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Smart Platform for Water Quality Monitoring System using Embedded Sensor with GSM Technology

Che Zalina Zulkifli[1], Suliana Sulaiman[1], Abu Bakar Ibrahim[1,*], Chin Fhong Soon[2], Nor Hazlyna Harun[3], Nur Hanis Hayati Hairom[2], Muhammad Ikhsan Setiawan[4], Ho Hong Chiang[2]

1 Computing Department, Universiti Pendidikan Sultan Idris, Perak, Malaysia
2 Microelectronics and Nanotechnology-Shamsuddin Research Centre (MINT-SRC), Univeristi Tun Hussein Onn, Malaysia
3 Data Science Research Lab, School of Computing, College Arts & Sciences, Universiti Utara Malaysia, Malaysia
4 Department of Civil Engineering, Narotama University, Surabaya, Indonesia

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ABSTRACT

Point and non -point sources Surface water pollution causes damaging effects to the environment, aquatic life and human health. Thirty existing water monitoring stations use Industrial Revolution (IR) 3.0 technology with limited access to the public. A multi-sensory hub with Internet-of-Things (IoT) functionality can be developed to monitor river health and data collected continuously through the Global System for Mobile Communications (GSM) and cloud systems that inform locals about water quality index (WQ) for reducing the likelihood of early. harmful effects produced from oil palm plantations in Sungai Semborong, Batu Pahat, Johor. The inclusion of machine learning into the system will help classify and estimate pollutant types. The potential for pollution reduction using Algae balls is proposed and will be investigated. The methodology that will be used in this research is the Design and development Research (DDR) study. The objective is to design and develop a GSM cloud-based multi-sensor system to monitor river health related parameters such as dissolved electrical conductivity (EC), acidity (pH), dissolved oxygen (DO) and oxygen reduction potential (ORP) b) to develop modeling solid real -time WQ forecasts. Expected discoveries are an IoT -based multi-sensor system with machine learning data analysis capabilities, a new machine learning model for pollution estimation and the discovery of effective methods to treat polluted water using green technology. As such, the project addresses two sustainable development (SDG) objectives, to provide clean water and protect underwater life as gazetted in the national water resources policy.

1. Introduction

Recently, object-based (loT) technology has spread to different areas of water supply systems. This is in line with the IoT-based Smart water quality monitoring platform initiative which aims to propose methodologies to improve the quality of operational performance and monitoring efficiency of water supply systems. LoT-based technology has a number of issues when it comes to smart water

* *Corresponding author.*
E-mail address: abubakar.ibrahim@fskik.upsi.edu.my

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network management. Therefore, this study will present the application of IoT to monitor water supply networks with emphasis on its application to water pollution and quality. In this application, the technical challenges of loT-based technology are also discussed. Finally, indications of future research in this domain are also highlighted, which may be useful for further study. Effective water safety and care management are essential to ensure that water users are healthy and safe. The use of water is widely used, such as drinking, crops, irrigation, aquaculture. The physical, biological, and chemical aspects of water are monitored via water monitoring systems. In general, all water monitoring systems will have three basic layers of Architecture: Data acquisition, data transmission, and processing layers. This layer of data collecting is made up of a large number of sensor networks that communicate wirelessly [1].

The methods used for data transmission are autosampler, multi-sensor, and GSM 4G. The processing division will include monitoring tools, IoT platforms such as Ubidots for visualization. For water monitoring, sensor data include pH, DOC, turbidity. The controller is responsible for gathering all data and delivering it to the user. It can go through multi-sensor and GSM 4G. All information will be stored on cloud storage. Communication methods can be determined based on the demands and priorities of the data. The purpose of the application is to monitor water parameters. Through the software, users will be able to monitor water-related parameters in real-time scenarios. The advantages and disadvantages of current water monitoring systems are discussed in a paper by [2]. Existing systems include laboratory-based water monitoring, remote sensing-based monitoring, and automated systems with monitoring substations. Performing water sampling and analysis in a laboratory requires additional time. Water monitoring systems that use remote sensing are less accurate and more expensive than those that use a control centre with numerous substations for monitoring purposes. To provide continuous monitoring and visualisation, the proposed system employs multimodal monitoring nodes, primary data processing controllers, and servers. The rest of the paper discusses a real-time framework for water monitoring [3].

