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Monitoring Fluid level in Inverter using water level sensor and Mobile Application

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Abstract

Inverters are typically installed on rooftops or ele-vated platforms, making continuous monitoring of fluid levels challenging. These systems serve as a crucial backup power source during electrical outages. A reduction in fluid levels below a predefined threshold, if undetected, can lead to re-duced battery efficiency, decreased lifespan, and overheating. Overheating may cause the emission of hazardous gases such as hydrogen sulfide, posing health risks. Traditionally, fluid levels are manually monitored by physically inspecting battery caps, which is inefficient and unreliable. Existing automated solutions, such as float switches and ultrasonic sensors, present limitations including high cost, complex integration, and restricted real-time monitoring capabilities.

To address these challenges, an Internet of Things (IoT)-based monitoring architecture is proposed, which incorporates a fluid level sensor connected to an ESP32 microcontroller. The system transmits sensor data to the ThingSpeak cloud platform for real-time analysis. A binary decision-making algorithm evaluates the fluid status, and alerts are generated using IFTTT-based automation, providing real-time push notifications to the user's mobile device when fluid levels fall below the critical threshold.

The experimental evaluation indicates that the system provides timely and accurate notifications, with an average response time of less than 5 seconds. The solution provides a cost-effective, scalable, and efficient method for monitoring the level of inverter fluid in real-time, enhancing operational safety and extending battery longevity.

Index Terms: IOT, inverter fluid, battery caps, sensors

1. INTRODUCTION

A decade ago, computers started to play a major impact on human life. So, there was a huge consumption of electric power. From 2008 onwards we are in shortage of power consumption and storage. So, there occurs a need for power backup. Because of this reason batteries are invented. This project is developed keeping in mind to maintain and enhance the lifetime of the battery. Nowadays batteries are having an indicator at the top, which will show the level of distilled water. In the busy schedule, most humans forget to check the water level indication periodically. Failing which, the battery gets overheated and Hydrogen Sulphide (H2S) hazardous gas turns out from batteries which creates an odor smell affects human health and in turns reduces the lifetime of battery. Due to this, the efficiency and lifetime of the batteries gets affected. To overcome this, smart inverter monitoring system (SIMS) has been developed which will monitor and inform the authorized owner by SMS notification to phone number via a GSM Module in the following cases if the-

1) Temperature increases beyond the threshold limit.

2) Hydrogen Sulphide (H2S) hazardous gas starts leaking.

3) Distilled water level of the battery gets reduced.

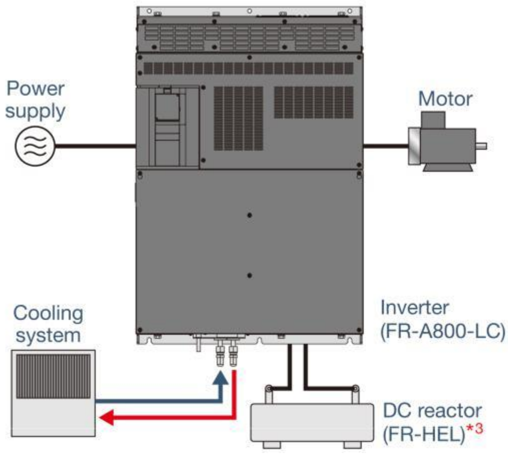

Fig. 1. Inverter Battery with Water Level Caps

In an inverter battery, distilled water is poured through the battery caps using a funnel or a water-filling bottle until it reaches the recommended level. Each cell has a marked indicator or a float mechanism that signals the correct water level. When the water level drops below the threshold, it can affect battery performance and lifespan. In our system, a water level sensor continuously monitors the electrolyte level.

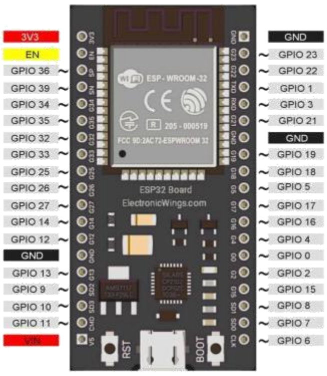

Fig. 2. Pin diagram of ESP32-WROOM-32 development board.

