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WIRELESS SENSOR NETWORKS FOR WATER QUALITY MONITORING

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ABSTRACT

In our cities, many times we see that the garbage bins or dustbins placed at public places are overflowing. It creates unhygienic conditions for people. Also, it creates ugliness to that place.At the same time bad smell is also spread.To avoid all such situations, we have implemented a project called GSM based smart dustbins for smart cities.In this, dustbin is interfaced with microcontroller-based system having IR wireless system. If the dustbin is loaded with garbage, the status will be displayed on the screen. If the garbage is not collected in specific time, then SMS will be sent to the person informing that dustbin is not cleaned yet. At the same time, status report will be updated so that the sweeper for contractor responsible for the cleanliness can be question for the delay..Hence an automatic system can be designed to maintain the city Clean with the help of electronics. However, we see that in case there is some festival or some function, lots of garbage material is generated by people in that particular area. In such cases the garbage dustbin gets immediately full and then it overflows which creates many problems. So, in situations, with help of our project the government authority person can get SMS immediately. So, they will get SMS before their periodic interval visit of picking up the dustbin. Then they can go and pick up the dustbins. After every pick-up interval the dustbins will be under servicing, while every dustbin's individual battery will be charged under the guidance of NMC.

INTRODUCTION

Lake Victoria Basin (LVB) is an important ecosystem in the Eastern African Region. It is shared among five East Africa countries which are Burundi, Kenya, Rwanda, Tanzania andUganda. The Basin is also rich in natural resources which include fresh water, fishery, minerals, forests and fertile land for agriculture. These resources have recently contributed to rapid urbanization and increasing human population. The negative impacts of climate change and variability are compounding the existing challenges. Consequently, increasing number of human activities has gradually speedup contamination and damage to fresh water resources in the LVB [1].Water quality monitoring and evaluation is therefore very critical for sustainable water resources management and utilization programs and has increasingly attracted a great deal of research and development attention. However, in most developing countries like Tanzania, water quality monitoring and evaluation is entirely a manual process.This traditional approach of water quality monitoring based on sampling and subsequent analyses in water laboratories is expensive, timeconsuming and has a low resolution both in time and space. Over recent years, wireless sensor networks (WSNs) have received considerable attention in environmental and industrial monitoring and control applications.Being one of the main building blocks in ambient intelligence,WSNs provide significant advantages both in cost as well as in distributed intelligence [2]. On the other hand, installation and maintenance expenses are reduced because of the use of cheap devices which do not require wiring. It is for this reason that WSN technology has been attracting

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rapidly growing attention both from academia and in industry.

I. LITERATURE SURVEY

A paper by Zhang et al., published in the IEEE Sensors Journal in 2020 provides a thorough literature survey on the application of wireless sensor networks (WSNs) for water quality monitoring. It begins by discussing the importance of water quality monitoring and the challenges associated with traditional monitoring methods.Zhang et al. then delve into the key components of WSNs for water quality monitoring, including sensor node design, communication protocols, data aggregation techniques, and deployment strategies. They review various sensor technologies utilized in water quality monitoring, such as pH sensors, turbidity sensors, and dissolved oxygen sensors, highlighting the importance of sensor accuracy and reliability.Communication protocols play a crucial role in WSNs, and the paper discusses the suitability of different protocols such as Zigbee, LoRa, and NB-IoT for water quality monitoring applications. The authors analyze the trade-offs between data transmission range, energy consumption, and data rate to identify the most suitable protocol for specific deployment scenarios

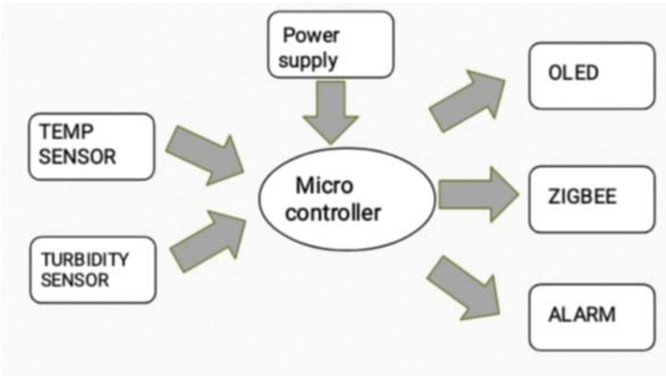
II. METHODOLOGY

WORKING:

