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SMART ELECTRIC VEHICLE CHARGER AND CONTROLLER

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ABSTRACT
This study has been undertaken to investigate the growing prominence of electric vehicles (EVs) necessitates advanced safety measures for battery systems and charging infrastructure. To address safety concerns, a sensor-based battery protection system is proposed, offering real-time monitoring of battery status, temperature regulation, controlled charging, and discharge display. Additionally, it facilitates locating nearby charging stations, presenting distance, and directions. Meanwhile, the demand for safer and more efficient EV chargers rises, emphasizing the need for comprehensive safety features to mitigate risks like overcurrent, overvoltage, overheating, and electrical hazards. This solution strives to enhance EV safety, sustainability, and user accessibility.

Keywords:
Battery, charge controller, depth of discharge (DOD), state of charge (SOC), rectifier bridge, relay module, step-up & step-down transformer.

INTRODUCTION

The transportation industry has seen a change thanks to electric vehicles (EVs), which also portend an era of eco- friendly and efficient mobility. But the exponential rise in EV use has highlighted how urgently we need dependable, secure, and easy-to-use EV controls and chargers. Though promising, there are still issues, particularly about cost- effectiveness, environmental sustainability, and most importantly, making sure the charging systems have complete safety measures. Safety concerns have gained more prominence as the EV market grows. Events like battery fires in electric vehicles have sparked concerns about the viability of EV technology by 2022, especially about efficiency and safety. These events, which are frequently ascribed to battery explosions or fires, emphasize how urgently safety precautions inside the charging infrastructure must be improved. To overcome these obstacles, creative solutions strengthening the effectiveness and safety of EV charging infrastructure are needed.

A possible option is to put in place a thorough system that is specifically made to protect batteries from anything that could start a fire. Numerous benefits targeted at reducing hazards and improving user experience are present in this system. This system's battery status monitoring and display feature, which offers current battery information, is one of its most important features. Important parameters including the state of charge, depth of discharge, charging status, and remaining charging time are included in this. Furthermore, the system integrates sophisticated charging algorithms to customize the charging procedure based on certain input factors, maximizing effectiveness and lowering hazards. An essential component of guaranteeing safety when charging is temperature monitoring. order to reduce the risk of fire, the system is outfitted with automated cutoff mechanisms that avert overcharging, overvoltage, and overheating. Additionally, it provides thorough insights into the charging and discharging statuses, giving customers all the knowledge, they need to make well-informed decisions. Furthermore, the system's capabilities extend beyond simple charging. To improve the ease and accessibility of EV charging, it has functions including estimating the remaining range depending on the current charge, pointing users in the direction of local charging stations, and giving distances and instructions. The charge controller, an essential part that controls the amount of electricity provided to the car's battery, is at

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the center of this safety system with the use of pulse width modulation technology, this controller defends against overvoltage problems and stops overcharging.

OBJECTIVES

The main objective of the study is to identify the challenges in the implementation of the newly adopted Electric vehicles surely are the future of transportation, but EV technology has not been fully developed with respect to efficiency and safety as of 2022. We come across electric vehicle battery fire and similar incidents as the EV market expands. Most electric vehicle fire incidents occur due to battery blast or fire. So here we attempt to solve the problem by using below some of these advantages. The system is designed to protect batteries from various parameters that may incite a fire.

This System provides the following objectives are:

- Battery Status Monitoring and Display
- Charging of Battery as per required input parameters
- Temperature monitoring with auto cutoff
- over charge turn off method and also it will display the battery charging and discharging
- state of charge and depth of discharge
- Charging remaining & distance (kms) to be travelled
- Locate the nearby Charging Station & Provides distance & direction.

