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Charging Station for Two-Wheeler Electric Vehicles

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ABSTRACT: The global need for daily transportation has historically relied on conventional vehicles powered by fossil fuels such as petrol, diesel, and gas. However, the detrimental environmental effects of these fuels, including carbon dioxide emissions and global warming, have prompted the development of Electric Vehicles (EVs). EVs operate solely on electricity, eliminating the need for fossil fuels and associated emissions. Despite their environmental benefits, EVs face challenges related to limited range and a scarcity of charging infrastructure, particularly in comparison to traditional fuel stations. It focuses on addressing the specific challenges encountered by two-wheeler electric vehicles (EVs) in accessing charging infrastructure. The limited range of EVs underscores the importance of widespread availability of charging stations to support their widespread adoption. However, constructing charging stations presents challenges such as high construction costs and space requirements, especially when catering to different battery voltage types. Additionally, the variability in charging station compatibility with different EV models adds complexity to accessibility.

I. INTRODUCTION

As the automotive industry undergoes a profound shift towards sustainability, electric vehicles (EVs) have emerged as pivotal players in this transformation. With technological advancements and a growing environmental consciousness, consumers are increasingly embracing electric alternatives for their transportation needs. The surge in electric vehicle adoption underscores the urgent need for a robust and accessible charging infrastructure. Unlike traditional vehicles, EVs rely on charging stations, and the availability of these stations significantly influences adoption rates. Establishing efficient and strategically located charging infrastructure is paramount to overcoming challenges such as range anxiety and ensuring the seamless integration of electric vehicles into everyday life. Our project is dedicated to addressing this critical need, with a specific focus on the two-wheeler EV segment. Recognizing the unique requirements of two-wheeler EVs, we are designing charging stations that cater to their needs effectively. These stations not only provide electricity-based charging but also harness solar energy, enhancing sustainability and reducing reliance on the grid. In the context of India, with its extensive road network spanning over 5.4 million kilometres, establishing a nationwide network of charging stations for electric vehicles is imperative. This initiative aligns with the government's ambitious plan to transition to exclusively selling EVs by 2030.By leveraging both electricity and solar energy, our charging stations for two-wheeler EVs aim to contribute significantly to the evolution of sustainable transportation. Our goal is to alleviate concerns related to charging accessibility and convenience, thus fostering greater adoption of electric vehicles and supporting India's transition towards a greener future.

II. LITERATURE REVIEW

The literature survey on electric vehicle (EV) charging station infrastructure encompasses a diverse range of research endeavours aimed at comprehensively understanding and advancing this crucial aspect of the electric mobility landscape. The following papers contribute significant insights into the design, implementation, challenges, and future trends in EV charging infrastructure:

Ali Jawad Alrubaie: "A Comprehensive Review of Electric Vehicle Charging Stations with Solar Photovoltaic System Considering Market, Technical Requirements, Network Implications, and Future Challenges" (Published on 16th May 2023). This paper reviews EV charging stations integrated with solar photovoltaic systems, covering market dynamics, technical requirements, network implications, and future challenges. It explores the concept of utilizing solar energy while vehicles are parked, alongside traditional charging methods. Challenges and suggestions for future infrastructure expansion and grid integration are also discussed, including the profitability and limitations of PV-grid charging.

Muhammad Shahid Mastoi: "An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends" (Published on 4th September 2022). This paper discusses the transition from fossil fuel-powered to zero-emission vehicles and the infrastructure needed for electric vehicle charging stations (CSs). It highlights the importance of information technology, distributed energy generation units, and government policies. The

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paper examines factors influencing the planning of charging infrastructure, including grid integration, optimal station placement, challenges, and future trends such as renewable energy procurement and vehicle-to-grid technology.

