Design and Fabrication of Automatic UPS Battery Maintenance System

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ABSTRACT. The Automatic UPS Battery Maintenance System is an innovative and technologically advanced solution developed to optimize the upkeep of Uninterruptible Power Supply (UPS) battery cells. Utilizing precision sensors and real-time data analysis, the system intelligently assesses the electrolyte levels and triggers automated distilled water replenishment when necessary. By eliminating the need for manual water level checks and refilling, the system minimizes the risk of under filled batteries, which can lead to decreased battery lifespan and compromised performance. User-friendliness is a cornerstone of the system's design. It features an intuitive interface that provides users with a comprehensive view of battery health, water levels, and system status. In the event of anomalies, the system promptly issues notifications and alerts, ensuring timely response and minimizing potential disruptions during power outages.Key advantages of the Automatic UPS Battery Maintenance System include prolonged battery lifespan through reduced plate corrosion and sulfation, consistent and uninterrupted power supply, reduced labor and time overhead, data-driven insights for informed decision-making, and environmentally responsible water usage.In conclusion, this project introduces an intelligent and efficient solution to enhance UPS battery maintenance practices. By automating the critical process of water level management, the Automatic UPS Battery Maintenance System contributes to the overall reliability and longevity of UPS batteries, making it a valuable asset for businesses and individuals reliant on continuous and dependable power supply.

KEYWORDS: UPS Battery, Distilled Water Filling, Maintenance

1. Introduction

The proposed system involves in the maintenance of the Lead Acid batteries by filling the distilled water in the battery cells. This system plays a major role in the field of battery maintenance especially the situation where the distilled water dries creates a huge impact in which the battery life gets reduced or the battery failure situation occurs. This system is a solution for that problem which occurs in the battery due to the distilled water. To enhance the backup capacity for household Electric Vehicle Uninterruptible Power Supply (EV-UPS), a thorough evaluation process is crucial. This involves assessing battery technology, charging infrastructure, and energy consumption patterns. Improvement strategies may include upgrading battery systems, optimizing charging schedules, and integrating renewable energy sources to ensure reliable and sustainable power backup for EVs in homes[1].An Internet of Things (IoT) approach is employed to automate the process of filling inventory batteries with distilled water. Sensors and connected devices monitor water levels in batteries, triggering automatic refills when needed. This smart system enhances efficiency, reduces maintenance costs, and ensures batteries are consistently maintained for optimal performance

[2].Integrating home automation with an uninterruptible power supply (UPS) for low-power household appliances enhances efficiency and reliability. The system enables remote control and monitoring of appliances, ensuring seamless operation during power outages. It optimizes energy usage, enhances convenience, and safeguards critical devices, making it an intelligent solution for modern homes[3].Line-interactive Uninterruptible Power Supply (UPS) systems with Shunt Active Power Filter (SAPF) function employ voltage regulation, battery backup, and active filtering to enhance power quality. Control methods include real-time monitoring of voltage and frequency, battery charging and discharging management, and active filtering algorithms to mitigate harmonics and voltage distortions, ensuring reliable and clean power supply during utility disturbances [4].HDAC6 plays a crucial role in preventing neurodegeneration by serving as a vital connection between two cellular processes: autophagy and the ubiquitin-proteasome system (UPS). It helps maintain neuronal health by facilitating the efficient clearance of misfolded proteins, which is essential for preventing neurodegenerative diseases[5].An automatic battery water topping device is a system designed to maintain optimal water levels in battery cells. It senses water levels and adds distilled water as needed, preventing electrolyte imbalance and extending battery life. This technology is commonly used in industrial applications and backup power systems to ensure the consistent performance and longevity of lead-acid batteries [6]. Lead-acid batteries are a widely used type of rechargeable battery known for their reliability and affordability. They employ lead dioxide and sponge lead electrodes immersed in sulfuric acid electrolyte. They are commonly used in vehicles, backup power systems, and industrial applications. While they have a lower energy density compared to some newer battery technologies, they remain popular due to their well-established and cost-effective technology [7].UPS (Uninterruptible Power Supply) battery life characteristics refer to the key factors influencing the longevity of UPS batteries. These include temperature, cycling frequency, depth of discharge, and maintenance practices. Proper management of these factors can significantly extend battery lifespan, ensuring reliable backup power for critical applications while minimizing replacement costs and environmental impact [8].The Charge Equalizer is an innovative system designed to prolong the lifespan of batteries in photovoltaic and UPS systems. By balancing charge distribution among battery cells, it mitigates uneven wear and tear, optimizing overall battery health. This technology increases the longevity of batteries, reduces maintenance costs, and enhances the reliability of energy storage in solar setups and uninterruptible power supplies (UPS)[9].The UPS Battery Monitoring System employs battery and supply changeover mechanisms to ensure uninterrupted power supply. It constantly monitors battery health and power input sources. When necessary, it seamlessly switches power sources and alerts users to battery issues, preventing downtime and maintaining critical operations' reliability. This system enhances power management, safeguards against outages, and optimizes UPS performance [10].From these studies the system has been developed and the system contributes much in the field of maintenance of the Lead acid batteries. This system particularly focuses on the distilled water filling as an automated system which operates entirely without human intervention. The project completely runs on the basis of the points that were obtained from the study which played a major role in creating this system.

