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Real-Time IoT-based Control and Monitoring System for Drinking Water Pipelines

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ABSTRACT

All living organisms on Earth depend on water, which is a crucial component. According to statistics, only 1% of the water on Earth is fit for human use. The penstock pipes are how the people get their hands on this valuable drinking water. It makes its way to the Municipality Corporation's distribution system. A gi pipe is used to deliver drinking water from the municipality company to the public. Although the pipes are robust enough to endure mechanical stress, other individuals may cause harm to them as a result of maintenance tasks performed by the Municipality. Because of this circumstance, a substantial amount of potable water is wasted for the future, meaning that a lot of precious drinking water will be used for road drainage instead of being consumed by people. The proposed technique and the note The MCU will act as a master note, and client nodes are connected to every corner when distribution ends. A solenoid valve that regulates the water supply is activated by the municipality company via an Android application or web framework.

Keywords: Smart Distribution System, Node MCU, Android application, IoT

INTRODUCTION

On Earth, water is a valuable resource. It is a reality of modern life. A person can survive for more than 30 to 60 days without food, but only 3 to 4 days without water. Over 99 percent of the water on Earth is unfit for human consumption. In this situation, ensuring that there is no water loss while providing drinking water to the populace via the municipal distribution system is crucial. Through a solenoid valve, a NodeMCU and a water flow sensor are connected to the water distribution system pipeline for each street in this proposed system. Each corner of this road will have a solar power panel that will power the MCU. The solar panel was likewise powered by the same solenoid valve. Here, several of the street's distribution systems are connected to the main water distribution line. Between the distribution pipeline and main pipeline, each distribution system features a water flow sensor. The Android app is used to arrange regular operation for this distribution system. Only at the designated time should the water flow sensor display the water flow. The valuable drinking water is being squandered if a water distribution pipeline water flow sensor indicates any value, indicating that the pipeline is broken or damaged. In addition to turning off the solenoid relay that connects the main water pipeline to the particular water distribution by clients and staff and the water supplies from the main pipeline to the street's water distribution pipeline, the NodeMCU will now send a notification message to the government officials via the Android application. Conversely, a water flow sensor that is connected to their NodeMCU will provide the data to the

web framework. Additionally, the web framework can control or operate the solenoid valve that connects the main pipeline to the distribution pipeline on the street.

RELATED WORKS

It was suggested to use the NDVSL[1] method for leak detection. The procedure is based on the analysis of thermal images obtained using a thermogram-capturing IR viewer device. To locate the leak in this system, thermal images of the ground surface were gathered along the anticipated leak location. The thermograms were then visually inspected. The predicted leak location from the developed approach was compared to the actual leak location in order to confirm the applicability of the suggested approach. Irrigation enables Roselle[2] and other crops to thrive in inaccessible regions like gardens, balconies, and dry zones with limited rainfall. Since effective rainfall was estimated zero, crops relied entirely on irrigation. Water loss happens through evaporation and transpiration, which combined create evapotranspiration—key to calculating proper irrigation scheduling[3]. The Automated Leak and Water Quality Detection (ALWQD)[4] system effectively finds pipeline breaches and monitors water quality using sensors and ESP-32 microcontrollers. Tested under various settings, it obtained 70–80% efficiency. Pressure drops at leak spots permitted pollutant infiltration, emphasising ALWQD's potential to enhance water safety and system resilience. Bifacial photovoltaic (PV) panels catch light from both direct and reflected sources, boosting power density and energy production. Compared to monofacial panels[5-7], they perform better on flat roofs and ground-mounted arrays. This study investigates the efficacy of bifacial PV technology[8-10] in Qatar's different winter and summer climatic conditions. The method[11-14] will identify the leak part in pipeline using ultrasonic waves. This ultrasonic wave has limitation to travel in side the soil, mud and rock [15].

