



Smart Contactless Water Dispensing and Monitoring System with Dual-Platform Notification via Blynk and Telegram

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Article Info	Abstract
Article history: Received Feb 24 th , 2026 Revised Aug 7 th , 2026 Accepted Aug 16 th , 2026 Published Sep 30 th , 2026	Conventional water dispensing systems may lack hygienic operation, real-time monitoring, and energy efficiency, particularly in public and educational settings. The objective of this research was to design a smart, contactless, and solar-powered water-dispensing and monitoring system using Internet of Things (IoT) technology. The designed system uses an ESP32 microcontroller with dual ultrasonic sensors for water-level monitoring and hand detection, and a DS18B20 sensor for temperature measurement. The system uses threshold-based control logic to automatically disable dispensing function under low-water conditions while activating local alerts through LEDs and a buzzer. Real-time data is recorded in Google Sheets, while remote monitoring and notifications are provided through Blynk and Telegram. The system also incorporates a regulated solar-battery subsystem to support off-grid operation. Experimental results demonstrated the successful operation of the system in hand detection, water-level measurement, cloud-based data logging, remote notifications and off-grid power supply.
Index Terms: Internet of Things (IoT) Contactless Water Dispensing Dual-Platform Notification Solar-Powered System	

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I. INTRODUCTION

The growing demand for hygienic, efficient, and sustainable water-dispensing systems has fueled the development of intelligent automation systems in public and educational institutions [1], [2]. Conventional water dispensers are generally operated manually and continuously consume grid electricity, which can result in hygiene concerns due to frequent physical contact, inefficient monitoring of water usage, and higher operational costs [2], [3]. Additionally, traditional systems lack real-time monitoring capabilities, making it challenging to immediately identify low water levels or system malfunctions [1], [4].

Recent developments in Internet of Things (IoT) technology have made it possible to combine smart sensing, cloud-based monitoring, and automated control systems into various engineering applications [1], [4], [5]. Several studies have proposed automated water-level monitoring systems or contactless dispensing systems; however, most of the existing literature focuses on individual system functionalities rather than an integrated system [1]-[3]. Some systems employ ultrasonic water-level measurement without automated dispensing, while others provide contactless dispensing without cloud-based monitoring, remote data logging, or renewable-energy integration [1], [2], [5]. Furthermore, most grid-connected systems are unsuitable for off-grid or energy-

constrained applications, making them less scalable and sustainable [3], [6].

To overcome these limitations, this paper proposes a Smart Contactless Water Dispensing and Monitoring System with Dual-Platform Notification via Blynk and Telegram. The proposed system combines two ultrasonic sensors for water-level detection and hand sensing with a digital temperature sensor, all of which are interfaced with an ESP32 microcontroller. The system uses threshold-based safety logic to automatically stop the water dispensing process when a low water level is detected while simultaneously sending notifications through Blynk and Telegram. The sensor readings are recorded in real-time in Google Sheets for cloud-based monitoring and analysis. In addition, a solar-powered subsystem incorporating battery storage control and DC-DC voltage conversion is used to support sustainable and autonomous operation.

The proposed system offers a cost-effective, hygienic, and energy-efficient smart water management solution system for public institutions, and smart campus environments.

II. RELATED WORKS

Research on intelligent water-dispensing and water-management systems has increased in response to the growing need for automation, sanitation, and energy conservation. Existing work can be grouped into three main categories: IoT based water-level monitoring, contactless or

automatic dispensing and renewable energy-powered water systems. Table 1 compares the main functions of the

proposed system with those of existing IoT-based water-management systems.

Table 1
Comparison of the Proposed Smart Contactless Water Dispensing System with Existing IoT-Based Water Management Systems

Study/System	Water-level monitoring	Contactless dispensing	Temperature monitoring	Cloud logging	Blynk	Telegram	Solar powered	Low-water safety cut-off
Nath et al.	✓	–	–	✓	–	–	–	✓
Al-Shareeda et al.	✓	–	–	✓	–	–	–	–
NAAS	✓	–	–	–	✓	–	–	✓
Eraña et al.	✓	–	–	✓	–	–	✓	–
Mulyanto et al.	✓	–	–	–	✓	–	✓	–
Proposed system	✓	✓	✓	✓	✓	✓	✓	✓

