IMPLEMENTATION OF AN IOT-BASED WATER QUALITY MONITORING SYSTEM IN WATER BATTERY ELECTRICITY GENERATION PLANTS

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ABSTRACT

Background
Water batteries can feed into an existing electric grid and help in ensuring constant electricity by redistributing electricity when demand is high. However, the water-based water system's main significant problem with battery maintenance is knowing when to fill batteries with water and checking the quality of water coming into it. The quality and level of water in a water battery electricity generating system need to be monitored and managed to ensure that it lasts a long time. This study, therefore, looked at how IoT systems can be used in that regard to ensure constant electricity.

Objective
The objective of this research is to develop and implement a prototype IoT-based water quality monitoring system for use in the water battery system.

Method
Arduino Uno was used as the microcontroller for this project. The sensors needed in this project consist of a pH sensor, Turbidity sensors and conductivity. A Wi-Fi module was used to send the results to the smartphone via Wi-Fi. The results were sent through Blynk software and the results were shown on a smartphone.

Results
The developed water monitoring quality system detected water quality parameters like Ph, water level and turbidity. The data obtained from the sensors were uploaded to the Blynk/ThingSpeak dashboard for online monitoring purposes. The system can also control the water quality of the samples by interfacing with pumps to maintain acceptable water levels and quality.

Conclusion
The prototype system monitored water quality according to the scheduled plan and objective. The developed system was successfully implemented and determined the turbidity, pH, Total dissolved solids (TDS), flow rate and level of water. The paper recommends that the prototype should be adopted and developed along with the water battery electricity generation system.

Keywords: IoT, Water Battery, Water Monitoring,

1. INTRODUCTION

1.1 Background to the study

One widely used source of energy storage is the battery. Battery storage, or battery energy storage systems (BESS), are devices that enable energy from renewables, like solar and wind, to be stored and then released when customers need power most. Lithium-ion batteries, which are used in mobile phones and electric cars, are currently the dominant storage technology for large-scale plants to help electricity grids ensure a reliable supply of renewable energy (Fowler, 2016). In terms of power from renewable sources like the sun or wind using solar panels or wind turbines, battery storage technology ensures that homes and businesses can be powered by green energy, even when the sun isn't shining or the wind has stopped blowing.

Lithium-ion cells are commonly used, however, they do have drawbacks. They are unable to retain much energy due to their high energy density (big storage capacity). Regular discharges reduce their longevity and using highly toxic electrodes and sulphuric acid as the electrolyte only offers a little amount of energy density. It is weak and needs a protection circuit to keep running safely (Hughes, 2019). The protection circuit, which is built into each pack, controls the peak voltage that each cell can reach while loading and prevents the cell voltage from going too low during discharge. A mono rechargeable battery for a mobile Arduino microcontroller (such as a phone or a tablet PC) cannot get around resulting in shortages of its objective battery because various batteries exhibit their own advantages and disadvantages. Because of its high energy density, the lithium cobalt oxide (LCO) battery, for instance, is the most preferred cell for mobile integrated systems, however, these systems have rapid capacity deterioration (Kwak, & Lee, 2020).

A significant problem with battery maintenance is knowing when to fill batteries with water. Operations often need to devise watering schedules or conduct periodic inspections to maintain the batteries. Also, the quality of water in the water-based system needed to be measured and monitored and kept from impurities. If the water level is not maintained always, the battery can be destroyed beyond repair. To solve this problem IoT technology can help to monitor the quality of water and ensure that the water level does not fall below the required level (Tripathi & Vishwakarma, 2019). Thus, employing the Internet of Things (IoT), a class of devices that can help regulate water by sensing its environment and exchanging data with other devices over wireless connections can be used to solve water problems in the water battery system.

1.2 Objective of the Study

The main aim of this paper is to develop a preeclampsia risk prediction model using machine learning tools and algorithms.

The specific objectives of this research work are

1. Develop a prototype water quality (ph, turbidity, level) monitoring system for the battery system
2. Designs an automatic water level filling system for the battery water system

1.3 Organization of the Paper

This paper is summarized as follows: Section 2 presents a literature review, Section 3 presents the methodology used in the research, Section 4 presents experimental results and finally, Section 5 concludes the work.

