SMART AQUIFER

An IoT-Based Water Quality Monitoring System for Sustainable Urban Water Management.

[1*]Joel Stewart J, [1]Dr. R. Sakthivel, [2]Dr. D. Mahesh Kumar,[3]Dr. S. Mohan Kumar.

[1*]*Department of Applied Electronics, PSG College of Arts and Science, Coimbatore – 641014, Tamil Nadu, India.*
[1,2,3]*Associate Professor, Department of Applied Electronics, PSG College of Arts and Science, Coimbatore – 641014, Tamil Nadu, India.*

Abstract: Addressing water contamination in cities requires an approach, encompassing improved waste management practices, infrastructure upgrades, and community awareness initiatives. Designing an IoT-based Water Quality Monitoring system involves integrating sensors to measure various water quality parameters, collecting data from these sensors, and transmitting the data to a central platform for analysis and visualization and to inform the user when the contamination level reaches the TDS level higher than 70l. In this system, the microcontroller overlooks the sensor data collection and processing. Utilizing the Arduino At-mega microcontroller provides a robust and versatile platform for integration and development. Communication is facilitated through a Wi-Fi module, allowing seamless data transmission from the microcontroller to the cloud or a central server. The cloud platform chosen for this setup is Thingspeak.com, providing a user-friendly interface for data visualization, storage, and analysis. intimating the user about the intense levels of data. Overall, this integrated water quality monitoring system offers a comprehensive solution with an mobile application interface for monitoring and maintaining water quality, contributing to environmental sustainability and public health.

Keywords: Alkalinity and acidity in water: pH sensor; concentration of ions: conductivity sensor; clarity and particle content: turbidity sensor; GSIM gps 900A; Application interface;

INTRODUCTION

Water contamination in Chennai has been a longstanding issue, primarily due to factors like industrial pollution, sewage discharge, and urban runoff. As we navigate the complexities of urbanization, the demand for clean and safe water has never been more pressing. In an era where urbanization is rapidly expanding, ensuring the quality of essential resources such as water is paramount. With the advent of Internet of Things (IoT) technology, monitoring and managing water quality have become more accessible and efficient than ever before. This documentation presents an IoT-based Urban Water Quality Monitoring System tailored for homes, designed to provide real-time insights into the quality of water consumed by residents.

With rapid population growth and industrial expansion, traditional monitoring methods struggle to keep pace with the evolving challenges of water contamination and scarcity. Our solution leverages the power of the Internet of Things (IoT) to create a dynamic and proactive approach to water quality management. By deploying a network of sensors throughout our urban water infrastructure, we can continuously monitor key parameters such as pH levels, dissolved oxygen, turbidity, and contaminant concentrations in real-time. Cities are having a hard time keeping their water clean because of things like pollution, old pipes, and lots of people living close together. Usually, people check water quality by taking samples and testing them in a lab, but this takes time and might not catch pollution fast enough. Also, these tests don't always tell us if the water is safe right where we use it, like in our homes. This means they might not be the best way to make sure everyone has clean water to use

The main goal of this project is to create a system that lets people check their water quality at home instantly using the IoT. This system will use sensors and technology to send data, along with easy-to-use screens, to give important information quickly. This helps people know about their water quality and make smart choices for their health. The system's purpose is to keep people updated about their water's condition in cities using IoT, so they can get this information right away and know what to do.

Using IoT technology means we can watch the water quality all the time, without a break, and know right away if something's wrong. It checks things like how acidic the water is, how clear it is, how warm it is, how much oxygen is in it, and if there are any harmful substances. The system uses smart sensors that talk to each other and send data, so if the water isn't as clean as it should be, it'll tell us quickly. People get messages on their phones or computers to let them know, so they can do something about it fast. This way, everyone can see the water quality information easily and use it to make smart choices about using water safely in their homes and neighborhoods. The system shows the information in a way that's easy to understand, with charts and interactive tools, so people can spot any changes over time and decide what to do next.

