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Solar Powered Water Tank Level Monitoring System with IoT

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Abstract

This project gives us an insight into the use and monitoring of water through the application of a water level monitoring system. This thesis outlines a monitoring system that uses IoT technology and is powered by solar energy. Inadequate water supply is a source of constraints for the smooth running of an industry as well as work at home. This is addressed with an innovative approach that aims to improve water tank level monitoring capabilities by integrating solar energy. The system uses an ultrasonic sensor placed on top of the water tank to consistently monitor the water level and deliver real-time data to the microcontroller unit. This system is equipped with solar panels, ensuring continuous power supply and not producing environmental pollution, also promoting a system with better green energy. It may be possible to improve communication by utilizing Internet of Things (IoT) technology. Wireless communication is used by the system to provide smooth data flow between microcontrollers, sensors, and users. The user's mobile device may show sensor data thanks to the Wi-Fi module, which also makes it easier for the user and the system to connect. A visual depiction of water levels is another feature that user-friendly online interfaces, like the Blynk application, offer to its customers. This enables consumers to decide quickly by using the information on display to guide their choices.

1. Introduction

Malaysia, despite having an average annual maximum rainfall exceeding 2000 millimeters, faces geographical and temporal variability in rainfall, with the lowest precipitation in June and July. In 2017, domestic water consumption was high at 201 liters per capita per day, significantly above the WHO recommendation of 165 liters, necessitating an 18% reduction [1][2]. The Internet of Things (IoT) facilitates data transfer between devices without human intervention, exemplified by applications like heart implant monitors, tire pressure sensors, and smart trash cans [3]. Solar energy, the most abundant energy source, is effectively harnessed through photovoltaic (PV) generation. PV pumping systems (PVPs) are cost-effective, easy to install, require minimal maintenance every 5 to 10 years, and rely on renewable solar power, eliminating the need for non-renewable energy sources [4].

1.1 Problem Statement

Having a reliable water supply is essential for any community, but in our town, we have been dealing with these unpredictable water outages that have become a thing of the past. These outages have taken a toll on us, affecting everything from our day-to-day lives to the things we do for our businesses. We want to do something about it, and we have come up with a solution that could really help. It is a water tank monitoring system that could really help us get back on track with our water supply problems.

Several water tank monitoring systems that provide water level monitoring have already been developed. However, most designs depend on traditional power sources such as batteries or alternating current energy, which can be unreliable and require maintenance over time. In addition, the design emphasizes an eco-friendlier system to help protect the ecosystem. This is why zero-emission panels will be used in this design as they are more reliable and cost-effective to power the system [5].

1.2 Objective

The primary goal of this project is to design and develop a solar-powered water tank level monitoring system utilizing IoT technology. The specific sub-objectives are threefold: firstly, to create an automated system that can continuously monitor water levels in tanks, thereby eliminating the need for manual checks and ensuring real-time accuracy. Secondly, the system will be powered by green energy, specifically solar power, making it environmentally friendly and sustainable. Lastly, the project aims to establish a seamless connection between the water tank level monitoring system and the user, allowing for remote monitoring and management through IoT applications. This will enable users to access real-time data and receive notifications about water levels, ensuring efficient water management and timely interventions when necessary.

1.3 Scope of Study

The scope of this project is to design and develop a solar-powered water tank level monitoring system specifically for residents in areas facing water supply challenges. The system will include a comprehensive water tank level monitoring setup employing an ultrasonic sensor to measure the water level accurately, a water flow sensor to monitor the rate of water usage, and an Arduino Uno microcontroller to process the sensor data. This system will be powered by solar energy, making it environmentally sustainable and independent of the electrical grid. Additionally, the system will be integrated with user interfaces via Arduino and the Blynk software, which can be installed on mobile apps. This integration will allow users to remotely monitor and manage the water levels in their tanks, receive real-time updates, and get notifications, ensuring efficient water usage and timely interventions when needed.

1.4 Material and Method

The materials and methods for developing a solar-powered water tank level monitoring system with IoT involve several key components and steps. The system will utilize an ultrasonic sensor to accurately measure water levels and a water flow sensor to monitor the rate of water usage, both connected to a Durian Uno microcontroller for data processing. A solar panel, paired with a rechargeable battery, will provide a renewable power source, ensuring continuous operation. An IoT module, such as the ESP8266, will enable wireless communication, allowing the Durian Uno to send data to the cloud. The Blynk software will be employed to create a user-friendly interface on mobile devices for remote monitoring and control. The system setup will include calibrating the sensors, integrating solar power components, and configuring the IoT connectivity. The Durian Uno will process and transmit data to the cloud, with the Blynk app displaying real-time water levels and flow rates and sending alerts for threshold breaches. The system will undergo rigorous testing to ensure reliability and accuracy, making it a sustainable and efficient solution for water management in areas with water supply challenges.