2. LITERATURE REVIEW

2.1 Water Battery Water Quality

One type of hydroelectric energy storage is a water battery or pumped storage power station. An electric current can be formed by the flow of electrons and exploited to perform tasks. To avoid short-circuiting the grid, water batteries are utilized. Water batteries, also known as pumped storage hydropower, are made up of two pools of water that work together like an hourglass to generate electricity. Two sizable water pools spaced at various elevations make up a water battery. Water is moved from the lower pool to the pool at a higher height using excessive power when power production is high, which is similar to charging a conventional battery (Sean, 2020)

The water battery has solar cells which contain light particles or photons that a semiconductor absorbs. These photons transform the electrons in the battery into electricity. Generally, the fluid has different chemicals, including dimethyl sulfoxide and lithium perchlorate. Water works as a solvent with lithium iodide and offers an eco-friendly solution in comparison to other electrolyte concoctions. This type of battery relies on electrolytes or water to operate. The size of the battery plates influences the amount of water it requires (Steven, 2016).

The level of water in the water battery needed to be monitored and managed to ensure that it lasts a long time. Otherwise, the battery would fail and would have to be replaced often. Water needs to the added to the battery to recharge it. The water is converted into oxygen and hydrogen, and this gassing provides power. If the water level drops below the plates, the battery would be beyond repair. The more one uses the battery, the more one has to recharge it. Consider water loss. This is more pronounced in warmer climates.

If the water battery is to work effectively, the water quality must be monitored. In order to maintain the highest level of detail with respect to other parts of the water battery system subject to corrosion, such as the turbine which is mostly composed of metals, water quality parameters such as pH, Turbidity, and free residual chlorine are monitored and data are passed to the authority. The system design will also consider such other water quality parameters as temperature, conductivity, and dissolved oxygen. Every point in the water network has sensors and actuators, and their data is wirelessly transferred to the central server so that the authority may observe it and make decisions (Eris, 2016).

2.2. Internet of Things (IoT)

The Internet of Things is not explicitly or universally defined (IoT). It is described variably by different authors. The Internet of Things (IoT), according to Ma (2011), is a network that connects common physical things with identifiable addresses in order to offer intelligent services. The ability of IoT to connect a variety of heterogeneous devices, such as prevalent objects, embedded intelligent sensors, context-aware computations, traditional computing networks, and smart objects that vary in design, systems, protocols, intelligence, applications, vendors, and sizes, is what gives it its true value (Ramson, Vishnu & Shanmugam, 2020). Through management and application systems located in computer servers or network clouds, these entities can interface and integrate each other in order to gather, generate, and share data. This enables collaboratively performing complex operations and intelligent operations as well as independent decision-making (Jusoh, Muttalib, Krishnan & Katimon, 2021).

The IoT is changing the landscape of environmental resources monitoring and the case of water quality and quantity is no exception (Budiarti, Tjahjono, Hariadi & Purnomo, 2019) . The Internet of Things technology has been growing rapidly and has already bypassed conventional systems in terms of features and functionalities. Its applications in the field of remote monitoring and advanced analytics are revolutionizing businesses and are offering exemplary benefits to them. IoT is not new to electricity. In the year 2000, NEC Europe and Bell Labs introduced a network protocol to monitor and improve the efficiency of electricity networks which includes a water battery system. Thus, the history of the Internet of Things (IoT) is a timeline of events and inventions that have led to the development, adoption and use of the Internet of Things.

2.3 Review of IoT and Water Battery Monitoring System

The study revealed and showed that several studies were conducted in Alkaline batteries, maintenance and other water monitoring unit. Studies such as Omar Faruq et al. (2017) showed that a water quality monitoring system based on microcontrollers for people living in Bangladesh's outskirts, where safe drinking water is not available, is a proper concept that can be employed in the water battery system. The study by Wang, Zhang, Sun, Yang, Liu and Jin (2020) proposes a lithium-ion battery monitoring system with a diagnostic interface for marine equipment.

The methodology by Chi, Chen, Chen, and Abu (2021) increased accuracy by 0.16-0.39% by moving the sensor to estimate the range relative to various locations. In a consistent charging scenario, the battery level can effectively exceed 50%. In order to measure water quality, Budiarti, Tjahjono, Hariadi, and Purnomo (2019) developed an atmospheric water management monitoring system based on the Internet of Things. Consequently, the IoT water quality monitoring system may be used to automatically monitor surface water and provide real-time online data. Santos, Caeiro, Martins, Santos and Palma (2020) present a study of Internet of Things (IoT) systems used on physical and chemical water quality and resource sense. The architecture integrates the sensing of physical and chemical parameters, data communication and processing. Jamaluddin, Sihombing, Supriyanto, Purwanto, and Nizam (2013), the real-time Battery Monitoring System (BMS) has been designed using the LabVIEW Interface for Arduino (LIFA). The result showed that BMS can monitor voltage and current with real-time conditions. Assaouy, Zytoune and Ouadou's (2020)results show that the expected total transmitted data and the battery life are maximized when all the charge units inside the battery are consumed.

