

Wireless Ev charging System

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Abstract— An inductive power transfer technology-based wireless electric vehicle (EV) charging system to overcome the shortcomings of traditional wired charging. The system eliminates the use of physical connectors, giving more convenience, reduced mechanical wear, and more safety and efficiency. The system includes a transmitter unit mounted on the charging station and a receiver unit integrated into the vehicle. ARM Cortex microcontroller is used to handle the charging, with two-stage authentication for ensuring safe operation. The transmitter coil supplies power wirelessly by means of electromagnetic induction, and the receiver coil converts the electrical power from magnetic flux, which gets processed and routed to the battery. A Battery Management System (BMS) is employed to monitor electrical and temperature conditions in a bid to prevent overcharging and overheating, featuring protection mechanisms to disconnect and resume charging as needed. Experiment proved that efficient wireless power transmission with regulated output was possible, demonstrating the viability of scalable low maintenance and low-price wireless charging for small electric cars

Keywords— Wireless Charging, Electric Vehicle, Inductive Power Transfer, ARM Cortex Microcontroller, Battery Management System, RFID Authentication, Power Transfer Efficiency, Electromagnetic Induction, Receiver Coil, Transmitter Coil.

I. Introduction

The increasing environmental awareness and dwindling fossil fuel supplies have hastened the shift towards renewable energy sources, especially in transportation. Electric vehicles (EVs) have become a practical choice over conventional fuel-powered cars, thanks to their ability to cut carbon emissions substantially and lessen reliance on non-renewable resources. Nevertheless, although they are increasingly popular, charging stations remain a significant obstacle. Modern wireless charging methods, although more convenient, face issues like the requirement for manual insertion, wear on charging ports, potential safety hazards from electrical contact, and reduced user satisfaction. These issues hinder the smooth integration of electric vehicles into contemporary smart cities and residences.. This project introduces a wireless electric vehicle charging system employing inductive power transfer technology to address these challenges. Wireless charging eliminates the need for physical contact, offering greater convenience to users, reducing wear on charging ports, and facilitating safer and more efficient automated detection authentication are

Participate in the wireless charging setup to ensure it is user-friendly and secure. This document elucidates the notion of work, the component design, and the practical implementation of the wireless charging system that we have proposed. The prototype demonstrates an economical, low-maintenance, and scalable system, ideally suited for urban intelligent infrastructures and home garages. Without adhering to the limitations of conventional plug-in systems, the endeavor supports the overarching objective of intelligent and eco-friendly mobility. The project fulfills this requirement by incorporating contactless energy transfer, temperature regulation, and RFID-based vehicle authentication to ensure secure charging sessions. The system is designed to charge the battery exclusively when a verified vehicle is present, ensuring both safety and energy efficiency. Temperature and voltage monitoring safeguards against overcharging and thermal runaway. The user receives immediate feedback through voltage and current readings, enhancing transparency and ease of use. This document outlines the creation of a wireless electric vehicle charging infrastructure using a microcontroller, highlighting the practical implementation of wireless coils, sensor networks, and embedded control systems. The goal is to develop a robust, efficient, and expandable system for small electric vehicle applications, including two-wheelers, while maintaining safety, efficiency, and quick response times.

II. LITERATURE REVIEW

.Ahmed and Khalifa [1] present a method of improving the wireless power transfer (WPT) system used in electric vehicle charging. Coil orientation and resonant circuit design optimization to improve efficiency in transfer is what their research addresses. Improved charging rates and minimizing WPT system power loss is why this study remains applicable today. Riekerk et al. [2] address WPT system start-up and shut-down procedures. By the achievement of a soft start-up and shut-down routine, they intend to reduce electrical stress, thereby providing improved system reliability and increased life. They are protective measures against the safeguarding of the system during power transfers, especially dynamic operation.Panchal et al. [3] explain static as well as dynamic wireless EV charging systems and mention the back-up dynamic charging system's limitation that is driving while charging. Their studies discuss the

challenges of power transmission efficiency when in motion, essential for long term EV operation. Mohamed et al. [4] also look at wireless charging technology including inductive, capacitive, and magnetic gear system. They see the strengths and weaknesses of every technology and propose hybrid solutions that can offer more efficient and cleaner charging methods.