Morris Brenna: "Electric Vehicles Charging Technology Review and Optimal Size Estimation" (Published on 2nd October 2020), This paper provides an overview of existing and proposed EV charging technologies, converter topologies, power levels, and charging control strategies. It focuses on effective and fast charging techniques for lithium-ion batteries to prolong cell cycle life and maintain high efficiency. The paper also estimates the optimal size of charging systems using genetic algorithms and discusses future trends in the field.

K. C. Akshay: "Power consumption prediction for electric vehicle charging stations and forecasting income" (Published in 2024), This paper addresses the importance of accurate power consumption forecasting for EV charging stations and its implications for effective management. It employs time series models to predict electricity demand, with a focus on the SARIMA model. Using data from public charging outlets, the study forecasts power usage based on vehicle types and subscription data to anticipate income. The paper highlights the significance of accurate forecasting in operational costs, subscription pricing, and infrastructure planning.

III. OBJECTIVE

- The primary goal of the project is to encourage the widespread adoption of electric two- wheelers by addressing the current lack of dedicated charging infrastructure.
- To establish charging EV station for two-wheeler electric vehicles.
- To design and implement charging without affecting battery life cycle.

IV. DESIGN AND DEVELOPMENT

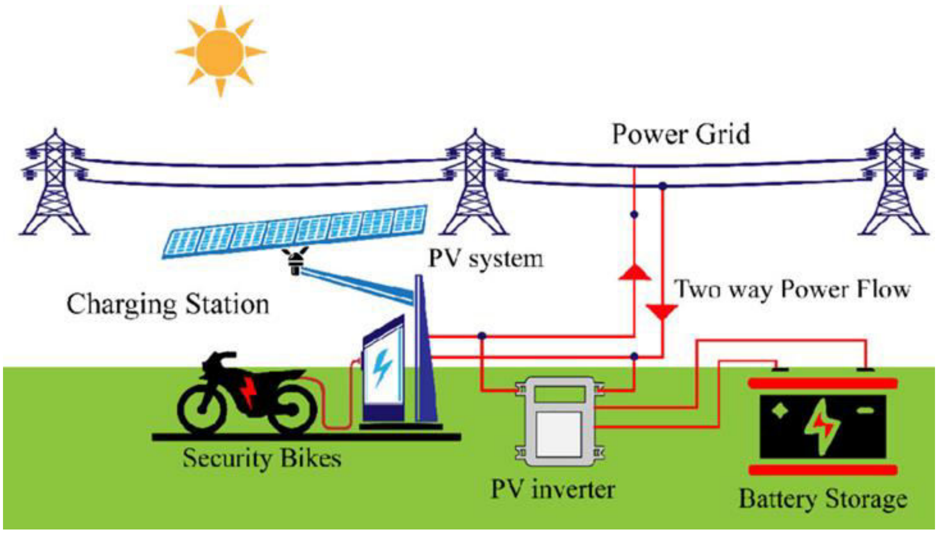

Fig 1: Structure of EV charging station

The design and development of the electric vehicle charging system begin with configuring a step-down transformer to achieve the desired voltage reduction based on the windings ratio between primary and secondary coils. This setup is verified through voltage measurements at both input and output terminals. Next, a bridge rectifier is installed and configured to convert AC input from the grid or solar panels into a suitable DC output for charging, followed by testing to ensure efficient AC to DC conversion and correct polarity. A filtering mechanism using capacitors and inductors is integrated to smooth current fluctuations and eliminate noise, with its effectiveness evaluated by analysing the output waveform. A user interface is developed to allow mode selection via a single key press, triggering the microcontroller, which adjusts charging parameters for rapid or gradual charging as per user preference. The microcontroller regulates the charging level by controlling the transformer and relay section, with thorough testing to ensure reliable management. An EM-18 RFID reader is integrated for payment processing, communicating with the microcontroller via UART. An LCD module operates in 4-bit mode to display charging information, connected to the Arduino

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microcontroller. A 12V charging socket is installed for convenient battery charging, ensuring compatibility with the power supply system. Automatic charging initiation is implemented, and a speed control feature allows users to adjust the motor's speed through the battery output, catering to specific needs.

