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Research Article

Design & Implementation Of An Improved Battery Charger For Two-Wheeler Electric Vehicle

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ARTICLE INFO **ABSTRACT**

With the accelerating global transition towards electric mobility, the necessity for efficient and accessible improved fast charging infrastructure is becoming increasingly imperative. This paper addresses the critical requirement for improved fast charging solutions tailored specifically for two-wheeler electric vehicles (EVs). It illuminates the limitations inherent in conventional charging systems, including concerns regarding efficiency and weight, thereby emphasizing the urgency for innovative solutions. Leveraging insights from the dynamic landscape of EV adoption, this research introduces a pioneering charger design that integrates advanced ferrite core transformers. Through meticulous comparative analysis with traditional chargers, our prototype showcases a remarkable increase in operational efficiency, surpassing the threshold of 90%. Furthermore, the proposed charger offers substantial reductions in weight, significantly enhancing its portability and usability, which are crucial factors for two-wheeler EV users. By harnessing cutting-edge charging technology, this study not only addresses the immediate challenges but also contributes significantly to the evolution of electric vehicle ecosystems. The optimized charger design introduced in this research lays a solid foundation for sustainable transportation solutions, particularly tailored for urban environments where two-wheeler EVs play a pivotal role in alleviating congestion and emissions. This research underscores the potential of technological innovation in fostering the widespread adoption of electric vehicles, thereby paving the way for a greener and more sustainable future.

Keywords: electric two-wheelers, battery charger, ferrite core transformer, dc boost converter, portability.

1. INTRODUCTION

The escalating global population has precipitated a corresponding surge in transportation vehicles, predominantly reliant on fossil fuels, exacerbating the environment and the acceleration of limited fossil fuel decline reservoirs. In response, the burgeoning adoption of electric vehicles (EVs) represents a pivotal green initiative, offering myriad advantages such as zero emissions, governmental subsidies, and reduced maintenance requirements. However, EVs necessitate periodic recharging, typically facilitated by chargers employing iron core transformers, a technology plagued by inherent inefficiencies and consequential energy wastage[1].

Addressing this critical inefficiency presents a opportunity to enhance energy conservation and foster widespread EV adoption. The objective of this study is to develop and deploy a sophisticated cell converter tailored specifically for two-wheeler electric vehicles[2]. The proposed charger aims to significantly improve charging efficiency, surpassing conventional counterparts by achieving efficiencies approaching 90%. Drawing from existing research in electric vehicle charging systems, including advancements in wireless charging schemes, the effects of electric vehicle (EV) charging on power distribution infrastructures and inductive energy transfer design factors, this study seeks to contribute novel insights into the development of high-efficiency charging solutions[3]. By leveraging advancements in charger design and technology, this research aspires to mitigate energy losses, optimize charging operations, and thereby promote the broader adoption of electric vehicles within the transportation ecosystem[4].

1.1 Why electric vehicle?

The key area of this study includes development and implementation of a supercharging system for two-wheeler EVs exclusively. As a new element of transport technologies, EVs are fully based on batteries and are replacing ICE with a motor driven by electricity[5]. The developing EV battery charger intends to maximize the charging cycle, which leads to the increase of the efficiency and effectiveness of EVs. This paper regards technical aspects and benefits of the incorporation of electric vehicles, highlighting the impact of an advanced battery charger on improvements in their functionality and sustainability[6].

a. Noise Pollution Reduction

Electric cars to a large extent are quieter than vehicles with internal combustion engines (ICE) because the combustion engines are not present. The added benefit of battery charger amplification is that it cuts off the need for noisy maintenance procedures that are common with ICE cars, such as valve adjustment, engine tuning, and exhaust system repair[7].

b. Enhanced Riding Experience

Integration of electric motors in two-wheeler EVs result in a better ride comfort which is constituted by their lighter weight and outstanding torque characteristics in comparison with ICE engines. The integration of the battery charger that is optimized is one of the key aspects of the delivery of a consistent and reliable power which further ads with other features to the overall riding experience hence reducing power fluctuations and ensuring optimal energy utilization[8].

c. Eco-Friendly Operation

Electric cars, likewise, are driven by power that may be produced from sources of clean energy. thus greatly reducing harmful greenhouse gases and air pollution[9]. The incorporation of an advanced battery charger will ensure that electricity is used productively for charging the two-wheeler EVs, hence, the greenness of these vehicles is enhanced by lessening the energy waste during the charger process.

d. Cost-Effectiveness:

The lacking need for the consumption of conventional fuel in electric vehicles would cause this to be an economical operational cost[10]. It becomes cost-effective by keeping high charging efficiency and prolonging the lifespan of the battery through making the use of a better battery charger which reduces the rate of replacement and maintenance costs.

e. Air Quality Improvement:

Electric vehicles rapidly become widely used may result in the clear atmosphere since not only it will lead to the decreases in Particulate matter (PM) emissions, nitrogen oxides (NOx), and carbon dioxide (CO2). Through developing a superior charging infrastructure to encourage the adoption of electric vehicles, air quality will be significantly improved as a result, driving towards public health benefits and environmental protection that come with.

f. Increased Efficiency:

In contrast to ICE vehicles, electric vehicles have higher efficiency rates owing to the electricity motor which is more efficient and the regenerative braking system. The introduction of a next generation battery charger would be a great boost for environmental-friendly electric vehicles through the optimization of parameters, power losses reduction and complete utilization of available power.

