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STUDY OF ELECTRIC VEHICLE – EV TECHNOLOGY

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Abstract— **The emergence of electric two-wheelers in India has sparked a new wave of trans-potation revolution. With an increasing emphasis on sustainable mobility and a desire to reduce pollution, electric two-wheelers have garnered significant attention. However, along with their rising popularity, new challenges have surfaced. The need for a robust charging infrastructure, limited range, and high initial costs are among the hurdles that need to be addressed. Nevertheless, the growing demand for electric two-wheelers in India is undeniable.**

This paper provides a detailed functional tester and the subsequent development of a second-generation the findings from this research aid in the creation of safer and more efficient electric two-wheelers, promoting their adoption in the market and advancing sustainable transportation. Testing an electric vehicle with all possible edge cases involves subjecting the vehicle to various extreme and unusual scenarios to ensure its performance and safety under diverse conditions

Keywords— **Electric Vehicle, EVs Components, Functional Tester, Matlab Simulink**

I. INTRODUCTION

Electric two wheelers, also known as e-bikes or electric scooters, have gained significant popularity in recent years, especially in countries like India. As a developing nation with a growing concern for environmental sustainability, India has witnessed a surge in the adoption of electric vehicles, including electric two wheelers. The introduction of electric two wheelers in India has been driven by several factors. Firstly, the government has implemented various policies and incentives to promote electric mobility, including subsidies, tax benefits, and charging infrastructure development. The adoption of electric two wheelers in India has not only benefited individuals but also contributed to the overall societal and environmental well-being. The reduced dependence on fossil fuels has helped conserve natural resources and reduce greenhouse gas emissions[1]. It has also spurred the growth of the electric vehicle industry, creating job opportunities and promoting technological advancements.

