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HYDRAGUARD : AN INTEGRATED WATER INFRASTRUCTURE MONITORING SYSTEM

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Abstract - *This paper proposes an all-inclusive Internet of Things (IoT) solution that integrates a range of sensors and Arduino-based hardware for leak detection and water quality monitoring. The system uses pH and turbidity sensors to check water quality in real time, guaranteeing ongoing monitoring of important parameters. Water flow rates are measured with a flow sensor, and temperature fluctuations are detected with a temperature sensor (DS18B20). Using the NodeMCU platform and an Arduino microcontroller, the data gathered from various sensors is processed and sent to a central hub. Proactive reactions to variations in water quality are made possible by the IoT infrastructure, which makes remote monitoring and analysis easier. The system also includes a leak detection mechanism that allows for the early detection and control of possible leaks. The proposed solution intends to improve water quality management by offering a low-cost, real-time monitoring system capable of detecting and preventing leaks, thereby contributing to the sustainable and efficient use of water resources.*

Key Words: **IoT, pH and turbidity sensors , temperature sensor, flow sensor, NodeMCU, Arduino UNO Microcontroller,**

1. INTRODUCTION

As the world's population grows and environmental concerns grow, so does the demand for sustainable and clean water resources. This study suggests an inventive way to handle two crucial issues: leak detection and water quality monitoring - by utilizing the Internet of Things (IoT) technology. This is in response to the urgent demand for efficient management of water resources. Maintaining the sustainability of the ecosystem and public health depend heavily on the availability of pure, uncontaminated water. In order to minimize infrastructure damage and prevent water loss, leaks in water distribution systems must be promptly detected and fixed. Within this framework, our work focuses on creating a complete Internet of Things system using a variety of sensors and Arduino technologies. In order to enable real-time analysis of water quality, turbidity and pH sensors are used, providing information on acidity and suspended particle levels.

The incorporation of a flow sensor facilitates precise volume measurements, hence augmenting comprehension of water consumption trends. The temperature sensor (DS18B20) also keeps track of temperature fluctuations, which is an important aspect of water quality evaluation. When these sensors are combined with Arduino microcontrollers, a strong, data-driven ecosystem for evaluating water quality is produced. The IoT Node MCU microcontroller, which allows for smooth data transfer and communication between the sensors and a central hub, is the brains behind the system.

Recognizing the importance of leak detection in water distribution systems, our solution also includes a mechanism to locate leaks and take immediate action to stop water loss and minimize damage to infrastructure. This research aims to lead to the development of more advanced, scalable, and technologically affordable water management strategies. In the end, the suggested system will be crucial in guaranteeing that there will be clean and readily available water resources for both the current and future generations. It seeks to improve the effectiveness of water distribution networks, encourage sustainable water usage, and protect water quality.

1.1 Disadvantages of Existing System:

- **Limited Accuracy:** Conventional temperature sensing systems may lack the precision required for modern applications, leading to inaccuracies in temperature measurements.
- **Lack of Real-time Data:** Many existing systems provide periodic or delayed temperature readings, limiting their suitability for dynamic environments where real-time data is essential.
- **High Power Consumption:** Traditional temperature sensors may consume significant power, restricting their use in battery-operated devices and contributing to higher operational costs.

- **Limited Connectivity:** Conventional sensors often lack wireless connectivity, hindering seamless data transfer and remote monitoring capabilities.
- **Obsolete Communication Protocols:** Older temperature sensing systems may rely on outdated communication protocols, limiting interoperability with modern devices and systems.