V. WORKING PRICIPAL

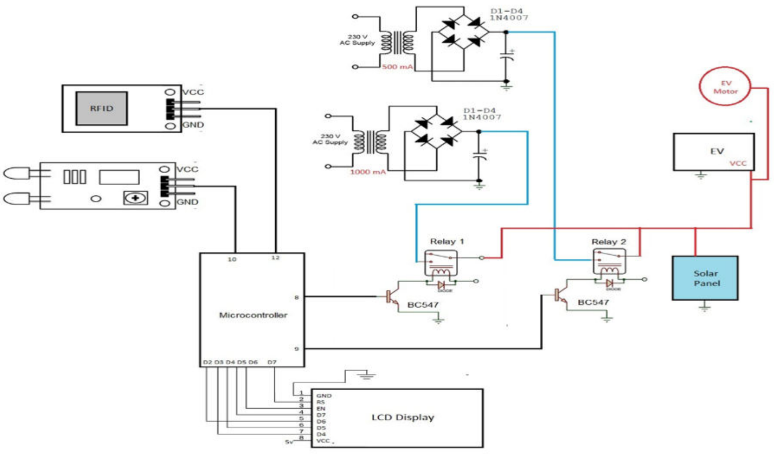

Fig 2: Circuit diagram

To design and implement a robust electric vehicle (EV) charging system, begin by configuring a step-down transformer to achieve the desired voltage reduction, determined by the ratio of windings between the primary and secondary coils. Verify the transformer's functionality by measuring voltage at both input and output terminals. Next, install and configure a bridge rectifier to convert AC input from the power source (either grid or solar panels) into a DC output suitable for charging. Test the bridge rectifier to ensure efficient AC to DC conversion, checking the output voltage levels and polarity.

Integrate filtering components, such as capacitors and inductors, into the circuit to smooth current fluctuations and eliminate noise. Evaluate the filter's effectiveness by analyzing the output waveform for ripple or distortion, ensuring a stable charging current. Develop a user interface for selecting charging modes with a single key press, triggering the microcontroller. Implement software logic in the microcontroller to interpret user inputs, adjusting charging parameters for rapid or gradual charging as needed.

Program the microcontroller to regulate charging levels by controlling the transformer and relay section based on the chosen mode, and perform comprehensive testing to ensure reliable charging management. Integrate an EM-18 RFID reader to enable payment processing via 125KHz tags, establishing UART communication with the microcontroller for seamless transactions during charging sessions.

Configure an LCD module to operate in 4-bit mode for efficient data transfer and connect it to the Arduino microcontroller to display charging information. Install a 12V charging socket in the EV, ensuring compatibility with the power supply system by verifying voltage and current ratings. Implement automatic charging initiation upon connection to the power source. Additionally, incorporate a speed control feature for the motor, allowing users to adjust motor speed through a user interface, meeting their specific driving needs. This comprehensive approach ensures a seamless, user-friendly EV charging experience with efficient power management and payment processing capabilities.

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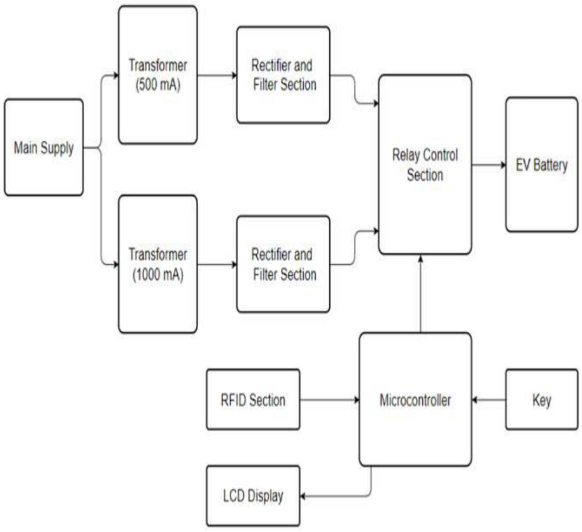