IoT-based water-level monitoring systems are commonly used to improve maintenance efficiency in residential, institutional, and critical-infrastructure settings. Nath et al. developed an IoT based water-level management system that uses ultrasonic sensors and radio-frequency (RF) communication for tank-level monitoring and automatic pump control. The system automatically controls the water level in the tank, thereby reducing water and electricity wastage; however, it does not incorporate renewable energy or public water-dispensing function [7]. Similarly, Al Shareeda et al. developed a secure ESP32- based real-time water-level monitoring system using ultrasonic sensing for critical infrastructure. Although the system provides accurate monitoring and display function, However, it is not intended for hygienic water dispensing or off-grid operation. [8]. A comprehensive review by Jan et al. identified numerous solutions for IoT-based solutions for water-tank level monitoring, leak detection, and automatic pump control. However, most of these systems are grid-powered and are not designed for contactless public use. [1].

Contactless or non-contact liquid-level systems generally employ ultrasonic sensing and microcontroller-based control. Kang et al. [9] proposed an energy-efficient ultrasonic water-level detection system with dual-target monitoring and a low-power design suitable for renewable energy harvesting. However, the system was designed for flood and inundation monitoring rather than potable-water dispensing or improved user hygiene. NAAS developed an IoT-based smart-tank monitoring system using ultrasonic sensing, Global System for Mobile Communication, and Blynk visualization to provide remote alerts and automated low-level notifications. However, the system was intended for general tank management and did not provide a contactless interfaces for public drinking-water dispensing [10].

Renewable energy integration is also evident in recent studies. Eraña et al. developed a solar-powered, wireless IoT-based water-level monitoring system for irrigation in paddy fields. The system demonstrated an extended operating time using harvested solar energy but focused on agricultural water management rather than hygienic public water dispensing [11]. Mulyanto et al. further integrated solar power, ultrasonic level sensing, turbidity sensing, an ESP32 microcontroller, and Blynk-based remote monitoring for reservoir water management. However, their system focused on water-quality and storage management rather than automated contactless dispensing in public settings [12].

Overall, existing designs typically address water-level monitoring, automation, contactless operation, or renewable-energy utilization separately rather than integrating all these functions within a single embedded system, as shown in Table 1. This gap justifies the development of the proposed system, which integrates contactless dispensing, dual ultrasonic sensing, solar power, cloud-based data logging, and multi-platform notification into a scalable smart water-management solution.

III. METHODOLOGY

The Smart Contactless Water Dispensing and Monitoring System was developed using an integrated hardware-software co-design methodology. The proposed system integrates embedded sensing, microcontroller-based processing, cloud communication, and renewable- energy management into a single IoT system. The methodological process consisted of system modelling, hardware implementation, firmware development, and experimental validation to ensure operational reliability and sustainability.

A. System Architecture

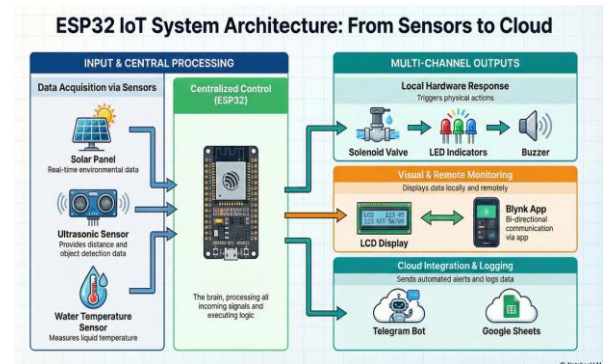


Figure 1. System architecture of the Smart Contactless Water Dispensing and Monitoring System with Dual-Platform Notification via Blynk and Telegram.

The overall architecture of the ESP32-based IoT system architecture of the Smart Contactless Water Dispensing and Monitoring System is illustrated in Figure 1. It presents the complete data flow from sensor readings to cloud integration. The input and central-processing sections comprise the sensing layer and the processing core. A solar-panel monitoring interface, two ultrasonic sensors, and a water temperature sensor are used to collect environmental and operational data.

The ultrasonic sensor provides distance measurements for water-level detection and hand-presence sensing, while the temperature sensor measures the water temperature. These inputs are transmitted to the central control unit, which is the ESP32 microcontroller. The ESP32 receives the sensor

signals, evaluates the predefined thresholds, executes the control logic, controls the output devices, and manage communication with external platforms.