Figure.2 illustrates the pinout of the ESP32-WROOM-32 development board, which serves as the central processing unit for the proposed fluid level monitoring system. The ESP32 is a versatile, low-power, dual-core microcontroller with integrated Wi-Fi and Bluetooth capabilities, making it well-suited for IoT-based automation and real-time monitoring applications. It includes 34 programmable GPIO pins, many of which support analog-to-digital conversion (ADC), pulse-width modulation (PWM), serial communication protocols (I2C, SPI, UART), and digital input/output.

In the proposed system, the analog water level sensor is connected to GPIO 34, which is an ADC-enabled input

pin, allowing for continuous analog monitoring of fluid level changes. A GND (Ground) connection is made to one of the GND pins, and the VCC of the sensor is connected to the 3.3V pin on the ESP32 to supply regulated power. The Wi-Fi module on the ESP32 is used to transmit real-time data to the cloud platform (ThingSpeak), while push notifications are triggered through IFTTT integration when the fluid level drops below a threshold.

The use of ESP32 not only facilitates wireless communica-tion but also ensures energy-efficient operation and scalability, making it a highly reliable and cost-effective solution for embedded smart monitoring systems.

2. RELATED WORK

Himanshu Singh and others in the paper [1] discusses various home automation solutions, focusing on their method-ologies and limitations. It highlights the use of 433 MHz radio frequency control modules and Bluetooth 4.0 for smartphone control, noting security risks and short-range limitations, re-spectively. IoT systems combining Bluetooth and Ethernet face deadlock issues with multiple device access. Energy management systems using ARM microcontrollers send alerts to raise energy awareness. Low-cost smart home systems with Arduino Ethernet promote energy efficiency. The review emphasizes the need for fully automated systems with wireless sensor nodes, especially in developing countries where energy efficiency is vital.

Aishwarya kumar and others in the paper [2] discusses how smart inverters are defined as inverters that are powered by solar energy and can perform solar tracking, allowing for efficient energy management. They feature bidirectional communication with users, enhancing user interaction through IoT (Internet of Things) capabilities. This interaction includes monitoring and controlling household appliances wirelessly, which provides users with real-time information about battery voltage and the runtime of connected loads.The integration of low-cost components like the ESP8266 Wi-Fi module enhances the overall affordability and functionality of the smart inverter system.

Ahmed and others in the paper [3] discusses about the IoT-based grid-connected inverter employs the RSA(Rivest–Shamir–Adleman) algorithm for enhancing commu-nication security in smart grid environments. This inverter is constructed using the H-bridge architecture and sinu-soidal pulse width modulation (SPWM) technology, which ensures low harmonic distortion and effective grid connectivity through a phase control technique. Its design prioritizes acces-sibility and cost-effectiveness while addressing cybersecurity challenges inherent in IoT systems.

Karode and others in the paper [4] focus on the smart solar inverter system integrates both hardware and software components to create an IoT-enabled solar power management system. The hardware implementation utilizes a 100W solar panel connected to a charge controller that maintains a con-stant DC output of approximately 15V. The system employs a 12V battery charging system, operating within a voltage range of 12.7V to 14V. For voltage measurement and monitoring, the design incorporates a potential divider circuit connected to an Arduino controller. The core processing is handled by an Arduino UNO board interfaced with NodeMCU ESP8266 for Wi-Fi connectivity.
R.R.Gandhi and others in the paper [5] explained about the details of a smart inverter system for PV applications that focuses on user-friendly control and monitoring. The system uses an ESP8266 WiFi module and NODEMCU to enable two-way communication between users and their solar power system through mobile devices. For power optimization, it employs solar tracking with stepper motors and the PO (Perturb Observe) algorithm. The inverter provides real-time monitoring capabilities and allows users to control different loads remotely through a mobile app. The hardware imple-mentation includes a charge controller, 12V battery system, and a 5V relay module for load switching. The system is integrated with the UBIDOTS platform for IoT functionality, allowing multiple users to monitor and control their solar power system remotely. The complete setup is designed to be cost-effective and environmentally friendly, making it suitable for both residential and small industrial applications.