2. RELATED WORK

K. Thenmozhi et.al (2016) proposed a novel approach to enhance the power capability of electric motor vehicles (EVs) by implementing a dual-inverter system with an open-end winding motor arrangement. This system utilizes two isolated DC sources, albeit with the consideration of employing only one charger to the main battery. The primary objective was to enable the charging of a secondary battery from the main battery through the motor, whether stationary or in motion. Results indicated a significant improvement in motor power output beyond its base speed, particularly notable through unity-power-factor operation which maximizes charging power. **Simon Heckford et.al (2001)** unveiled an off-board, dual-purpose, high-capacity battery converter specifically engineered for electric vehicles (EVs). By integrating grid conditioning capabilities, this novel charger significantly improves its practicality and utility. Active filtering is integrated with rapid EV battery charging in a novel application that employs conventional power electronic converter topologies to ensure effective energy delivery. In addition, bidirectional power transmission abilities are incorporated into the charger to meet peak power demands on the grid. The field test and simulated outcomes demonstrated the abilities of this novel battery construction[11]. **Yu-Jing Lu, K. Cheng et.al (2011)**

analysed the design of a 2.4 kW power converter optimised for lead-acid battery cells in electric vehicles. The implementation of a shifted in phase resonant converter was fundamental to their design, as it allowed them to optimize circuit operation, design parameters, and accomplish soft-switching. Charging modes encompassed trickle the driver's seat constant current/voltage, and float, all of which contributed to the device's excellent performance and high efficiency. Experimental outcomes validated the effectiveness of this charger and its triumphant integration into electric cars[12]. **C. G. da S. Moraes et.al (2019)** The author introduced a compact electric vehicle on-board battery charger with two stages, with an emphasis on sluggish and rapid charging capabilities. To achieve consistent and high-quality grid current even when faced with fluctuations in power levels, an altered bridgeless boosted rectifier and a phase-shifted full-bridge rectifier with current doubler were utilised. Incorporating a functioning power separation cell improved both power density and dependability. The charger's function was validated through simulations across both a steady-state and unpredictable circumstances[13]. **K. M. Salim et.al (2016)** addressed the need for efficient battery chargers for electric three-wheeler auto rickshaws, known as easy bikes. Their proposed charger utilized a ferrite core transformer, achieving efficiency exceeding 90% and significantly reducing weight compared to conventional chargers. This innovative design responds to the power shortage challenges in Bangladesh while promoting the transition to electric vehicles[14].

Kim et al. (2010) demonstrate their expertise by conceptualising and executing a high-efficiency on-board charger for batteries that is specifically designed for plug-in hybrid electric vehicles and electric cars. By employing a series-loaded resonant DC-DC converter in conjunction with frequency oversight, their methodology places emphasis on factors such as price, effectiveness, reliability, and volume. Through the utilisation of a wide frequency range of 80–130kHz and the implementation of a zero voltage swapping method, they successfully attained noteworthy outcomes with the created 3.3 kW charger, which boasts a maximum efficiency of 93% and a small volume of 5.84 litres[15]. **Kuperman et al. (2013)** Introduce a commercially viable rapid charger specifically engineered to operate in battery transition stations and accommodate the lithium-ion electric vehicle propulsion batteries. The design of their dual-stage-controlled AC/DC converter enables swift charging, with the capacity to restore a 25 kWh depleted battery in less than an hour. Constant power, constant current, and constant voltage are the three standard charging modes of operation of the charger, which demonstrates its adaptability and effectiveness in EV charging applications[16]. In furtherance, **Kuperman et al. (2011)** This paper introduces a prototype of a resilient 50 kW vehicle battery rapid charger that incorporates a power factor correction rectifier operating in two stages. By skillfully integrating active filter control circuitry and DC-DC control circuitry into its design, their charger satisfies the grid interface requirements of battery management systems (BMS) with adaptability and dependability[17]**. Heckford (2001)** Proposes the integration of grid cooling functionalities into a dual-purpose, high-power off-board battery charger designed for electric vehicles, thereby augmenting its usability and feasibility. Heckford's charger effectively integrates active filtering and rapid EV battery charging through the utilisation of conventional power electronic conversion topologies in an innovative implementation. This allows the charger to feature bidirectional power flow capabilities, which are crucial for accommodating peak power demands on the grid[11]. **Cousland et al. (2010)** Assist in the development of a charging management system and battery charger that is specifically designed for series-connected multi-cell battery banks. The design should prioritise clever management, per-cell monitoring, and management. The aforementioned studies jointly emphasize the importance of sophisticated battery charging techniques in enabling the extensive implementation and viability of electrical modes of transportation[18].