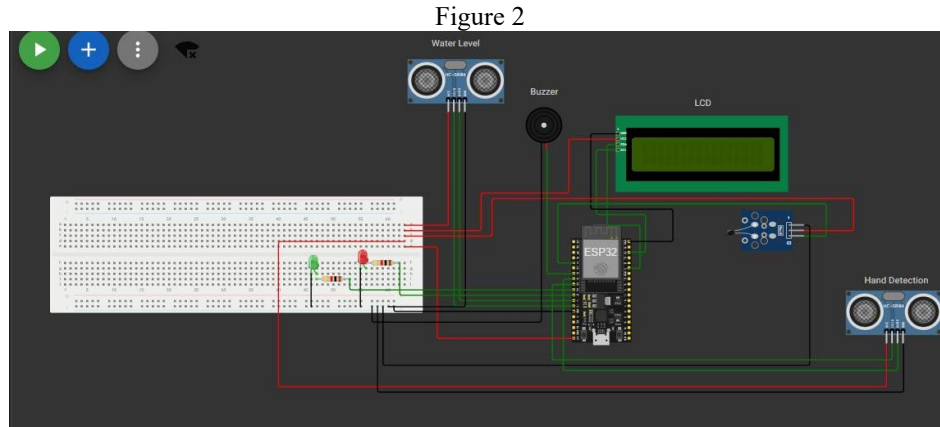


Figure 2. The schematic diagram Smart Contactless Water Dispensing and Monitoring System with Dual-Platform Notification via Blynk and Telegram

The multi-channel outputs section represents the physical response mechanisms of the system. The ESP32 operates the solenoid valve according to the control decisions. The LED indicators provide visual feedback, while a buzzer produces an audible alert during low-water conditions. At the same time, the real-time data are displayed locally on the LCD module, allowing users to view the current system parameters.

The cloud integration and data-logging section represents the remote-monitoring capabilities of the system. The processed data are transmitted to the Blynk application for dashboard visualization, to the Telegram bot for automated alerts, and to Google Sheets for cloud-based data storage and historical analysis. This layered architecture enables synchronized local control, remote monitoring, and data storage within a unified IoT framework. Thus, Figure 1 presents the complete end-to-end system process, from sensing to cloud communication, while highlighting centralized processing and multi-channel responses.

B. Schematic Diagram

The schematic diagram of the system is illustrated in Figure 2, and the system is built around an ESP32 DevKit module. The diagram shows the connections among the input sensors, output actuators, and communication interfaces. The ultrasonic sensors, LEDs, buzzer, and solenoid-control circuit are connected through digital general-purpose input/output (GPIO) pins. The DS18B20 temperature sensor uses the 1-Wire communication protocol. The solenoid valve is driven through a metal-oxide-semiconductor field-effect transistor (MOSFET) to isolate its high-current load from the microcontroller. The LCD communicates through the inter-integrated circuit (I²C) protocol to reduce pin usage. The DC-DC boost converter regulates the power supply to provide a stable 5V to the system components. The connections between the system components and the ESP32 pins are summarized in Table 2.

Table 2
Connections between the system components and ESP32 microcontroller

Component	ESP32 Pin Connection	Remarks
Ultrasonic Sensor (Water Level)	D5 / D18	Tank-level Measurement
Ultrasonic Sensor (Hand Detection)	D19 / D21	Contactless Dispensing Activation
DS18B20 Temperature Sensor	D4	1-Wire Communication
Solenoid Valve (via MOSFET)	D23	Water-dispensing Control
Red LED	D12	Low-water Indicator
Green LED	D13	System-ready Indicator
Buzzer	D14	Alert Notification
LCD 16×2 (I ² C)	D21 / D22	Real-Time Display
Google Sheets / Blynk / Telegram	Built-in Wi-Fi	Cloud Communication



Figure 3 The completed prototype of Smart Contactless Water Dispensing and Monitoring System with Dual-Platform Notification via Blynk and Telegram.

The hardware prototype shown in Figure 3 integrates the sensing modules, the control circuitry, the solar power subsystem, and IoT communication components. The two ultrasonic sensors are strategically positioned to detect the water level and the presence of a user's hand. The solenoid valve is connected to the water outlet to provide automatic

dispensing control. The LCD is positioned for user visibility and displays real-time system parameters. The LED indicators and buzzer provide immediate feedback during alert conditions. The solar panel and battery are securely integrated to provide a stable power supply. Experimental validation was conducted to evaluate sensing accuracy, Wi-Fi connectivity, cloud data logging, dual-platform notification transmission, and system operation under solar-powered conditions.