Fig 3: Block diagram

VI. RESULT

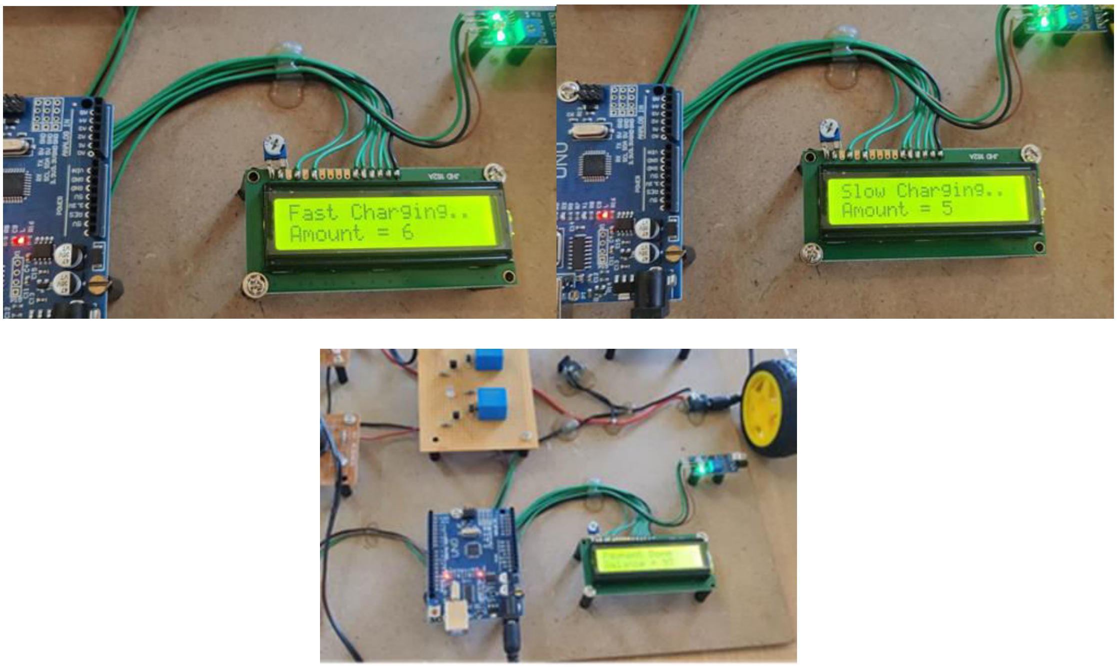

Fig 4: Fast Charging, slow charging and payment status

VII. SCOPE OF IMPROVEMENT

Future improvements for the electric vehicle charging system can focus on enhancing efficiency, user experience, and sustainability. Incorporating advanced power electronics, such as GaN or SiC devices, could significantly boost efficiency and reduce heat loss. Implementing wireless charging technology would offer greater convenience and eliminate the need for physical connectors. Enhancing the user interface with a touchscreen display and integrating mobile app connectivity would provide more intuitive control and real-time monitoring. Furthermore, incorporating renewable energy sources, such as dedicated solar panels, and integrating smart grid capabilities for optimal energy management and cost savings would make the system more sustainable and eco-friendly.

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VIII. CONCLUSION

To create a versatile electric vehicle charging system, the process begins with configuring a step-down transformer for voltage reduction, followed by verifying functionality through voltage measurements. Integration of a bridge rectifier ensures efficient AC to DC conversion, while filtering mechanisms smooth out current fluctuations. A user-friendly interface allows for mode selection, managed by a microcontroller adjusting charging parameters. EM-18 RFID reader enables seamless payment processing. LCD module displays relevant data. Compatibility of the 12V charging socket with the power supply is ensured. Automatic charging initiation and speed control for the motor enhance user experience. This system accommodates both grid and solar power sources, ensuring sustainable and convenient electric vehicle charging.