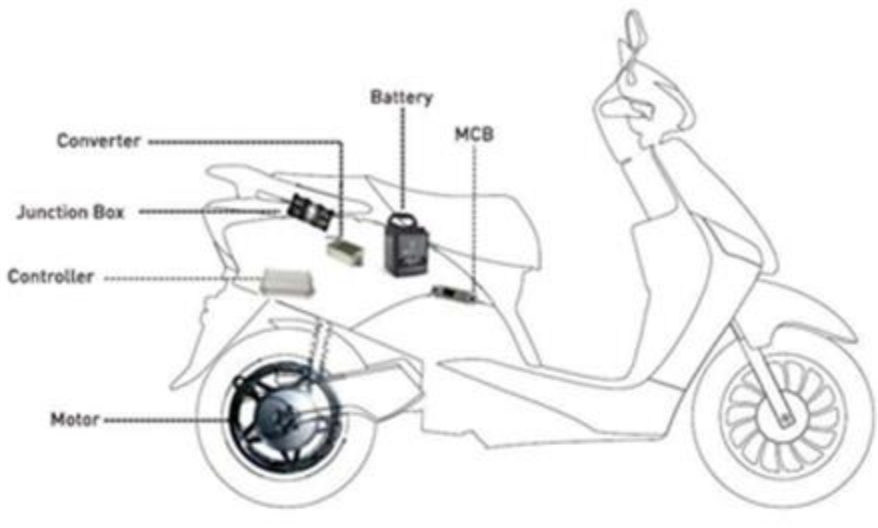

Fig. 1. Two wheeler model

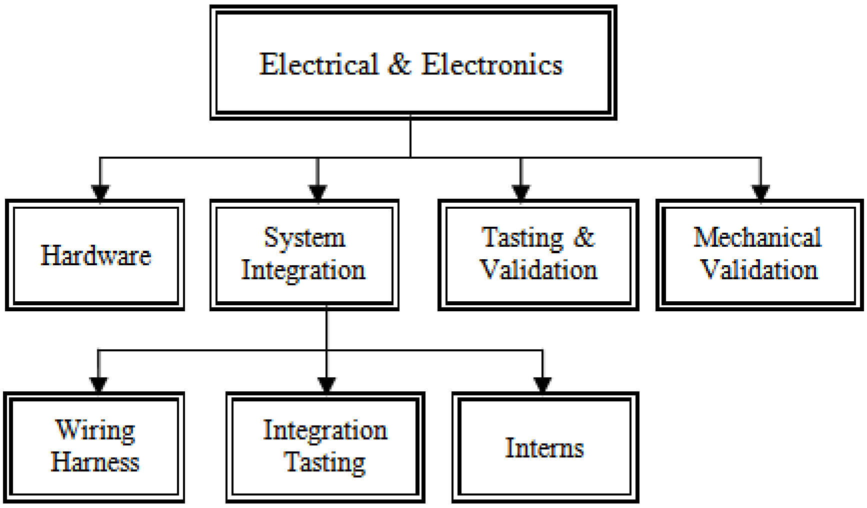

Fig. 2. Model structure

The past five years have witnessed a remarkable evolution in the Electric Vehicle (EV) Two wheeler (2W) landscape in India. With a growing focus on sustainability and a concerted effort to reduce carbon emissions, the Indian government has implemented various policies and initiatives to promote the adoption of electric vehicles[3]. This has resulted in significant advancements in technology, infrastructure, and market penetration of EVs across the country.

Companies like Ather Energy, Bajaj Auto, and Hero Electric have emerged as prominent players in the electric two-wheeler space. Bajaj Auto, one of India's leading two-wheeler manufacturers, launched the Chetak electric scooter, marking its reentry into the electric segment after a long hiatus. Hero Electric, with its wide range of electric scooters, has been a consistent presence in the market. However, the past five years have witnessed some notable developments. Major automakers like Tata Motors, Mahindra and Mahindra, and Hyundai have introduced electric vehicle models in the market. Furthermore, the Indian government has taken initiatives to develop a robust charging infrastructure network to alleviate range anxiety and promote EV adoption[2].

II. COMPONENTS OF AN ELECTIC VEHICLE

Electric vehicles (EVs) consist of several main components that work together to power, control, and provide a user-friendly interface. These components include the motor, motor controller, battery pack, charger, power electronics, control systems, and user interface. The motor is the heart of an electric vehicle, responsible for converting electrical energy into mechanical energy to propel the vehicle. Various types of motors, such as AC induction motors or permanent magnet motors, can be used in EVs, each offering its own advantages in terms of efficiency and performance.

MOTOR

Permanent magnet synchronous motors (PMSM) are widely used in various industries due to their high efficiency, compact size and excellent torque characteristics. A PMSM motor consists of a stator with windings and a rotor with permanent magnets. The stator windings produce a rotating magnetic field, and the rotor permanent magnets produce a stationary magnetic field. The interaction of these magnetic fields produces the torque required to operate the motor.

MOTOR CONTROLLER BATTERY PACK

A motor controller for Permanent Magnet synchronous Motor (PMSM) using Field oriented Control (FOC) is critical in achieving precise and efficient motor control. FOC is a control technique that enables independent control of the motor's flux and torque components, resulting in improved dynamic performance and efficiency[4].

BATTERY PACK

Lithium-ion batteries have become the preferred choice for various applications, from consumer electronics to electric vehicles. These battery packs contain multiple lithium cells connected in series and parallel. Lithium batteries have a high energy density, long cycle life and low self-discharge rate. Advances in lithium battery technology will facilitate improved energy storage and enable the development of more powerful and long-lasting battery packs.

VARIOUS MODULES IN THE VEHICLE

Electric two wheeler contains several modules such as the Vehicular control unit, Battery Management System , Motor controller Unit, display unit and the telematics unit for providing various features and helps in ensuring safety of the driver.

VEHICLE CONTROLLER UNIT (VCU)

The VCU in an electric two-wheeler is a critical component that plays a vital role in controlling and managing various aspects of the vehicle's operation. It serves as the central hub for integrating and coordinating the functionalities of different systems and subsystems within the electric two-wheeler. One of the primary functions of the VCU is to manage the power flow between the battery pack and the electric motor. It receives signals from the throttle position sensor and interprets the rider's input to control the motor's speed and torque output. The VCU ensures smooth and responsive acceleration by modulating the power delivery to the motor.