METHODOLOGY

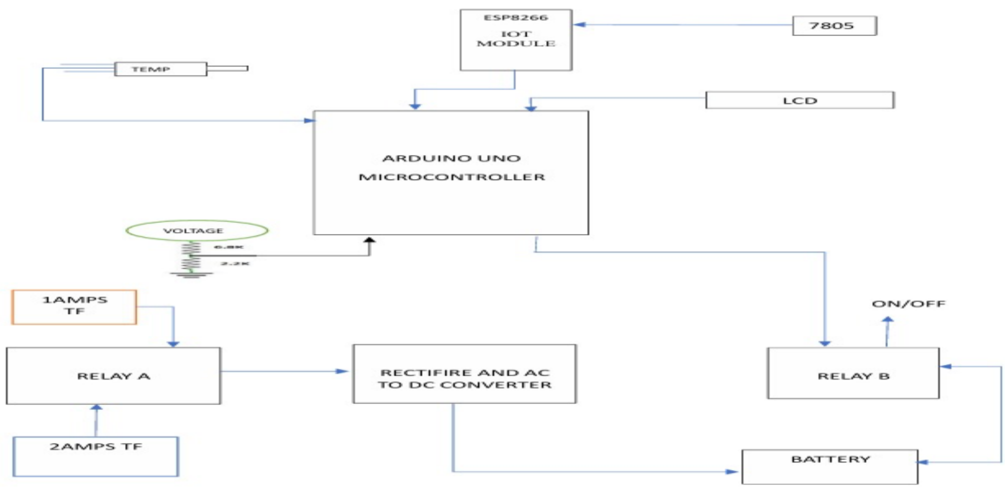

Figure (1) block diagram of Smart Electric Vehicle Charger and Controller

The Arduino Uno microcontroller is the main element and block diagram of the circuit seen in Figures (1). It performs the role of the system's brain, managing several operations. In order to interpret data and carry out orders, the Arduino interfaces with other modules and sensors. The Arduino and temperature sensor are directly linked. It gauges the battery's temperature. Another essential element is the ESP8266 IoT module. It offers wireless communication as well as internet access. To send and receive data via the network, the Arduino and ESP8266 connect with one another. The ESP8266 and an LCD obtain the proper voltage thanks to the 7805-voltage regulator. By regulating the voltage supply, it shields linked components from harm. The Arduino and LCD (Liquid Crystal Display) are linked. It probably displays pertinent data, including sensor readings, system status, or user prompts. Switch A connected by a transformer (1 amp TF) and a second transformer (2-amp TF), perhaps for alternating current (AC) load switching. attaches to an ac to dc converter and a rectifier. attaches to a

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switch for on/off use. used to regulate a different circuit component. attaches to a power source, or battery. AC voltage (from RELAY A) is converted to DC voltage using a rectifier and an AC to DC converter. Other parts of the circuit can be powered by the DC output. The system's full power supply comes from the battery. It provides power to the sensors, Arduino, and other devices that are attached.

The EV charger and controller, which transform AC power from an external source into DC power appropriate for the vehicle's battery, are essential parts of the charging system in two-wheeled electric vehicles (EVs). The vehicle and the power supply are connected through the EV charger. Using a rectifier circuit, the incoming AC power is first converted to DC power. A power factor adjustment stage then optimizes efficiency by adjusting the power factor. The voltage and current are then adjusted by the charger using a converter stage, which is often a switch-mode power supply, to the proper values for charging the battery. To guarantee security and lessen electromagnetic interference, isolation transformers and filters are also included in this step.The controller oversees the charging procedure concurrently. Interacting with the battery management system of the car and the charger. It uses a variety of sensors and algorithms to track temperature, voltage, and battery condition. The controller uses this information to optimize the charging parameters, dynamically modifying the voltage and rate of charge to maintain the longevity and good health of the battery. Both the charger and controller come with built-in safety features. To safeguard user safety and avoid damage to the battery, the charger is equipped with protective systems such as temperature monitoring, overvoltage protection, and overcurrent protection. In the meantime, the controller keeps an eye on a few factors and, if needed, gives the charger instructions to modify the charging procedure to prevent potentially dangerous scenarios like overcharging or overheating. Additionally, the controller allows for several charging modes. Higher currents are provided via the fast-charging mode for faster recharge times; slower charging modes, on the other hand, offer a more gradual charge that extends the battery's life. Furthermore, modern controllers may be equipped with networking features that enable over-the-air upgrades, diagnostics, and remote monitoring. Through communication with web services or smartphone apps, these controllers can give consumers information about their charging patterns, battery health, and even enable functions like charging session scheduling. To sum up, the EV charger and controller collaborate to transform and control the incoming power, guaranteeing an effective, secure, and optimized charging procedure for the batteries of two-wheeler electric cars. This ultimately improves the longevity of the batteries and the overall performance of the vehicle.