Solero et al. (2001) Utilising the power parts of the electric vehicle (EV) motor drive, propose an unorthodox on-board battery charging configuration for EVs that satisfies the stringent demands of low cost, minimal volume, high efficiency, and dependability. The solution, which was executed in the form of an early-stage electric vehicle, exhibits encouraging outcomes in mitigating environmental issues in highly populated urban regions[19]. **Fahem et al. (2017**) This paper investigates bidirectional battery adapters designed for plug-in hybrid electric vehicles (PHEVs), focusing on the optimisation of EV charging infrastructure through the examination of different topologies and the integration of "Vehicle-to-Grid" technology[20]. **Duan et al. (2018)** Present a battery balance system for electric vehicles (EVs) that utilises solar power and provides multiple operating modes in order to optimise battery life and save energy. **De Sousa et al. (2010)** propose a configurable electric powertrain system capable of serving as a battery charger without additional components, thereby improving propulsion efficiency and reducing system complexity. These studies collectively contribute to advancing the efficiency, reliability, and sustainability of electric vehicle technology[21].

3. Methodology

The methodology involves designing and optimizing the charger to incorporate advanced ferrite core transformers and a DC-DC boost converter. These components are essential for enhancing charging performance and efficiency Initially, the charging process commences with a meticulous assessment of the battery's state of charge (SOC) and voltage. Should the SOC fall below 75% and the voltage remain under 54 volts, the charger employs a constant current (C-rate) charging methodology set at a rapid 1C rate. This approach facilitates swift replenishment of the battery's charge, crucial for efficiently addressing initial depleted states. Upon reaching the 75% SOC threshold, the charging strategy transitions to a constant current (CC) mode, albeit with a reduced charging rate. This gradual reduction in charging rate, exemplified by a decrease to 0.75C within the SOC range of 75-85%, serves to prioritize battery safety and longevity during the intermediate charging phase. Subsequently, as the SOC approaches 85%, the charger shifts into a constant voltage (CV) mode, maintaining a steady voltage level to facilitate the final stages of charging. This mode ensures a controlled approach towards reaching full charge, typically around 90% of the battery's capacity, while minimizing the risk of overcharging. The charging process terminates at this juncture, preventing any further flow of current to the battery to safeguard against potential damage associated with overcharging. This comprehensive methodology underscores a meticulous balance between charging efficiency, battery health, and safety considerations, ultimately contributing to the enhanced performance and longevity of two-wheeler EV batteries.

4. RESULT AND DISCUSSION

4.1 Improved fast charging method of electric vehicle

Constant current (CC) charging ensures an initial charge that is completed rapidly by supplying the battery with a constant current flow until it reaches a predetermined charge level. On the other hand, the constant voltage (CV) charging method ensures that the voltage across the battery terminals remains constant throughout the charging procedure. In order to prevent overcharging, the charging current is progressively decreased as the battery nears its maximum capacity. By integrating the strengths of the constant current and constant voltage (CC-CV) charging methods, the constant current constant voltage (CC-CV) method optimises battery longevity and speed by alternating between constant current and constant voltage modes. This approach enables rapid battery charging while maintaining a safe and controlled environment. The aforementioned charging techniques are pivotal in the development and execution of an improved battery charger for two-wheeler electric vehicles, guaranteeing charging performance that is both efficient and dependable.

4.1.1 Constant current(CC) of improved fast charging method:

Electric vehicle (EV) charging utilises the constant current (CC) method, which entails providing a consistent and uninterrupted current to the battery until it attains a state of full charge. Typically, EV battery packs consist of numerous cells connected either in series or parallel configurations, resulting in some cells potentially reaching full charge before others. This charging method aims to ensure a consistent flow of current throughout the charging process. However, it comes with drawbacks that impede its efficiency and reliability.

Table.1

SR NO	TIME OF CHARGING (seconds/hours)	SOC (%)
1	5767.5 SECONDS (2 hour)	10 to 90%

One of the primary drawbacks of the CC charging method is its inherent inefficiency. Maintaining a constant high current throughout the charging process can lead to energy wastage, as the battery may require more time to reach full charge due to variations in cell capacities and charging rates. Additionally, the uniform current flow may not adequately address variations in individual cell conditions, potentially resulting in overcharging of some cells while others remain undercharged.

Moreover, a significant concern associated with the CC charging method is the risk of battery overheating and premature degradation. Continuous high-current charging increases the temperature of the battery, which can accelerate chemical reactions within the cells and lead to thermal runaway or damage to the battery's internal components. Overheating poses a safety hazard and can significantly reduce the lifespan of the battery, necessitating costly replacements and maintenance.