EXISTING METHOD

The water quality leak detection system comprises water quality measurement operations combined with the internet of applications. This proposed system would monitor pH value and water contamination which has come up from the mixing of drainage water along with the internet of applications. This proposed system will ph value measurement and water condonation which has come up from the mixing of drainage water. This approach also has pH value measurement and turbidity sensors to measure the water contamination which is produced by the mixing of drainage or sewage water caused by broken water pipelines. This present approach also has a water sensor and the flow of water from one point to another place. The above means that all the sensors and actuators are coupled with a microcontroller to make decisions based on the data received from the sensors. Here the pH sensor deducts the pH value of the water that enters from the main pipeline and hence the quality of water arriving in the pipeline. Moreover, the turbidity sensor monitors the water pollution level and sends that value to the Arduino controller, which is coupled to the NodeMCU over serial connection. This permits real-time monitoring and ensures that any substantial changes in water quality are swiftly handled. By combining these sensors with the microcontroller, the system may automate responses, such as initiating filtering procedures or alerting users to potential hazards. The IoT framework is tied to the proposal system throw and note MCU. This MCU has received the data from the Arduino Nano board using serial communication. The received data from the Arduino board comprises parameters like water pH value, pollution level, water flow present in the pipeline and lastly the relay functioning position. The relay is coupled to the solenoid valve so that whenever it gets the signal from the ESP32, it immediately operates the solenoid valve to open or close based on the signal received from the ESP32. This also features the graphical representation of water level with pH value, pollution level with water level, and water's flow value with respect to those dates; finally, the functioning of the solenoid valve based on time in a day. Turbo claimed all the data can be kept on a cloud platform which can store the last seven days of data gathered from the above-described system. This also may monitor

the dissolved solids contained in drinking water arriving to the pipeline. Even though this present system has numerous characteristics to monitor the water quality, it lags in regulating the solenoid valve on the master note to the client or distribution mode.

PROPOSED METHOD

The proposal system has two parts. Master note which manages the full client note associated with this water distribution system. The next one is a client note which has an ESP32 coupled with water cloths, a siren and a solenoid valve. The master note has a primary water reservoir coupled with the penstock pipelines. At first the pipe outlet is linked to the water flow sensor, followed by a solenoid valve connected in series with the water flow sensor. The solenoid valve will be operated by the framework which is maintained at the municipality office. On the appointed time the solenoid valve will open the same moment the water flow sensor will give some value dependent on the water velocity via the pipeline. Even if the solenoid valve is not planned to supply the public with water, it will nevertheless indicate value from water flows. The next module is the client node, which has an ESP32 along with a water flow and solenoid valve. This client node is positioned at each state's starting or beginning point. All the client nodes at each corner will be powered by a solar panel so that the client module can be independent from the energy, or it is not needed to depend on any power sources.

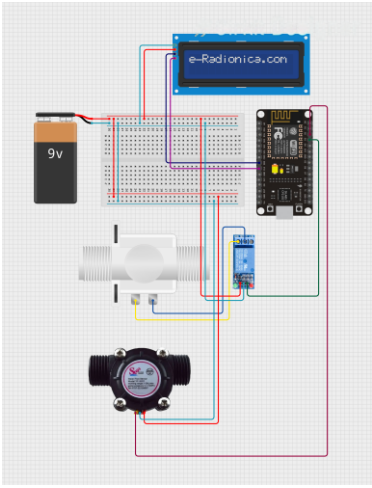

Figure 1. Circuit Diagram of Proposed System (Master Node)

Figure 1 presents the circuit diagram of the suggested master node methodology. It comprises a power supply powered by either batteries or solar energy. This power supply unit provides electricity to the NodeMCU, LCD module, solenoid valve, relay unit, and water flow sensor. The water flow sensor verifies the presence of water in a penstock pipeline, allowing an authority to confirm that water is entering the pipeline exclusively at the designated times. If the flow sensor indicates a value when the solenoid valve is closed, it triggers a message of pipeline rupture, malfunction, or water wasting. The solenoid valve is driven by a 12V DC source, therefore a relay unit is linked between the microcontroller and NodeMCU. Here the NodeMCU is connected to the cloud through a known Wi-Fi network. It will send the command to all the client nodes and receive the data from the same.

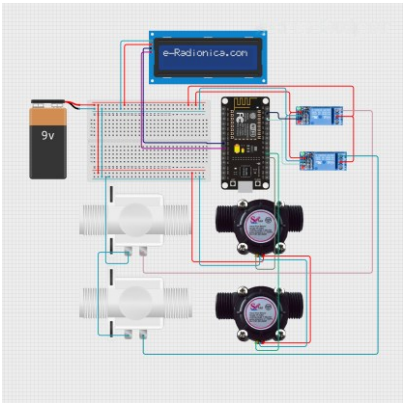

Figure 2. Circuit Diagram of Proposed System (Client Node)