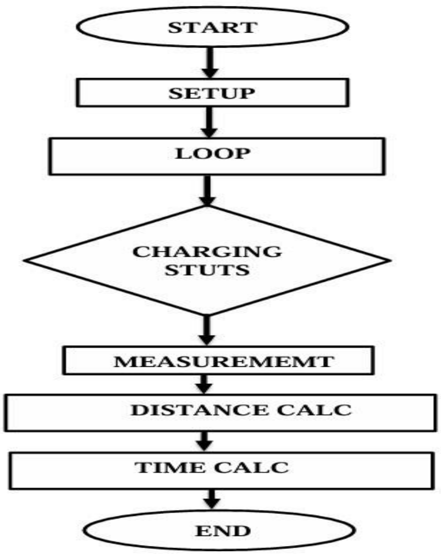

Figure of flow chart of Smart Electric Vehicle Charger and Controller

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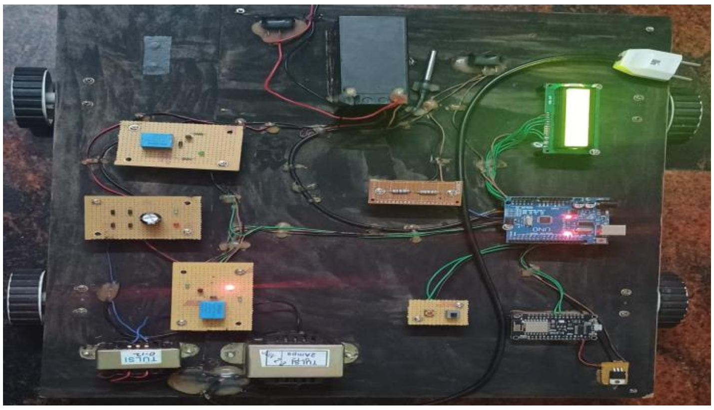
Start the program, Set up: In set, up Phase the program initializes various components such as LCD, Serial communication pins, for relays and begins communication with the sensors wait for 1 second, **Loop:** This is the main loop of the program where majority of the action takes place it continuously repeats until the program is stopped **.**Read the voltage sensor connected to a A0 pin and convert the analog reading to voltage. Display the voltage on the screen. Send the voltage data over serial communication, **Charging status**: Charging time the program determines the charging status (fast or slow) based on the input from digital pin 10 and 11 it controls the relay for charging accordingly and transients the charging status over serial communication, **Temperature measurement**: The program request temperature data from the temperature sensor(DS18B20) and display it on the LCD screens it also transients the temperature data over serial communication, **Distance calculation**: Calculate the distance travelled based on the voltage sensor reading display it on the LCD transient the distance data over serial communication, **Time calculation:** Calculate the time taken to full charge based on the voltage sensor reading display it on the LCD transient the distance data over serial communication, **End the program.**

RESULTS AND DISCUSSION



The above figure (3) shows the hardware implementation of smart Electric vehicle charger and controller.

- From this project we successfully developed a prototype of electric vehicle charger with controller.
- Battery Status is monitored and displayed on the LCD display.
- Charging of Battery as per required input parameters is done.
- Temperature is monitored with auto cutoff when battery temperature exceeds 40-50 degree Celsius.
- State of charge of the battery is monitored.
- Charging remaining & distance (kms) that could be travelled with the remaining charge is displayed on the LCD board.
- Provides the distance and direction of the nearby charging station.

READINGS DISPLAYED ON LCD:

Figure (4) Voltage supply to the battery and state of health of the battery is displayed

Figure (4) above illustrates the voltage supplied to the battery as well as its current condition of health. Voltage12.11, the primary measurement that shows the battery's current voltage level, is shown. A line with the

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notation "SOH=90%," which stands for "State of Health," appears beneath the voltage readout. This indicator indicates the battery's general state of health or condition.

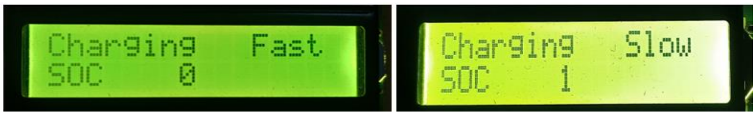

Figure (5) State of charge with fast and slow charging option is displayed

Above figure (5) shows the State of charge with fast and slow charging option is displayed. The image features two digital displays side by side, each indicating the state of charge of a battery during charging:

Left Display: "Charging Fast"

The SoC reading on this display is **0**.

This means the battery is completely discharged and is currently in a fast-charging mode.

Right Display: "Charging Slow"

The SoC reading on this display is **1**.

It indicates that the battery has started gaining charge but is still at a low level, now in slow charging mode.