Soylu, Soylu and Bayir (2017) experimental results indicated that accurate robust estimation results could be obtained by the proposed system. Thokar, Gupta, Niazi, Swarnkar, Sharma and Meena (2020) proposed an optimization strategy, and the application results on a benchmark 33-bus test distribution system highlight the importance of the proposed method. Kwak and Lee (2020) analyzed factors that affect capacity degradation, and choose dominant factors that are controllable in a mobile embedded system. Their evaluation with real experiments and simulations demonstrates the effectiveness of the proposed algorithm in minimizing capacity degradation.

Anang, Zolkapli, Hairuddin, Hassan, Manut, Zoolfakar and Abdullah (2021)created an IoT-based Solar Battery Monitoring System using two microcontrollers, Arduino UNO and NodeMCU. Throughout the system, users can easily track their solar PV system over the internet. Mali, PatilArti, GavadePratibha, ManeMrunal and PatilAniket (2022) results, showed that their system is capable of detecting battery performance.

Wang, Zhang, Sun, Yang, Liu and Jin (2020) proposes a lithium-ion battery monitoring system with a diagnostic interface for marine equipment. Arduino Nano was used as its main control chip. The experimental results show that the system can accurately obtain the status information of the lithium-ion battery pack in real-time. Omar Faruq et al. (2017) water quality monitoring system based on microcontrollers was designed with a high degree of accuracy and is sensitive to several water parameters such as temperature, turbidity and hydrogen potential.

(pH) displayed on the LCD monitor. Each of the parameter values is compared with the predefined equipment, and sensor values and errors are calculated.

The work revealed, Arduino Nano was used as its main control chip; LTC6811 and AD8210 were used for voltage and current monitoring of lithium-ion batteries. Studies on how it was used in battery monitoring are scanty. The study there for saw the gaps in their studies and proposed that the same technology can be employed in a water-based monitoring system.

3. METHODOLOGY

3.1 Introduction

The battery watering monitoring prototype system features dramatically improve battery water quality by ensuring a good amount of water level is in the water battery system. No battery watering schedule is needed and less time is wasted because the system works all the time. A red blinking LED means water is needed; a green blinking LED means that the electrolyte level is good. The red and green indication system ensures that mistakes are not made by the operator. The system eliminates water Additionally, Smart Blinky's "smart sensing" technology eliminates batteries drying out due to false signals. The conceptual IoT diagram is shown in Figure 1

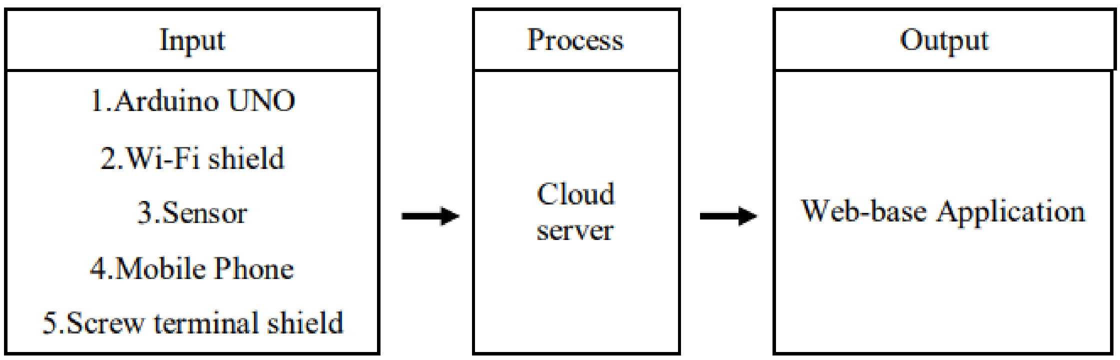

Figure 1. The conceptual framework for a water monitoring system (Mohd, et al 2022)

3.2 Turbidity sensor

The turbidity sensor detects water quality by measuring the level of turbidity. It is able to detect suspended particles in water by measuring the light transmittance and scattering rate which changes with the amount of total suspended solids (TSS) in water. As the TTS increases, the liquid turbidity level increases.