2. Block Diagram

Fig 1 shows the complete block diagram of the proposed project. The hardware configuration incorporates a variety of sensors, including an ultrasonic sensor, a water flow sensor, and a PIR sensor. Moreover, solar panel technology is employed to provide energy to the device, thereby enhancing its reliability while encouraging a more environmentally sustainable system. The primary objective of Blynk software development is to establish a connection between the user and the device through the utilization of IoT technologies. This connection enables remote monitoring of the water level. The system subsequently employs the LED to effectively show the level of water and the buzzer to drive away animal disturbances such as birds and monkeys. The data is transmitted to the user through the Internet of Things (IoT) and can be retrieved through the Blynk software.

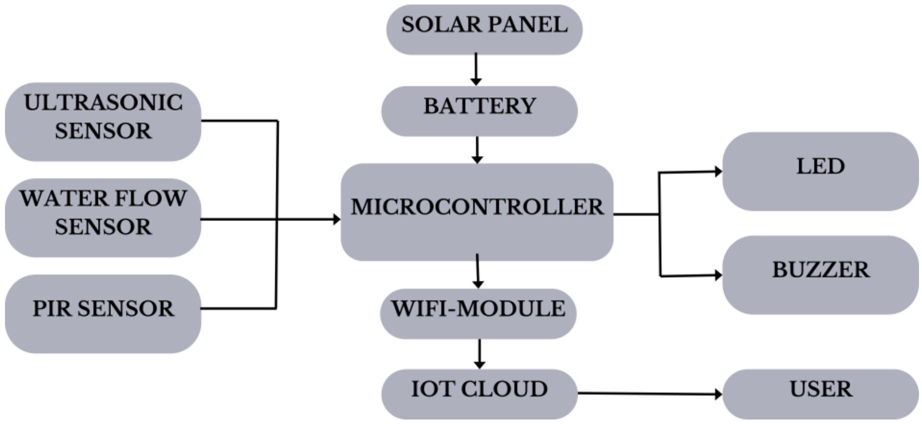


Fig 1 *Solar Powered Water Tank Level Monitoring System Block Diagram*

2.1 Flow Chart

The flowchart in Fig 2 will give a general overview of how the steps will be done in order to detect the water level in the water tank. The sensors will gather and measure the data, which will be displayed on the Blynk app and analysed through charts in the IoT cloud.