BMS

An essential part of an electric two-wheeler, the Battery Management System (BMS) supervises and regulates the functioning and health of the battery pack. It guarantees the battery's best performance, safety, and longevity.
The BMS includes Cell Monitoring, State of Charge Estimation, Temperature Control, Cell Balancing,

MOTOR CONTROLLER UNIT (MCU)

An essential component that manages and regulates the operation of the electric motor is the MCU in an electric two-wheeler. It plays a crucial part in converting human inputs into motor orders, ensuring the vehicle operates smoothly and effectively The MCU includes Power regulation, Motor Control Algorithms, Pulse width modulation, Fault Detection and Protection[5].

DISPLAY UNIT

The interface between the rider and the information system in an electric two-wheeler is the display unit. It improves the entire riding experience and gives essential realtime data. The display device normally comprises of an LCD or LED screen that shows data like speed, battery life, range, mode choice, and trip details. Additionally, it might incorporate smartphone integration, Bluetooth connectivity, and navigation[6].

TELEMATICS

Telematics plays a vital role in electric two-wheelers, providing valuable insights into various aspects. It enables real-time monitoring of battery status, range estimation, and aspects. It enables real-time monitoring of battery status, range estimation, and charging infrastructure availability. Additionally, telematics facilitates remote diagnostics, over-the-air updates, and theft tracking, enhancing user experience, efficiency, and overall safety of electric two-wheeler operations with Global Postioning System (GPS) tracking, Remote Monitoring[8]

III. ARCHITECTURE DESIGN IN MATLAB SIMULINK

The Simulink model simulates two critical components: the throttle logic and the motor controller logic. These components play a crucial role in the overall functioning of the system. The throttle logic module is responsible for processing the input from the accelerator pedal and converting it into a corresponding signal that reflects the desired power output. This module may include algorithms for signal conditioning, noise filtering, and calibration to ensure accurate throttle control[10].