IV. RESULTS AND DISCUSSION

A. Simulation Analysis

Prior to hardware implementation, the system was evaluated through simulation to verify the functionality of the control logic, sensor responses, and control mechanisms. The simulation evaluated three primary operating conditions: a normal water level, a low-water condition, and contactless dispensing activation.

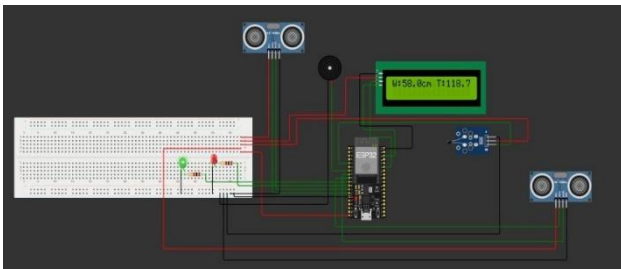


Figure 4. Simulation result under the normal water-level condition (> 4.0 cm)

Figure 4 shows the system operating under a normal water-level condition. In this state, the green LED indicator remains illuminated to indicate normal operation, while the red LED and buzzer remain inactive because no warning condition is detected.

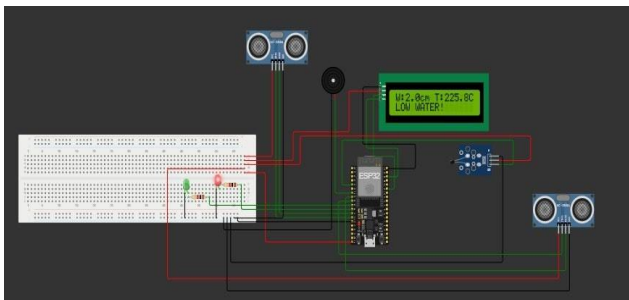


Figure 5. Simulation result under the low-water condition (< 4.0 cm)

Figure 5 shows the system operating under a low-water condition. When the measured water level falls below the pre-programmed safety threshold of 4.0 cm, the ESP32 activates the safety mode to prevent dry operation. In this condition, the solenoid valve is turned off to prevent water dispensing, even when a user's hand is detected. When the water level is low, the red LED is activated to provide a visual warning, while the buzzer produces an audible alert for users in the vicinity. The LCD screen displays a warning message, such as "LOW WATER" together with the current water level and water temperature. At the same time, a Telegram notification is sent to the administrator, the system status is displayed on the Blynk dashboard, and the sensor data are recorded in Google Sheets. This process protects the hardware from dry

operation and improves system reliability under low-water conditions.

The ultrasonic-sensor simulation confirmed the system's ability to measure the water level within the evaluated range. A threshold of 4.0 cm was selected to prevent dry operation. When the simulated water level fell below this threshold, the solenoid valve was automatically turned off and the warning indicators were activated. On the other hand, when the water level remained above the minimum threshold, the system enabled water dispensing upon detecting the presence of a user's hand.

Table 3
Results of Water-Level Threshold Control

Water Level (cm)	System Status	Solenoid Valve	LED Indicator	Telegram Alert
8.5 cm	Normal	Enabled	Green ON	No
6.0 cm	Normal	Enabled	Green ON	No
4.5 cm	Normal	Enabled	Green ON	No
3.9 cm	Low Water	Disabled	Red ON	Yes
2.5 cm	Low Water	Disabled	Red ON	Yes

The simulation demonstrated the correct execution of the control logic, with the system switching to safety mode when the measured water level fell below the predefined threshold. The notification mechanism was activated only under the low-water condition, confirming the correct integration of the notification logic. The results also indicate that the proposed threshold-based control strategy provides protection against dry operation. As shown in Table 3, the three water levels above the alarm threshold (8.5 cm, 6.0 cm, and 4.5 cm) did not activate the safety mechanism, allowing water dispensing without generating warning notifications. In contrast, the two water levels below the threshold (3.9 cm and 2.5 cm) activated the safety mechanism by disabling the solenoid valve and sending a warning message in each case. These results demonstrate the successful execution of the control logic under all five experimental conditions. This consistent pattern of operation suggests that the decision algorithm implemented in the ESP32 microcontroller can provide reliable real-time monitoring and automated protection. A threshold of 4.0 cm was chosen as an appropriate engineering compromise to maximize the amount of water available for use while preventing dry operation of the dispensing mechanism. The usable quantity of water would be reduced if the threshold were raised, whereas lowering the threshold could allow the solenoid valve to operate when insufficient water remained in the tank. Thus, the threshold value may vary depending on tank size and intended application, and the proposed control method can be adapted to different installations.