Figure (6)Temperature of the battery displayed on the LCD board

The LCD board clearly shows the temperature; the number "32°C" represents the battery's current temperature in Celsius. The optimal temperature range for increasing longevity and useful capacity is usually 15°C to 35°C. It's important to remember that the battery can produce its maximum energy (greatest power output) at a temperature of about 45°C. The majority of lithium-ion batteries operate best between 59°F and 95°F (15°C to 35°C), despite battery manufacturers' claims that their products operate at their best in temperature ranges of 50°F to 110°F (10°C to 43°C). This is seen in figure (6) above.

Figure (7) Distance that could be travelled with the remaining charge is displayed

As seen in figure (7) the digital display screen indicates how far an electric vehicle (EV) can go on its current battery charge. The EV's maximum range with a fully charged battery is 6 kilometers, as shown by the numerical figure "6 KM." However, depending on variables like the particular EV model, battery level, driving style, and meteorological circumstances, this might vary greatly.

Figure (8)Output from thingspeak.com app showing state of health and state of charge of the battery

Output from thingspeak.com app showing state of health and state of charge of the battery as shown in fig (8).

State of Health (SOH) Chart:

The left chart is titled "STATE OF HEALTH."

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The Y-axis represents the “Charge” level, ranging from 0 to 100.

The X-axis shows dates from 22nd to 25th April.

A red line indicates that the charge remained constant at 100% throughout this period.

State of Charge (SOC) Chart:

The right chart is labelled “SOC” (STATE OF CHARGE).

The Y-axis represents “Voltage in Volts,” ranging from 0 to 1.

Again, the X-axis displays dates from 22nd to 25th April.

Another red line indicates that the voltage remained constant at one volt during the same time frame.

Both charts seem to show consistent values for charge and voltage over those specific dates.

Figure (9) Output from thingspeak.com app showing temperature and distance in km

Output from thingspeak.com app showing temperature and distance in km as shown in fig (9) .

Battery Temperature Chart :

The left chart, titled “Field 3 Chart,” represents the temperature of the battery.

The Y-axis is labelled “temperature,” ranging from 0 to 20.

The X-axis corresponds to dates from 22nd to 25th April.

A red line indicates that the battery temperature remained constant at 20 degrees Celsius throughout these days.

Distance Covered by EV Chart :

The right chart, titled “Field 4 Chart,” displays the distance covered by the electric vehicle in kilometres.

The Y-axis is labelled “distance in km,” ranging from 0 to 5.

Again, the X-axis shows dates from 22nd to 25th April.

Another red line indicates that the EV covered approximately five kilometres consistently during this time frame.

These charts provide valuable insights into the battery’s thermal behaviour and the

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EV's travel distance.

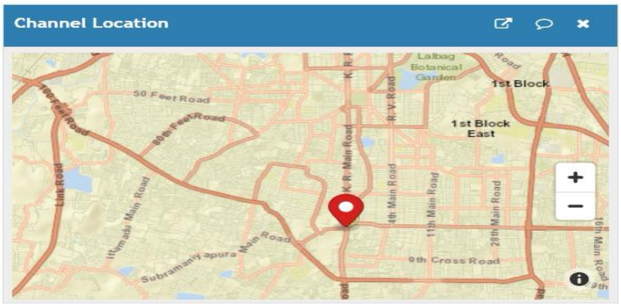

Figure (10) Location of the nearby charging station is displayed

A map displaying the location of a nearby charging station for electric vehicles. Here are the details as shown in fig (10).
Charging Station Location:
The charging station is marked with a red pin on the map.
It is situated near the intersection of Main Road and 9th Cross Road.
Other nearby landmarks include 50 Feet Road and 1st Block East.
Additionally, Lalbagh Botanical Garden is visible towards the north-east corner of the map.

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CONCLUSION

The integration of a controller into electric vehicle (EV) chargers significantly enhances the efficiency, security, and user experience of the charging process. The controller plays a crucial role in power flow management, optimizing charging parameters, and ensuring infrastructure reliability. It can dynamically change charging parameters based on user preferences, grid conditions, and battery health, addressing battery degradation and lifespan concerns. This also allows for smooth connections between the EV and the charging station, enabling real-time monitoring, smart charging features, and remote diagnostics. The controller also ensures safety by automatically adjusting parameters to minimize overheating and potential risks. The integration of a controller in EV chargers aligns with the global movement towards a more environmentally friendly and sustainable mode of transportation, presenting electric vehicles as a trustworthy and feasible choice for various consumers. In conclusion, the controller-equipped EV charger is a critical first step towards a smarter, more efficient, and user-friendly charging ecosystem, promoting the widespread use of electric vehicles in the future.

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