2. Literature Review

This research paper titled IoT Based Real-time River Water Quality Monitoring System aims to monitor water quality while it is a manual system with a tedious and very time-consuming process. This paper proposes a sensor-based water quality monitoring system. This study employs the main components of a Wireless Sensor Network (WSN), which comprise a microcontroller to process the system, a communication system for communication between and intra nodes, and several sensors. Internet of Things (IoT) technology allows for real-time data access via remote monitoring and remote monitoring. Using Spark streaming analysis via Spark MLlib, deep learning neural network model, Belief Rule Based (BRB) system, and standard values, data collected on distinct sites can be shown in a visual format on the server PC. If the value obtained exceeds the threshold value, an automatic SMS alert will be sent to the agent. This backup paper is to obtain a water monitoring system with high frequency, high mobility, and low power. Therefore, our suggested approach will considerably assist the people of Bangladesh in becoming aware of water pollution and furthermore stop the pollution of water [4].

New sensor capabilities are being created as a result of advancements in wireless communication. The current developments in the field of sensor networks are critical for environmental applications. The Internet of Things (IoT) enables devices to communicate with one other to exchange and collect data. IoT also extends its capability to environmental issues in addition to the automation industry by using industry 4.0. Water quality monitoring is essential because it is one of the most basic requirements for human survival. Around 40% of deaths are caused due to contaminated water in the world. As a result, there is a pressing need to ensure that people in both cities and rural areas have access to safe drinking water. To monitor drinking water quality, Water Quality Monitoring (WQM) uses Internet of Things (IoT) technology to save money and time. In this paper, the proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, water level in the tank, temperature and humidity of the surrounding atmosphere. Further processing is carried out on a Personal Computer (PC) that is connected to the sensors via the Microcontroller Unit (MCU) (PC). Finally, the obtained data is sent to the cloud using IoT-based Think Speak application to monitor the quality of the water [5].

This study presents novel approaches to allocating resources in Internet-of-Things sensor network (IoTSN) systems applied to water-quality monitoring for optimal and more sustainable utilization of resources. The long-standing energy shortage problem that currently plagues sensor network (SN) systems is addressed by utilising energy harvesting and exploiting its untapped potential to construct a wire-less power sensor network (WPSN) incorporated with a scheduling algorithm and operating as a non-orthogonal multiple access (NOMA) system. Similarly, quality of service parameters are crucial design considerations for network efficiency, and energy efficiency (EE) is considered here. Consequently, an EE optimization problem is formulated for the successive WPSN system and solved by exploiting the problem structure and a meta-heuristic algorithm. Numerical results from simulations of the proposed new meta-heuristic WPSN system are used to verify its validity, and the results are compared to those of previous WPSN systems that used a combination of the genetic algorithm (GA) and the ant-colony optimization (ACO) algorithm as well as a non-meta-heuristic algorithm specifically. Results from the experiments reveal that the suggested system is substantially better at EE performance than the current WPSN systems [6].

With the ever-rising pollution of water bodies caused by human-made actions as well as natural calamities, water monitoring systems are the focal point for society. Water-related application has much potential for automation. With the advent of big data analytic, there is a multitude of verticals in water quality, smart irrigation, and smart water distribution network. All of these operate effectively with accurate and real-time data. The most significant obstacle to establishing an automated application in this domain is the need for several sensor parameters and a robust communication infrastructure that can be expanded to diverse water monitoring applications. This work proposes a system that overcomes these problems. With the use of an industrial multi-parameter sensor node, EXO Sonde, the desired sensor values can be extracted from the physical world. The sensed data is processed and communicated forward to the server onwards through a layered architecture to a server. The sensor data is stored in a file system on the sensor node in case of network failure. GSM is used to communicate between sensors and nodes. The data is kept on the server and is accessible via a web UI [7].