2. Existing System

The existing systems for distilled water filling vary widely in complexity and scale depending on the application. In many cases, traditional methods involve manual labor to fill distilled water to pour into the battery cells , where operators oversee the filling

process, monitor water levels, and manually control valves.In this process humans have to fill the cells manually which can't be done every single time if there is nobody available in the place where the battery is kept. This approach is labor-intensive, potentially leading to inconsistencies in water quality due to human error. In more advanced setups, semi-automated machines may be employed, but they often lack the scalability and precision offered by modern automation technologies. Maintaining these systems can also be challenging, as they may require frequent manual adjustments and maintenance checks. As a result, there is a clear need for improved solutions that enhance efficiency, reduce labor dependency, and ensure consistent water quality, which the proposed automatic distilled water filling system aims to address.This system completely solves the issues created by the traditional method, such as overfilling and the effort taken by the human to accomplish the filling of the distilled water in battery cells.

3. Proposed Solution

Our proposed solution leverages the power of ESP8266, Solenoid Valve, Float Switch, and IR Sensors to create an efficient and precise automatic distilled water filling system. This system is designed to address the challenges associated with manual filling, ensuring water purity, reducing labor involvement, and enhancing scalability and maintenance. ESP8266 Micro-controller serves as the brain of the system, controlling the entire process and also linked with the sensors which get signals from them and also held a wifi module on its own which helps in notifying the user.Solenoid Valve controls the flow of distilled water into the containers and is activated or deactivated by the ESP8266 which receives the inputs from the IR sensors and provide instructions to the solenoid valve.Float Switch is placed in the distilled water container, it detects the water level in container which stores the distilled water in it. When the water reaches a specified level, it sends a signal to the ESP8266 to stop the filling process.IR Sensors are used for precise detection in the mechanical level indicator which is placed in front of indicator.They ensure that battery cell distilled water level by sensing the mechanical level indicator position. The system starts by initializing the ESP8266 which act as the heart of the system and calibrating the IR sensors to detect the mechanical level indicator's presence.The Esp8266 contains of WiFi-module, Blynk IoT which act as a user interface can be implemented, either through other mobile app allowing users to monitor the filling process remotely.The user would receive mobile notification or Email through this application.When a mechanical level indicator is detected and properly aligned by the IR sensors, the ESP8266 activates the Solenoid Valve.The valve opens, allowing distilled water to flow into the container.The Float Switch continuously monitors the water level. Once the water reaches the desired level, the Float Switch sends a signal to the ESP8266.The system is easily scalable to accommodate different mechanical level indicator sizes and quantities by adjusting settings through the user interface.Maintenance is simplified through remote monitoring capabilities, allowing for real-time diagnostics and troubleshooting. The real time diagnostics and troubleshooting involves the alert given when the water level in the tank is low or when the electrolyte levels are low in the battery cells. Efficient and precise filling process.Enhanced water purity through placing filtering cloth in both ends of the connecting pipes and reduced human interaction.Reduced labor dependency and costs.Scalable to meet changing production demands.User-friendly interface for customization and remote monitoring.Data logging for quality control and analysis.