Furthermore, the CC charging method may prolong the overall charging time, particularly if the battery is nearing full capacity. As the battery approaches its maximum charge level, the charging current must be gradually reduced to prevent overcharging. This tapering process prolongs the charging duration and may result in inefficiencies, especially if the charging system lacks dynamic adjustment capabilities to adapt to changing battery conditions. While the constant current charging method provides a straightforward approach to EV battery charging, it suffers from inefficiencies and drawbacks that limit its effectiveness. Addressing these limitations requires the development of advanced charging algorithms and technologies capable of optimizing charging parameters in real-time, guaranteeing secure and effective charge while optimizing battery performance and lifespan. Constant current charging method graph and time of charging with soc (increases from 10 to 90%)

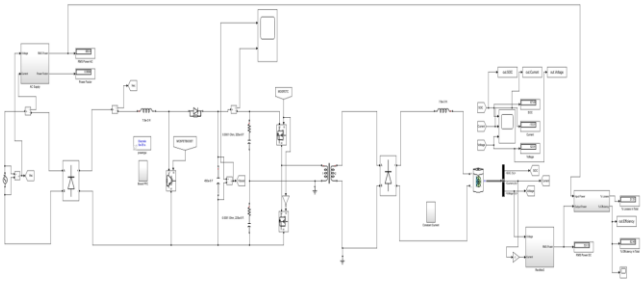
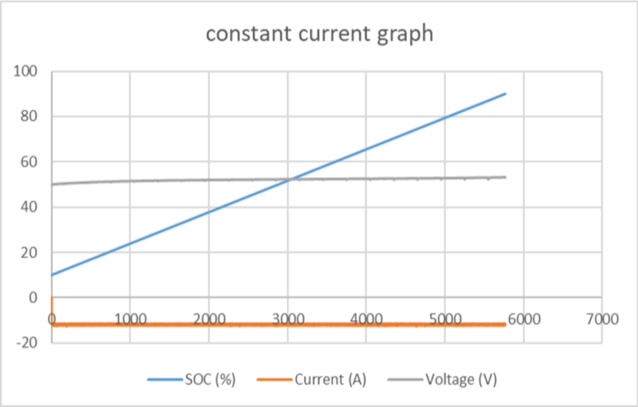


Fig.1



Graph.1

4.1.2 Constant voltage(CV) of improved fast charging method:

The provided table outlines the charging characteristics of electric vehicles (EVs) utilizing the constant voltage (CV) charging method. In this method, a direct current (DC) supply is employed to charge lithium-ion batteries at a constant rate, typically represented as a 1C rate, to ensure equalization of charge among cells. The charging process begins with a high charging current, gradually tapering off as the battery reaches its desired state of charge (SOC), typically from 10% to 90%.

Table.2

SR NO	TIME OF CHARGING (seconds/hours)	SOC(%)
1	3000 SECONDS (1 hour)	10 to 90%

However, an alternate method involves starting with a low voltage and gradually increasing it to mitigate excessive temperature rise within the rechargeable battery cell, thereby preserving battery integrity. Despite its benefits, this approach is not without drawbacks. One significant limitation is the prolonged charging duration, with charging times exceeding two hours. Moreover, maintaining a constant terminal voltage during the initial stages of the charging process necessitates high current flow, which poses risks to the structural integrity of the battery lattice, potentially leading to pole breakage.

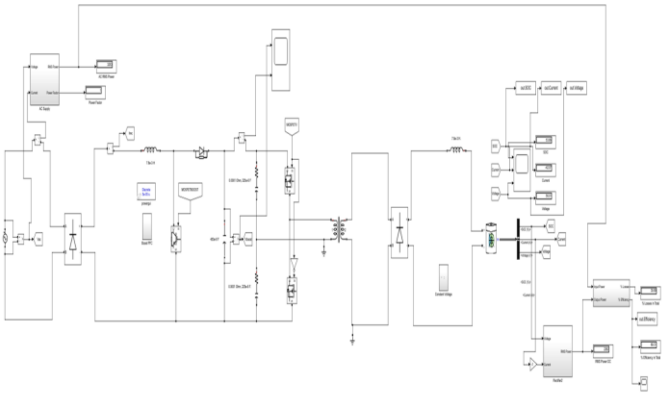
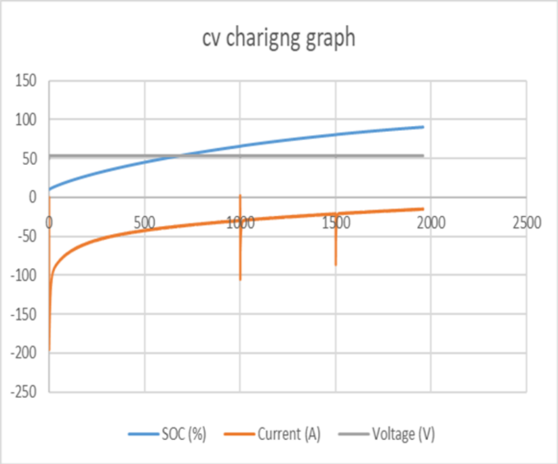


Fig.2

Above Fig shows the MATALAB circuit of constant voltage charging method.