1.2 Advantages of Proposed System

- **High Accuracy with Advanced Sensors:** The proposed system integrates advanced sensors like the DS18B20, ensuring high accuracy and reliable digital temperature measurements.
- **Real-time Monitoring Capabilities:** Leveraging the latest technologies, the proposed system enables real-time data monitoring, enhancing responsiveness to dynamic environmental changes.
- **Energy Efficiency:** Designed with energy efficiency in mind, the proposed system is suitable for battery-operated devices, contributing to longer operational lifetimes and reduced power costs.
- **Wireless Connectivity:** The inclusion of wireless connectivity options such as Wi-Fi or Bluetooth facilitates seamless data transfer and supports remote monitoring applications.
- **Integration with IoT Platforms:** The proposed system is designed to integrate with IoT platforms, allowing for efficient data exchange, analysis, and interoperability with other smart devices and systems.
- **Future-Ready Communication Protocols:** The system incorporates modern communication protocols, ensuring compatibility with contemporary devices and systems, thus future-proofing its connectivity.
- **Comprehensive Applications:** With improved accuracy, real-time capabilities, energy efficiency, and advanced connectivity, the proposed system is versatile and well-suited for applications in research, industry, and the broader IoT landscape.

2. LITERATURE SURVEY

2.1 A Low-Cost IoT System for Monitoring Air Quality in Indoor Working Places IEEE 2022

This paper describes the creation of an indoor air quality monitoring system based on the internet of things (IoT). The system's goal is to keep an eye on the office air quality. It is to ensure workplace health and safety, which is particularly important in light of the COVID-19 epidemic. Monitoring may be done from anywhere, at any time, by putting the IoT concept into practice. Three main parts are used in the construction of a monitoring system prototype: an IoT cloud platform (ThingSpeak), a microcontroller (NodeMCU ESP-12), and an air quality sensor (BME680). The outcome of the experimental test demonstrates that the system could track the following parameters: air pressure, temperature, humidity, and IAQ (indoor air quality) index, as well as the amount of carbon dioxide and volatile organic compounds (VOCs). These data are available anywhere at any time via a web application that displays them in real time for users of PCs or cellphones.

2.2 Development of an IoT-based Real-Time Air Quality Monitoring Device IEEE 2021

The air quality has been declining alarmingly over the past few decades, resulting in the deaths of around seven million people annually worldwide. In light of the aforementioned alarming statistics, people everywhere should have access to information on the state of their environment so that sensible actions can be taken before it's too late. This has led to the development of a prototype air quality monitoring system in this work. The NodeMCU ESP32, the MQ-135 gas sensor, and the DHT-11 temperature and humidity sensor module make up the suggested air quality monitoring equipment. Our suggested system has an advantage over its competitors in terms of cost, small size, and economical power consumption. The NodeMCU, which serves as the setup's base station, receives the data that the sensors capture. With its built-in microcontroller and on-chip WiFi transceiver, the NodeMCU not only monitors data but also transmits it to a distant server, opening up a vast amount of possibilities for extremely fine-grained and precise physical world communication. The gas sensor provides an overall air quality parameter along with the concentration of harmful gases such as smoke, CO2, benzene, and NOx. An alarm message is also shown on the server if the concentration of dangerous gasses is higher than a predetermined threshold. The integrated system may be a major factor in smart cities' ability to defend actions taken in the future to reduce pollution levels.

2.3 Water Quality Monitoring System Based on IoT 2022

This paper discusses an effective implementation approach that comprises a variety of sensor devices and other modules and their functionality. In this kind of implementation, the ATMEGA 328 with Wi-Fi module was employed. The embedded device's integrated ADC and Wi-Fi module allow for internet connection. Sensors are built into the Arduino UNO board for monitoring purposes. An ADC is used to transform the sensor readings into a digital value, which is then used to evaluate the related environmental parameter. after data has been gathered from numerous sensor devices placed in a particular area of interest. The detected data will be immediately sent to the web server after a successful connection has been made with the server.

2.4 Intelligent Water Quality Monitoring Using WSN and Machine Learning Approaches 2023

The useful implementation strategy that includes a range of sensor devices and other modules and their functionalities is covered in this paper. In this kind of implementation, the ATMEGA 328 with Wi-Fi module was employed. The embedded device's integrated ADC and Wi-Fi module allow for internet connection. Sensors are built into the Arduino UNO board for monitoring purposes. An ADC is used to transform the sensor readings into a digital value, which is then used to evaluate the related environmental parameter. once data has been gathered from multiple sensor devices placed in a particular area of interest. One of the main objectives for urban and rural areas is the development of complete Internet of things (IoT)-based solutions for water quality monitoring and management that support pertinent users and researchers.