3. PROPOSED METHODOLOGY

Users connect their mobile to the IoT setup that is connected to their home inverter through thingspeak. Water level sensor reads the fluid value in the inverter. When the fluid level falls below its threshold value, it sends a pop-up notification to the user mobile. It reflects that the user needs to refill the inverter. Users can check the fluid level whenever the user wants. Figure.3 illustrates the detailed architecture of the proposed fluid level monitoring system for inverter batteries. The architecture is divided into three main layers: Input, Process, and Output. The Input layer comprises the fluid level sensor, which continuously monitors the electrolyte level inside the battery, along with a predefined threshold value that acts as a decision point for triggering alerts. The Process layer includes the ESP32 microcontroller, which reads the sensor data and connects to the internet via Wi-Fi. It transmits the data to the ThingSpeak IoT platform, where it is stored, visualized, and evaluated against the threshold value. If the fluid level falls below the specified limit, the system initiates a webhook to IFTTT, which serves as an automation bridge. The Output layer is responsible for delivering actionable feedback to the user. This includes real-time data visualization on the ThingSpeak dashboard and push notifications sent directly to the user's mobile device via IFTTT. This layered architecture ensures seamless integration between hardware and cloud services, offering real-time monitoring and timely alerts to prevent battery damage.

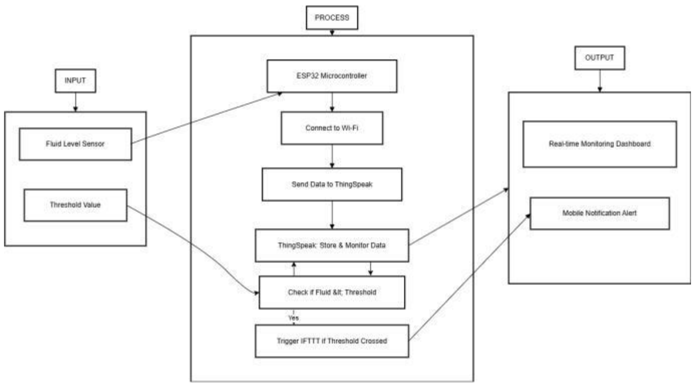

Fig. 3. Architecture diagram for proposed Model

The readings of the fluid level are sent to ThingSpeak for storage and analysis. The readings are visually represented in a graph and gauge on the ThingSpeak platform. The user sets a specific threshold representing the minimum acceptable fluid level, and the system continuously monitors the level using a water-level sensor. When the system detects a breach of the set threshold, it triggers a notification through the IFTTT applet. This notification is sent to the thingspeak server, which, in turn, delivers a push notification to the user's mobile device. The push notification serves as an immediate alert, notifying the user about the low fluid level condition. The system checks whether the fluid level is below a predefined threshold.

A. Modules

1) To indicate the distilled water level of the battery goes down below the indication level.
2) To indicate the temperature increases beyond the limit

3) To indicate the hydrogen sulphide hazardous gas start coming from the battery.

Figure.4 shown is the block diagram of the proposed system.The mechanism begins with the ESP32 connecting to a Wi-Fi network. A Wi-Fi module is a fundamental hardware component that facilitates wireless communication for electronic devices, enabling them to connect to Wi-Fi networks and exchange data wirelessly. These modules come in integrated or standalone forms, seamlessly adding wireless capabilities to devices. Operating within standard frequency bands such as 2.4 GHz and 5 GHz,

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Wi-Fi modules support protocols like TCP/IP, essential for internet communication. Security features, including encryption methods like WPA2, safeguard transmitted data.Once connected to Wi-Fi, the ESP32 establishes a connection with the ThingSpeak platform. The system uses a water level sensor to monitor

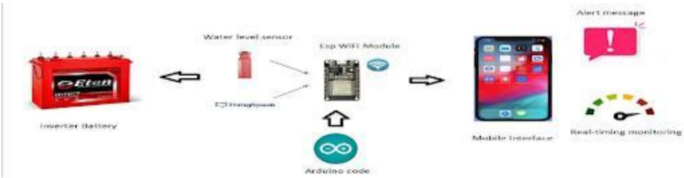

Fig. 4. Block diagram of Proposed model

4. IMPLEMENTATION AND RESULTS

The proposed IoT-based inverter fluid monitoring system was implemented using a water level sensor integrated with an ESP32 microcontroller. This section outlines the hardware setup, data visualization, and notification delivery process.

A. System Model

The system model, as illustrated in Figure.5 represents the complete hardware setup. It includes the water level sensor connected to the ESP32 microcontroller mounted on a bread-board. The sensor continuously monitors the fluid level inside the inverter battery and transmits data to the cloud platform.