This highlights the significant difficulty in determining the most effective voltage constant configuration that reconciles the demands of rapid charging, battery depletion, and power utilization. Achieving this balance is essential for ensuring efficient and safe battery charging operations in electric vehicles. Therefore, the development sophisticated charging algorithms and technologies is imperative to mitigate these challenges and enhance the overall performance and longevity of EV batteries. This circuit in MATLAB shows the charging of lithium ion battery in constant voltage mode with a value of and measure the parameters like SOC, voltage, time of charging of battery. The graph and duration of a constant current charging with soc (increases from 10 to 90%)



Graph.2

4.1.3 Constant Current Constant voltage(CC-CV) of improved fast charging method:

Charging in accordance with Constant Current Constant Voltage (CC-CV) stands as a widely adopted approach in the realm of electric vehicle (EV) charging due to its balance between efficiency and battery health. This method, characterized by a two-stage process, begins with a constant current phase, where the charger supplies a steady flow of supplying electricity to a battery until its voltage reaches a predetermined level. Subsequently, the charging enters the constant voltage phase, where the charger maintains a constant voltage while allowing the current to gradually decrease until the battery achieves a full charge.

For the purpose of achieving fast charging in lithium-ion (Li-ion) batteries, particularly in the context of EVs, higher charging currents are typically applied. However, this expedited charging process is not without its drawbacks. One notable limitation arises when the charging current surpasses a certain threshold, causing the rate of Li-ion travel to outpace the insertion rate into the graphite layer within the battery. This phenomenon, known as lithium plating, results in the deposition of Li-ions on the electrode layer rather than their proper insertion into the layers.

The consequences of lithium plating are multifaceted and can significantly compromise battery performance and longevity. Firstly, the excessive deposition of Li-ions on the electrode layer leads to the formation of metallic lithium, which not only diminishes the overall capacity of the battery but also poses safety risks such as overheating. Moreover, the accumulation of metallic lithium can trigger internal short circuits within the battery, potentially resulting in thermal runaway and catastrophic failure. Following fig shows the MATLAB circuit technique for steady voltage and current filling.

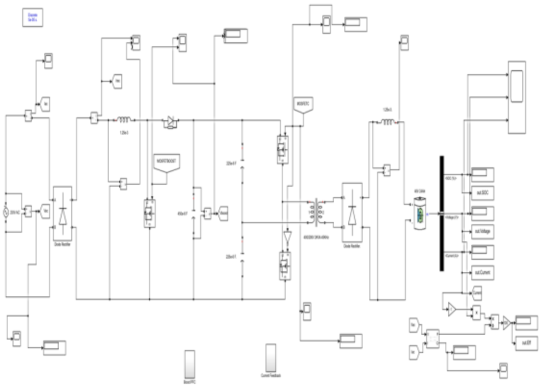
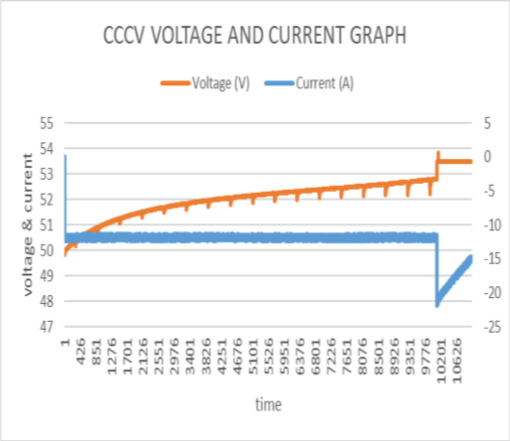


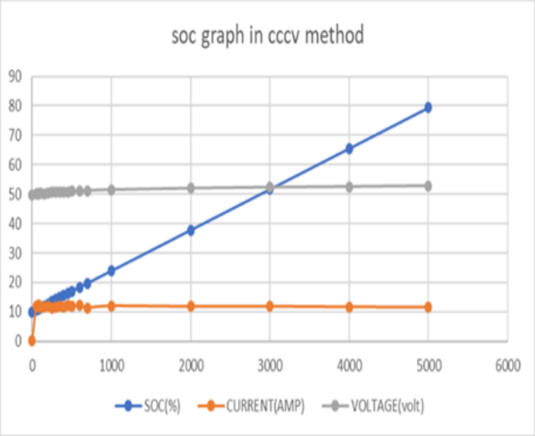
Fig.3

Furthermore, the occurrence of lithium plating exacerbates battery degradation over time, ultimately reducing its operational lifespan and compromising its ability to function effectively. As a result, the implementation of

CC-CV charging with excessively high charging currents can lead to accelerated battery deterioration, increased likelihood of malfunction, and diminished overall performance of EVs. To mitigate the adverse effects of lithium plating and ensure the long-term reliability of EV batteries, careful consideration must be given to the charging parameters, including the magnitude of the charging current and the duration of the charging process. By effectively managing the charging rate and battery condition, it is feasible to optimize the charging schedule and prolong the practical service life of lithium-ion batteries utilized in electric vehicles. Graph of the constant current, constant voltage (CC-CV0) charging method and charging time with SOC (from 10% to 90% increase): During the CC phase, which marks the initiation of the charging process, the charging current remains constant while the battery voltage increases progressively. Accelerated charging is facilitated during this phase, especially when the state of charge (SoC) of the power source is insufficient.