Keeping everyone informed as things happen helps to manage any risks better. People can take steps like using water filters or changing the way they use water to avoid health problems from bad water. Easy access to water quality information through IoT systems helps make sure that the people in charge of water are doing their job well. This way, everyone can make sure they have safe water and can quickly fix any water problems. IoT systems also help everyone work together to protect their water by sharing information. This lets people work with local groups and others to make water use better for everyone.

Overall, the main objective of urban water quality monitoring systems utilizing IoT technology to keep users updated is to ensure transparency, empower communities, and promote proactive measures to safeguard public health and the environment against water-related risks and challenges in urban settings.

LITERATURE REVIEW

The goal is to use modern technology to make our lives easier and protect the environment. This paper suggests a system that uses the IoT and data analysis to manage how water is given out. It will make sure water is used wisely in homes and buildings. This system will also keep track of how much water people use. This information can help plan cities better and save water from being wasted.[1][4]

Checking the quality of water we use at home is very important. Old ways of testing water in labs are slow, expensive, and don't give instant results. Newer systems that use wireless sensors have problems with battery life, keeping data safe, and reaching far enough. But now, thanks to improvements in IoT technology, we can make better, safer, and less expensive systems that give us information right away. This report talks about the latest IoT systems that check water quality at home. It looks at what we need to measure to make sure water is safe to drink, the sensors that can do this, and how good the current IoT systems are. It also suggests ways to make these systems better.[2]

As communication technology gets better, smart ways to check water quality are becoming more important. This paper gives a thorough look at the latest research in smart water quality checks. It also introduces a new, energy-saving, and easy way to monitor water quality inside pipes using Internet of Things technology. This new method tests water and sends the results online for review. If the water quality changes from what's expected, the system will warn the user no matter where they are.[6][3]

Today's water quality checks are done by hand, which is boring and takes a lot of time. This paper talks about a new system that uses sensors to monitor water quality more quickly. This system has a main computer, a way to send messages between sensors, and many sensors. With the Internet of Things (IoT), we can see the data right away from anywhere. The data is shown on a computer in an easy-to-understand way using advanced data analysis tools. If the water quality gets worse than what's normal, the system will automatically send a text message to warn someone. This new idea is special because it checks water often, can be moved easily, and doesn't use much power. It will help people in Bangladesh be more aware of dirty water and encourage them to keep their water clean.[10]

The paper introduces a low-cost system that uses a smartphone and sensors to check water quality in faraway places. It measures things like pH, salt levels, and temperature in the water. The system is smart and can even figure out more details about the water quality. It has a special app for phones that can show the data on maps and help understand it quickly. This system is handy for testing water quality and alerting people if something's not right. It's small, lightweight, and uses a rechargeable battery. The results match up with standard water quality checks. They've used different methods to squeeze all the water quality details into one simple number for quick and easy understanding. This system has been used to quickly check water quality and study various water sources. It's also used to keep an eye on ponds and lakes in real time. [4]

IThis paper describes a cheap system for checking water quality in real time using the Internet. The system has many sensors to measure different things in the water, like temperature, PH, and murkiness. The measurements from the sensors are handled by a main control system. The data from the sensors can be seen on the internet using Wi-Fi.[8][4]

Monitoring and managing how water is used can help save money and prevent wastage. In this project, a special IoT device is made to connect to a tap and keep an eye on water usage. The device is designed to be easy to put on a tap, small, protected from the weather, and able to send data to a server through Wi-Fi, so the user can check it on their phone. The user can also see how much water was used in the past few days or weeks. The device uses a NodeMCU ESP8266 board with Wi-Fi and a flow rate sensor that attaches to the tap. It runs on a battery. The device uses Thingspeak, an online platform, to send and receive data through the internet. Once it's installed on a tap, the sensor can send data to the user's phone. [11]

Figuring out what happens when water gets contaminated is a big deal for water security and making sure people have safe drinking water. The project focuses on creating a simple and cheap system to monitor water quality using wireless sensors. It checks things like pH, temperature, and turbidity in the water. The system includes sensors and tiny systems to process and analyze data, then send it to users. It also uses smart algorithms to make quick decisions based on real-time data and fuzzy logic to check water pollution risks. If contamination is found, the system can stop the flow of polluted water and notify users through a mobile app. Tests show this system is great at quickly catching water issues. This solution can also be used in other things like smart cities or transportation systems using IoT technology.[13][4]

