Implement code and installing

Module 3 has code implementation process in this module first download and install Arduino software on laptop then open file option and select preference option and paste json file link of additional board on epa32 then click ok and next click on toola option select board and board manager find esp32 microcontroller and after installation again click select tools option and select esp32 wroom board and select com 7 port then click ok button and write code and then upload code to esp32 microcontroller when not shown click boot button upload is in progress then skip button and continue uploading process upload after coding check if all sensors and iot components are showing readings.

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MODULE 4. Testing and threshold value comparison

Compare threshold values by entering sample and crate report in module 4. In this module check different water samples and check the readings and record all those sensor output with threshold values of sonars and compare and result shows that sample condition is not pure and not useful. We used three sensors ph sensor threshold values are 6.5 to 8.5 is normal and useful water range is 0 to 14 0 to 7 is acidic and 7 to 14 is alkaline second is turbidity sensor threshold value is 0 to 50 NTU it shows useful and normal water range is 0 to 2000 NTU is maximum this sensor shows water purity third sensor is TDS sensor and measuring by ppm means parts per million and this sensor threshold value is 50 to 150 ppm it shows normal water and drinking water and range is 0 to 500 ppm.

MODULE 5. Realtime data access and monitoring by blynk application

First you will quickly open the on ID software. As we have opened the software, as you are using it for the first time, you have to install the AESOP 32 board in the DIN ID. So first we will go to files, go to preferences, then here we will copy the link for Additional Board Manager URL and then paste it in the Additional Board Manager URL and click OK. We have to go to free tools, then go to this board, click on board manager, then search for AESOP 32 here. Install AESOP 32 by Expressive Systems. It will be written here that the processing will start and the download will start. As we have written here that it has been successfully installed and here also we have written that our P32 board has been successfully installed. So now we will go to the next step. We will cut it and then we will go to step two. And if you have come here then you have to open G.Com and here you have to search B.L.Y.N.K. B.L.Y.A. link. You have to go to this website. It will give you two options of login and sign up. You have to sign up for free. Here it will ask for your email ID. So we will enter our email ID and click on I agree and then click on sign up. It will be written here confirm your email now. So you have to open your email ID. So we open our email ID. So as we have received a mail from Blink, here it is giving the option of create password. So we will create it. Here we have to go to password and then we are creating our password. We have created our password. We will click next. We are entering the name, first name. So we are entering our name Piyush and will do it. So we will do never here. Let us read it once. Let's go and how it works. All this is about this, you guys can read it, if you want then finish it, we will look around first, so here as you guys do, you will get the option of new template, you have to click on new template, here you guys give the name of the template, we are giving the name of the template IoT IoT LED IoT LED and here we are writing our text, use latest digit and space only, so you can use space here, so here we will use 32 and let it be wifi here because in the description on this we can write whatever you want, you can write anything or you can not write, we will finish it with this, so as our template has been created 32 WiFi, so now what you have to do is go to data stream, click on new data stream, here you have to click on digital pin, you have to mark digital pin, then here But you have to write LED, you can write anything. We are writing LED. So here we will select the pin number to pin mode output. From here you can also select your color. So we will make this color and then we will create it here. So as our data stream has been created, its name is LED and if we use the pin number then it is showing data. Now we will go to the web dashboard. What do you have to do in the web dashboard? Here in the visit box you will see many types of slider number input and switches. So we will bring it here by clicking on this switch. Here we will go to the settings, which is optional here, that switch setting, we are writing LED, which will be the name of the switch. LED is being seen here, LED is being written here. But as we create data stream, we will see data.

V. ADVANTAGE AND DISADVANTAGE

Advantages:

1. Real-time Monitoring:

o You get live updates about the water's quality, so you can act quickly if something goes wrong.

2. Remote Access:

o You can check water quality from anywhere using a phone or computer.

3. Saves Time and Effort:

o No need to go to the site and test water manually. The system does it automatically.

4. Data Logging:

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o Keeps records of water quality over time, which helps in spotting trends and making better decisions.
5. Early Warning System:
o Sends alerts if water becomes polluted or unsafe, helping to prevent health risks.
6. Low Cost Over Time:
o After setting it up, it reduces the need for regular manual testing, which saves money in the long run.

Disadvantages:
1. Internet Dependency:
o It needs a stable internet connection. Without it, data may not be sent or received.
2. Power Supply Issues:
o Most sensors and devices need electricity or batteries, which can be a problem in remote areas.
3. Maintenance Needed:
o Sensors need to be cleaned and calibrated regularly to give accurate results.

VI. OUTPUT

	Excellent	Good	Fair	Poor	Very Bad
PH	6.5	7	8.5	9	14
TDS	50	300	500	800	1000
TURBIDITY	5	500	2550	3000	5000

SAMPLES	SAMPEL1	SAMPLE2	SAMPLE3
ACTUAL VALUES	PH : 6.8 TDS 73 TURBIDITY 141	PH 9 TDS 625 TURBIDITY 2851	PH : 7.2 TDS 457 TURBIDITY 1425
STATUS	Good quality of water	Bad quality of water	Fair quality of water

VII. CONCLUSION

In conclusion, the IoT-based water quality monitoring system presents a promising solution for addressing the limitations of traditional methods in monitoring and managing water quality. By leveraging the power of IoT technologies, the system enables real-time monitoring, data analytics, and decision support, contributing to efficient water resource management and safeguarding public health.
So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters. The operation is simple. This system could also be implemented in various industrial processes. The system can be modified according to the needs of the user and can be implemented along with lab view to monitor data on computers.
While further research and development are required to refine the system and adapt it to specific contexts, the IoT-based water quality monitoring system represents a significant advancement in the field of water quality management. It offers a valuable tool for monitoring, analysing, and managing water quality in a more efficient, cost-effective, and data-driven manner

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