Graph.3



Graph.4

Figure 6 and the figure. The seventh graph illustrates the relationship between cc-cv charging voltage and current. Initially, a constant current of 12 amperes is applied in cc mode, and the voltage increases to a predetermined threshold value before becoming constant in cv mode.

When the battery voltage reaches the threshold that has been predetermined, the charger enters the CV phase. As the power source approaches complete charge, the charging current progressively diminishes during this phase, while the voltage remains constant. This practice guarantees the battery is charged in a safe and effective manner, thereby averting overcharging and preserving the battery's durability. The total charging duration may differ based on variables including battery capacity, charging current, and initial SoC. However, the CC-CV charging approach guarantees an efficient charge while safeguarding the battery against potential harm.

Comparison of Different Charging Methods Charging Time of Battery

Constant Current (CC) Method: In this charging technique, a constant current is supplied to the battery until its voltage reaches a predetermined level. The CC method requires an estimated duration of 6000 seconds (1.67 hours) to fully charge the battery from 10% to 90% SoC.

The constant voltage (CV) method maintains a consistent charging voltage after a predetermined voltage threshold has been attained. The charging process for a battery from 10% to 90% SoC using the CV method is estimated to be around 3000 seconds (0.83 hours), which is significantly shorter than the CC method.

Table.3

Charging Method	State of Charge (SoC)	Time in seconds
CC Method	10% to 90%	6000 sec =2 hr.
CV Method	10% to 90%	3000 sec = 1 hr.
CC-CV Method	10% to 90%	5508 sec= 1 hr. 52 minutes

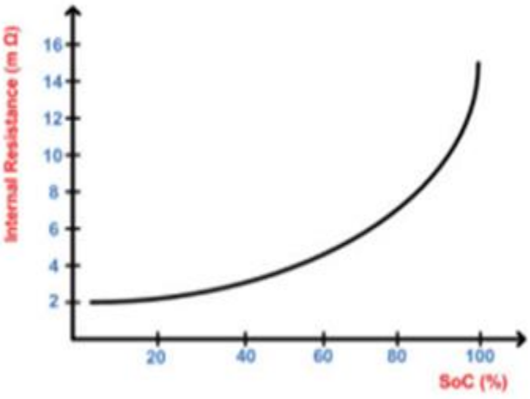
CC-CV: Constant Current-Constant Voltage Method The CC-CV method integrates charging phases characterized by constant current and constant voltage. The charging process commences by supplying a constant current until the battery voltage reaches a predetermined threshold; subsequent to that, the charging voltage remains constant. Using the CC-CV method, it takes roughly 5508 seconds (1.53 hours) to charge the battery from 10% to 90% SoC.

4.1.4 New improved fast charging method

Existing charging methods, as discussed in previous literature, commonly encounter challenges related to the time required for complete battery replenishment. One notable challenge lies in the management of charging currents, particularly concerning lithium-ion (Li-ion) batteries prevalent in two-wheeler electric vehicles (EVs). These batteries necessitate high charging currents for efficient fast charging, yet such elevated currents pose inherent risks such as lithium plating and joule heating.

To tackle this challenge, a novel approach is proposed, focusing on dynamic current modulation tailored to the internal resistance characteristics of the battery. The charging process entails varying the charging current levels determined by monitoring the resistance within of the battery in real time. The current used for charging is dynamically adjusted, as depicted in Figure 9, in order to maximize charging efficacy and minimize potential hazards linked to high electrical currents.

In order to accelerate the charging procedure during the initial phases, when the resistance inside of the battery is minimal, a greater charging current is administered. This methodology leverages the battery's capacity to accept larger currents with minimal resistance, thus enabling swift recharging of energy. In contrast, as the charging process advances and the internal resistance rises, a methodical reduction in the charging current occurs in order to avert detrimental consequences, including zinc plating and excessive heat production. This dynamic current modulation strategy offers several technical advantages. Firstly, it enables faster charging times by maximizing the charging current during favorable battery conditions, thereby minimizing overall charging duration. Secondly, by adjusting the charging current based on internal resistance variations, the method mitigates the risk of battery degradation and prolongs battery lifespan. Moreover, by optimizing the charging current levels, energy efficiency is enhanced, resulting in reduced energy wastage and lower charging costs over the long term.



Graph.5

Figure 10 illustrates the step charging process of current using MATLAB simulation, depicting the state of charge (SoC) increasing from 0% to 90% for an enhanced battery charging method designed for two-wheeler electric vehicles (EVs). The voltage waveforms corresponding to each step are showcased, representing various charging rates expressed as C-rates.

The C-rate represents the proportional rate of charge and discharge of a battery in relation to its capacity. A current denoting a C-rate of 1C is sufficient to charge or discharge the battery within a duration of one hour. To illustrate, when a 10Ah battery is charged at 1C, it will produce a current of 10A.