2.5 Water Pipeline Leakage Detection And Monitoring System Using Smart Sensor With Iot 2022

In order to manage water leaks that occur in it, this study provides a smart water pipeline monitoring system. Water usage is rising in direct proportion to rising water waste. In order to solve this, the Internet of Things (IoT) is used in the design and proposal of a smart monitoring system. In this system, a turbidity sensor is used to measure water contamination and a water flow sensor is used to monitor water flow in the pipeline. One of the most popular microcontrollers for Internet of Things applications, the NodeMCU microcontroller, is employed in this system. This microcontroller's interrupt pins are its primary function. The turbidity and water flow sensors transfer their measured information to the cloud server. Because the ThingSpeak cloud server is open source and free to use, it has been utilized for the system's cloud data storage. The data is shown on the ThingSpeak cloud website using the values that the water flow sensor measured. So, it will be extremely simple to monitor the water flow in the pipeline.

2.6 An Arduino-Based Water Quality Monitoring System Using Ph, Temperature, Turbidity, And Tds Sensors

In order to detect unintentional or intentional water contamination, this study describes an Arduino-based monitoring system that examines four physicochemical water parameters: pH, temperature, turbidity, and Total Dissolved Solids (TDS). The system consists of two nodes: the sink node and the sensor node. The sensor node manages LCD data presentation, pre-processing, and data collection. The sink node performs data receiving from the sensor node, data display on an LCD, and alert systems utilizing a buzzer when it is decided that the water is hazardous to drink. The four water quality parameters—pH, temperature, turbidity, and TDS—may all be monitored and data can be gathered by the researchers' system. They can then save this data in CSV file format on an SD card and on a ThingSpeak channel. With an Arduino Uno microcontroller, the planned drinking water quality monitoring gadget was implemented.

3. PROPOSED SYSTEM

- **Hardware Requirement:** Arduino UNO (Microcontroller) , Lcd, Flow Sensor, Temperature Sensor, pH Sensor, Flow Sensor, IoT.
- **Software Requirement:** Ardunio IDE, Blynk.

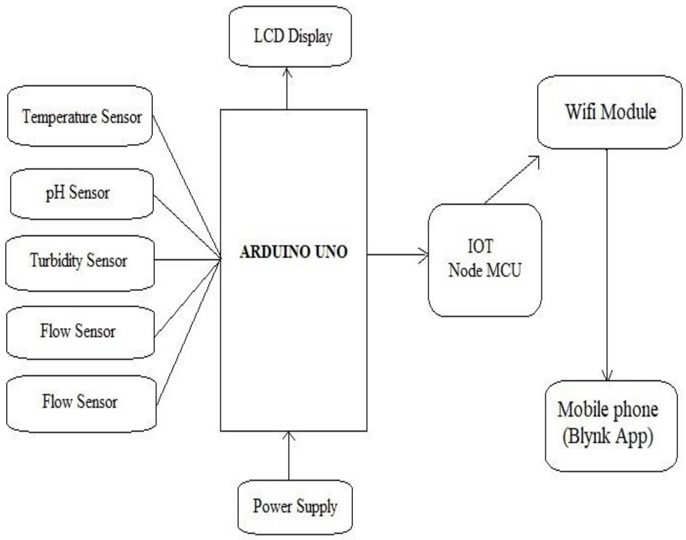

Fig -1: Block Diagram

The system's block diagram is displayed in Figure 1. An Arduino UNO microcontroller board, input, and output make up the system. The Arduino board, which is also connected to the output devices, its serial monitor, and a Blink App inventor-based mobile application that is connected to a Wifi module, are used to display the viewer's digitally altered data. Analog data is sent from sensors to the Arduino UNO microcontroller. Through the wifi module, the Arduino transfers the data to the mobile application in a readable digital format. It also shows it on the Arduino's serial monitor. Figure 1 above depicts the entire block diagram for the current project, which comprises the 16x2 LCD display, IOT or wifi module, power supply, PH, temperature, and turbidity sensors, as well as the controller unit.

