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IoT-Enabled Automatic Battery Health Monitoring Device for Measuring Internal Resistance, Capacity, and Remaining Life.

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***Abstract*—Batteries are used in almost every electronic device today, so checking their condition is important for safety and long working life. This project introduces a small and affordable Automatic Battery Health Tester that can measure a battery's internal resistance, usable capacity, and also track how many days the battery has been in use.The system works by applying a controlled load through a MOSFET and measuring the battery voltage and current before and during the test. From the change in voltage and current, the device calculates the internal resistance and estimates the State of Health (SoH) of the battery. For accurate readings, it uses a current-sensing circuit such as INA219, ACS712, or a shunt amplifier. A microcontroller (Arduino Nano or ESP32) handles load control, calculations, data storage, and displays the results on an LCD screen.The tester provides different working modes like a quick IR pulse test and a longer discharge test for checking capacity. It also includes safety features such as over-current and temperature protection. A special function of this design is the life-tracking system, which records usage days and predicts when the battery will reach the end of its useful life, helping users decide the right time for replacement. Testing result shows that the prototype gives stable and repeatable measurements, making it suitable for students, technicians, and hobby users.**

***Index Terms*—Battery Health Tester, Internal Resistance, State of Health (SoH), Electronic Load, Capacity Measurement, Life Tracking System.**

I. INTRODUCTION

Batteries play a crucial role in powering modern electronic systems ranging from smart phones and laptops to electric vehicles, solar storage units, and small embedded projects. As technology advances and energy demand increases, understanding the condition and performance of batteries has become extremely important. A weak or aging battery can lead to problems such as reduced backup time, slow charging, overheating, sudden shutdowns, and serious safety risks like swelling or fire. Therefore, regular battery health monitoring is necessary to maintain reliability and ensure safe operation.Two major factors that determine battery health are internal resistance (IR) and usable capacity. When a battery becomes older, its internal resistance increases and the capacity decreases, resulting in less efficiency and reduced lifespan.

Measuring these parameters helps identify damaged or failing cells early, preventing system failures. However, most existing battery testing tools are expensive, complicated to use, or limited to specific battery types. This creates a need for a compact, affordable, and easy-to-operate battery health testing device.To address this need, the project introduces an Automatic Battery Health Tester capable of measuring internal resistance, estimating capacity, calculating State of Health (SoH), and tracking battery usage life in days.

The device uses a micro controller-controlled programmable load to test the battery under different conditions and provides accurate readings through sensors and real-time calculations. With safety protection features and data storage options, the tester becomes a useful tool for students, technicians, and hobby users to evaluate battery performance and make informed decisions for battery replacement and maintenance.

II. RESEARCH GAP

Although many battery testing devices and methods are available today, several important limitations still exist, especially for small users, technicians, and students. Most commercial battery analyzers are expensive, bulky, and designed mainly for industrial or laboratory use. They often require complex calibration and are not suitable for quick, on-site battery checks. Low-cost hobby testers available in the market can measure only voltage or a simple discharge test, but they cannot accurately measure internal resistance or estimate battery State of Health (SoH). Another major gap is the lack of systems that combine IR measurement, capacity testing, and real-time usage tracking in a single, portable unit. Existing devices rarely track how many days a battery has been used or predict how long it will last.

As a result, users cannot easily estimate the remaining useful life of their batteries, leading to sudden failures and unnecessary replacements. Many devices also lack proper data logging features, making it difficult to compare battery performance over time.Additionally, most low-cost testers do not include advanced safety protections like over current, overheating, or isolation for high-voltage cells, making them risky for everyday users. There is also limited availability of testers that support multiple battery types with customization test modes. These gaps highlight the need for a compact, affordable, and user-friendly device that provides accurate battery health measurement along with long-term tracking and prediction features.

III. PROBLEM STEAMENT

Modern electronic devices depend heavily on batteries to operate efficiently and safely. As batteries age, their internal resistance increases and usable capacity decreases, leading to reduced performance, overheating, sudden shutdown, and safety risks. However, most available battery testing equipment is expensive, complex to operate, or limited to specific battery types, making it difficult for students, technicians, and hobby users to check battery health accurately.There is a need for a compact, low-cost, and user-friendly device that can automatically measure internal resistance, capacity, State of Health (SoH) and track battery usage life, while ensuring testing safety and reliability. A system that provides real-time information and alerts about battery condition would help users identify weak cells early, prevent failures, and reduce maintenance costs.

IV. OBJECTIVES

1. To design and develop a compact and low-cost Automatic Battery Health Tester that can be used by students, technicians, and hobby users.
2. To measure the internal resistance (IR) of different types of batteries using a controlled, programmable electronic load.
3. To estimate the usable capacity and State of Health (SoH) of the battery through short-pulse and long-discharge test modes.
4. To track the total number of days a battery has been in use and record its long-term performance for better maintenance planning.
5. To predict the remaining useful life (RUL) of the battery based on IR, capacity reduction, and usage history.
6. To display battery health results clearly on an LCD/OLED screen and store test data in internal memory, SD card, or serial communication.