The water we use has gotten worse because of more industries, people moving from rural areas to cities, and using up land and sea resources too much. Fertilizers on farms and chemicals from mining and construction also make water quality drop worldwide. Water is crucial for us to live, so we need better ways to check that the water we drink in towns, cities, rivers, and lakes is safe. Having good quality water is vital to avoid diseases and make life better. The Fiji Islands, surrounded by the Pacific Ocean, need a network to collect water quality data often to track and improve it. This project introduces a smart system for monitoring water quality in Fiji using technology that can sense things remotely.[12][7]

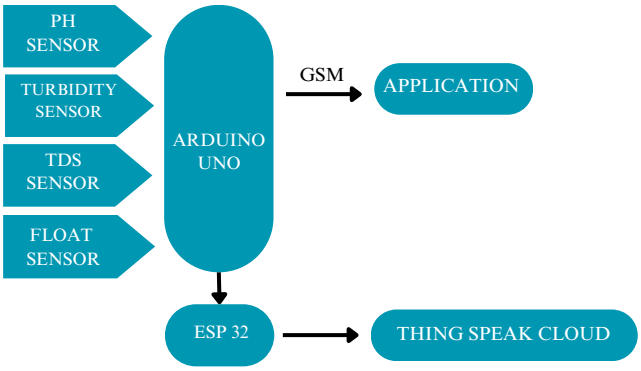
PROBLEM STATEMENT

In many cities, people don't realize that water sources might be dirty. Clean water is crucial for life and public health, but pollution in water often goes unseen. This lack of awareness can be dangerous since people could unknowingly drink or touch contaminated water with harmful substances. Contaminated water problems in cities are hard to spot because they're hidden but can harm public health. To deal with this issue, our system keeps an eye on water quality and warns users about contamination. It's important to note that water pollution is a problem in both cities and rural areas due to issues like old pipes, pollution from industries, farm runoff, and poor sanitation.

PROPOSED SYSTEM

To address this pressing issue, our system has been developed as a proactive solution to monitor and mitigate the risks associated with water contamination in urban environments. By employing cutting-edge sensor technology, our system continuously gathers data on key parameters indicative of water quality, including pH levels, turbidity, total dissolved solids (TDS), conductivity, and float sensor readings.

Through this comprehensive monitoring process, our system serves as a vigilant guardian, tirelessly scrutinizing the condition of the water supply and detecting any deviations from acceptable standards. When sensor readings indicate that water quality has fallen below predetermined thresholds, our system promptly generates alerts to notify residents of potential contamination risks. The alert mechanism is designed to promptly notify urban residents of potential water contamination through an intelligently crafted message. This message serves as a clear and actionable warning, urging users to take immediate precautions or seek alternative sources of water until the issue is resolved. By leveraging advanced sensor technology and data analytics, our system empowers urban communities to stay vigilant against the insidious threat of contaminated water. By providing timely alerts and actionable insights, we aim to raise awareness and promote proactive measures to safeguard public health and well-being in urban environments.



FLOW CHART

Users can access real-time data through an application interface. This data is continuously updated as new information becomes available. For example, if the pH value in a water tank exceeds a certain threshold indicating potential over contamination, the system could send an alert to administrators or technicians via email, SMS, or push notifications on the application. When the system detects that a threshold has been crossed, it sends alert messages to notify users. These messages typically include details about the triggered event, such as the nature of the threshold violation and potentially actionable insights or recommendations. The purpose of alert messages is to promptly inform users of important events or conditions that require attention or intervention.