Here, analog signals from the temperature, pH, turbidity, and flow sensors are sensed from the water supply and sent to the microcontroller. These analog impulses are fed into the Arduino UNO, which transforms them into digital signals that are shown in real time on the Arduino IDE monitor. The Wifi module, which transmits the data to a mobile application called blynk app that displays the leakage metrics and real-time variations in water quality.

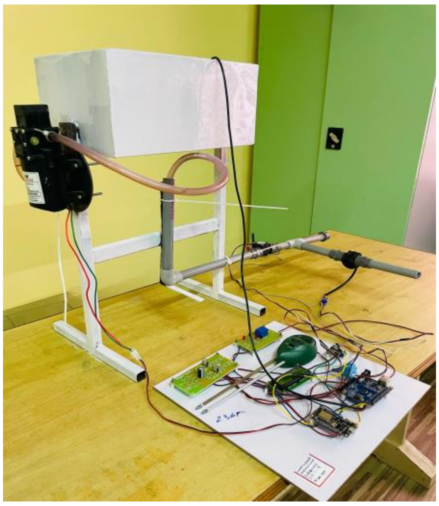

Fig -2: Prototype

4. EXPERIMENTAL RESULTS

1. Incorporating all of the sensors—pH, temperature, turbidity and flow—into the pipe line network and sampling the water.

2. This prototype indicates how each component is connected.

3. Turn the power source on and the LCD screen will show the parameter values.

4. Threshold value for each parameter is set in the source code. Water is considered contaminated if any of the parameter values are higher than the threshold value.

5. Flow sensors would independently measure flow rate, and their readings could be compared to ensure consistency. If there's a discrepancy between the readings, it could indicate a potential leak in pipeline network