The client nodes have ESP8266 along with their power supply unit with LCD, relay module, solenoid valve and lastly a water flow sensor depicted in figure 2. In this client node cluster, each node comprises of a load and a see, which is coupled to waterfall sensor and solenoid valve. The water flow sensor is attached to the distribution pipeline, and the solenoid valve is installed after the waterfall sensor. If the water flow sensor shows the value whenever the solenoid is constantly in an open condition, this won't convey any other message to the NodeMCU. If in the case of a closed condition of the solenoid valve, the water flow sensor gives any value which states that the pipeline connected between the water flow sensor and the distribution line was

broken or damaged. In such a circumstance, the NodeMCU will send an error notification to the government official so an Android application. At the same time, the controller will send the command signal to the solenoid valve to close its operation and stop the water flow through it. This simply saves the precious water being lost for a long duration and also mixing of the same with drainage or on the road. Hence the proposed system will monitor the water supply or distribution to the consumer at the proper moment. And also prevent the water from being wasted owing to the above stated scenarios, including the broken or damaged penstock pipeline which is utilised to distribute the water from the main municipality corporation. This not only prevents water wastage owing to the variable conditions. It also warns the government officials to take appropriate actions against the destruction or breaking of water pipelines, and water is being squandered to drainage regions on the roadside, which is not useable for human people or living things on the earth. The Android application has control of this hardware, like turning on or off the solenoid valve on the master or client notes. Eat also has to track water supply during the day during the week by graphical view. From the graph, the analysis of water providing to a particle localisation is extremely easy. In this existing technology, the manual operation of the solenoid valve on the master or client node is conceivable.

RESULT AND DISCUSSION

The Android application comprises of a valve operating switch together with the client node's valve operation button, as shown in Figure 3. It is the final result of the suggested system. It may inform the system to respond swiftly and fix, avoiding water loss due to the accidental scenarios. The proposed method system will serve as an effective and efficient mechanism to avoid valuable drinking water loss and inform the official to take the appropriate action to get rid of such situations. Moreover, this can provide week-wise data analysis for water distribution to the specified node utilising a graphical way. It may inform the system to respond swiftly and fix, avoiding water loss due to the accidental scenarios. The proposed method system will serve as an effective and efficient mechanism to avoid valuable drinking water loss and inform the official to take the appropriate action to get rid of such situations. Moreover, this can provide week-wise data analysis for water distribution to the specified node utilising a graphical way.

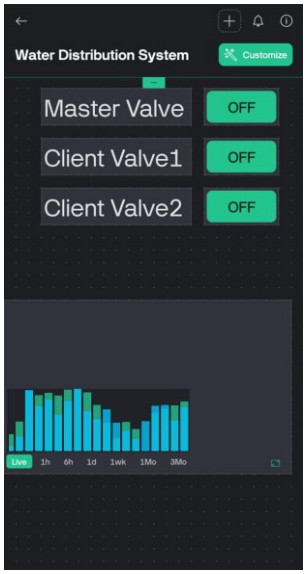

Figure 3. Screen shot of android application of proposed system

It also has the details of how much time a client node is being opened and supplied the water to a particular area.

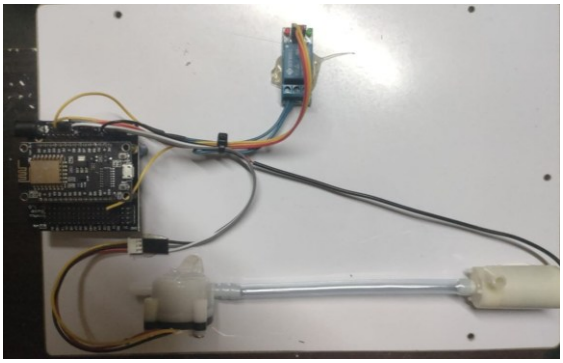

Figure 4. Prototype of Water Distribution System [Node – 1 & 2]

The figure 4 depicts prototype of water distribution system's nodes. the solenoid valve and the water flow sensor is coupled with the ESP8266 / Node MCU. the data obtained from water flow sensor is received and the same is uploded to the bylnk application and will be shown in android application in radial view as seen in fighre 3. Hence, a hassle-

free and effective water distribution system coupl ed with lowering the water loss risk using this pro posed method.