Water contamination is a critical issue in the country. Many people lose their lives due to water contamination. This paper consists of a water quality monitoring system using IOT. Different water samples are analysed as part of the project that has been put into place. The water sample application is examined based on the application in which the water can be used. The vast majority of people on the planet are cooking and drinking from water that has been contaminated by vector illnesses and other poisonous substances. Water has an important role throughout the world because it meets all progress demands; yet, holding flexible water is a brief one, and the total amount of water present on the planet remains constant all around the planet [8].

One of the main concerns for green globalization is water pollution. In order to ensure a safe supply of drinking water, the quality needs to be monitored 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). The system, which comprises of multiple sensors, is used to measure the physical and chemical properties of the water. The parameters such as temperature, PH, turbidity, and water flow sensor can be measured. The measured values from the sensors can be processed by the core controller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed on the internet using a WI-FI system [9].

To ensure that safety is guaranteed, it is essential to implement monitoring in real-time for potable water quality. This project uses Internet of Things (IoT) technologies to construct a low-cost system for real-time monitoring of water quality. Several sensors are integrated into the system to measure various chemical and physical water properties, such as conductivity, pH, turbidity, and temperature. Data from the sensor is processed by the core controller, which may also be a microprocessor. The visualization of data can be accomplished on cloud computing via the Internet [10].

We have designed the Internet of Thing (IoT) system for monitoring and controlling the water parameters in aquaculture. The system can detect and control the parameters such as temperature, pH value, dissolved oxygen, water level, foul smell detector, and ammonia in the water. The sensor nodes gather the real-time data from the water and transmit it to the Arduino processor for processing. If the measured parameters exceed the desired range, the processor activates the corresponding controller to take the necessary action. Using a Wi-Fi modem, sensors send their readings to the cloud, where they may be accessed from the control room. Additionally, the values are communicated to the recipient through GSM modem as short messages. The proposed technology is compatible with any form of aquaculture system [11].

DSDV, which was introduced by C. Perkins and P. Bhagwat [20], is one of the earliest ad hoc routing protocols. Essentially, this protocol is based on the improved version of Bellman-Ford algorithm, the improvements of which include the freedom from loops in routing tables by using sequence numbers [20]. In DSDV, each node periodically transmits routing information to its intermediate neighbors to update a routing table, and the updating of such routes can be either time-driven or event-driven. Each entry in the table contains the destination address, the number of hops to reach the destination, the next hop address, and the sequence number provided by the destination node.

The destination node chooses the shortest path according to the hop count and sequence number such that the route with the highest sequence number will be selected. Once the routes are selected, the destination node then forwards the RREP control messages for route establishment. In order to reduce the amount of overhead transmitted through the network; the routing table can be updated in two ways, namely full dump update and incremental update. For the full dump update, complete information of the routing table is sent to the neighbors by a packet. On the other hand, the incremental update involves only those entries that have changed since the last update, with a packet carrying only the information that has changed since the last full dump. Between the two types of update, the incremental update messages are sent more frequently than that of the full dump packets [20, 23].

3. Methodology

This section displays the methodology used to complete this project. Research methodology determines systematic research on what research activities are, how to proceed, how to measure progress, and what constitutes success. The method employed is Design and Development Research (DDR), which is defined by RC Richey, JD Klein, and WA Nelson [12] as a systematic study of design, development, and assessment processes with the goal of developing for product and tool creation instructional and non-instructional with new or superior developments. According to T.J. Ellis & Y.

Levy [13], they were able to construct associations in a sequence of concepts and evaluations. The DDR process has several methods and data collection approaches, as Figure 1 shows each phase of DDR included in this project.

