



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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PLC Based Electric Vehicle Battery Swapping and Battery Parameters Monitoring

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ABSTRACT: Transport is a fundamental requirement of modern life, but the traditional combustion engine is quickly becoming outdated. Petrol or diesel vehicles are highly polluting and are being quickly replaced by fully electric vehicles. Fully electric vehicles (EV) have zero tailpipe emissions and are much better for the environment. The running cost of an electric vehicle is much lower than an equivalent petrol or diesel vehicle. Electric vehicles use electricity to charge their batteries instead of using fossil fuels like petrol or diesel. Electric vehicles are more efficient, and that combined with the electricity cost means that charging an electric vehicle is cheaper than filling petrol or diesel for your travel requirements. So far, almost all EVs have relied on wired charging solutions in which drivers plug in a cable to recharge the car's battery. But wireless or automated charging holds vast potential to make EV ownership more convenient, cost-effective, and appealing for drivers and fleet operators.

Today, vehicles are charged at home or, in the case of fleets, at the owner's place of business. Tomorrow, they'll be charged in a variety of additional places, including at work, at the store, on the street and in places of interest. The provision of wireless electric vehicle charging points at these locations may increase employee/customer loyalty, attract new customers, and encourage wider adoption of wirelessly charged vehicles in larger population centres, thus reducing air pollution. Ideally, vehicles can be charged whenever and wherever they are parked and EV owners should not have to concern themselves with the grid connection, which will happen automatically.

KEYWORDS – Electric Vehicle, Battery Swapping, PLC, Arduino UNO,

I. INTRODUCTION

The growing demand for electric vehicles (EVs) has led to the need for efficient and convenient charging solutions. One promising solution is battery swapping, where depleted EV batteries are exchanged for fully charged ones at dedicated stations. To automate and streamline this process, Programmable Logic Controllers (PLCs) are employed. This report provides an overview of PLCbased electric vehicle battery swapping systems and discusses key battery parameters. The adoption of electric vehicles (EVs) is on the rise due to increasing environmental concerns and government initiatives promoting sustainable transportation. However, the limited range and long charging times of EVs have been significant challenges. Traditional charging infrastructure, relying on plug-in charging, requires substantial time for recharging, hindering the widespread adoption of EVs. To overcome these limitations, battery swapping has emerged as a promising alternative.

II. METHODOLOGY

PLC-Based Electric Vehicle (EV) Battery Swapping is a process that involves the automated exchange of depleted EV batteries with fully charged ones. Programmable Logic Controllers (PLCs) are used to control and coordinate the battery swapping operations. Here is a general methodology for PLCbased EV battery swapping:

- **Battery Identification:** Each EV battery has a unique identification code or serial number. The PLC system reads this code to identify the battery to be swapped.
- **Battery Status Check:** The PLC system performs a series of checks to ensure the safety and operability of the battery. These checks include voltage level, temperature, state of charge, and overall battery health.



- **User Authentication:** The user's identity and access rights are verified before initiating the battery swapping process. This may involve scanning an identification card or entering a password.
- **Battery Removal:** The PLC system controls the robotic mechanism or conveyor system to safely remove the depleted battery from the EV. It ensures that the electrical connections are disconnected, and the battery is securely held during removal.
- **Battery Transport:** The depleted battery is transported to a designated area where it can undergo charging or further maintenance.
- **Battery Insertion:** A fully charged battery is retrieved from the charging area or battery storage and transported to the EV for insertion. The PLC system ensures that the electrical connections are properly aligned and connected.
- **Battery Verification:** The PLC system verifies the successful insertion of the new battery by checking the electrical connections and conducting initial status checks.
- **System Reset:** Once the battery swapping process is complete, the PLC system resets the charging system and updates the EV's information to reflect the newly installed battery.

PLC-based Electric Vehicle Battery Swapping Systems

PLCs are computer-based control systems that are widely used in industrial automation. In the context of battery swapping systems, PLCs play a crucial role in controlling and coordinating various components involved in the process. These systems typically consist of the following key elements:

- **Swapping Stations:** Swapping stations are equipped with multiple battery modules, each containing several individual batteries. These stations serve as the central hub for battery swapping operations.
- **Battery Management System (BMS):** Each EV battery is equipped with a BMS, which monitors and controls its charging and discharging operations. The BMS communicates with the PLC to provide real-time data about the battery's status, health, and energy capacity.
- **Robotic Arm or Conveyor System:** A robotic arm or conveyor system is employed to handle the battery swapping process. The PLC coordinates the movement and positioning of the robotic arm or conveyor system to ensure precise and efficient battery swapping.
- **Human-Machine Interface (HMI):** The HMI provides an interface for users and operators to interact with the battery swapping system. It allows EV owners to initiate the swapping process, provides instructions and status updates, and handles payment transactions.
- **Communication Network:** A reliable communication network is essential for exchanging data between the PLC, BMS, HMI, and other components of the system. This network enables real-time monitoring, control, and coordination of the battery swapping process.