CONCLUSION

The real-time pipeline monitoring system will provide insurance to give a quality of drinking water to the human beings on the globe. Also, this will eliminate water loss in the distribution owing to the manual error, like diking the hole for any government-related operations or any other unexpected situations. It also allows the control over how much water is given through a node during a day/week/month. This statistical data is highly useful to schedule the water distribution to the corresponding districts without fail. This approach contains virtual buttons to manipulate the solenoid valve from the remote operations aswell. Hence, this will reduce human error and preserve the highly precious drinking water from the worst eventualities / accident scenarios. This node in the distribution system of water does not require any additional electricity power supply. Because it features a photovoltaic cell for each node. Here on all the modules, solenoid valves and NodeMCUs utilised in each node will be powered up by solar panels. How long time this will provide the entire module depends on the battery unit attached to each node. Overall, this proposed system is independent from power and efficient and successful in all the forms.

REFERENCES

[1] A. Al Hawari, M. Khader, T. Zayed, and O. Moselhi, "Non-destructive visual-statistical approach to detect leaks in water mains," *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering,* vol. 9, pp. 225-229, 2015.

[2] E. Atojunere and O. Ogundipe, "Artificial Intelligence into Drip Irrigation of Roselle's (Hibiscus Sabdariffa Linn) Cultivation Development," *Agricultural Mechanization in Asia, Africa and Latin America-AMA (00845841.53 (01): 6883-6895,* 2022.

[3] Y. Khulief, A. Khalifa, R. B. Mansour, and M. Habib, "Acoustic detection of leaks in water pipelines using measurements inside pipe," *Journal of Pipeline Systems Engineering and Practice,* vol. 3, no. 2, pp. 47-54, 2012.

[4] E. E. Atojunere and G. E. Amiegbe, "Automated Leak and Water Quality Detection System for Piped water Supply," *Malaysian Journal of Science,* pp. 98-108, 2024.

[5] P. Govindasamy, B. Ramraj, P. Sasirekha, V. Sabarivelu, and S. Rajan, "Electricity Generation of Dynamic Bifacial Solar Panels using IoT," in *2023 International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS)*, 2023: IEEE, pp. 1605-1610.

[6] M. Jothi *et al.*, "Intelligent irrigation system with multiple nodes and smart sensors using IoT for agricultural field," in *2nd International Conference on Computer Vision and Internet of Things (ICCVIoT 2024)*, 2024, vol. 2024: IET, pp. 328-333.

[7] E. A. Karthick, M. Srinevasan, A. A. Prabakaran, and K. Tamilselvan, "Embedded Based Automation of Ration System Using ATmega 162," ed: JNCET, 2016.

[8] K. Pachiappan, K. Anitha, R. Pitchai, S. Sangeetha, T. Satyanarayana, and S. Boopathi, "Intelligent machines, IoT, and AI in revolutionizing agriculture for water processing," in *Handbook of Research on AI and ML for Intelligent Machines and Systems*: IGI Global Scientific Publishing, 2024, pp. 374-399.

[9] M. Srinevasan, V. Parameshwari, T. Abirami, and N. Divyaa, "Artificial Intelligence and Supervised Learning based Solid Waste Segregation Mechanism using ESP 32," in *2023 Third International Conference on Ubiquitous Computing and Intelligent Information Systems (ICUIS)*, 2023: IEEE, pp. 81-84.

[10] S. E. Zahab, F. Mosleh, and T. Zayed, "An accelerometer-based real-time monitoring and leak detection system for pressurized water pipelines," in *Pipelines 2016*, 2016, pp. 257-268.

[11] T. Al Qahtani, M. S. Yaakob, N. Yidris, S. Sulaiman, and K. A. Ahmad, "A review on water leakage detection method in the water distribution network," *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences,* vol. 68, no. 2, pp. 152-163, 2020.

[12] J. Bartram and R. Ballance, *Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes*. CRC press, 1996.

[13] S. Datta and S. Sarkar, "A review on different pipeline fault detection methods," *Journal of Loss Prevention in the Process Industries,* vol. 41, pp. 97-106, 2016.

[14] S. El-Zahab and T. Zayed, "Leak detection in water distribution networks: an introductory overview," *Smart Water,* vol. 4, no. 1, p. 5, 2019.

[15] Behmel, Sonja, Mathieu Damour, Ralf Ludwig, and M. J. Rodriguez. "Water quality monitoring strategies—A review and future perspectives." *Science of the Total Environment* 571 (2016): 1312-1329.