PORTABLE EV CHARGING SYSTEM WITH SHORT CIRCUIT DETECTION

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Introduction:

The increasing demand for **Electric Vehicles** (EVs) highlights the need for accessible and reliable charging infrastructure, especially in remote and underdeveloped areas where charging stations are limited or non-existent. The proposed project, **"Portable Electric Vehicle Charging System and Short Circuit Detection,"** addresses this challenge by offering a smart and portable EV charging solution designed specifically for emergency and remote scenarios

To understand the project in a real-world context, consider a situation where a vehicle is traveling a distance of 400 kilometres from Point A to Point B. After covering 300 kilometres, both EV batteries may become fully discharged, leaving the driver stranded with no nearby charging facility in immediate reach — the nearest station being 20 kilometres away. In such cases, the proposed system uses **Dijkstra's algorithm** in combination with **GPS (Neo M8N)** to locate the nearest EV charging station. Once the nearest station is identified, the system initiates a call through the **GSM 900A** module to alert the station master. Upon receiving the call, the station master is provided with the vehicle's precise location, and a support vehicle equipped with a wireless and portable charging setup is dispatched to the stranded EV. Charging session details, including energy delivered and vehicle identity, are recorded using an **RFID card** system and stored in an **Excel sheet** for record-keeping and analysis. In parallel, the project also introduces a Short Circuit Detection System to improve vehicle safety.

Market research and recent case studies reveal that many EV fires occur due to undetected internal wiring short circuits. To counter this, the system uses transistors and buzzers to detect when the phase and neutral wires come into unintended contact. Upon detection, an immediate audio alert is triggered to warn the driver, helping prevent potential damage or fire incidents.

To implement these features, the system is built around an Arduino Uno microcontroller, integrating components like the L298 Motor Driver, Bluetooth modules, Tesla coils for wireless charging, GSM and GPS modules, and the short circuit detection unit. By addressing the twin challenges of EV charging accessibility and vehicle safety, the proposed system presents a comprehensive solution suited for remote areas, emergency response scenarios, and off-grid environments where traditional EV infrastructure is lacking**.**

Objectives:

- To develop a portable **EV charging system** capable of delivering emergency power in **remote locations** where **charging stations are unavailable**.
- To implement GPS and **Dijkstra's algorithm** to identify and locate the **nearest EV charging station** based on vehicle location.
- To design a **GSM-based alert** system that notifies station authorities and shares the real-time location of stranded vehicles.
- To **detect internal short circuits** using a **transistor-based circuit** and provide immediate audio alerts via a **buzzer** to enhance vehicle safety.
- To integrate **RFID technology** to log charging data into an **Excel sheet** for monitoring and maintaining vehicle **service records**.

Methodology:

Methodology refers to the systematic, theoretical analysis of research methods within a field, encompassing research design, data collection, sampling, data analysis, ethical considerations, and validity and reliability. It provides a framework for collecting, analysing, and interpreting data. This ensures the research is methodologically sound and credible.