BLOCK DIGRAM

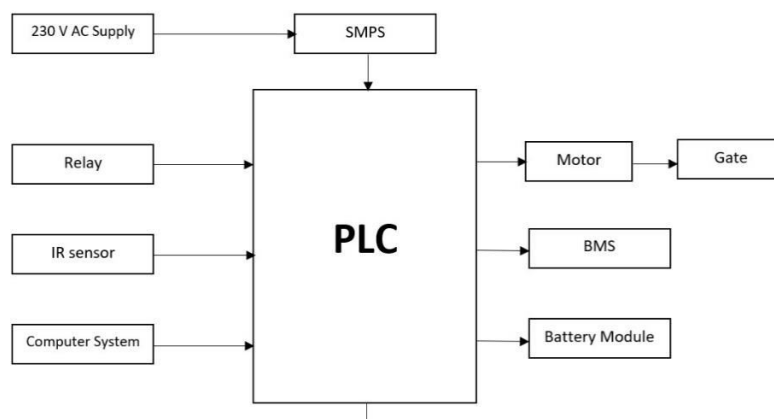


Fig: Block Diagram Of PLC Based Battery Swapping Station

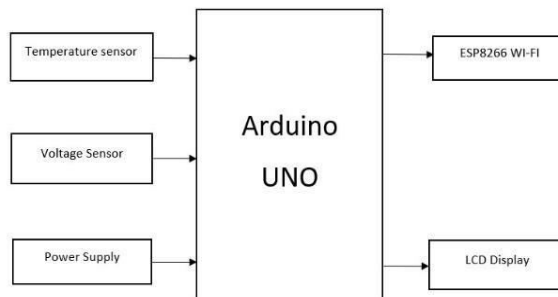


Fig:Block Diagram Of Arduino Based Battery Parameter Monitoring

SOFTWARE DETAILS

1. **PLC** - A programmable logic controller (PLC) or programmable controller is an industrial computer that has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, machines, robotic devices, or any activity that requires high reliability, ease of programming.
2. **Things to speak** – Thing Speak provides a cloud based IoT platform that allows users to collect, analyze, and visualize data from internet-enabled devices. It offers an API for developers to send and retrieve data from IoT devices, as well as a web interface for data visualization and analysis. Users can create channels to store and organize their data, and they can also share their data with others or integrate it with social network websites.
3. **Arduino** - The Arduino software, which includes the Arduino IDE (Integrated Development Environment), libraries, and programming language, is released under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL). These licenses permit the distribution and modification of the Arduino software by anyone, ensuring that the software remains open-source.

HARDWARE DETAILS

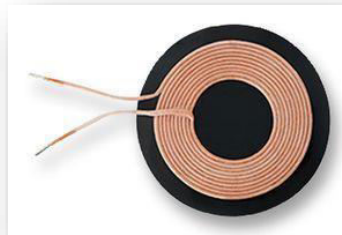
1 IR Sensor - An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum).



2 Relay - A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.



3 Wireless Charging Coils - Wireless charging coils produce an alternating electromagnetic field (EMF) used to transfer energy via induction to another coil that is placed parallel and nearby. You can use this power to operate the gadget getting the energy or to charge a battery.



4 NODE MCU - The Node MCU (Node Micro Controller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. Node MCU is a low-cost open source IOT platform. NODE MCU provides access to the GPIO and a pin mapping table is part of API documentation.



5 Smoke Detector - A smoke alarm is critical for the early detection of a fire in your home and could mean the difference between life and death. Fires can occur in a variety of ways and in any room of your home. But no matter where or how, having a smoke alarm is the first key step toward your family's safety.

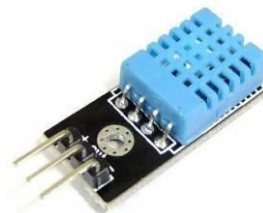


6 Flame Detector - The sensors in the flame detector will detect the radiation that is sent by the flame, the photoelectric converts the radiant intensity signal of the flame to a relevant voltage signal and this signal would be processed in a single chip microcomputer and converted into a desired output.



7 Transmitter Coil and Receiver Coil - Wireless charging needs two kinds of coils named the transmitter coil and the receiver coil. The receiver coil will collect power from the transmitter coil while going over it in the means of mutual induction. But the variation of distance between two adjacent coils affects the wireless power transfer (WPT).

8 Temperature Sensor - Temperature sensors are devices that detect and measure coldness and heat and convert it into an electrical signal. Temperature sensors are utilized in our daily lives, be it in the form of domestic water heaters, thermometers, refrigerators, or microwaves.



9 GPS - The Global Positioning System (GPS) is a U.S.-owned utility that provides users with positioning, navigation, and timing (PNT) services. This system consists of three segments: the space segment, the control segment, and the user segment.