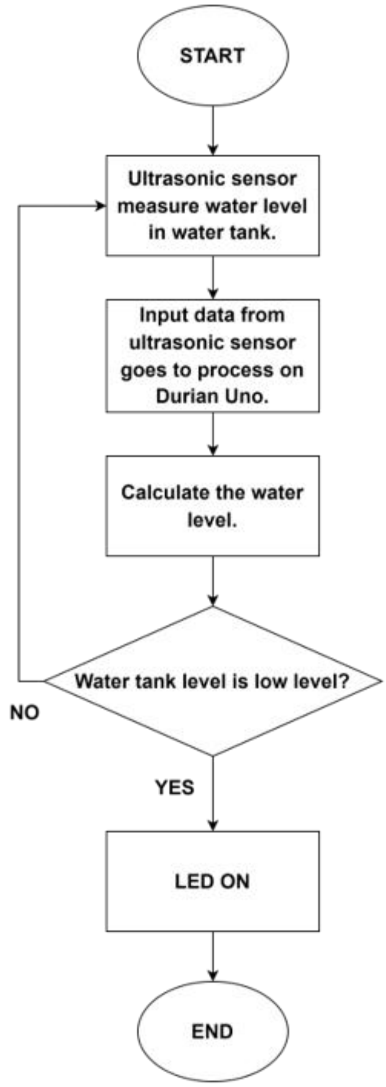


Fig 2 *General Flowchart of the project.*

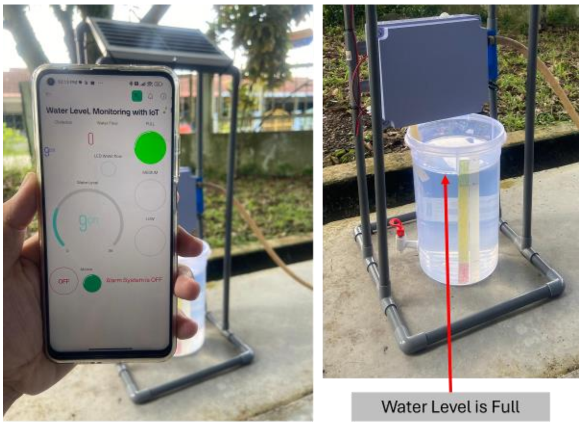
3. Result and Discussion

The finalized development of this system incorporates an ultrasonic sensor for water level detection, a water flow sensor, and a PIR sensor for motion detection. The system can notify users through two approaches. The first involves piezoelectric buzzers that ring when the PIR sensor detects movement, providing immediate alerts to nearby users. The second approach uses the Blynk application installed on mobile phones, which aggregates data from all sensors to provide real-time updates on water level, flow rate, and detected motion. The system's reliance on solar power ensures continuous operation even during power outages or adverse weather conditions, enhancing reliability. Additionally, a three-color LED setup can be used to display water level data from the ultrasonic sensor, notifying nearby users. This integration of solar energy and IoT technology aims to deliver efficient, reliable monitoring and notifications of water conditions and disturbances, ensuring user readiness and promoting eco-friendly practices.

Table 1 *The Condition and output of the system*

No.	Conditions	Output
1.	Ultrasonic sensor detect water level is High.	Indicator display “Green LED” (Bynk)
2.	Ultrasonic sensor detect water level is Medium	Indicator “Yellow LED” (Blynk)
3.	Ultrasonic sensor detect water level is Low	Indicator “Red LED” (Blynk)
4.	Water flow Sensor	• Show value 0 if water flow not detect water flow. • Show value 1 if water flow detect water flow. • LED green and red blink if water flow detect.
5.	PIR sensor	Buzzer will ON if movement detected.

The water level monitoring system employs an ultrasonic sensor that triggers different LEDs based on measured distances, providing clear visual indications of the tank's water levels. When the water level is less than 12 cm, depicted in Fig 3 (a), the system activates the green LED, signaling a high-water level. In situations where the water level ranges between 13 and 29 cm, as illustrated in Fig 3(b), the yellow LED illuminates, indicating a moderate to decreasing water level. For water levels between 30 and 35 cm, as shown in Fig 3(c), the red LED lights up, alerting users to a low water level that requires attention. This system not only facilitates real-time monitoring but also enhances user awareness through intuitive visual feedback, ensuring timely interventions to manage water resources effectively.



(a)

(b)

(c)

Fig 3 *Water level conditions result*

Fig 4 shows when water begins filling the container, the water flow is detected by a hall sensor. This sensor continuously monitors the presence and movement of water, sending corresponding data to a connected microcontroller. The microcontroller, which interfaces with the Blynk platform, processes this data and updates its status by assigning a value of either 1 or 0. A value of 1 indicates that water is detected entering the container, while a value of 0 signifies no water flow. As the water is detected entering the container, the water flow LED provides a visual indicator by blinking in red and green, signalling active water flow. This blinking pattern serves as an immediate, visible confirmation that the system is functioning correctly, and that water is indeed entering the container. If the hall sensor does not detect any water flow, the microcontroller maintains the value at 0 or 1, depending on the last detected state, and the water flow LED remains unlit, indicating that no water is currently entering the container.

Fig 4 *Water Flow Detect Result.*

Fig 5 shows the PIR sensor serves as the primary sensor for detecting any movement or motion of objects within its range. Initially, the alarm system must be activated through the Blynk application, which will display the status message "Alarm System is ON." Once the system is activated, any detected motion triggers the buzzer to ring for several seconds, and a notification will be sent to the Blynk application to alert the user. If no further motion is detected, the buzzer will stop ringing. However, if movement is detected again, the buzzer will resume ringing, and another notification will be sent to the Blynk application. To cease the buzzer's ringing, the user can deactivate the alarm system via the Blynk application, which will then update the status message to "Alarm System is OFF." This system ensures that users are promptly alerted to any motion detected by the PIR sensor, while also allowing for easy control and monitoring through the Blynk application.