B. Hardware Analysis

Following successful simulation validation, hardware testing was conducted on the fully assembled prototype. The experimental testing evaluated sensing accuracy, response time, communication reliability, and solar-subsystem stability.



Figure 6. Integrated low-water condition response showing local LCD warning, Blynk dashboard visualization, Telegram alert notification, and Google Sheets data logging.

Figure 6 depicts the hardware response under a low-water condition, in which the measured water level was 3.9 cm, below the predefined safety threshold of 4.0 cm, as detected by the ultrasonic sensor. Under this condition, the system activated the red LED, displayed the measured temperature and the “LOW WATER” warning message on the LCD, and generated an audible buzzer alarm to alert nearby users. At the same time, the IoT communication layer transmitted the critical system status through the various platforms.

A Telegram notification was immediately sent to the administrator's smartphone, enabling remote monitoring and a prompt response. The Blynk dashboard was updated in real time to support continuous system monitoring through its gauges and status indicators. Meanwhile, the measured data, such as date, time, and temperature and the water level, were automatically recorded in Google Sheets with their corresponding timestamps for record keeping and maintenance analysis. This coordinated interaction between the hardware and cloud platforms provided reliable system monitoring, timely notifications, and organized historical data storage.

The experimental results demonstrate the feasibility of integrating local alerts, embedded control, cloud communication and sensing into a single IoT platform. The results confirm not only the correct operation of individual components, but also their coordinated operation as an integrated system. The proposed system continuously monitors the water level and automatically activates protective measures when the water level falls below the predefined threshold, whereas conventional water dispensers generally require manual inspection and intervention. This autonomous operation reduces the likelihood of human error, improves system reliability, and reduces maintenance effort [13].

The dual-platform notification architecture also enhances operational robustness. The local indicators (LCD, LEDs, and buzzer) provide immediate feedback to users in the vicinity, while Telegram notifications, the Blynk dashboard and Google Sheets support remote monitoring and historical data analysis. The availability of information through several

communication platforms reduces dependence on a single notification channel and improves the accessibility and reliability of critical system information. [10], [14].

The prototype remained stable during the experimental evaluation; however, several practical limitations should be acknowledged. The HC-SR04 ultrasonic sensor measures the distance between the sensor and the water surface rather than directly measuring the volume of water in the tank. Therefore, measurement accuracy may be affected by the tank geometry, water-surface conditions, and the environment in which the sensor is installed [15]. In addition, unstable network connections may increase notification latency because cloud communication performance depends on WiFi connectivity and Internet availability [16]-[17]. However, these limitations are common among IoT-based monitoring systems and do not affect the proposed safety-control strategy because the local control functions continue to operate without an Internet connection.

C. Solar Power Subsystem



Figure 7. Solar energy circuit



Figure 8. Solar Controller

The solar energy circuit and solar controller are shown in figures 7 and 8, respectively. The solar-energy subsystem is integrated into the smart water dispensing system and comprises a solar panel, charge controller, battery module, and voltage regulation circuit. The solar panel serves as the main energy-harvesting device by converting solar energy into electrical energy, thereby supporting the system's independent operation. The harvested energy is managed by a TP4056 lithium-battery charging module, which controls the charging of a 3.7V, 18650 lithium-ion battery, protects it from overcharging, and supports stable energy storage. To operate the ESP32 Microcontroller, a DC-DC boost converter increases and regulates the battery output to provide a stable 5-V supply, thereby supporting reliable Wi-Fi connectivity and sensor operation. This integrated power-management system allows the system to operate in off-grid locations, remain connected to the cloud, and continue logging data

without relying on conventional electrical infrastructure, thereby supporting sustainable and energy-efficient operation.

The inclusion of the solar subsystem improves the reliability of the proposed system in public facilities where a continuous electric supply may not always be available. Unlike grid-powered dispensers, the proposed architecture enables autonomous operation while maintaining its sensing, cloud-communication, and notification functions [18].

The design supports sustainability goals by reducing reliance on grid electricity and facilitating off-grid and temporary installations. However, the long-term operating

performance of the solar subsystem may be affected by environment and operational factors, including solar irradiance, battery ageing, and charging efficiency as shown in [19]-[20]. If sunlight is not available for an extended period, the system's operating time may be reduced depending on the available battery capacity. Intelligent energy-management strategies, such as Maximum Power Point Tracking (MPPT) and adaptive power scheduling, should be explored in future studies to enhance energy efficiency and operational reliability.