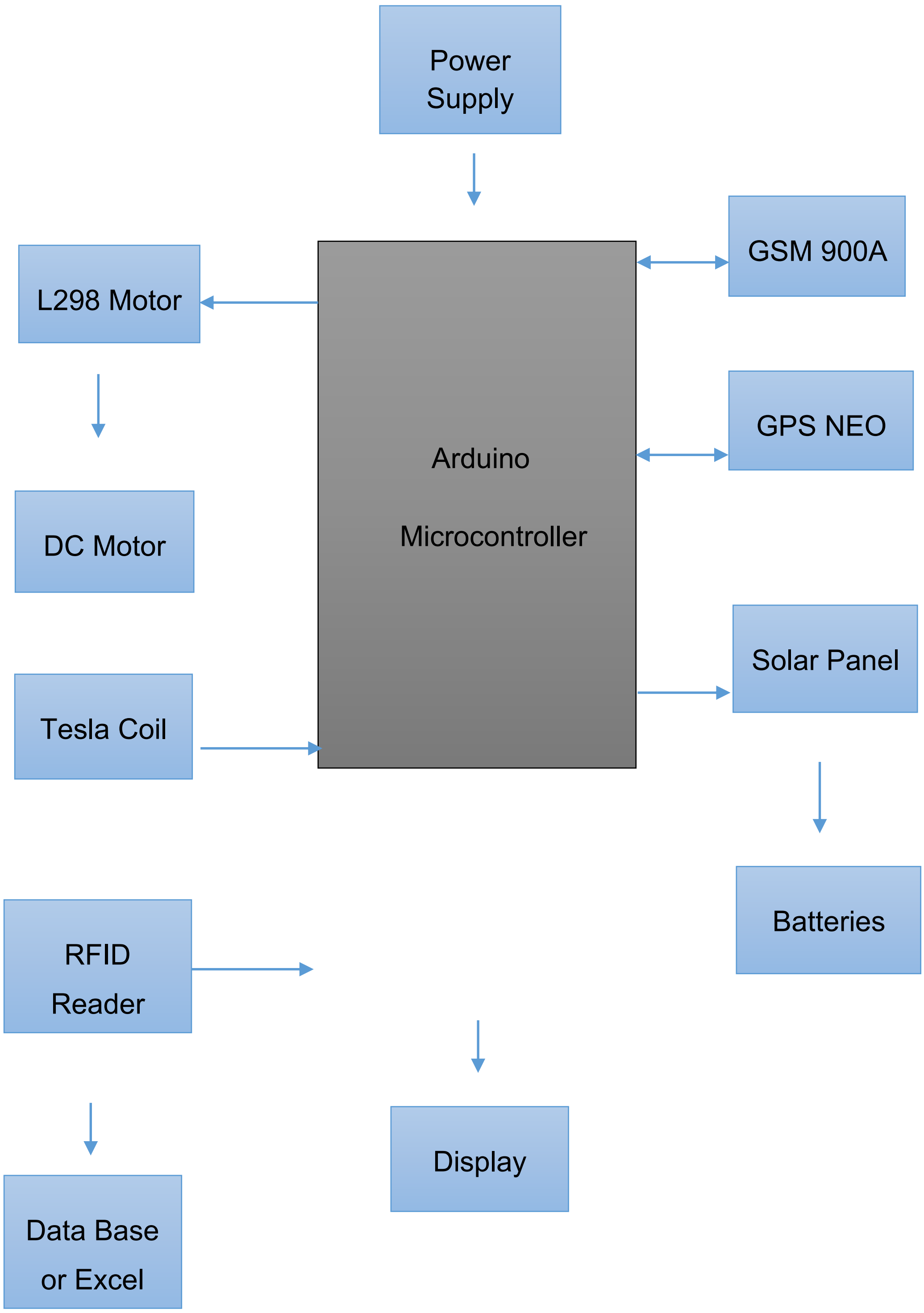

Fig 1 Block Diagram

The project focuses on two major aspects: portable EV charging in remote areas and short circuit detection to enhance safety in electric vehicles. The hardware setup is built around an Arduino Uno microcontroller, which acts as the central control unit. A GPS module (Neo M8N) is used to continuously track the location of the EV. When the battery is fully discharged, the system fetches the real-time coordinates of the vehicle.

- To identify the nearest charging station, the system uses Dijkstra's algorithm, which calculates the shortest path from the vehicle's location to the closest EV station among predefined coordinates.
- Once the nearest station is identified, the GSM module (SIM900A) is activated. It sends a call or SMS to the station master, including the live GPS location of the stranded vehicle. After receiving the alert, the station master dispatches a support vehicle equipped with a portable and wireless EV charging setup, including Tesla coils.
- The dispatched vehicle reaches the stranded EV and charges it wirelessly. For logging and authentication, the user taps an RFID card before the charging session begins. Charging details such as time, duration, and energy used are saved to an Excel sheet via the RFID module, enabling data tracking for future reference.
- To ensure safety, a short circuit detection unit is integrated. This unit uses a transistor-based circuit to detect any internal short caused by contact between phase and neutral wires. When such a condition is detected, the transistor changes its state and triggers a buzzer, alerting the driver to prevent vehicle damage or fire hazards.
- The L298 Motor Driver is used to control any required motor functions, and a Bluetooth module can be optionally integrated for local wireless control or configuration. The code is written using embedded C/C++ and uploaded to the Arduino board using the Arduino IDE.

Result and Conclusion :

The implementation of the proposed portable EV charging and short circuit detection system successfully addresses key challenges faced by electric vehicle users in remote and emergency scenarios. The system demonstrated effective real-time location tracking using the GPS Neo M8N module. When the EV battery was intentionally drained in the test scenario, the system accurately calculated the shortest route to the nearest EV charging station using Dijkstra's algorithm. The GSM module then promptly communicated the vehicle's coordinates to the designated station master, validating the remote alert mechanism. As shown in Figure 2, when the main EV (represented by the smaller vehicle in the image) runs out of battery and cannot reach the nearest charging station, the system tracks the vehicle's location using Dijkstra's algorithm and GPS. The GSM module initiates a call to the station master.

Fig 2 Wireless Charging System

The short circuit detection (Fig 3) unit also performed reliably during testing. The **transistor-based circuit** was able to detect when a phase and neutral wire were shorted. As designed, the circuit triggered the buzzer immediately, alerting the driver about the fault. This early warning system is essential in real-world scenarios to prevent hazardous situations such as fire or system damage in electric vehicles.