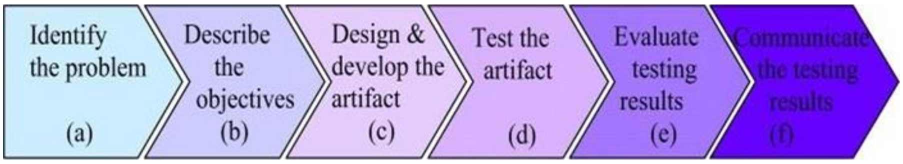

Fig. 1. Design and Development Research (DDR) Method

The project will involve the development of hardware and software for an IoT-based water autosampler and multi-sensor system to obtain parameters for river water conductivity, acidity, dissolved oxygen, and oxygen reduction potential. To deliver raw data from a multi-sensor data logger, the IoT system uses a cloud GSM 4G and a GSM communication network to transmit the information. Cloud servers and services provide APIs for data visualization, processing, and alerts on android phones. Raw data can be saved in CSV format and used in subsequent data mining procedures. The acquired results will be compared to the water quality indicators tested in the laboratory [14].

On the basis of the ESP32 microcontroller technology, a solar-powered GSM TTGO Sensor logger for Industrial IoT will be developed. The microcontroller will be programmed using C/C++ language. A solar charge controller will be used to distribute electricity from a UPS backup battery system. This ensures that even if the energy cycles or the power goes out, the monitoring systems will continue to operate. The system will be housed in an IP65 compliance enclosure. Industry-standard GF Signet conductivity sensors will be used in line with the water flow, outside the box, and in the pipes. This gives continuous readings of water quality in the unit of siemens/m. pH/ORP Electrodes (PF-20, Yokogawa, Japan). This ensures that even if the energy cycles or the power goes out, your monitoring systems will continue to operate. Coaxial plug and socket with watertight sealing that meets the requirements of IP65. The mounting inflow- and immersion fitting with being standardized. The monitoring station will be installed at Sungai Semborong at Parit Raja, Batu Pahat, Johor [15-17].

Sensor readings are automatically uploaded to the Ubidot cloud-based system through the GSM-TTGO-ESP32 microcontroller as often as necessary after the water quality monitoring systems have been put in and set up. The sensor logger will be interfaced with an automated sampler (ISCO 3700). The automated sampler can be filled up to 2 L capacity, a standby current of 10 mA, and energy consumption of 2A at 12 VDC during sampling. The water autosampler would draw river water into the inlet pipe system, flow to the sensoring system and exit from the outlet pipe. This is done to protect the sensor against extreme weather or temperature fluctuations [18].

Figure 2 illustrates how a real-time data architecture will be built around the Internet of Things platform to ensure rapid deployment. Ubidot platform was considered to include authentication, security, data storage, device interface functionality, easy-to-use libraries, or application programming interfaces (APIs). The payload syntax can be altered in accordance with Ubidots' web services and architecture. The platform requires all sensors or devices to be IOT-enabled at the lowest level of interface. These sensors will be interfaced with a GSM-microcontroller module. Data can be sent and received between cloud services using Ubidots' APIs, which can be accessed via HTTP/MQTT/TCP/UDP protocols. The data structure will be stored in CSV format and plotted in a dashboard supported by the Ubidots platform for interactive, real-time data visualization (widgets). The API app will be written in HTML/JS code [19-22].

