VELAMMAL
ENGINEERING COLLEGE

Design and Implementation of Portable Water Contaminant Detection Device for Early Identification of Waterborne Disease Outbreaks

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ABSTRACT

❖ Waterborne diseases pose a significant threat to global health, particularly in regions lacking reliable water quality monitoring. Traditional water testing methods often necessitate laboratory facilities, which are not always accessible or timely.

❖This project aims to develop a portable, user-friendly device capable of detecting critical water contaminants in real time, thus enabling early identification of potential disease outbreaks.

❖Our device will target key contaminants including heavy metals (e.g., lead, mercury, arsenic), bacteria (e.g., E-coli) and harmful chemicals (e.g., nitrates, pesticides).

- By integrating advanced sensor technologies such as biosensors, electrochemical sensors, and colorimetric sensors, the device will provide accurate and rapid detection of these pollutants.

- A microcontroller-based processing unit will analyze sensor data and display results on an integrated LCD/LED screen, supplemented by immediate alerts for contamination levels exceeding safe thresholds.

- To enhance usability and accessibility, the device will be paired with a mobile application that facilitates data visualization, logging, and remote monitoring.

- The app will sync data in real time, allowing users to track water quality trends and receive notifications on their smartphones.

OBJECTIVES

- Develop a portable device for immediate detection of critical water contaminants, including heavy metals and harmful chemicals.
- Create an intuitive and easily transportable device suitable for various environments, including remote and rural areas.
- Pair the device with a mobile app for real-time data visualization, logging, and remote monitoring, ensuring easy access to water quality information.
- Implement algorithms to analyze sensor data accurately and provide immediate alerts when contaminant levels are unsafe.
- Perform comprehensive lab and field tests to validate the device’s accuracy, reliability, and durability in real-world conditions.

LITERATURE SURVEY

Sr. No	Name of the paper	Journal	Year	Advantages	Disadvantages
1.	Waterborne pathogens detection technologies: advances, challenges, and future perspectives	Frontiers	2023	I provides information about all methods to detect pathogens	It does not mention how to implement these methods.
2.	Recent advances on portable sensing and biosensing assays applied for detection of main chemical and biological pollutant agents in water samples	Springer	2021	Provides a basic idea on how to create a portable device to detect water contaminants.	Exactly does not coincide with our project

EXISTING SYSTEM

- Requires samples to be collected and sent to specialized labs.
- Installed at specific locations for continuous monitoring.
- Manual Test Kits - Portable and relatively inexpensive.
- Complex Equipment -High-precision instruments like ICP-MS and AAS used in labs
- Advanced testing facilities are not available in remote or underserved areas.

DISADVANTAGES OF EXISTING SYSTEM

- Laboratory-Based Testing - Time-consuming and not suitable for real-time monitoring.
- Fixed Monitoring Stations – Limited coverage and high installation/maintenance costs.
- Manual Test Kits - Often less accurate and require user interpretation.
- Complex Equipment - Expensive, requires skilled operators, and not portable.