Zaheer et al. [5] analyze decoupling coil topologies as an important step in improving the performance of inductive power transfer (IPT) systems. Their work explores how decoupling can be used to improve the interoperability and adaptability of the system so that various electric vehicle models can be supported. Budhia et al. [6] contribute further by developing single-sided flux couplers that provide maximum magnetic coupling and minimum energy losses. The innovation increases the performance of WPT systems

Ahmad, Alam, and Mohamed [7] present the design and interoperability of quadruple pad structures in wireless EV charging. They demonstrate how the same designs increase the flexibility and efficiency of charging stations to serve different EV models. Zhang and Chau [8] extend this effort by suggesting homogeneous wireless power transfer systems, which support efficient charging when the vehicle is in motion. This remedy corrects the deficiencies of traditional stationary charging systems by ensuring constant power transfer during driving, reducing downtime for EVs.

Kim et al. [9] present fault detection methods for onboard battery management systems (BMS) of electric vehicles, presenting a disturbance observer and normalized residual based method. The technique strengthens the detection of faults in the initial stage, preventing severe damage to batteries and enhancing the reliability of the system. Noreen et al. [10] contrast the traditional and modern estimation methods in predicting battery state-of-charge (SOC) and state-of-health (SOH). Their comparative analysis reveals that contemporary estimation methods using machine learning algorithms are more accurate and provide improved performance over conventional approaches, which is imperative for extending battery life and keeping vehicles efficient.

Roth et al. [11] highlight the significance of proper measurement of electrical conditions like voltage, current, and temperature of EV batteries. They argue that real-time monitoring is required in order to prevent issues like overcharging, heating, and aging of batteries. Liu et al. [12] present a new BMS architecture, in which a modular configuration can adjust energy flow among the battery pack for optimal vehicle performance. This design supports effective power distribution and fosters better battery life and electric vehicle performance.

Lau et al. [13] also outline contributions to the optimization of BMS designs, specifically for lithium-ion batteries. They outline new control strategies that optimize charging and discharging cycles to their maximum and sustain temperature and diagnostic conditions in order to enhance battery performance and lifespan. Xu et al. [14] discuss integrating variable speed limiting control with dynamic wireless charging systems for the sake of improving power transfer rate. Their research explains how varying the speed of the vehicle could optimize real-time charging to enable better power management during

driving. Shaier et al. [15] offer a new hollow solenoid receiver based on the global double-D transmitter for inductive powering. The proposed design eliminates most of the disadvantages found in typical charging systems, including efficiency loss and mismatch between transmitter-receiver coils. Their work is a necessary step toward better EV charging, even when conditions are not aligned. Ahmad, Alam, and Chabaan [16] critically review wireless charging technology for electric vehicles and compare its potential and drawbacks. They recommend the creation of both static and dynamic charging methodologies to create more efficient and more practical EV charging systems, which will meet the growing world demand for electric transportation.

III.METHODOLOGY

The proposed gadget introduces a smart, wi-fi electric car (EV) charging solution especially tailor-made for two wheelers. this technique outlines the entire layout— from the sensing mechanisms and strength drift