3.1 Need of Automation

There are many incidents occurred in the Ups battery system while filling distilled water in the cells of the Ups battery like uneven filling ,over filling of higher then the level capacity of the cell which makes the battery life lesser than the usual period of time.So,our goal in the project is to fill distilled water automatically in the battery at the permitated level into the battery cell.

3.2 Advantages

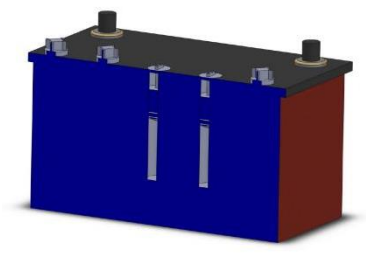
The controlling operations of automatic distilled water filling system is to be easy and simple. The system can automatically fill distilled water in the battery cells. So, we can improve the battery performance. At the same time, the system can control and intimate the user by notifying the level of the cell and also the level of the distilled water in the storage tank which is placed above the Ups battery.

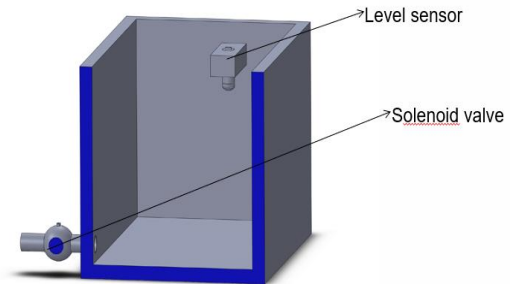
4.Design Specification

The automatic distilled water filling system will feature a robust and compact design, suitable for various industrial settings. It will consist of an ESP8266 microcontroller as the central control unit, coordinating the operation of Solenoid Valves, Float Switches, and IR Sensors. The system will be equipped with precision calibration mechanisms to ensure accurate level indicator detection and water level monitoring. A user-friendly interface blynk IoT, either through a mobile app or web-based dashboard, will facilitate customization of mechanical level indicator and remote monitoring.The container sizes-30x20 and quantities is upto 2 liters. Safety features will include emergency shutdown protocols and fail-safes to prevent overfilling and maintain water quality. The system will be scalable, allowing flexibility to accommodate different container sizes and quantities. Proper waterproofing and protection measures will be incorporated to ensure reliability and durability. Data logging capabilities will be included to record key parameters for quality control and analysis. Ease of maintenance, with clear documentation and user training, will be integral to the design. Overall, the system's design will prioritize efficiency, accuracy, scalability, and user-friendliness while maintaining water purity and safety.

4.1 CAD Modelling

The design phase is the most crucial for any product. SolidWorks software was used to design this model. The part drawings are initially created to the desired dimensions, and the parts are subsequently assembled. 3D model Distilled water filling system in battery cells are shown in Fig. 1. SolidWorks' simplicity of use as a work environment is the primary factor in choosing it over AutoCAD. The motors' step-by-step actuation is shown in vivid detail. Every product has a design phase, which is its most important stage. Utilizing the software SolidWorks, this model was created. SolidWorks were chosen over AutoCAD because of the issues with the latter's working environment. AutoCAD is the simpler tool to use if a total beginner was to compare the two, and after gaining a basic understanding of 2D drafting, the user might advance to 3D modelling and more complicated designs that would contain several parts, assemblies, and animations.