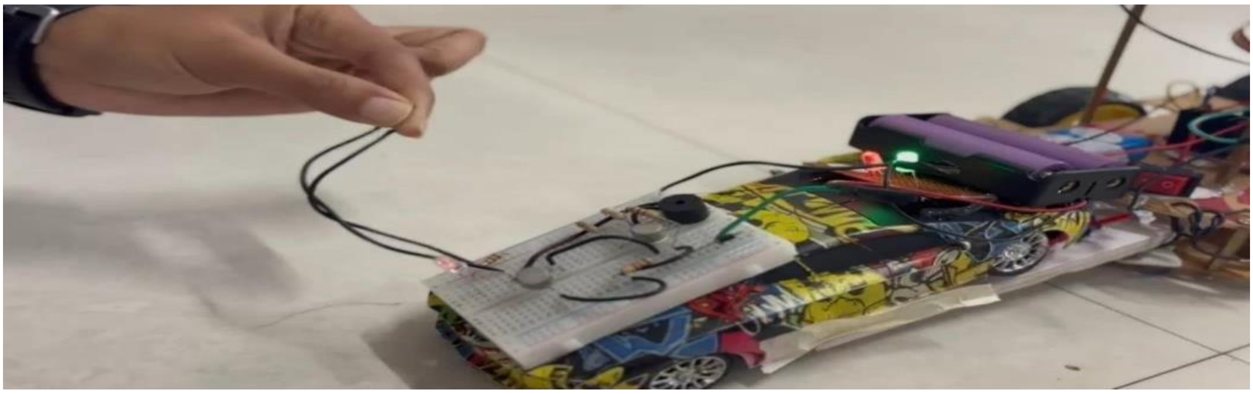

Fig 3 Short Circuit Detection

Overall, the project results validated the feasibility and practicality of providing emergency EV charging solutions in remote areas, while also enhancing safety through early fault detection. The integration of both GPS-based routing and GSM communication made the system robust and adaptable to various real-world conditions. Furthermore, the compact design and modular approach make the system suitable for future upgrades.

Project Outcome & Industry Relevance :

The Portable EV Charging System with Short Circuit Detection has strong practical implications, especially in addressing real-world problems related to electric vehicle mobility and safety. The project successfully demonstrates a method to provide wireless charging support to stranded EVs in remote or rural areas where fixed charging infrastructure is unavailable. By using GPS and Dijkstra's algorithm, the system effectively tracks the nearest EV station and facilitates communication through GSM, ensuring timely deployment of a portable charging vehicle.

Additionally, the integrated short circuit detection system improves vehicle safety by alerting users immediately when a phase and neutral wire come into contact, potentially preventing EV fires. This solution is highly relevant in the current industry scenario where EV adoption is increasing rapidly, yet infrastructure development is still catching up. The project can be applied in highway emergency services, EV rental companies, and future smart city planning. Its features like wireless energy transfer via Tesla coil and real-time RFID data logging further enhance its applicability in modern EV servicing and roadside assistance industries.

Working Model vs. Simulation/Study:

This project involved the development of a physical working model. A fully functional prototype was created to demonstrate the concept of a Portable EV Charging System with integrated Short Circuit Detection. The model includes hardware components such as Arduino Uno, L298 Motor Driver, GPS Neo M8N, GSM 900A, Bluetooth module, Tesla coil for wireless charging, RFID card for data storage, and a short circuit detection mechanism using a transistor and buzzer. The working model was tested in real-time scenarios to validate its functionality in identifying remote locations, alerting the station, wirelessly charging the EV, and detecting internal wiring faults, thereby proving its practical feasibility.

Project Outcomes and Learnings:

The key outcome of this project is the successful implementation of a Portable Electric Vehicle (EV) Charging System capable of delivering emergency charging support in remote areas, along with a Short Circuit Detection Module for enhanced safety. The system utilizes GPS and Dijkstra's algorithm to track nearby EV stations, while GSM is used to communicate the location to the station master. A portable vehicle carrying wireless charging equipment is dispatched, and Tesla coils are used for contactless charging. Additionally, the project effectively detects internal wiring faults using transistors and triggers a buzzer alert system.

From the process of designing, implementing, and analysing this project, we learned how to:

- Integrate multiple embedded systems such as Arduino, GPS, GSM, and RFID.
- Apply real-world algorithms like Dijkstra's for shortest path identification.
- Implement wireless charging using Tesla coil technology.
- Understand circuit protection techniques and design short circuit detection.
- Work as a team to debug and test a real-time working prototype, simulating emergency EV scenarios.

Future Scope:

In the future, the Portable EV Charging System can be further enhanced by increasing the range and efficiency of wireless power transfer using advanced Tesla coil designs or inductive charging methods. The use of solar panels on the supporting vehicle can make the entire system eco-friendlier and more self-sustaining. Integration with a mobile app can allow real-time tracking and direct request placement by EV users in remote areas, reducing dependency on manual communication with the station master.

Additionally, the short circuit detection system can be upgraded to include smart fault prediction using AI and real-time analytics, enabling proactive maintenance alerts. The project can also be scaled for implementation in highway emergency response systems, particularly in areas where charging infrastructure is still under development. Future improvements may include faster charging techniques, battery health monitoring, and cloud-based data storage for better fleet and service management.