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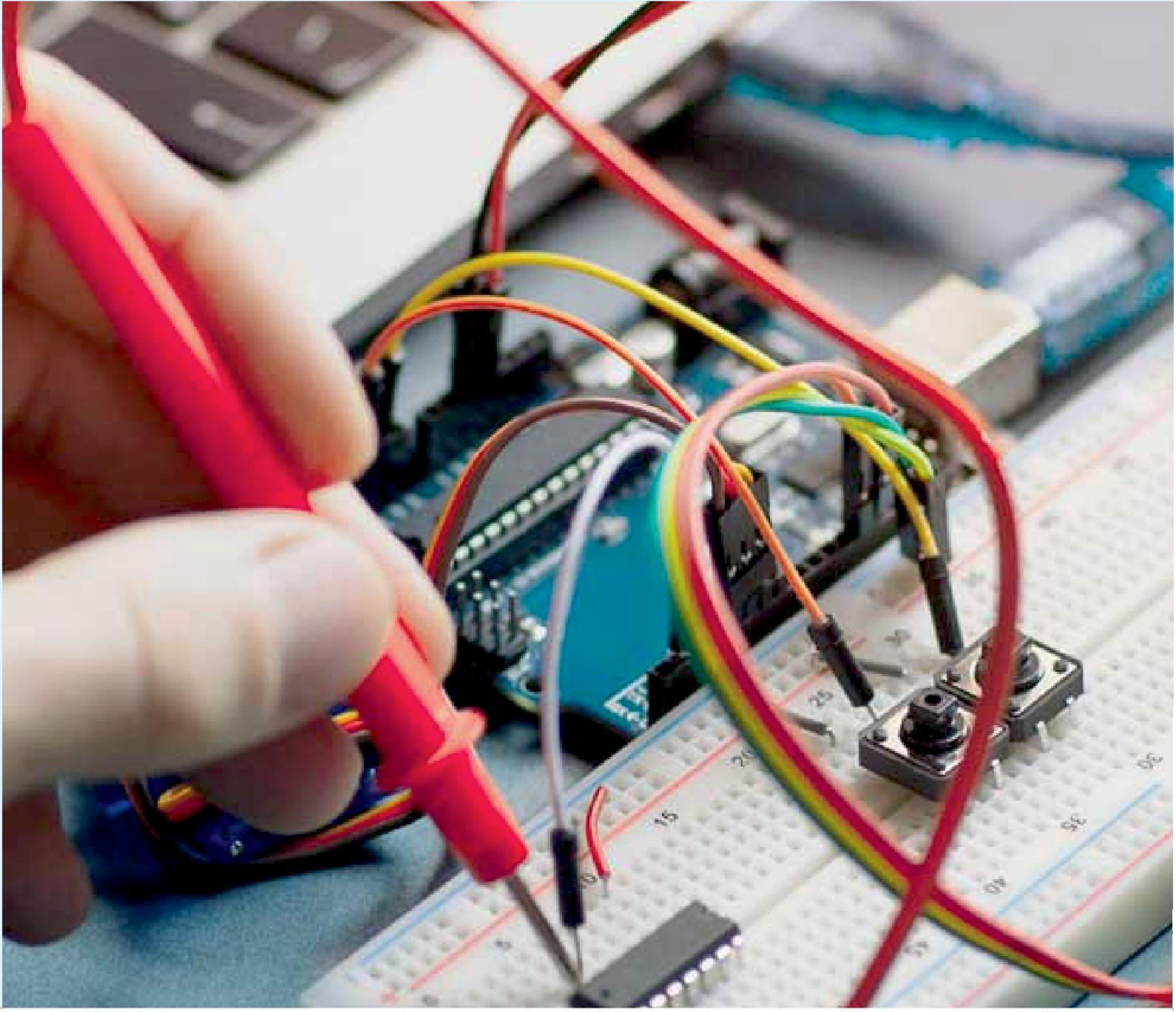

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