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Design of Powertrain for E-Cycle Using MATLAB

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Abstract: ***The primary objective of this review paper is to present a comprehensive overview of earlier research efforts in the development of 'electric cycle (E-Cycle) systems' with an innovative approach. The review delves into existing literature findings on the design of electric cycles, exploring both theoretical frameworks and practical experiences associated with E-Cycles. The paper encompasses recent studies on electric bicycles and showcases the evolution of various types of electric cycles. Specifically, it focuses on the design and simulation of a low-speed electric cycle, emphasizing power optimization. Given the environmental concerns associated with internal combustion engines emitting hazardous gases, there is a notable shift in the automotive industry towards electric-powered vehicles. This paper underscores the significance of electric cycles as a future mode of transportation. To enhance the efficiency and range of electric cycles, improvements in powertrain design are imperative. Consequently, the review emphasizes the necessity to devise and implement an optimized powertrain system for electric cycles, contributing to the ongoing evolution of electric vehicles.***

Keywords: Electric cycle (E-Cycle), Innovative approach, Literature findings, Design optimization, Experiences with electric cycles, Electric motorcycles, Powertrain design, Simulation, Low-speed electric cycle, Environmental impact, Future transportation, Electric vehicle (EV), Powertrain optimization, Mileage improvement.

I. INTRODUCTION

The burgeoning interest in sustainable transportation solutions has propelled electric cycles (E-Cycles) to the forefront of innovative mobility. This review paper embarks on a comprehensive exploration of the evolving landscape of electric cycles, examining the contributions of earlier investigators and presenting an innovative perspective on E-Cycle systems. In the quest for eco-friendly and efficient alternatives, the focus extends to three pivotal aspects of electric cycle technology: mid-drive systems, hub-drive systems, and pedal assist mechanisms.

Mid-drive systems, strategically positioned at the bike's crankset, have gained considerable attention for their ability to leverage the bike's gears, optimizing power distribution and enhancing overall efficiency. Hub-drive systems, on the other hand, position the motor within the wheel hub, simplifying the design and maintenance of electric cycles. Both mid-drive and hub-drive configurations offer distinct advantages, prompting a nuanced investigation into their respective strengths and limitations Pedal assist, a fundamental component of electric cycling, integrates human effort with electric power, augmenting the overall riding experience. As electric cycles continue to redefine modern transportation, the nuanced interplay between these technologies becomes crucial for designing systems that cater to diverse user preferences and address the varied challenges associated with electric mobility.

This paper delves into existing literature findings, providing insights into the design considerations, experiences, and recent advancements related to mid-drive, hub-drive, and pedal assist mechanisms in electric cycles. By synthesizing the knowledge derived from earlier research, this review aims to contribute to the ongoing discourse on sustainable and efficient electric cycle systems, ultimately shaping the future of urban mobility.

II. REVIEW ON TRADITIONAL CYCLES

Traditional cycles, time-tested and enduring, remain a fundamental mode of transportation and recreation. Their simplicity and mechanical elegance have sustained their relevance despite the proliferation of modern alternatives. The design of traditional cycles, characterized by a sturdy frame, manual pedaling, and uncomplicated mechanics, ensures a straightforward and reliable riding experience. These cycles hold a special place in the hearts of enthusiasts, embodying a sense of nostalgia and a connection to a bygone era. Their eco-friendly nature, devoid of motorized components, aligns seamlessly with the growing emphasis on sustainable transportation. Additionally, traditional cycles promote physical well-being, offering an effective means of exercise while traversing diverse terrains. While contemporary technologies have ushered in a new era of cycling, the enduring appeal of traditional cycles persists, making them a timeless choice for those who appreciate the simplicity, versatility, and inherent charm of a classic mode of two-wheeled transport.

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III. REVIEW ON HUB DRIVE E-CYCLES

Hub-drive electric cycles have carved a niche in the electric mobility landscape, offering a streamlined and efficient design that prioritizes simplicity. Placing the motor within the wheel hub distinguishes these systems, influencing their performance characteristics and user experience. Hub-drive e-cycles are celebrated for their user-friendly design. With fewer moving parts and a direct integration into the wheel hub, these systems require minimal maintenance, making them an attractive option for riders seeking a hassle-free electric cycling experience. The inherent design of hub-drive motors contributes to a notably quiet operation. Riders can enjoy a peaceful and unobtrusive journey, as the absence of gear engagement and intricate mechanisms minimizes noise levels during electric-assisted cycling. Hub-drive systems often result in a cleaner and more aesthetically pleasing bicycle design. The absence of external gears and chains contributes to a sleek and modern appearance, appealing to riders who value both form and function. Hub-drive e-cycles tend to be more cost-effective compared to their mid-drive counterparts. The simplified design and reduced manufacturing complexity often translate to a lower overall price point, making electric cycling more accessible to a broader consumer base. Hub-drive motors can impact the overall weight distribution of the bicycle, potentially affecting its handling characteristics. Some riders may find that the added weight in the wheel hub alters the feel of the ride, especially in situations that demand precise maneuvering. Unlike mid-drive systems that leverage the bicycle's gears for optimized power distribution, hub-drive e-cycles may have a limited range of gears. This could potentially impact performance on challenging terrains, especially when compared to the versatility offered by mid-drive systems. Hub-drive electric cycles stand out for their simplicity, quiet operation, and cost-effectiveness. As an ideal choice for riders prioritizing ease of use and minimal maintenance, hub-drive systems contribute to the diversification of the electric cycling market. While considerations regarding weight distribution and gear range exist, the overall appeal of hub-drive e-cycles lies in their approachable design and efficient performance.