structure to protection protocols and feedback systems. the key emphasis lies in automation, efficiency, and safe wireless power transfer the use of incorporated microcontroller-based totally choice good judgment. The device is extensively divided into most important subsystems: the transmitter unit, mounted on the charging station, and the receiver unit, integrated into the EV. on the coronary heart of the transmitter unit lies the STM32 Nucleo-F103RB microcontroller, which acts as the main controller for sensing and relay switching. The charging method is initiated while the device first verifies the presence and identity of the EV using a twin-level detection mechanism. first of all, an RFID module tests for a certified tag. Secondly, an IR sensor detects the bodily presence of the automobile by way of tracking for its proximity. handiest whilst each situations are satisfied does the STM32 spark off a relay module that allows the wireless electricity transmitter coil. This transmitter coil is powered by a 12V lithium battery and is capable of transmitting electricity wirelessly at 5V/2A using electromagnetic induction. Charging Station (Transmitter Side): This includes the primary coil connected to a high-frequency oscillator and MOSFET-based amplifier, which generates the alternating current required to produce a magnetic field. A microcontroller (Arduino) monitors input parameters and displays system status on an LCD screen. Sensors are used to track temperature and current at the station, while tuning capacitors are added to achieve resonance with the receiver coil.

Vehicle Unit (Receiver Side): This has the secondary coil that receives the magnetic flux and converts it to AC voltage. A

bridge rectifier converts AC to DC, and the output is regulated before reaching the vehicle's battery. An onboard microcontroller checks the battery voltage, temperature, and triggers alerts or automatic cut-offs to prevent overcharging or overheating. It also manages user authentication before allowing power flow. A comprehensive overview of the architecture is illustrated in the block diagram (Figure 1), which

presents the complete interconnection of components across both the transmitter and receiver units. Power transmitted by the coil is received by the receiver coil embedded within the vehicle. This coil is connected to a rectifier circuit which converts the AC induction signal into DC. The output then flows through a boost converter (XL6319E1) to amplify the voltage to suitable levels for charging the onboard 3.7V lithium-ion battery. This output is then passed through a Battery Management System (BMS), which regulates the charging current, prevents overvoltage, and ensures the battery operates within safe thermal and electrical limits.

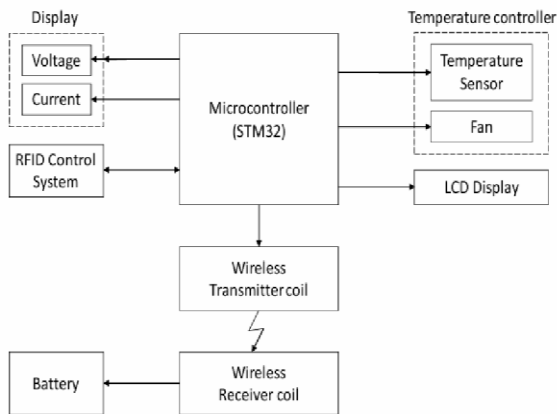
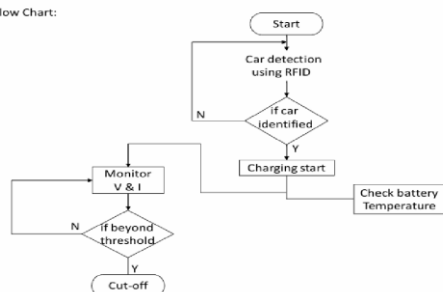


Fig 1. Block Diagram

The output from the BMS is directly connected to the battery. To allow real-time monitoring of battery health, a voltage sensor (ZMPT101B) is connected to the positive terminal of the battery and a current display module is connected to the negative motor pin to estimate load current. Data from these sensors is displayed on a 16x2 I2C LCD display, which is placed on the transmitter side for user reference. This helps users easily observe charging voltage and current during operation.

Further safety and monitoring are enabled through a parallel control unit using an Arduino Nano. This microcontroller receives temperature input from a DHT11 sensor and battery voltage via an analog pin. It then controls two relays: one for voltage-based protection and another for temperature regulation. If the voltage exceeds 4.10V, or the ambient temperature rises above 35°C, the respective relay is deactivated, stopping the charging process. Once the voltage drops below 3.90V or temperature falls to under 34°C, the relays reactivate to resume charging. This setup introduces a hysteresis-based safety mechanism to avoid frequent toggling and ensures charging stops under potentially hazardous conditions.