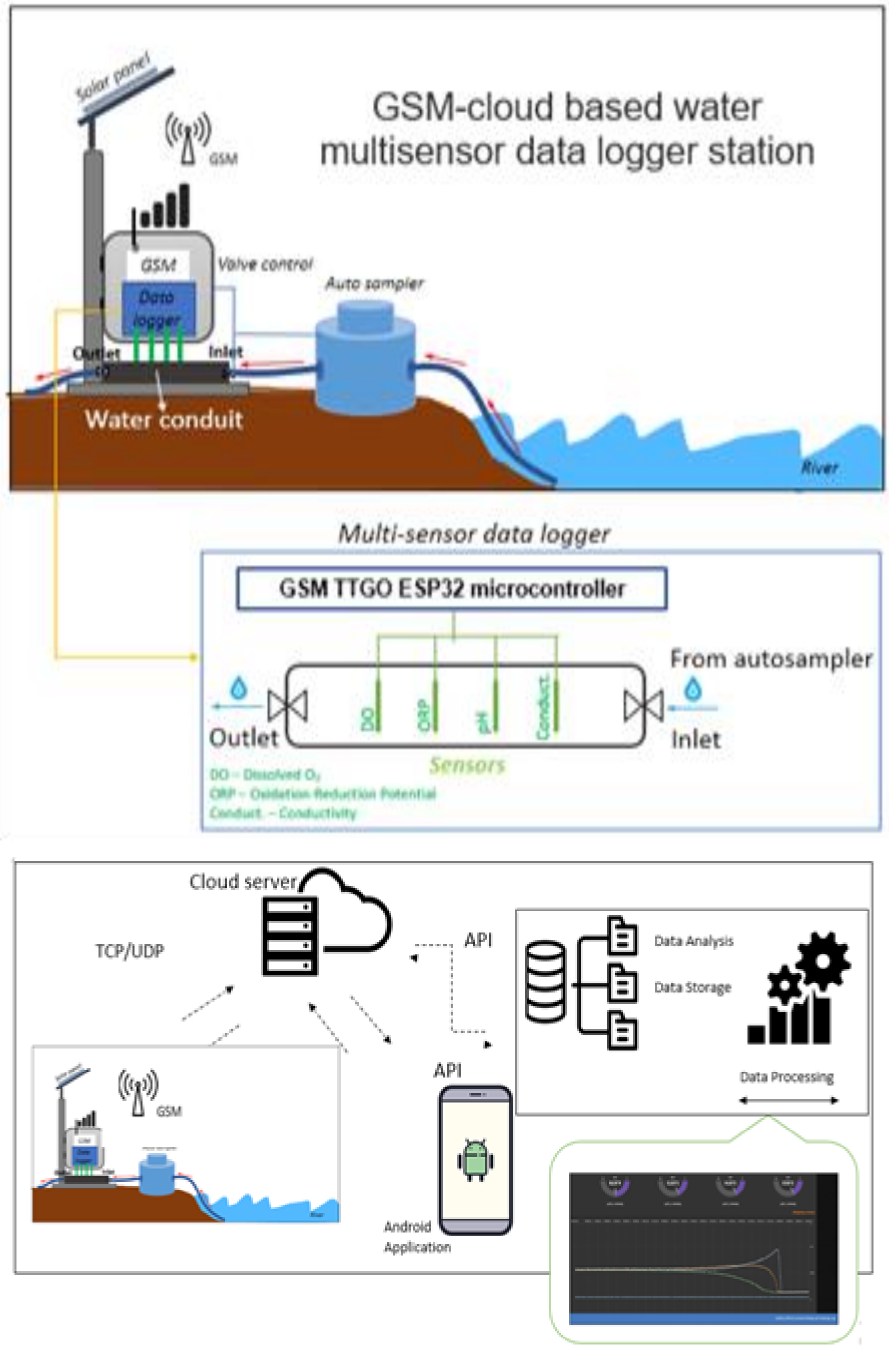

Fig. 2. A Real-time Data Architecture Around Internet-of-Things Platform

The system will be installed, and data will be collected continuously for 3 months in Sungai Semborong as shown in Figure 3. The data obtained based on the four measured parameters are estimates of contamination or unpolluted status, and therefore, we will compare the data obtained with the water analysis performed by our Micropolitan Research Center (MPRC). Manual sampling will be done once in two weeks for three months, and 24 samples will be collected and labelled carefully with time and date. Atomic Absorption Spectroscopy (AAS) and a DR6000 spectrophotometer will be used to perform a comprehensive examination to identify the precise elemental composition of river water [24-29].