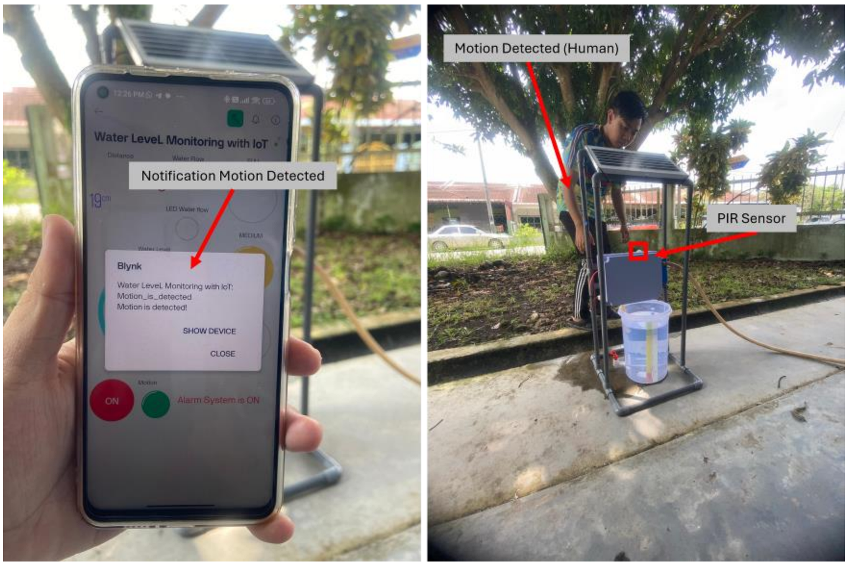


Fig 5 *Motion Detect Result.*

4. Conclusion

In conclusion, the objective of developing a remote monitoring solution for areas prone to water supply issues, prioritizing proactive management of water resources has been successfully done in this project. By utilizing zero-gas emission solar technology, the system ensures ecological sustainability while providing accurate, real-time water level measurements. It incorporates self-monitoring capabilities with real-time alerts for water level variations and remote monitoring of water flow, contributing to environmental conservation efforts. The integration of solar panels successfully achieves energy independence, supported by sensors like PIR, water flow, and ultrasonic sensors to detect disturbances. The system employs an ESP8266 Wi-Fi module and a buzzer for efficient user notifications, underwent rigorous performance testing to ensure reliability, and effectively delivers constant monitoring via IoT technology. This initiative supports efficient water management practices and offers a greener approach to monitoring water levels, aiming to reduce water wastage while promoting environmental responsibility.

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References

[1] Muhammad, N. S., Abdullah, J., Rahman, N. A., & Razali, N. A. (2021). Water usage behaviour: Case study in a southern state in Peninsular Malaysia. *IOP Conference Series. Earth and Environmental Science*, *646*(1), 012017. https://doi.org/10.1088/1755-1315/646/1/012017

[2] IEEE Computer Society and Institute of Electrical and Electronics Engineers., *2016 International Conference on Mechatronics, Electronics, and Automotive Engineering : ICMEAE 2016 : proceedings : 22-25 November 2016, Cuernavaca, Morelos, México.*

[3] S. Sachio, A. Noertjahyana, and R. Lim, "IoT Based Water Level Control System."

[4] S. E. Babaa, S. A. Al-Jahdhami, M. Ahmed, S. A. Khan, B. S. Ogunleye, and J. R. Pillai, "Smart Irrigation System using Arduino with Solar Power." [Online]. Available: www.ijert.org

[5] A. Munns, L. E. Ramirez, J. C. Witchgers, J. Rodriguez, and A. E. Goulart, "Netrix: A Solar-Powered Water Measurement Device for Rainwater Collection Tanks."

[6] S. Hasib Cheragee, N. Hassan, S. Ahammed, and A. Z. Md. Touhidul Islam, "A Study of IoT based Real-Time Solar Power Remote Monitoring System," *The International Journal of Ambient Systems and Applications*, vol. 9, no. 2, pp. 27–36, Jun. 2021, doi: 10.5121/ijasa.2021.9204.

[7] C. J. Rhodes, "Solar energy: Principles and possibilities," *Sci Prog*, vol. 93, no. 1, pp. 37–112, 2010, doi: 10.3184/003685010X12626410325807.

[8] IEEE Tunisia Section, International Conference on Composite Materials & Renewable Energy Applications 2014.01.22-24 Sousse, and ICCMREA 2014.01.22-24 Sousse, *2014 International Conference on Composite Materials & Renewable Energy Applications (ICCMREA) 22-24 Jan. 2014, Sousse, Tunisia*.

[9] N. M. Farrag and S. Omran, "Designing a building integrated photovoltaic system (Bipv) for residential façade: Case study in Egypt DESIGNING A BUILDING INTEGRATED PHOTOVOLTAIC SYSTEM (BIPV) FOR RESIDENTIAL FAÇADE: CASE STUDY IN EGYPT," vol. 12, no. 21, 2017, [Online]. Available: https://www.researchgate.net/publication/321666992

[10] L. A. Gama-Moreno, A. Corralejo, A. Ramirez-Molina, J. A. Torres-Rangel, C. Martinez-Hernandez, and M. A. Juarez, "A Design of a Water Tanks Monitoring System Based on Mobile Devices," 2016, doi: 10.1109/ICMEAE.2016.27.