Wireless Sensor Networks (WSNs) revolutionize water quality monitoring through their integrated components and operational framework. Sensor nodes, equipped with diverse sensors, continuously collect data on key parameters such as pH , temperature, turbidity, and dissolved oxygen. These nodes communicate wirelessly using protocols like Zigbee or LoRa, facilitating seamless data transmission to a central processing unit. Here, sophisticated algorithms process and analyze the incoming data, extracting meaningful insights into water quality trends and anomalies. This processed information empowers decision-makers to take timely actions, ensuring the effective management and conservation of water resources. With their real-time monitoring capabilities and adaptability to various environments, WSNs represent a pivotal advancement in the field of water quality management, offering scalable and cost-effective solutions for sustainable water resource management.

III.BLOCK DIAGRAM:

WSNs enable the automatic transfer of the data as well as providing a feedback mechanism in some instances, to refine the granularity of data collection. Typically, a wireless sensor node consists of the sensor unit.



1. Power Supply:
Provides electrical control to all components of the system. May incorporate batteries, voltage controllers, or other control administration circuitry.

2. OLED:
OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays

3.Raspberry pi pico:
The Raspberry Pi Pico is a microcontroller board based on the Raspberry Pi RP2040 microcontroller chip. Like Raspberry Pi computers, Raspberry Pi Pico features a pin header with 40 connections, along with a new

debug connection enabling you to analyse your programs directly from another computer.
The Raspberry Pi Pico can serve as a controller or interface for a communication aid using Zigbee technology. It can handle tasks such as data processing, interfacing with Zigbee modules,
managing communication protocols,and controlling connected peripherals.The Raspberry Pi foundation changed single-board computing when they released the Raspberry Pi computer, now they're ready to do the same for microcontrollers with the release of the brand new Raspberry Pi Pico.

4. ZIGBEE:

Zigbee enables wireless communication in communication aid systems, supporting low-power, short-range data transmission crucial for
energy conservation. It ensures reliable connectivity between aid components, facilitating data exchange and control signals,thus enhancing overall performance and usability.

5.Temperature sensor:

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications.

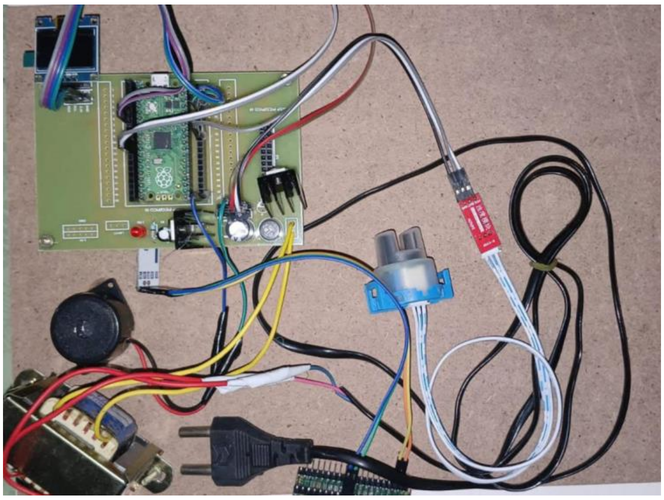
A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, thesensor will reflect the change of environmental temperature.

6.Turbidity sensor:

The sensor operates on the principle that when the light is passed through a sample of water, the amount of light transmitted through the sample is dependent on the amount of soil in the water. As the soil level increases, the amount of transmitted light decreases. The turbidity sensor measures the amount of transmitted light to determine the turbidity of the wash water.

7.Alarm:

Alarm can be integrated to provide notifications or alerts regarding the system's status or any abnormal conditions. The alarm can be implemented using a buzzer or a similar audio output device. The alarm in this block diagram serves as a visual or audible indicator to alert users or operators about specific events or situations. For example, the alarm can be programmed to sound when the system detects a malfunction, such as a sensor failure or motor error. It can also alert users when the solar panel is not tracking the sun properly or when the system encounters environmental conditions that may affect its performance.