3.3 Water Level Sensor

The water level sensors are made up of several exposed parallel wires that work as a variable resistors to change resistance in reaction to the water level. This sensor can be used to gauge the water level, keep an eye on a sump pit, track down rain, or find leaks. It is constituted of several exposed parallel conductors that work as a variable resistor whose resistance varies with the level of the water. The variation in resistance reflects the space between the water's surface and the sensor's top. The resistance is inversely related to the water's height.

3.4 Operations

If the turbidity and the TDS of the water sample are not within the safety limit, a warning SMS is automatically sent to the user through an applet made from the IFTTT (If This, Then That) platform. The IFTTT platform enables us to design custom applets which can be triggered depending on a specific condition.

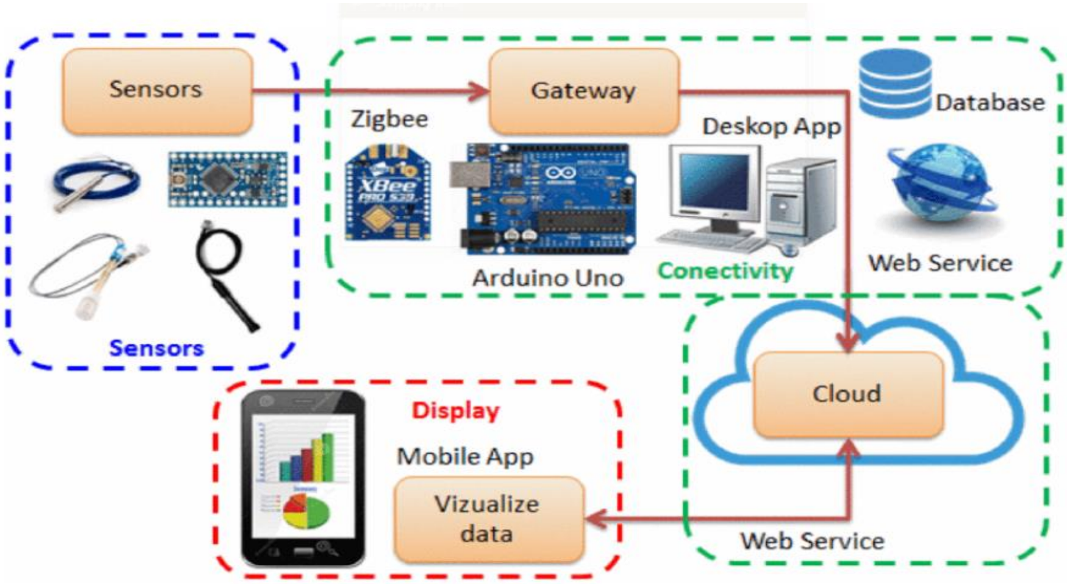

Figure 2 The Flow in the Established Water monitoring - IoT system (Encinas, Ruiz, Cortez & Espinoza, 2017)

4. ANALYSIS

This chapter presents the result of the findings, shows the final implementation of the system, and analyzes the performance of the system. In order to evaluate the proposed system, data is collected from Water Flow Sensor and all data recorded is transferred to the ThingSpeak cloud.

Figure 3 shows the developed prototype. The system prototype was built according to the design methodology. That is the prototype IoT water quality monitoring system for use for water batteries. In this system, a wireless sensor node was designed to monitor the pH, Total dissolved solids (TDS), water level and overall quality of water continuously, which affects the water quality.