IV. FUTURE SCOPE

- Electric vehicle has enormous future potential. The charging station is the obvious starting point for these vehicles. However, this is only the first step in a potentially long journey that will include charging banks and other industrial areas, as well as homes and cities.
- One of the most important aspects is the power source, and the global market segmentation is thoroughly examined. Electric vehicles today use a variety of power sources, including wind power, solar power, and hydroelectric power. The majority of these technologies have emerged in Africa. Morocco, South Africa, Tanzania, Namibia, Zimbabwe, and Brazil are among the countries that have developed these technologies. It should be noted that all of these countries have very low fuel costs, which means that installing a charging system on cars is very affordable.
- All over the world, batteries have been the primary concern. Lithium-ion batteries are replacing traditional alkaline batteries as technology advances. This has presented a significant challenge to the manufacturers. The market research report provides information on the major key players in this industry as well as the various strategies they are employing to overcome the challenges.
- Electric vehicle technology has existed in labs such as NASA since the 1970s. In a few years, current technology will undoubtedly be far more advanced.
- EVs are even expected to power themselves by harvesting energy from their surroundings. Such vehicles will require little maintenance and may even be powered by renewable energy sources such as wind. It will also be interesting to see the impact of EU and US regulations that will go into effect. These regulations are intended to reduce the use of gasoline-powered vehicles. As the popularity of electric vehicles grows so will the need to reduce their use. It is obvious that new zeroemission technologies will be required.

APPLICATION

PLC (Programmable Logic Controller)-based electric vehicle (EV) battery swapping systems offer several advantages in terms of efficiency and convenience. These systems involve the use of PLCs to automate the process of removing discharged batteries from EVs and replacing them with fully charged ones. Here are some key applications and battery parameters associated with PLC-based EV battery swapping:

Efficient Battery Swapping: PLC-based systems enable quick and automated battery swapping, reducing the time required for the process. This is particularly useful in applications where fast turnaround is necessary, such as fleet operations or shared mobility services.

Increased Charging Availability: Instead of waiting for a single EV to charge, battery swapping allows for continuous operation as discharged batteries are replaced with charged ones. This improves the availability of EVs for use, especially in highdemand scenarios.

Scalability and Flexibility: PLC-based battery swapping systems can be easily scaled to accommodate a large number of EVs. The modular nature of the system allows for flexible expansion as the fleet size grows, making it suitable for various applications.

Battery Health Monitoring: PLCs can be programmed to monitor battery parameters during the swapping process. This includes parameters such as voltage, current, temperature, and state of charge. By continuously monitoring these parameters, the system can identify and reject batteries that do not meet the desired performance or safety criteria.

Battery Authentication and Identification: PLCbased systems can integrate authentication mechanisms to ensure that only authorized batteries are swapped. Each battery can be uniquely identified using RFID (Radio Frequency Identification) or other identification technologies, preventing the use of counterfeit or incompatible batteries.



Battery Performance Analysis: The PLC can collect and analyse battery data over time, providing insights into battery performance, degradation, and health. This information can be used for predictive maintenance, optimizing battery life, and identifying patterns or anomalies in the performance of different batteries.

Safety and Fault Detection: PLCs can be programmed to implement safety protocols and detect faults during the battery swapping process. This includes monitoring for abnormal battery behaviour, such as excessive heat generation or voltage irregularities, and initiating appropriate safety measures.

Energy Management: PLC-based systems can integrate with the power grid or renewable energy sources to optimize charging and swapping operations based on energy availability and demand. This enables efficient utilization of energy resources and can contribute to load balancing and peak shaving strategies.

V. CONCLUSION

Programmable Logic Controllers (PLCs) play a crucial role in automating the battery swapping process and monitoring important battery parameters. This paper provides a comprehensive analysis of PLC-based electric vehicle battery swapping systems, with a specific focus on the role of PLCs in automating the swapping process and monitoring key battery parameters. The study highlights the significance of battery parameters such as State of Charge (SoC), voltage, current, temperature, and battery identification. By delving into the functionality of PLCs and the importance of battery parameters, this paper aims to enhance understanding and promote the implementation of efficient and reliable electric vehicle battery swapping systems.

- PLC-based electric vehicle battery swapping systems offer an efficient and reliable solution to address the limitations of traditional charging infrastructure. By automating the swapping process and monitoring crucial battery parameters, PLCs play a pivotal role in ensuring safe and seamless battery exchanges.
- The comprehensive analysis presented in this paper enhances understanding and promotes the implementation of efficient and reliable electric vehicle battery swapping systems. Further research and development in this field will continue to advance the adoption of electric vehicles and contribute to a sustainable transportation future.
- The charging systems are the area in which the report outlines the future scenario. The majority of vehicles today have an electrical charging system. The size of the battery pack is determined by the user's electricity consumption.
- The global market segmentation provides information on charging systems and the reasons why manufacturers have chosen to use them or not. The electric vehicle industry is growing at an unprecedented rate and is always looking for ways to make it more sustainable. Many opportunities are being created for large and small industries as a result of vehicle decarbonization. It will be remembered not only for its environmental sustainability but also for its economic and technological transformation in the long run.

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INNO SPACE
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Impact Factor: 8.423



ISSN INTERNATIONAL
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