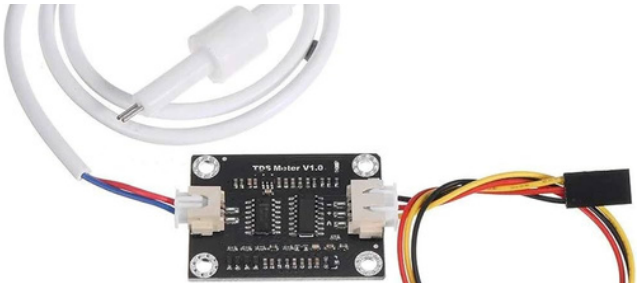
Overall, this system provides users with the ability to access and monitor both historical analytic data stored in the cloud and real-time data through an application interface. Threshold alerts ensure that users are promptly notified of critical events or conditions, enabling them to take appropriate actions in response.

SYSTEM REQUIREMENTS

Ph Sensor : A pH sensor is a tool that checks if a liquid is acidic or alkaline. It works using a science called electrochemistry. The sensor has a glass part and a reference part. The glass part has a special layer that reacts with hydrogen ions in the liquid being tested. The reference part provides a steady electrical measure to compare with the glass part. When the glass part touches the liquid, the hydrogen ions in the liquid affect the glass, making an electrical measure. This measure shows if the liquid is acidic or alkaline. A measure of 7 is neutral, lower than 7 is acidic, and higher than 7 is alkaline.

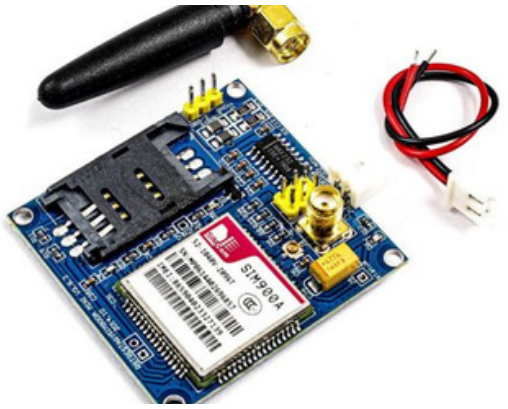
Turbidity Sensor : A turbidity sensor checks how cloudy or hazy a liquid is because of tiny bits suspended in it. These bits can be things like dirt, silt, or even tiny living things. Light scattering is key to measuring turbidity. When light goes through a liquid with bits in it, the bits scatter the light in different directions. The more bits there are, the more the light scatters. Turbidity sensors use light and a detector to measure how the light scatters. An LED sends light through the liquid, and a photodetector or photodiode measures the scattered light.

TDS conductivity Sensor: The sensor uses electrical conductivity to measure dissolved solids in water. Things like salts, minerals, and metals make the water more conductive. The sensor checks how conductive the water is, and this tells us how much stuff is dissolved in it. The conductive measure is then turned into a TDS reading, showing how many solid things are in the water. TDS is often shown in parts per million (ppm) or milligrams per liter (mg/L). It's important to regularly adjust and take care of TDS sensors to make sure they give accurate results. This involves matching the sensor's reading with known conductivity or TDS standards.



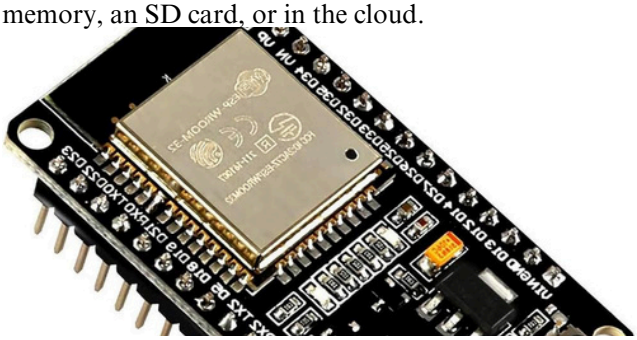
Float Sensor : A float sensor, also called a float switch, is a device that checks how much liquid is in a container. It works based on the idea of buoyancy. The sensor has a float that's attached to a lever or rod. The float moves up and down as the liquid level changes. The sensor has a switch that's turned on by the float's movement. There are different types of switches, such as reed switches, mechanical switches, or solid-state switches. When the liquid level reaches a certain point, the float moves enough to turn on the switch.