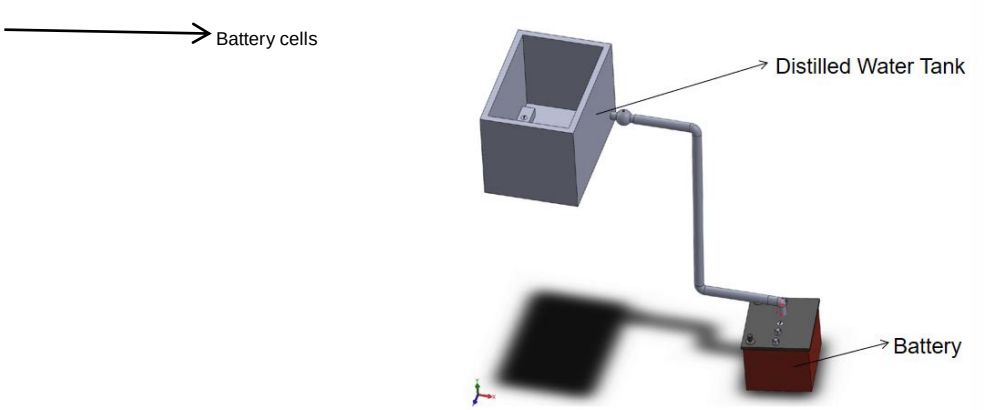


Fig. 1 3D model of Ups maintenance system

5. Methodology

The implementation process commences with the careful hardware setup, encompassing the mounting of ESP8266 controllers, establishment of electrical connections, and precise calibration of Solenoid Valves, Float Switches, and IR Sensors to ensure accurate container detection and water level monitoring. Subsequently, the software development phase involves programming the ESP8266 microcontrollers to interface seamlessly with the sensors, execute control algorithms, and optionally create a user interface, with a particular focus on remote monitoring and data logging functionalities. Rigorous testing follows, encompassing various scenarios to validate the system's performance, safety mechanisms, and water quality compliance. The deployment phase includes the installation of the system in the production environment, accompanied by comprehensive documentation and operator training. Ongoing monitoring, including data analysis, ensures continuous improvement and adherence to quality standards.

5.1 Mechanism of The System

The workflow of the system consists of stages of the process. Figure 2 shows the process, the first stage is that there is distilled water tank which is placed higher position of the battery and the distilled water is flows towards the solenoid valve and also a float switch placed on the tank. The float switch is connected with both of solenoid valve and Esp8266 which allows to monitor the water flow and also indicates to the user by indicator or notification through mobile. The solenoid is directly connected to the Battery for refilling.

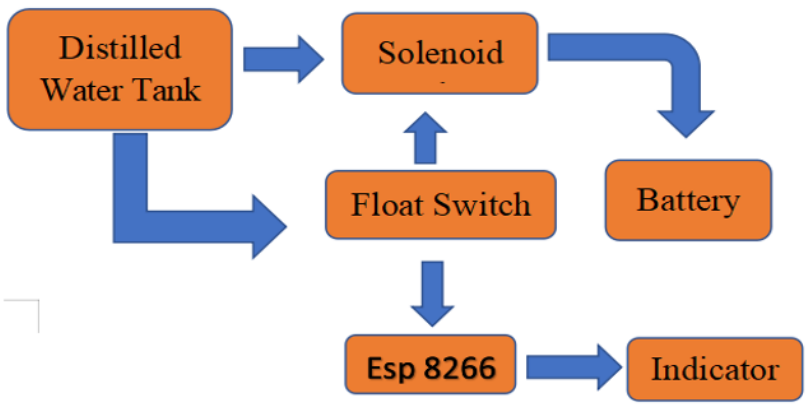


Fig.2 Flowchart showing working of automatic distilled water filling system.

5.2Automatic Distilled water filling system

The figure3 shows the construction and integration of the setup and the distilled water flow from the higher position from the storage tank to individual battery cells .