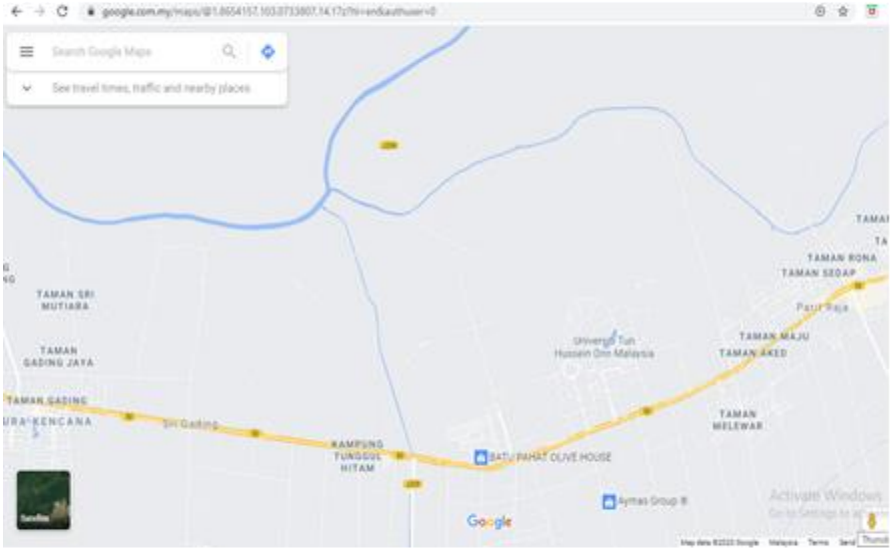

Fig. 3. A Location of Sungai Semborong Batu Pahat Johor

4. Result and Discussion

In general, the proposed system will provide real-time feedback on the desired measurement. The data collected by the sensor is sent over the network and to the cloud, where users can then access it on their smart devices (mobile phones, laptops, computers) at any time. The proposed smart platform architecture can also generate text signals when the water characteristics we want to measure fall outside the predetermined parameters so that stakeholders can address potential problems quickly. As stated in the introduction section, this project proposes to monitor water pollution and improve water quality. Researchers have also looked at several past studies [4 - 11] that use IoT as the primary method in developing this project. Table 1 shows a comparison between several past researchers who have successfully created water quality monitoring projects using IoT. This proposed project uses several IoT components such as multi-sensor, auto sample data, cloud server, cloud storage, and GSM 4G/5G. Therefore, the study to be developed can produce its objective which is to design and develop a GSM cloud-based multi-sensor system to monitor river health related parameters such as dissolved electrical conductivity (EC), acidity (pH), dissolved oxygen (DO) and oxygen depletion potential (ORP).

Table 1
A comparison between several past researchers Water Quality Monitoring

Reference	Title:	IoT-main component
[4]	IoT Based Real-time River Water Quality Monitoring System	WSN, SMS, PC Server,MLlib
[5]	Smart water quality monitoring system with cost-effective using IoT	MCU, PC, Sensor and Cloud Storage
[6]	Energy efficiency maximization in a wireless powered IoT sensor network for water quality monitoring	IoTSN, Sensor Network, and NOMA
[7]	IoT based Water Parameter Monitoring System	Web UL, Storage, GSM, and Sensor
[8]	Implementation of Water Quality Sensing System using Internet of Things	Arduino, Wi-Fi, PH Sensor, and TDS
[9]	Water Quality Monitoring System Based on IOT	Arduino, Wi-Fi, Several Sensor
[10]	IoT Based Water Quality Monitoring System for Rural Areas	Microcontroller, Sensor, Cloud Computing
[11]	A Novel Methodology for Monitoring and Controlling of Water Quality in Aquaculture using Internet of Thing (IoT)	Sensor, Cloud Storage, Wi-Fi, and GSM
This work (Proposed)	Proposed a Smart Platform for Water Quality Monitoring System Based on IoT Technology	Auto sample, Multisensor, Cloud Server, and Cloud Storage, GSM 4G/5G

5. Conclusion

In conclusion, this proposed project will improve water quality where water pollution is influenced by point and non -point sources of pollution, including wastewater discharges, discharges from industry, effluents from agricultural farms, and urban effluents. Other causes of water pollution include floods and are due to the lack of awareness among consumers. Water quality monitoring is one of the procedures that can be taken immediately in the event of severe water pollution. In order to discover water quality anomalies and enable early threat detection, water quality monitoring comprises the assessment of physical, biological, and chemical properties. With the advent of 5G, the development of technologies based on the industrial revolution (IR4.0) such as (GSM) and cloud-based systems, will allow water quality sensor information to be shown on maps, graphics, and other analytical tools. The analysis tool will be a Convoluted Neural Network model that classifies inputs (sensing parameters) and maps to possible contamination outputs that will be confirmed through data analysis.

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