GSM Module: A GSM module is a tool that lets devices like computers or microcontrollers connect to a mobile network. Its main job is to link up with the network and help the device send and get messages and data. This module has a GSM modem that talks to the network's cell towers or base stations using regular GSM rules.



Arduino UNO : The Arduino Uno is a small but powerful board used for making electronic projects. It's easy to work with and has pins that can connect to sensors and other devices. It has digital pins for different tasks and can connect to things like sensors and motors. You can power it using a USB cable or an external power supply. It can handle a range of power input, typically between 7 to 12 volts.

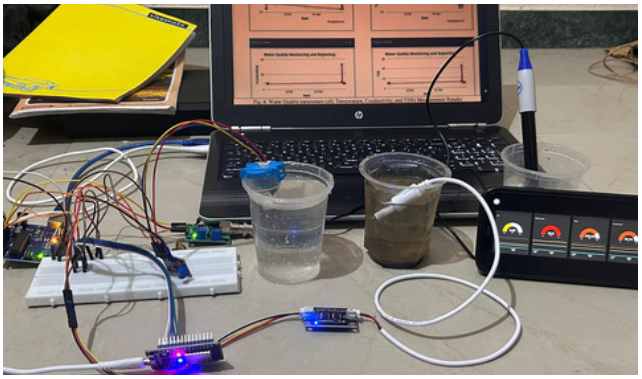
ESP-32 : The ESP32 is a strong microcontroller often used in IoT projects. It's popular because it's versatile, affordable, and can connect using Wi-Fi and Bluetooth. It can work with sensors like ones for temperature, humidity, motion, and light, making it great for sensor networks. The ESP32 can communicate wirelessly over Wi-Fi, Bluetooth Classic, and Bluetooth Low Energy (BLE), ideal for devices needing wireless connections. It can gather data from sensors and store it on its memory, an SD card, or in the cloud.