Flow Chart:



The sequential logic and choice-making method are certainly depicted in the flow diagram (determine 2). The process begins with idle monitoring through the IR sensor. once a car is detected, the device awaits RFID verification. Upon successful authentication, the STM32 enables the relay and activates the transmitter coil. In parallel, the Arduino continues checking the voltage and temperature conditions. If both threshold is breached, the corresponding relay is turned off. The charging resumes best whilst values return to secure degrees. This ensures multi-layered safety and stops battery overcharging or overheating. The performance of power transfer in this system may be described by Equation (1), even as Equation (2) represents the voltage law mechanism at some stage in battery charging.

The efficiency (η) of the wireless power transfer is given by the formula:

$$\eta = \frac{P_{received}}{P_{transmitted}} \times 100 \quad (1)$$

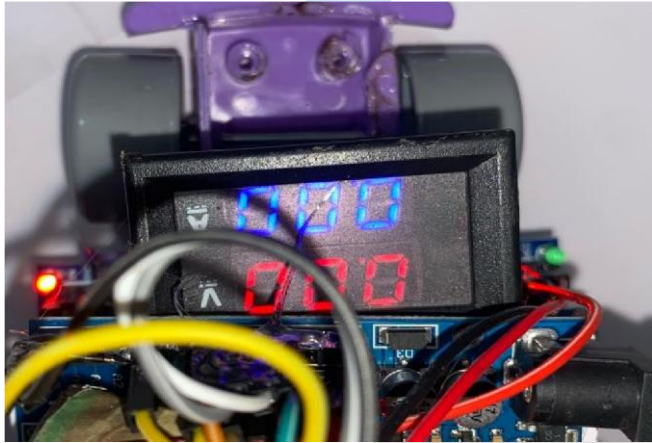
The output voltage V_{out} from the rectifier and boost converter is regulated to ensure safe charging of the battery, using the following relation:

$$V_{out} = V_{in} \left(1 + \frac{D}{1-D} \right) \quad (2)$$

As shown again in determine 1, each thing is carefully chosen and positioned to make certain modularity and reliability. using the I2C protocol for show communicate simplifies wiring and decreases GPIO usage, at the same time as analog and digital pins manipulate sensors and relays. energy isolation and switching are controlled thru electromechanical relays, supplying robust protection at some stage in faults. wi-fi power switch takes place over a separation distance of 2 to 10 mm between the coils. The 5V output from the receiver coil (after rectification and regulation using a 7804 voltage regulator) is solid and steady, allowing efficient battery charging. The wi-fi charging module, even though compact, is optimized for this utility, enabling up to 2A cutting-edge transfer, which is enough for charging the lithium-ion mobile from approximately three.7V to 4.2–four.5V in about 20 minutes. The flow common sense represented in discern 2 allows destroy down the control process into absolutely described tiers. This modular breakdown not most effective enhances machine reliability however also permits smooth troubleshooting and enlargement. The dual microcontroller design allows department of duty— STM32 handles authentication and relay control, even as Arduino manages protection monitoring—thereby improving gadget robustness. together, the machine forms a distinctly functional, wise, and safe wireless EV charging mechanism, balancing modern embedded protocols with price effective hardware. The insights won from figure 1 and parent 2 assist visualize the gadget's bodily interconnections and selection-making good judgment in a clean, established way.