6. The user will then receive the alert message in blynk app when leakage is detected with the assistance of Wifi module

4.1 Water Quality Monitoring

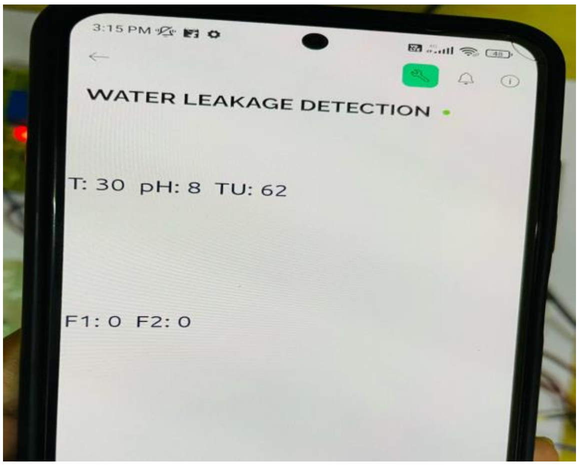

Fig -3: Parameters value shown in Blynk App

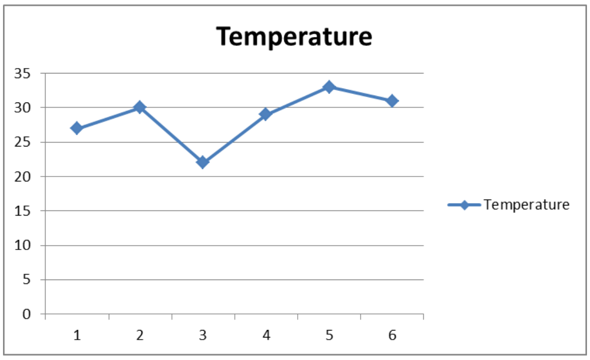

Fig -4: Temperature variations of different water samples

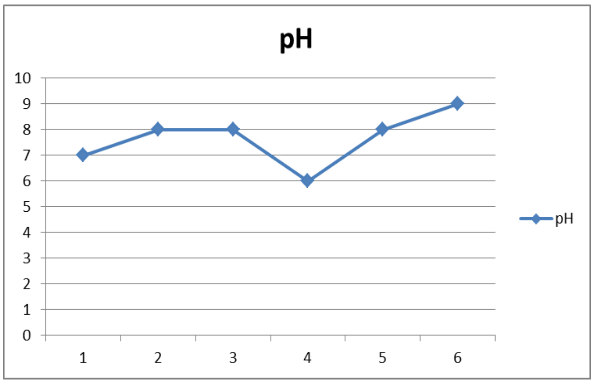

Fig -5: pH values of different water samples

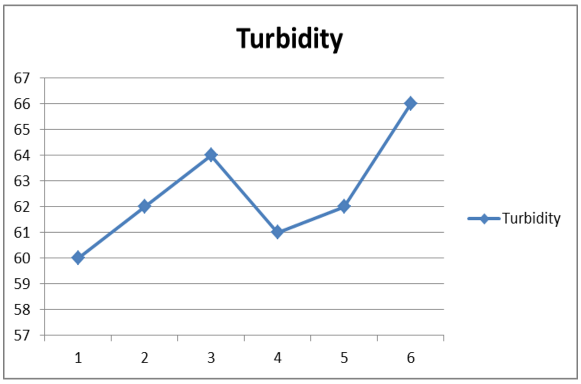

Fig -6: Turbidity values of different water samples

4.2 Leakage Detection

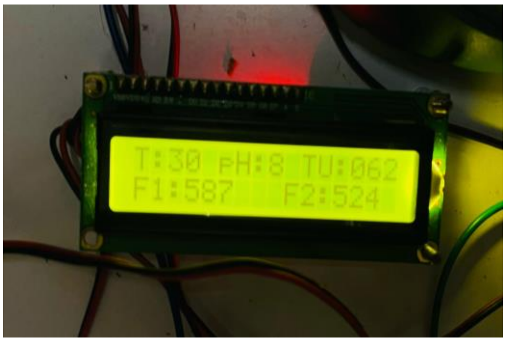

Fig -7: Flow values without variations

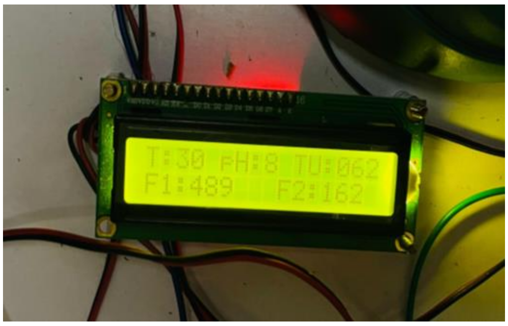

Fig- 8: Flow values with variations

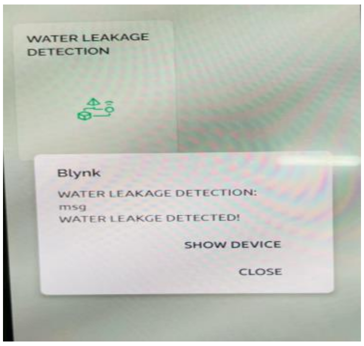

Fig -9: Leakage detection alert message

5. CONCLUSION

Utilizing the already-existing GSM network and a water detection sensor with a special advantage, turbidity, PH, temperature, and water leakage are all monitored. The system is inexpensive, self-sufficient, and capable of autonomously monitoring the quality of the water obligation. Therefore, it is likely to be faster, easier, and less expensive to test the water quality. There is good flexibility in the system. This device can only be used to monitor additional water quality metrics by swapping out the appropriate sensors and updating the necessary software. The process is easy to follow. It is possible to expand the system to monitor hydrologic conditions, air pollution, industrial and agricultural output, and other aspects. Its application and extension value are extensive.
Maintaining embedded devices in the surroundings for observation allows the environment to protect itself (smart environment). In order to put this into practice, sensor devices must be placed throughout the environment to gather and analyze data. Sensor devices allow us to bring the environment to life by allowing it to communicate with other items over a network, thereby bringing it closer to reality. The end user will then have access to the gathered data and analysis findings via Wi-Fi.

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