Table 4
Experimental Performance Evaluation of the Proposed Smart Contactless Water Dispensing and Monitoring System

Test No.	Water Level (cm)	Dispensing Activated	Dispensing Duration (s)	Water Dispensed (mL)	Telegram Alert	Google Sheets Logged	Battery Voltage (V)	Off-grid Operation
1	8.5	Yes	3	100	No	Yes	4.05	Stable
2	6.0	Yes	3	100	No	Yes	4.05	Stable
3	4.5	Yes	3	100	No	Yes	4.05	Stable
4	3.9	No	0	0	Yes	Yes	4.05	Stable
5	2.5	No	0	0	Yes	Yes	4.05	Stable

D. Experimental Performance Evaluation

To provide an integrated quantitative evaluation of the proposed system, the performance of the water-level monitoring, dispensing control, cloud communication, and off-grid power subsystems was assessed under five operating conditions. Table 4 summarizes the measured system responses at water levels above and below the predefined safety threshold.

Table 4 summarizes the integrated experimental performance of the proposed system. Under normal water-level conditions of 8.5, 6.0, and 4.5 cm, the system consistently activated water dispensing for 3 s and delivered approximately 100 mL of water. These results indicate consistent dispensing performance across the tested normal water levels. When the water level fell below the 4.0 cm threshold, at 3.9 and 2.5 cm, dispensing was successfully inhibited while Telegram alerts were generated.

Throughout the tests, data were successfully logged to Google Sheets and the battery voltage remained approximately 4 V with stable off-grid operation observed under all tested conditions. These results demonstrate that the prototype maintained its dispensing, monitoring, communication, and power functions under the evaluated operating conditions. However, longer-duration testing is required to evaluate long-term off-grid performance and battery endurance.

V. CONCLUSION

This paper has presented the design and development of a Smart Contactless Water Dispensing and Monitoring System with dual-platform notification system via Blynk and Telegram. The system was evaluated through simulation and hardware experiments. The results confirmed its ability to detect the water-level conditions, provide contactless dispensing, maintain stable Wi-Fi connectivity, transmit notifications through multiple platforms, and log water-level data in Google Sheets. The threshold-based safety mechanism successfully prevented dry operation, while the renewable-energy subsystem maintained a stable battery

voltage and supported off-grid operation under the tested conditions. Local status indicators, remote dashboard monitoring, instant Telegram notifications, and cloud-based timestamped data logging were synchronized within a single system to improve safety, cleanliness and maintenance readiness. Finally, the proposed system has demonstrated the feasibility of an integrated smart water management solution for public facilities and smart-campus applications. It successfully combined contactless dispensing, cloud monitoring, dual-platform notification, and renewable-energy operation within a single IoT platform. However, several areas still require further improvement. Future work should include more extensive quantitative performance evaluation of measurement accuracy, communication latency, energy consumption, battery endurance and long-term operating performance. Predictive analytics could also be applied to historical cloud data to forecast water consumption and improve maintenance scheduling. Furthermore, the system's suitability for large-scale deployment could be investigated by connecting multiple dispensing units through centralized cloud management and incorporating intelligent energy-optimization methods, such as Maximum Power Point Tracking (MPPT).

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest regarding the publication of the paper.

AUTHOR CONTRIBUTION

The authors confirm contribution to the paper as follows: study conception and system design: Nur Amalina Muhamad and Muhammad Syazwan Farhan Shamsuri; hardware development and implementation: Muhammad Syazwan Farhan Shamsuri with guidance from Nur Amalina Muhamad; software integration, cloud configuration, and experimental validation: Muhammad Syazwan Farhan Shamsuri; methodology refinement and technical validation: Nur Amalina Muhamad and Norhalida Othman; data analysis and interpretation of findings: Muhammad Syazwan Farhan Shamsuri, Nur Amalina Muhamad, Nor Diyana Md Sin, and Nor Hasliza Abdul Rahman; manuscript drafting: Muhammad Syazwan Farhan Shamsuri; manuscript review, editing, and critical revision: Nur Amalina Muhamad, Norhalida Othman, Nor Diyana Md Sin, and Nor Hasliza Abdul Rahman; supervision and project oversight: Nur Amalina Muhamad. All authors have reviewed the manuscript and approved the final version for publication.

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