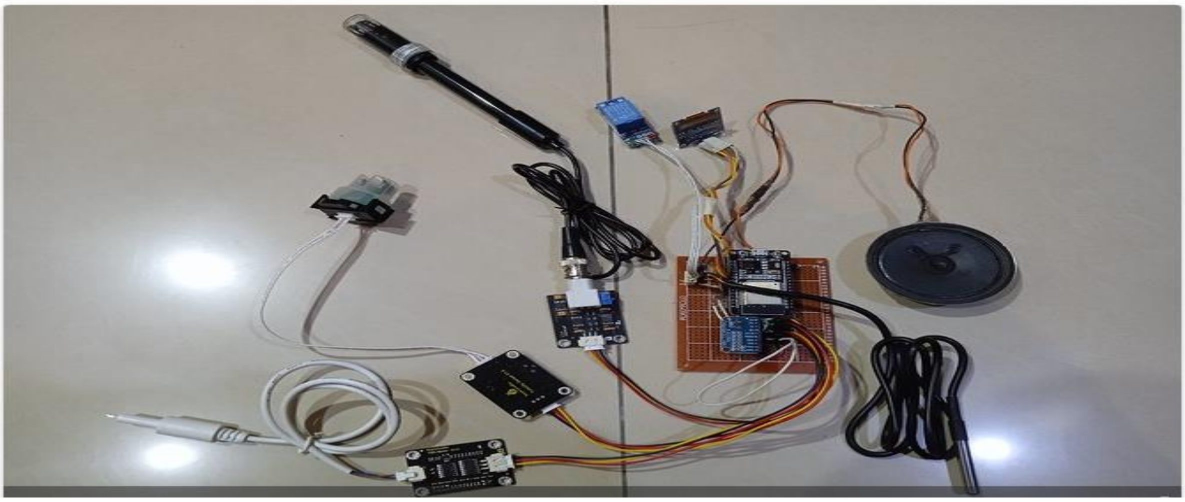

Figure 3 Snapshot of the Developed Prototype water monitoring system for water quality monitoring

Figure 4 Snapshot of the Registration of the Project on the app portal

Results obtained from the app Blynk show that the water monitory system worked and can read and monitor water quality.

Figure 4. 5 The Blynk Reading

An Arduino Mega and NodeMCU microcontrollers were used to process the readings from the sensors and upload them to the ThingSpeak server. We used Blynk for monitoring and analysis of the Turbidity of water. When the values of these parameters are not within a normal range, a warning message is notified to the user. The system showed that water quality in the water batteries can be monitored. The system implemented with the aid of IoT is ideal for real-time water monitoring.

The system implemented with the aid of IoT is ideal for real-time water monitoring. This is shown in the form of the graphs that are generated by ThingSpeak. The turbidity of the water was measured. If any mud, silt or sand particles etc. are mixed with the water, their quality value was displayed. According to the water quality norms, normal water ranges from 0 NTU (Nephelometric Turbidity Units) to 5 NTU and also a maximum of up to 5 NTU is permissible. If the water goes over 6 NTU up to 3000 NTU it is classified as turbid or mud-mixed water.

5.0 CONCLUSION

5.1 Summary and Discussion

The paper looks at water quality monitoring systems when applied to water batteries. This is proving important as there is a growing demand for the development of sustainable electrical energy from wind and solar-generated sources in many countries. These natural sources provide only intermittent energy. The intermittent energy from the sun or wind needs to be stored when they are available, so it can be used when they are unavailable. This means that there is a need for a rechargeable energy storage system or unit that can store the energy.

Water batteries also referred to as pumped storage hydropower contains two pools of water that act as an hourglass and provide a means for storing intermittent energy. Water batteries can be incorporated into the system to handle or regulate changes that might affect the electricity drooped. The water battery however can suffer damage when the water level drops or when the water quality is not suitable.

Monitoring the quality of the water in the water battery system is important. Proper management of the water level and quality is crucial for maintaining the life of the water battery system in sustainable electricity generation and distribution. To ensure that the water battery system water is maintained the Internet of Things provided a robust and cost-effective solution for real-time monitoring of various parameters of water. The implementation of our system was robust and showed the result obtained from our battery monitoring system.

The study used IoT devices and Blynk and ThingSpeak as cloud software that provided a suitable environment for analyzing and comparing the sensor data observed in graphics and smart alerts. As per the obtained results, the proposed system produced results from the sensors displaying the quality of water in the monitoring system.

5.2 Contribution to the Body of Knowledge

The paper developed a water monitoring system that can monitor water quality so that water-based batteries can maintain water levels for electricity generation. This study contributes to the water-based battery technology/method by designing a prototype water-level battery and quality maintenance system. The study adds to our understanding of how water battery is developed and the need to move to sustainable electricity generation. This paper contributes to the literature on the area of using normal water monitoring systems for water battery electricity generation systems. It further contributes to the literature on how the quality of water in a river or dam can be controlled with the aid of an embedded system consisting of a wireless sensor network and IoT.

5.3 Conclusion

The paper concludes that the prototype water quality monitoring system worked according to the scheduled plan. The developed system was successfully implemented and determined the turbidity, pH, Total dissolved solids (TDS), flow rate and level of water. The data obtained from the sensors are uploaded to the Blynk/ThingSpeak dashboard for online monitoring purposes. This paper has successfully improvised an intelligent water battery quality monitoring system. The system can be monitored from a PC and is also capable of sending a smart alert through IFTTT. The application of the system will improve the quality of water in a river or dam with a water battery system. The embedded system controls the system with the aid of a wireless sensor network and IoT. It is recommended that

5.4 Limitations and Suggestions for Further Study

More sensors can give a better reading and detect more parameters. The supply of water can be controlled by an interfacing relay for easy detection. The system can be expanded to monitor industrial and agricultural production.

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