Fig. 5. Model of the product

the fluid level in the inverter battery. A water-level sensor is a device designed for measuring and monitoring the level of water or other liquids in a container, providing critical information for a variety of applications? Modern water-level sensors often integrate with IoT systems, enabling wireless data transmission for remote monitoring and control through platforms or mobile apps. Accuracy and calibration are crucial considerations, and materials used in sensor construction must be compatible with the monitored liquids.

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B. Fluid level Monitoring

Figure.6 demonstrates the detection of various fluid levels inside the inverter. The system reads real-time sensor data through the serial monitor of the ESP32. These readings are subsequently uploaded to the ThingSpeak platform for real-time visualization. The sensor data is displayed on the serial

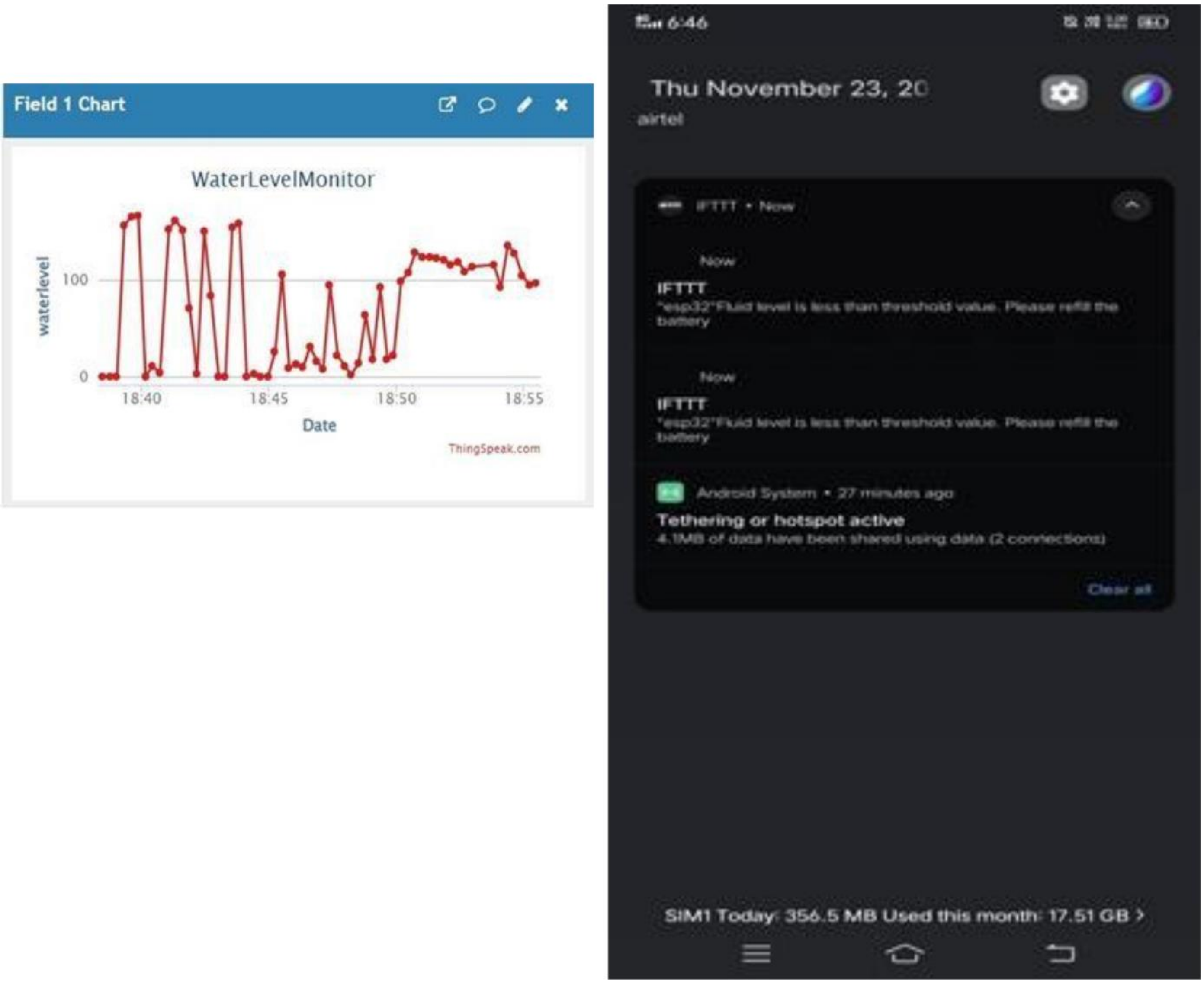

Fig. 6. Fluid levels in inverter

monitor, where each value corresponds to a specific fluid level. Based on these readings, the fluid levels are dynamically repre-sented using gauges on the ThingSpeak dashboard, providing an intuitive understanding of the current fluid status.