IV. REVIEW OF MID DRIVE

Mid-drive electric cycles have emerged as a transformative force in the realm of electric mobility, redefining the dynamics of e-cycling. Positioned at the crankset, the motor of mid-drive systems engages directly with the bicycle's gears, offering distinct advantages that warrant a closer examination. One of the primary advantages of mid-drive e-cycles lies in their efficient power distribution. By utilizing the bicycle's gears, these systems optimize torque delivery, enabling riders to navigate varied terrains with ease. This efficiency is particularly pronounced when climbing hills or navigating challenging landscapes. Placing the motor at the bike's centre contributes to balanced weight distribution. This not only enhances stability but also improves the overall handling of the electric cycle. The rider experiences a more natural feel, akin to traditional cycling, fostering a seamless transition for those accustomed to non-electric bikes.

Mid-drive systems often lead to better battery range optimization. By leveraging the bike's gears, the motor operates within its optimal RPM range, ensuring that the energy from the battery is used more efficiently. This results in extended ride distances on a single charge. Mid-drive e-cycles are renowned for their versatility in tackling diverse terrains. Whether it's steep inclines, off-road trails, or urban commuting, the ability to utilize the gears ensures a responsive and adaptable riding experience. This makes mid-drive e-cycles suitable for a wide range of users with varying cycling preferences. The intricate nature of mid-drive systems, involving a connection to the bike's gearing mechanism, can introduce an element of complexity.

While these systems are designed for durability, maintenance may be more involved compared to simpler hub-drive configurations. Some mid-drive motors may produce more noise compared to hub-drive counterparts. While advancements in technology aim to minimize noise, the audible hum of mid-drive systems can be a consideration for riders who prioritize a quiet cycling experience. In the evolving landscape of electric cycles, mid-drive systems stand out as a sophisticated and efficient option. Their advantages in power distribution, weight balance, and terrain versatility make them a compelling choice for riders seeking a dynamic e-cycling experience. However, potential challenges such as maintenance complexity and cost highlight the need for a nuanced evaluation based on individual preferences and requirements. As technology continues to advance, mid-drive e-cycles are poised to play a pivotal role in shaping the future of electric mobility.

V. REVIEW ON PEDAL ASSISTED E-CYCLE:

Pedal-assisted electric cycles, commonly known as e-bikes, represent a harmonious blend of human-powered pedalling and electric motor assistance, ushering in a new era of cycling that seamlessly integrates technology with traditional pedal power. This review explores the multifaceted appeal and functionality of pedal-assisted e-cycles, emphasizing their impact on urban commuting, recreational riding, and the broader landscape of sustainable transportation. At the heart of the pedal-assisted e-cycle experience is the augmentation of human effort with electric power.

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This synergy allows riders to conquer longer distances, navigate challenging terrains, and overcome physical limitations with relative ease. The electric assistance is often modulated through various levels, enabling riders to tailor the degree of support based on their preferences or the nature of the journey. One of the key advantages of pedal-assisted e-cycles lies in their accessibility. They provide an inclusive solution for individuals of varying fitness levels, allowing a broader demographic to embrace cycling as a mode of transportation or recreation. Commuters, in particular, benefit from the electric assistance, arriving at their destinations with less fatigue and perspiration compared to traditional cycling. This accessibility contributes to the democratization of cycling, making it a viable option for a diverse range of riders. The integration of pedal-assist technology also addresses the common barriers to cycling, such as steep hills and challenging topography. Riders can confidently tackle uphill climbs or traverse uneven surfaces with the support of the electric motor, expanding the range of cycling possibilities. This makes pedal-assisted e-cycles an excellent choice for individuals commuting in hilly or geographically diverse regions. Furthermore, pedal-assisted e-cycles serve as a gateway for non-cyclists to adopt a more sustainable mode of transportation. The electric assistance provides a safety net for those hesitant about the physical demands of cycling, encouraging a gradual transition to a healthier and environmentally friendly commuting option. As a result, these e-cycles contribute to the reduction of carbon emissions and alleviate the strain on traditional transportation infrastructure. In terms of design, pedal-assisted e-cycles seamlessly integrate the electric motor and battery, preserving the aesthetics of a conventional bicycle. The unobtrusive nature of the electric components ensures that the e-cycle retains the classic silhouette and appeal of traditional bikes. This design consideration aligns with the preferences of riders who appreciate the elegance and simplicity of a bicycle while enjoying the advantages of electric assistance. Pedal-assisted e-cycles are also gaining popularity in the realm of recreational cycling. Whether exploring scenic trails or embarking on extended rides, cyclists can toggle between manual pedalling and electric support, tailoring the experience to match their energy levels and the demands of the terrain. This versatility makes pedal-assisted e-cycles a compelling choice for those seeking a dynamic and enjoyable outdoor adventure. The pedal-assisted e-cycles have redefined the cycling landscape by seamlessly merging human-powered locomotion with electric assistance.