As the state of charge of the battery advances, the charging current is progressively increased in the step charging procedure. By employing this methodology, the charging efficacy is enhanced, and the battery's longevity and safety are guaranteed. The battery is exposed to diverse degrees of strain through the

manipulation of the charging current at various phases of the charging procedure. This mitigates the potential hazards associated with charging excessively or overheating.
The table 4 demonstrate the significant influence of charging rate on battery performance, as observed changes in state of charge (SOC), voltage, and charging duration across different C-rate conditions. Higher charging rates yield faster SOC increments and voltage rises, albeit with shorter charging durations, while lower rates result in more gradual SOC increases and extended charging times. Charging at 0.25C allows the battery to approach full capacity with a nearly 100% SOC and peak voltage, albeit with the longest charging duration. These findings underscore the necessity of balancing charging speed with battery health considerations, as slower charging rates exhibit the potential for maximizing SOC and voltage levels while minimizing adverse effects on battery longevity.

Table 4.

Sr no	Current value (ampere)	C-rate	Soc (%)	Voltage in (volts)	Time in (seconds/hour)
1	24	1-C	87.5%	54.11	3150
2	18	0.75C	93.77%	54.15	3450
3	12	0.5C	97.6%	54.9	3750
4	6	0.25C	99.98%	55	4049

The voltage waveforms illustrated in Figure 5 are indicative of the voltage fluctuations that occur at each stage of the charging procedure. The waveforms exhibit significant information regarding the battery's operation and reaction to the charging current that is being applied.

The MATLAB simulation results demonstrate the effectiveness of the new improved fast charging method in efficiently charging the battery of two-wheeler electric vehicles. By optimizing the charging current and voltage levels at each stage of the charging process, the proposed method enhances charging speed while maintaining battery safety and reliability. These findings contribute to the design and implementation of advanced battery charging systems tailored for the specific requirements of electric two-wheelers, facilitating their widespread adoption and promoting sustainable transportation solutions.

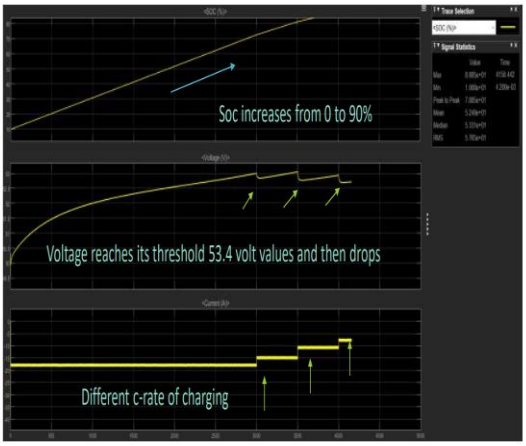
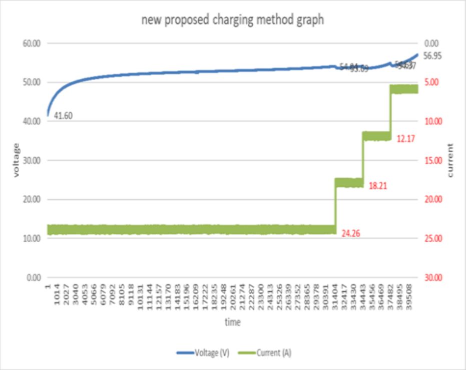
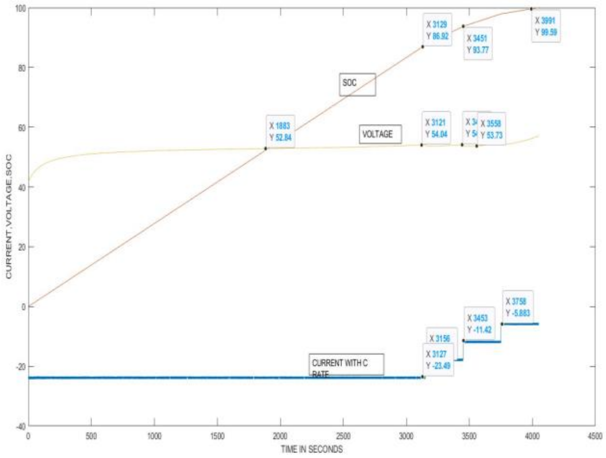


Fig.5



Graph.6

The graph illustrates a three-stage charging process for a two-wheeler electric vehicle battery, suggesting a modified constant current stage for faster initial charging, followed by a transition phase ensuring efficient charging. The constant voltage stage minimizes overcharging risk. Benefits include faster charging and potentially improved battery lifespan. However, without specific axis values and detailed control logic, precise assessment is limited. Overall, the method appears to strike a balance between rapid charging and battery health preservation, though further data is needed for a comprehensive evaluation.