III. RESULTS

The deployment of wireless sensor networks (WSNs) for water quality monitoring yields significant results across multiple fronts. Firstly, WSNs enable real-time monitoring of critical water quality parameters, offering continuous insights into the state of aquatic environments. This real-time data acquisition enhances the ability to detect and respond swiftly to changes, ensuring prompt interventions to mitigate potential risks to water quality and ecosystem health. Additionally, WSNs provide highly accurate and reliable data, thanks to advancements in sensor technology and data processing algorithms, thereby facilitating informed decision-making in water resource management. Moreover, the cost-effectiveness of WSNs compared to traditional monitoring methods makes them accessible for large-scaledeployment, even in resource-constrained areas, fostering widespread monitoring initiatives. Furthermore, WSNs contribute to environmental impact assessment by providing comprehensive data on water quality trends over time, aiding in the identification of anthropogenic impacts and the formulation of targeted conservation strategies.

The integration of WSNs into early warning systems enhances resilience against water-related hazards, enabling timely responses to potential threats such as algal blooms or chemical spills. Lastly, WSNs have the potential to engage local communities in water quality monitoring efforts, fostering citizen science initiatives and promoting public awareness and stewardship of water resources. Overall, the results of deploying WSNs for water quality monitoring underscore their pivotal role in advancing environmental management practices and ensuring the sustainability of water ecosystems for future generations.

IV. CONCLUSION

In conclusion, the development and demonstration of a low cost, continuous water quality monitoring WSN system prototype is described. The system uses low cost sensors and open source hardware aiming at providing continuous water quality measurements at substantially reduced cost. Preliminary field test results demonstrated that with appropriate calibration, the system has capability to continuously measure water quality parameters and transmit them to a database in real-time. With the use of web-based portal and mobile phones platforms, the values of measured parameters are displayed in easy-to-comprehend graphical and tabular formats anytime and anywhere. This capability has potential to enhance accountability, transparency, and participation which are attributes for good governance of water resources. More testing of the prototype is needed to identify areas that will require fixing.Moreover, the integration of WSNs into early warning systems enhances resilience against water-related hazards, mitigating risks associated with algal blooms, chemical spills, and other environmental threats.

Additionally, WSNs contribute to comprehensive environmental impact assessments, aiding in the identification of anthropogenic impacts and the formulation of targeted conservation strategies.

Furthermore, the scalability and flexibility of WSNs make them suitable for deployment in a variety of settings, from small-scale monitoring projects to large-scale initiatives covering extensive water bodies. The engagement of local communities through citizen science initiatives further enhances the effectiveness and sustainability of WSN-based monitoring efforts, fostering public awareness and stewardship of water resources.

The successful implementation of WSNs for water quality monitoring offers promising opportunities for advancing environmental management practices and ensuring the long-term sustainability of water ecosystems. Continued research and innovation in this field will further enhance the capabilities of WSNs and contribute to the protection and preservation of water resources for future generations.

V. FUTURE POSSIBILITIES

The future possibilities for wireless sensor networks (WSNs) in water quality monitoring are promising and multifaceted. Firstly, advancements in sensor technology and data processing algorithms will lead to even greater accuracy, sensitivity, and reliability in detecting and monitoring water quality parameters. Miniaturization of sensors and improvements in energy efficiency will further enhance the capabilities of WSNs, enabling longer deployment durations and expanded monitoring coverage in remote or inaccessible areas.Moreover, the integration of emerging technologies such as artificial intelligence (AI), machine learning (ML), and Internet of Things (IoT) will revolutionize data analysis and interpretation, enabling WSNs to provide deeper insights into complex water quality dynamics.

AI and ML algorithms can autonomously analyze large datasets, identify patterns, and predict future trends, thereby supporting more informed decision-making and proactive management of water resources.

Furthermore, the convergence of WSNs with other environmental monitoring systems, such as remote sensing platforms and satellite imagery, will enable a more holistic understanding of water quality across spatial and temporal scales. Integration with Geographic Information Systems (GIS) will facilitate spatial analysis and mapping of water quality parameters, aiding in the identification of hotspots and priority areas for conservation and remediation efforts.

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