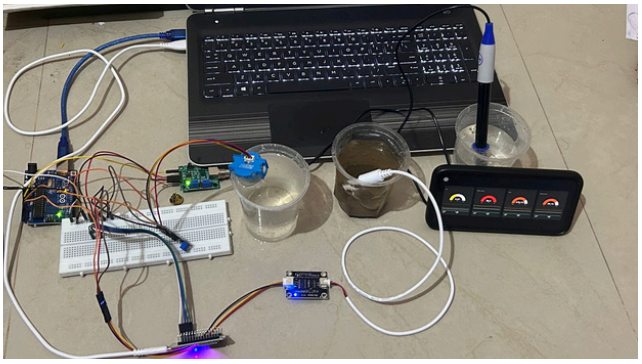


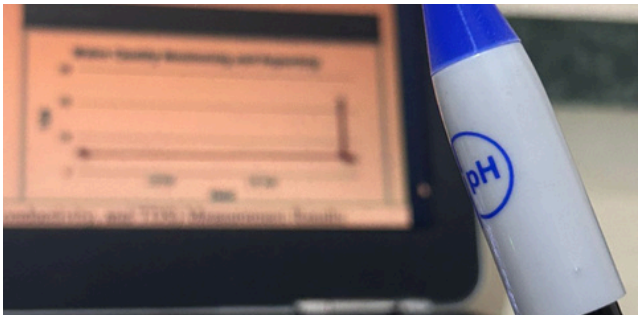
IMPLEMENTATION

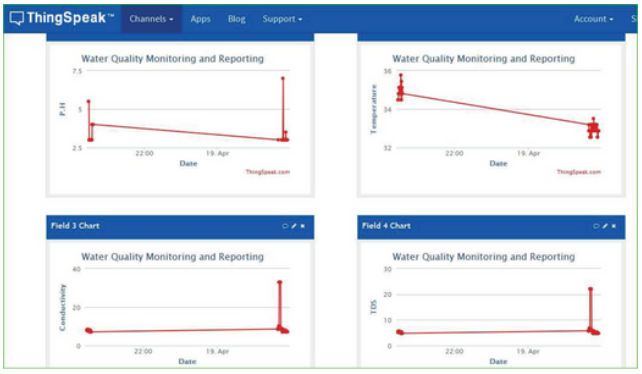
First, the float sensor is connected to an Arduino Uno by linking its power and ground pins to a breadboard. The prototype initiates operation only when the tank reaches full capacity. Subsequently, the pH sensor is integrated with the Arduino Uno. The V (5V) pin is linked to the power source, while the analog output (Po) is connected to A0 on the Uno, with the ground pin being grounded. Notably, the pH sensor features two ground pins, both of which are grounded to ensure proper connection of the pH electrode system to earth ground. This precaution prevents current flow through the reference electrode in case of an additional earth-ground connection, thereby avoiding the creation of multiple electrical paths. Following this, the turbidity sensor (operating at 5V) is attached to the module, with its analog pin connected to A1 of the Uno, and the remaining pins connected accordingly. The TDS Conductivity sensor (operating at 3.3V) is then connected to the Uno, with its analog output linked to A2, and power and ground connections established. With the sensors successfully interfaced with the Uno, the Rx and Tx pins are connected to an ESP-32 to transmit sensor data to the board, facilitating storage in the ThingSpeak cloud. The ESP-32 is utilized primarily and to enable cloud-based data storage, accessible remotely at any time. Upon successful storage in the cloud, users can access and monitor the data via a dedicated application, providing real-time updates.

Furthermore, the system is programmed to issue alert messages through the application in the event of sensor readings exceeding predefined thresholds, thereby ensuring timely intervention. Additionally, users are alerted when the water tank reaches full capacity, effectively reducing water wastage. The mobile application provides users with comprehensive insights into pH levels, TDS concentrations, and the presence of solid particles within the water tank, thereby constituting a smart aquifer system.









CONCLUTION

n this professional setting, users are empowered to engage with our application, accessing comprehensive sensor data. All supplementary information is meticulously stored in the cloud for thorough analysis. Should users require aggregated data, they can seamlessly refer to our cloud-based analysis. Day-to-day data is readily available and updated every 5 minutes within the mobile application. This real-time monitoring ensures the continual assessment of water quality. Should any parameter exceed predefined thresholds, the application promptly notifies the user via alert messages. This proactive approach mitigates exposure to contaminated water, safeguarding users from potential health risks. Our platform serves a crucial role in informing urban populations, particularly those unaware of water contamination issues, thereby enhancing awareness and fostering safer water consumption practices.

FUTURE SCOPE

- Advanced analytics and machine learning algorithms will enable deeper insights into water quality trends, facilitating more informed decision-making by water management authorities.
- Automated alerts and notifications will streamline communication between stakeholders, leading to more efficient crisis management and mitigation strategies.
- This interconnected approach will optimize resource allocation, minimize environmental impact, and promote resilience in the face of climate change and urbanization.
- Citizen science initiatives, facilitated by user-friendly interfaces and accessible data visualization tools, will enable residents to contribute valuable data, monitor local water bodies, and advocate for sustainable water management practices.
- IoT-based monitoring systems can provide policymakers and regulatory agencies with comprehensive, up-to-date data on water quality parameters and compliance with water quality standards.

ADVANTAGES

- This real-time data enables prompt detection of contamination events or changes in water quality, allowing for rapid response and mitigation measures.
- With mobile application assistance, stakeholders can receive alerts and notifications regarding any anomalies detected in water quality. This early warning system helps prevent potential health hazards and environmental damage by allowing timely interventions.
- The collected data is analyzed and presented through the mobile application, providing stakeholders with valuable insights into trends, patterns, and correlations in water quality. This facilitates informed decision-making for urban water management strategies, such as optimizing treatment processes or identifying pollution sources.
- This remote accessibility enhances the efficiency of water management tasks by allowing personnel to monitor multiple locations simultaneously without being physically present at the site.
- By accurately monitoring water quality parameters in real-time, IoT-based systems help optimize the use of resources This optimization leads to cost savings and reduces the environmental footprint of urban water management operations.

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