V. DESIGN

Fig. Design of the battery tester

VI. WORKING

The Automatic Battery Health Tester works by applying a controlled load to the battery and observing how its voltage and current change during the test. When the device starts, the microcontroller initializes the sensors, display, and protection circuits. The user selects the type of battery and the test mode from the menu. First, the tester measures the open-circuit voltage of the battery without any load. After this, a MOSFET-based electronic load is activated to draw a fixed amount of current for a short duration. During this load pulse, the system records the voltage drop and the exact amount of current flowing. Using these two values, the internal resistance (IR) of the battery is calculated. A higher voltage drop indicates a higher internal resistance, which means the battery is aging or becoming weak.

For capacity testing, the tester discharges the battery at a constant current for a specific time or until it reaches the cut-off voltage. By multiplying the discharge current with the total time, the usable capacity of the battery is estimated in mAh. Using both the IR value and measured capacity, the device calculates the State of Health (SoH) and compares it with the battery's original specifications. The system also includes a cell life tracker that records how many days the battery has been used and predicts how long it will last before needing replacement. All-important readings voltage, current, IR, capacity, SoH, days used, and remaining life are displayed on the LCD.

Throughout the test, safety features such as over-current protection, overheating detection, and voltage limits ensure that the battery is tested safely. If any abnormal condition is detected, the system immediately stops the load and alerts the user. After the test, all results are saved to memory or an SD card for record-keeping. This continuous monitoring and data logging help users identify weak batteries early and make better maintenance decisions. In this way, the tester provides an accurate, user-friendly, and safe method to analyze overall battery health.

VII. ADVANTAGES

1. Automatically adjusts orientation based on user's eye movement.
2. Provides hands-free operation and reduces neck and eye strain.
3. Integrated wireless charging ensures continuous and cable-free use.
4. Equipped with Li-ion battery and BMS for safe and reliable power management.
5. Compact and portable design suitable for various environments.
6. Ensures user privacy by processing data locally without transmission.

VIII. APPLICATION

1. Technicians can quickly test mobile, laptop, and gadget batteries to identify weak or damaged cells before replacement.
2. Useful for checking batteries in devices like UPS systems, emergency lights, medical equipment, handheld tools, and portable electronics.
3. Helps analyze individual lithium cells or small battery modules used in e-bikes, scooters, and EV battery packs.
4. Can be used to monitor the health of batteries used in home solar setups, solar streetlights, and off-grid power units.
5. Ideal for engineering students and lab experiments to study battery characteristics, IR behavior, discharge curves, and SoH.

IX. FUTURE SCOPE

The future scope of the eco-friendly dual-compartment dustbin is highly promising, with opportunities for technological upgrades and large-scale deployment. The system can be integrated with smart sensors, IoT modules, and mobile applications to automatically detect the waste level, send alerts, and support efficient waste collection management. Solar-powered operation can be added to make the system more sustainable and energy-independent. Future versions may include features like automatic waste segregation using AI-based image processing, odor-control units, and compacting mechanisms to increase storage capacity. The design can be expanded for use in public places, hospitals, schools, industries, and smart cities to support Swachh Bharat and environmental sustainability initiatives. With continuous improvement, the system can contribute significantly to reducing pollution, improving hygiene, and creating an efficient and modern waste-management ecosystem.

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XI. CONCLUSSION

In conclusion, the eco-friendly dual-compartment dustbin provides an effective and practical solution for improving waste management and promoting environmental cleanliness. By separating wet and dry waste at the source, the system reduces foul odor, prevents waste mixing, and supports proper recycling and disposal processes. It's simple yet efficient design helps minimize human contact with waste, reducing health risks and improving hygiene in homes, public places, and institutions. The project not only promotes cleanliness but also encourages responsible waste disposal habits among users. With the potential for future upgrades such as automation, odor control, and solar-based operation, this dustbin design can significantly contribute to sustainable living and support national initiatives focused on cleanliness and environmental protection

REFERANCES

[1] Battery Management Systems – Design & Application, Texas Instruments, Technical Document, 2023.

[2] Understanding Battery Internal Resistance, Analog Devices Application Note, 2022.

[3] INA219 / ACS712 Current Sensor Datasheets, Texas Instruments & Allegro Microsystems, 2021.

[4] Lithium-ion Battery State of Health Estimation Techniques, IEEE Journal, 2020.

[5] Arduino Nano & ESP32 Technical Documentation, Arduino.cc & Espressif Systems, 2023.