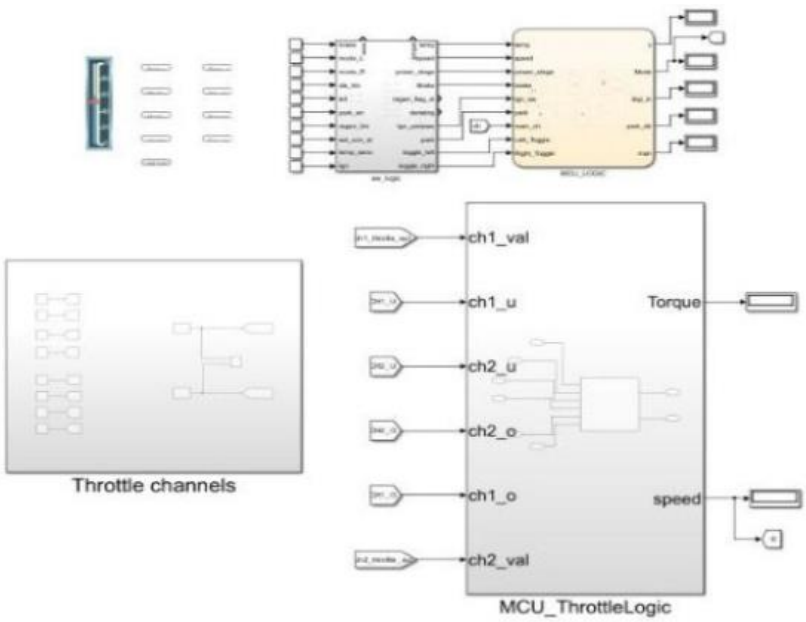

Fig 3 Simulink model of throttle and MCU unit

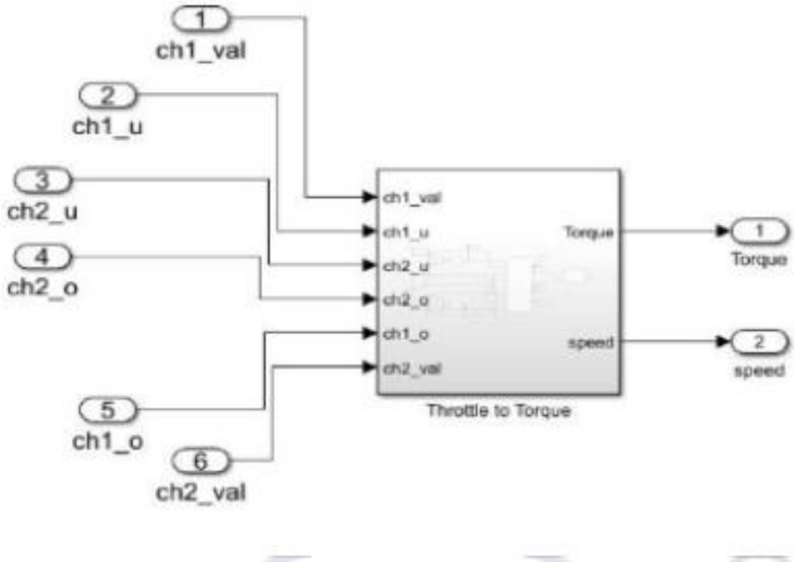

Fig 4 Throttle to torque mapping

The different modes available in many electric two-wheelers include Eco mode, Ride mode, and Rush mode. Each mode is designed to offer distinct performance characteristics and energy efficiency levels. Eco mode prioritizes energy conservation, optimizing the power delivery and reducing acceleration for maximum range. Ride mode provides a balanced performance, offering a blend of efficiency and responsiveness suitable for regular commuting. Rush mode, on the other hand, is designed for maximum performance, providing quick acceleration and higher speeds. This chapter provides a comprehensive overview of the implementation of the Functional Tester and simulates the system architecture. It delves into the details of how the Functional Tester is designed, developed, and integrated into the testing process for electric two-wheelers. The chapter explores the key components, interfaces, and connections involved in the implementation of the Functional Tester. Furthermore, the chapter discusses the simulation of the system architecture, which enables a virtual representation of the electric two-wheeler and its interactions with the Functional Tester. This simulation allows for comprehensive testing of various scenarios and conditions in a controlled environment, providing insights into the performance and behavior of the electric two-wheeler [7].

IV.CONCLUSION

The functional tester for the electric vehicle has proven to be a valuable tool in identifying and addressing edge cases while providing crucial insights for the development of the next generation architecture. Through extensive testing and analysis, the functional tester has successfully evaluated the performance, functionality, and limitations of the electric vehicle, enabling the identification of critical edge cases that need to be addressed. The results obtained from the functional tester have been instrumental in gaining a comprehensive understanding of the electric vehicle’s behavior and performance under various operating conditions. By meticulously analyzing the data collected during testing, valuable insights have been gained regarding the vehicle’s response to different stimuli, its efficiency, and the effectiveness of its control systems. These findings have served as a foundation for the development of a MATLAB Simulink model for the next generation architecture of the electric vehicle. By leveraging the knowledge gained from the functional tester, the Simulink model has been designed to eliminate the identified edge cases and further enhance the performance and safety of the electric vehicle. The MATLAB Simulink model provides a powerful platform for simulating and analyzing the behavior of the electric vehicle’s systems and subsystems. By incorporating the knowledge gained from the functional tester, the Simulink model can accurately replicate real-world scenarios and predict the vehicle’s response, allowing for the evaluation of the vehicle’s performance in a controlled and virtual environment. Through iterative simulations and analysis, the Simulink model enables the identification and elimination of potential edge cases. This iterative process involves refining the control algorithms, optimizing the powertrain, and fine-tuning various parameters to ensure that the electric vehicle operates reliably and efficiently under all conditions. By integrating the results and insights obtained from the functional tester into the Simulink model, the next generation architecture of the electric vehicle can be enhanced to eliminate potential edge cases, ensuring improved safety, performance, and overall user experience. In conclusion, the functional tester has played a pivotal role in evaluating the electric vehicle's performance and identifying edge cases. The analysis of the results obtained from the functional tester has led to the development of a MATLAB Simulink model that serves as a powerful tool for refining and optimizing the next generation architecture of the electric vehicle, with the ultimate goal of eliminating edge cases and delivering a robust and reliable electric vehicle.

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