C. Data Visualization using gauges

In Figure.8, the fluid levels are depicted on a gauge, provid-ing a visual representation of the fluid quantity in the inverter. The gauge updates in real time according to the sensor data obtained from the ESP32. This visualization allows users to monitor fluid levels without physically inspecting the inverter.

Fig. 7. Guage representation of fluid levels

D. Mobile Notification System

Figure.?? illustrates the message received on the user's mobile device through the IFTTT applet. When the fluid level falls below a predefined threshold, the system triggers an alert and sends a notification via SMS, email, or push notification. This ensures timely intervention and prevents damage due to low fluid levels.

1) System Performance Evaluation: The system was tested under various conditions to evaluate its performance:

1) Accuracy of Detection: The water level sensor provided precise fluid measurements with minimal deviations across multiple test scenarios.
2) Notification Delivery Time: Notifications were sent to the user within 5 seconds of detecting low fluid levels, ensuring rapid alerts.

3) Reliability: The system performed consistently without interruptions during extended monitoring, providing sta-ble data transmission and accurate alerts.

5. FUTURE WORK

The inverter monitoring system has been developed and implemented for monitoring and remind the authorized owner by pop-up intimation. Real-time data logging and cloud inte-gration may be implemented to maintain fluid level records and analyze maintenance patterns over time. Furthermore, the system can be improved by adding functionalities such as automatic fluid refilling, battery health diagnostics, and inte-gration with home automation systems, which would enhance reliability and reduce the need for manual intervention.

REFERENCES

1. H. Singh, V. Pallagani, V. Khandelwal, and U. Venkanna, “IoT based Smart Home Automation System using Sensor Node,” in Proc. Int. Conf. Recent Adv. Inf. Technol. (RAIT), IEEE, 2018.

2. A. Kumar, A. A. Bijapur, C. B, K. R. Kulkarni, and K. Natarajan, “An IoT based Smart Inverter,” in Proc. IEEE Int. Conf. Recent Trends Electron. Inf. Commun. Technol., India, May 20–21, 2016.

3. N. Ahmed, M. Ziaur, and R. Khan, “A secure IoT based grid-connected inverter using RSA algorithm,” in Proc. Australasian Univer-sities Power Engineering Conference (AUPEC), 2021, doi: 10.1109/AU-PEC52110.2021.9597724.

4. A. H. Karode and M. T. Deshmukh, “Title not available,” Int. J. Res. Publ. Rev., vol. 5, no. 9, pp. xx–xx, 2024. [Online]. Available: https://doi.org/10.55248/gengpi.5.0924.2416

5. R. R. Gandhi, S. D. Prabha, G. N. Danyashri, S. Arnesh, S. Aishvarya, and C. Kathirvel, “PV based Smart Inverter for Reliable System,” in Proc. IEEE 2nd Int. Conf. Mobile Netw. Wireless Commun. (ICM-NWC), 2022, pp. 1–6, doi: 10.1109/ICMNWC56175.2022.10031717.
M. O. Arowolo, E. A. Oyetade, O. S. Agboola, and O. S. George, “Development of a Mobile App for Inverter System Management,” ABUAD Journal of Engineering Research and Development (AJERD)*, vol. 6, no. 2, pp. 85–99, Oct. 2023, doi: 10.53982/ajerd85.

6. M. J. Mnati, A. Hasan, A. H. Ali, D. V. Bozalakov, and A. Van den Bossche, “Design and Implementation of a Smart Monitoring and Controlling System of Three-Phase Photovoltaic Inverter Based on LoRa,” IOP Conf. Ser.: Mater. Sci. Eng., vol. 518, no. 4, p. 042022, 2019, doi: 10.1088/1757-899X/518/4/042022.

7. D. A. Prastika, S. Hariyadi, and D. Dwiyanto, “Solar Cell Monitoring Design IoT Based 3 Phase Inverter Using Power Monitor System Application,” Int. Conf. Adv. Technol. Eng. Appl. Sci. (ICATEAS), vol. 3, no. 1, 2024. doi: 10.46491/icateas.v3i1.1924.