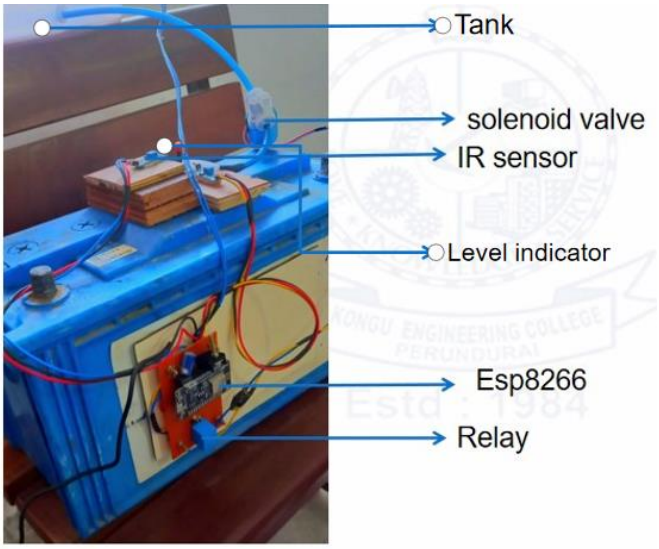


Fig.3 Automatic distilled Water filling setup

5.3 Electrical Section

In an electrical setup, load analysis is paramount for assessing power needs and circuit safety. Thoroughly calculating device power requirements ensures circuits can handle loads without overloads. This electrical section shows the connectivity of the devices like the solenoid valve,float switch, controller etc., where the actuation of the system is controlled by the input given to the controller and the signal will be transmitted to the solenoid valve or the float switch according to the progress of the system. Integrating energy-efficient elements like LED lighting and renewables enhances sustainability and cost-effectiveness. Safety measures such as GFCIs and AFCIs prevent electrical hazards. Incorporating smart technology allows real-time monitoring and remote control, optimizing efficiency and reliability. Prioritizing these aspects ensures a well-balanced electrical infrastructure capable of meeting power needs efficiently and safely. The electrical section shows in Figure 4.

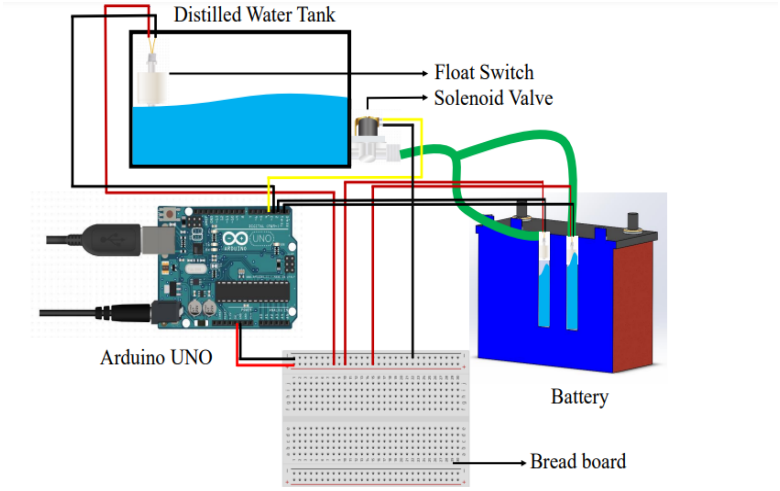


Fig.4 Electrical section

6.Conclusion

The development and implementation of an automatic distilled water filling system for UPS batteries represent a significant advancement in ensuring the reliability and longevity of these critical power backup solutions. The literature survey reveals a growing interest in this field, with researchers exploring various innovative approaches, from sensor-based monitoring to automated filling mechanisms and remote control systems. These efforts are poised to alleviate the challenges associated with manual maintenance, reducing the risk of battery failure and enhancing the overall performance of UPS systems. As technology continues to evolve, it is evident that automatic distilled water filling systems will play an increasingly pivotal role in maintaining uninterrupted power supply for essential applications, underscoring their importance in modern infrastructure and critical systems.

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