IV. RESULTS AND DISCUSSION

The evolved wi-fi electric vehicle (EV) charging machine turned into correctly examined, demonstrating effective overall performance and protection features. The tool changed into powered with the useful resource of a 12V input from a lithium-ion battery linked to the transmitter coil. The receiver coil, placed in proximity to the transmitter, delivered on an AC voltage, which became into in the end rectified into DC voltage. A voltage regulator version 7804 inside the rectifier circuit supplied law of the output voltage to 5V DC, which changed into used in the charging of a three.7V lithium battery. computerized charging changed into carried out in the vehicle while the use of detection thru an RFID control module. Charging began inner the battery



whose initial analyzing end up approximately 4.0V and which increased step-clever up to 4.5V inside a time body of 20 minutes. in the direction of the charging manner, the device ensured comfy and managed charging without overheating or voltage variation beyond affordable limits. The parameters such as voltage, current, and temperature had been monitored

continuously all through the system. The black-colored voltage and present day indicator in figure 2 became into used to measure the receiver coil voltage and provide real-time comments for the electric parameters of the system. The equal readings have been additionally indicated on an output display screen so that the charging circumstance may need to be resultseasily found. To in addition assure comfortable operation, a fan become mechanically engaged while the battery temperature changed into at 45°C to keep away from thermal accumulation. moreover, the gadget stopped charging if the voltage went above five.2V or the temperature multiplied above 50°C, protective the battery from possible harm.

The gadget changed into determined to be capable of controlling and monitoring the charging technique properly, reliably, and effectively. discern 1 indicates the lcd display showing the charging fame as nicely as actual-time parameters, even as discern verified via these first-rate findings, such as a charging duration of approximately 20 mins, an enter voltage of 12V, a regulated output of 5V, and a upward thrust in battery price from 4.0V to four.5V. All of those findings suggest the feasibility of the use of RFID-managed wi-fi charging in electric cars, displaying the protection and performance of the device

Parameter	Value
Voltage Cut-off	5.2 V (Charging Stop)
Temperature Cut-off	50 degree C (Charging Stop)
Charging Status	Active During charging
Battery voltage(Start)	3.7 V (Norminal Voltage)
Battery Voltage (End)	.2V (Fully Charged)
Charging Time	20 minutes4
Input Voltage	12 V
Regulated Output Voltage	5 V
Voltage at Receiver Coil	Display on LCD (fig 2)
Temperature at Battery	Below 45 degree C before charging Fan activates after 45 degree C

TABLE 1 : Charging Parameters And Operational Status

Fig2 Voltage and Current Display

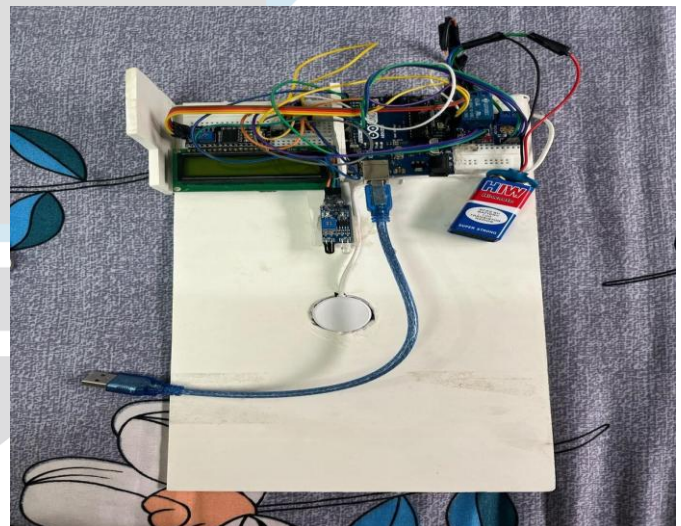


Fig3. Setup

V. CONCLUSION

The venture on wi-fi electric powered automobile charging the usage of a coil device demonstrates a sustainable and handy opportunity to conventional plug-in charging strategies. with the aid of using the precept of electromagnetic induction, the machine efficiently transfers power wirelessly from the transmitter coil to the receiver coil, making

the charging manner simpler, more secure, and person friendly. The proposed device reduces dependency on bodily connectors, minimizes wear and tear, and gives stronger safety by means of warding off dangers such as electric powered shocks and

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