Graph.7

Flow chart of the fast charging method of EV:

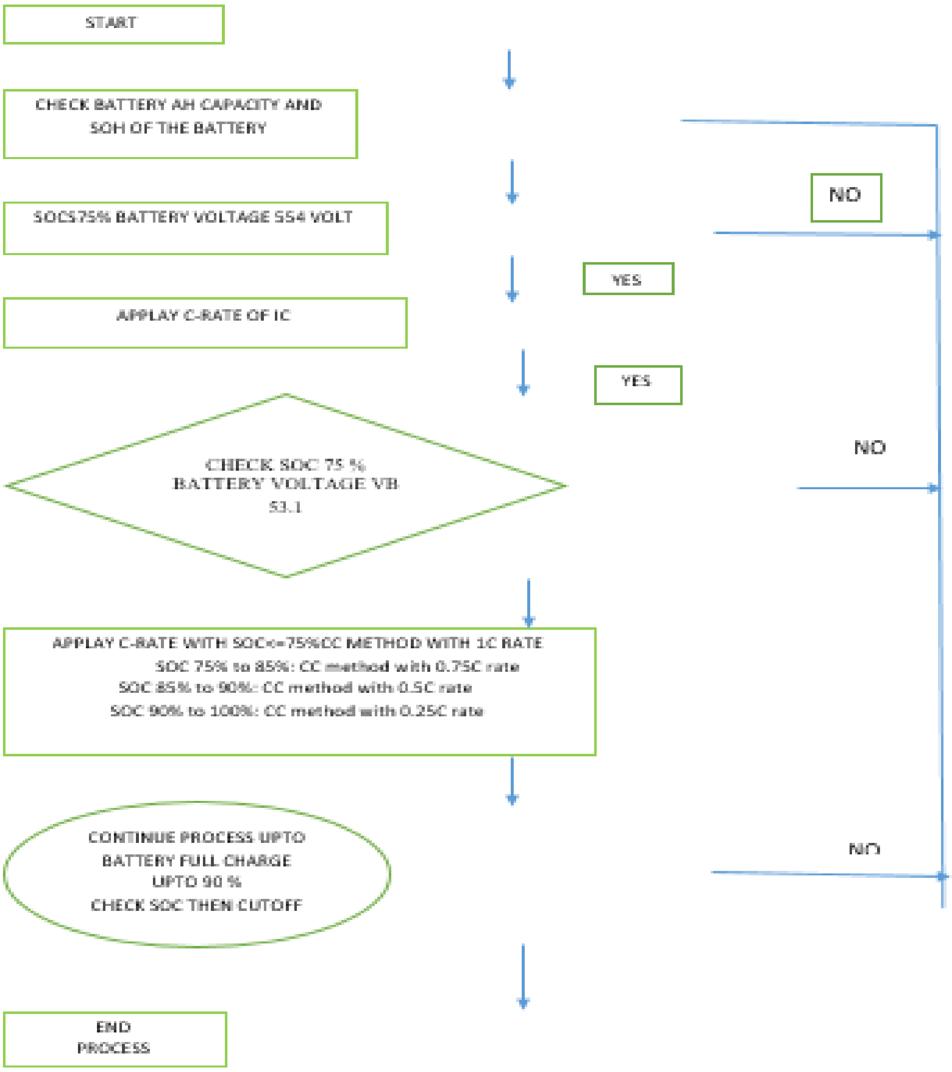


Fig.4

Comparison of MATLAB results of the time of CCCV data and proposed new improved fast charging method:

The comparison of MATLAB results between the existing Constant Current Constant Voltage (CCCV) charging method and the proposed new charging method for two-wheeler electric vehicle batteries reveals significant improvements in charging efficiency.

The existing CCCV method requires approximately 1 hour and 52 minutes to charge the battery from 10% to 90% State of Charge (SoC). In contrast, the proposed new charging method achieves a remarkable reduction in charging time, completing the same charge from 10% to 99% SoC in just 1 hour and 12 minutes.

This interpretation underscores the superior performance of the proposed new charging method, demonstrating its ability to charge the battery more rapidly while achieving a higher SoC. By leveraging MATLAB circuit simulation, these results validate the efficacy of the new charging method in enhancing the charging process for two-wheeler electric vehicle batteries.

Overall, the significant reduction in charging time coupled with the attainment of a higher SoC highlights the potential of the proposed new charging method to enhance the efficiency and usability of electric vehicles, ultimately contributing to the widespread adoption of sustainable transportation solutions.

Table 5.

SR NO	CHARGING METHOD	TIME IN HOUR	SOC(%)
1	CCCV	1 HR 52 MINUTES	10 To 90%
2	NEW IMPROVED CHARGING METHOD	1 HR 12 MINUTES	10 TO 99%

5. Conclusion

In conclusion, this research addresses the imperative need for enhanced battery charging solutions tailored for two-wheeler electric vehicles (EVs). By leveraging advanced ferrite core transformers and employing comparative analysis against conventional chargers, our prototype demonstrates a substantial increase in charging efficiency, surpassing 90%. Through the utilization of MATLAB simulations, we validate the efficacy of our proposed charger design, showcasing its potential to mitigate energy losses and optimize charging operations. This advancement holds significant promise for fostering sustainable transportation solutions within urban environments, contributing to the broader adoption of electric vehicles and furthering the evolution of efficient charging infrastructure.

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