VI. CONCLUSION

The landscape of electric cycles is richly diverse, with mid-drive, hub-drive, and pedal-assist systems offering unique advantages. Mid-drive systems impress with their efficiency and adaptability, ideal for riders navigating diverse terrains. Hub-drive systems prioritize simplicity, quiet operation, and cost-effectiveness, appealing to those seeking a straightforward and affordable electric cycling solution. Pedal-assist mechanisms, inherent in the design of both mid-drive and hub-drive systems, bridge the gap between manual and electric power, fostering a harmonious and energy-efficient riding experience. Ultimately, the choice between mid-drive, hub-drive, or pedal-assist electric cycles depends on individual preferences, riding requirements, and the desired balance between performance and simplicity. As electric cycling continues to evolve, these diverse approaches collectively contribute to a sustainable and dynamic future for urban mobility.

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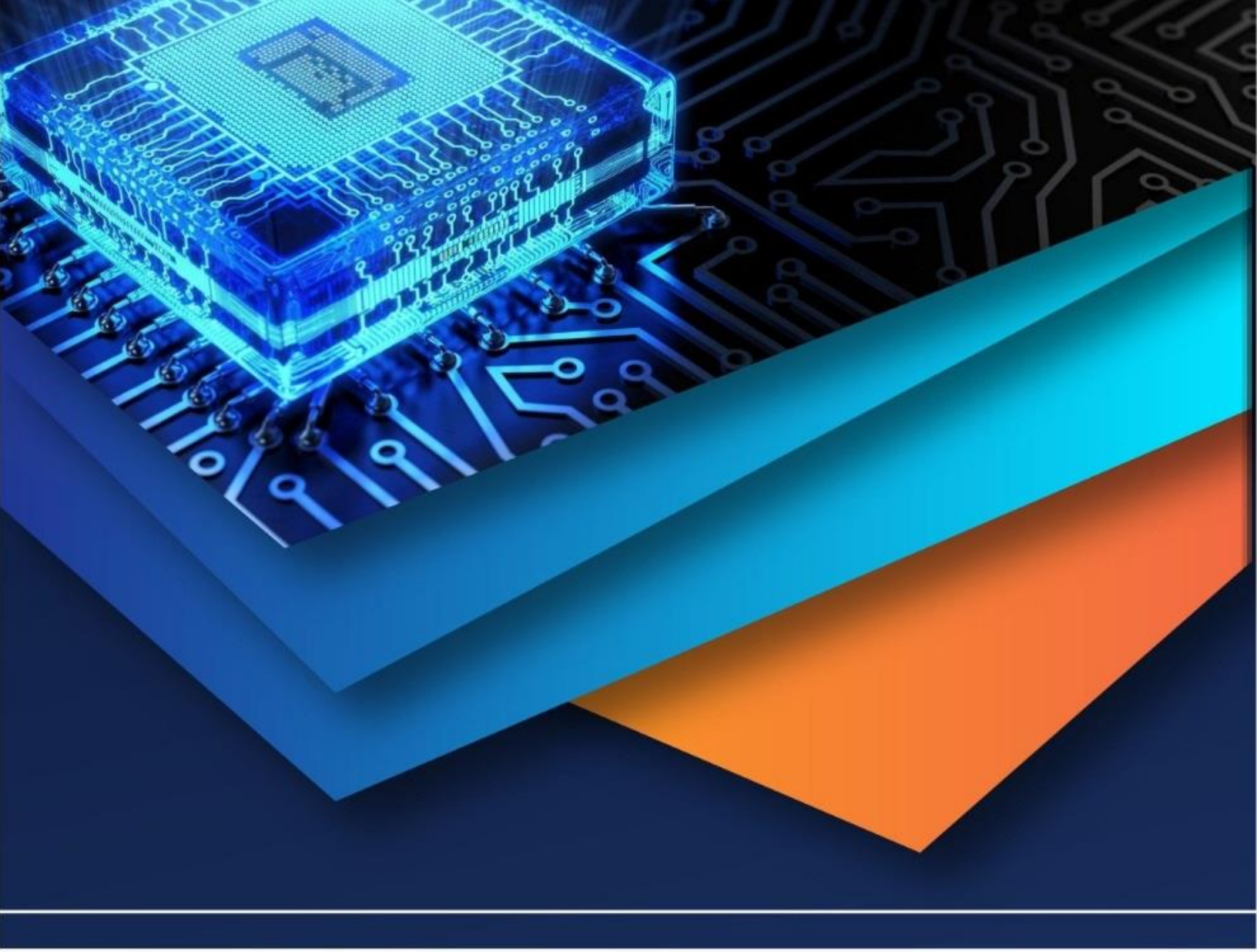

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