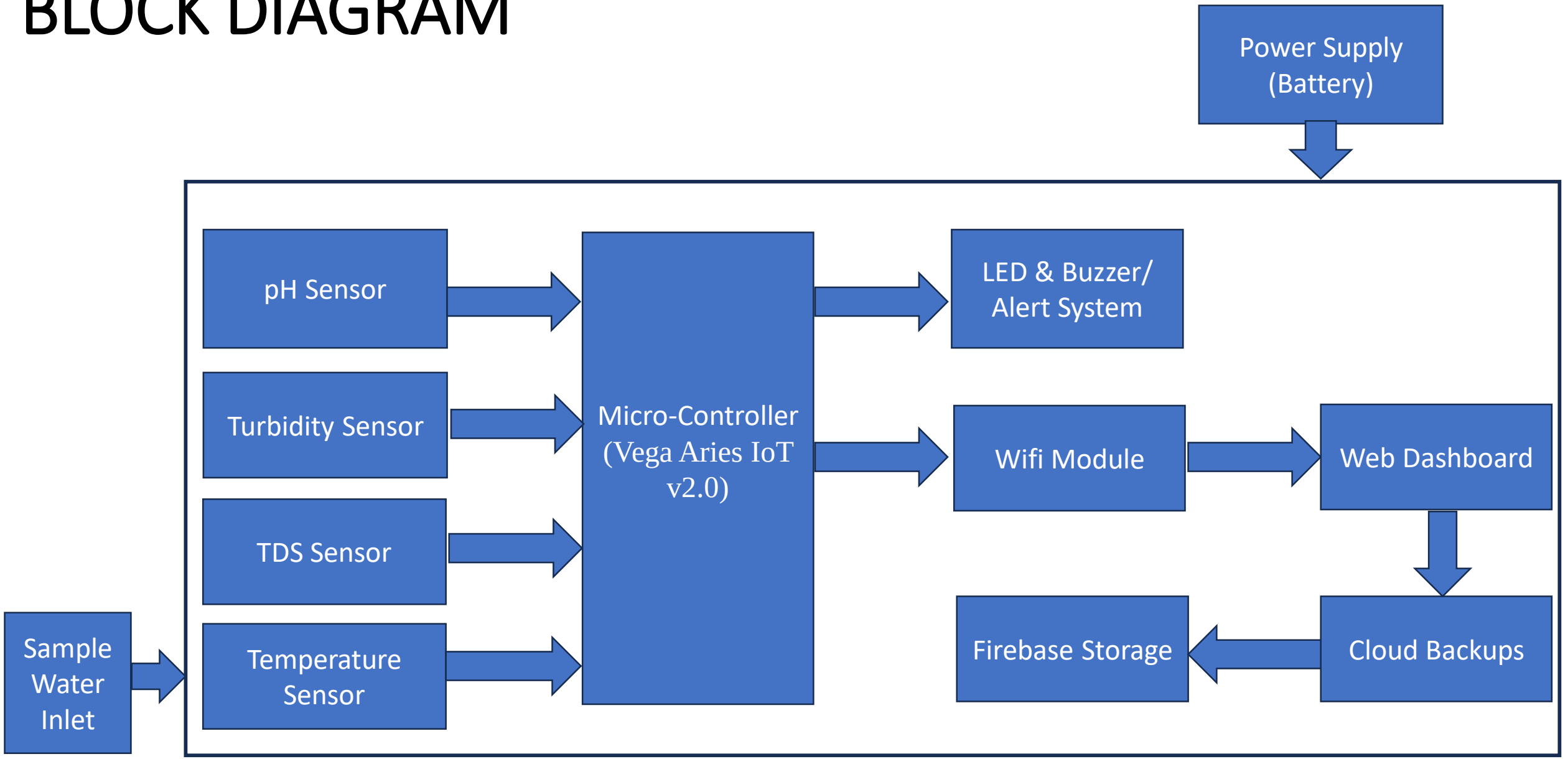
PROPOSED WORK

- Compact, easy-to-use device suitable for on-site testing in various environments, including remote and rural areas.
- Immediate identification of critical water contaminants like heavy metals (e.g., lead, mercury) and harmful chemicals (e.g., nitrates, pesticides).
- Utilizes biosensors, electrochemical sensors, and colorimetric sensors for accurate and rapid contaminant detection.
- Pairs with a mobile application for real-time data visualization, logging, and remote monitoring, allowing users to track water quality trends and receive instant notifications.

ADVANTAGES

- The device is compact and lightweight, making it easy to carry and use in various locations, including remote and rural areas.
- Immediate identification of contaminants like heavy metals and harmful chemicals.
- Incorporates high-precision sensors (biosensors, electrochemical sensors, colorimetric sensors).
- Pairs with a mobile application for data visualization, logging, and remote monitoring.

BLOCK DIAGRAM



PROPOSED WORKING PROCEDURE

Step 1: The user collects a water sample through the sample inlet. The water sample passes through a filtration unit to remove large particulates, ensuring accuracy in detection.

Step 2: Data from all sensors is sent to the microcontroller. The microcontroller processes the data using built-in algorithms to determine the concentration of each contaminant.

Step 3: If any contaminant exceeds safe levels, the alert system activates, showing a warning on the screen and/or sounding an alarm.

Step 4: The device pairs with a web app via Wi-Fi and the Cloud. Data is transmitted to the app, providing real-time updates.

Step 5: The app displays data in a user-friendly format, including graphs and trend analysis.

NOVELTY AND INNOVATION OF THE PROJECT

- ❖Combines pH, Turbidity, TDS and Temperature sensors in a single portable device.
- ❖Provides immediate results on contaminant levels directly on the web dashboards.
- ❖ Seamless connectivity with a web application via Wi-Fi and uploads in cloud as backup.
- ❖Compact and lightweight, designed for easy transportation and use in various locations, including remote areas.
- ❖ Built-in alert system that triggers visual and/or audible warnings when contaminant levels exceed safe thresholds.
- ❖Utilizes advanced algorithms for data analysis, ensuring high accuracy and reliability in detecting contaminants.

HARDWARE COMPONETS

S.NO	HARWDARE	SPECIFICATION
1)	Sensors	pH, Turbidity, TDS and Temperature Sensor
2)	Microcontroller	Vega Aries IoT v2.0
3)	Display	No Display at the moment
3)	Alert System	In built Vega Board Buzzer and LED
4)	Connectivity Modules	Built in Vega Board Wifi Module
5)	Power Supply	3.7V 2000mAh Li-ion battery, Micro-USB charging, 5V input

SOFTWARE COMPONENTS

S.NO	SOFTWARE	DESCRIPTION
1)	VISUAL STUDIO IDE	For Programming and dumping the Arduino code into the Vega Board.
2)	Python with SciPy/Numpy	For developing data processing scripts, offering powerful libraries for numerical operations and signal processing.
3)	Firebase	A cloud-based service for real-time data storage and synchronization, providing backend support for mobile applications.
4)	Wi-Fi Libraries	For managing Wi-Fi connectivity and communication, such as ESPAsyncWiFiManager for ESP32.
5)	Mobile Application	Platforms for developing the mobile application that interfaces with the device, providing data visualization, alerts, and connectivity features.

CONCLUSION

In conclusion, our Portable Water Contaminant Detection Device integrates cutting-edge hardware and software to provide real-time, reliable water quality analysis. By combining advanced sensors, user-friendly interfaces, and seamless mobile connectivity, the device offers an innovative solution for detecting and addressing water contaminants. This comprehensive approach ensures accurate, accessible, and immediate results, making safe drinking water more accessible and protecting public health. Thank you for your attention.

REFERENCES

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