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Design and Fabrication of Offroad Electric Wheelchair

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Abstract: *This paper presents the design, development, and testing of an innovative Off-Road Electric Wheelchair (OREW) aimed at addressing the limitations of conventional electric wheelchairs that primarily cater to indoor use and paved surfaces. By focusing on off-road capabilities, the OREW project seeks to enhance the quality of life for individuals with mobility impairments, enabling them to explore outdoor environments and participate in various activities. The OREW has the potential to promote social inclusion, provide opportunities for recreation, exercise, and exploration, and significantly contribute to overcoming accessibility barriers faced by people with disabilities.*

Keywords: Off-road mobility, Electric wheelchair design, Fabrication techniques, Terrain adaptation, Accessibility technology

I. INTRODUCTION

In today's world, where accessibility and mobility are crucial aspects of daily life, the development of off-road electric wheelchairs emerges as a significant breakthrough in engineering innovation. The project, "Design and Fabrication of an Off-road Electric Wheelchair," addresses the pressing need to expand mobility options for individuals with physical disabilities, particularly in challenging terrains. By skillfully integrating advanced engineering principles and ergonomic design considerations, this project aims to transform the landscape of mobility by providing a robust, agile, and all-terrain electric wheelchair solution.

Guided by the principles of inclusivity and empowerment, this project delves into the exploration of cutting-edge technologies to revolutionize the way people with disabilities navigate their surroundings [1]. Our objective is to develop a prototype that caters to the needs of people with physical disabilities who may have limited or no functionality. The target users include senior citizens who often live alone and rely on attendants for assistance, making it difficult for them to move within their homes.

People in wheelchairs face several challenges, such as:

1. Limited accessibility in public spaces
2. Inadequate physical infrastructure in rural areas, where many old houses are not wheelchair-friendly
3. The lack of suitable facilities that hinder comfort and independence for the elderly population.

By focusing on these issues, our project aims to create a more inclusive and accessible environment for people with mobility impairments, enabling them to lead more active and independent lives.

II. LITERATURE SURVEY

In the pursuit of designing and developing an Off-Road Electric Wheelchair, several research papers and studies have provided valuable insights and guidance. This section highlights some of the key contributions in this field.

1. Podobnik, Jure Rejc, Sebastjan Slajpah, Marko Munih, and Matjaz Mihelj's research paper, "All-terrain wheelchair: Increasing personal mobility with a powered wheel-track hybrid wheelchair," published in IEEE Robotics & Automation Magazine (2017), explores the development of an all-terrain wheelchair that can navigate various surfaces effectively [1].
2. Madanhire, Ignatio, Tinashe Gwizo, and C. Mbowa's study, "Design Improvement of Off-road Rough Uneven Rural Terrain Wheelchair," presented at the 2nd European Conference on Industrial Engineering and

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Operations Management (IEOM) in Paris, France (2018), focuses on the challenges faced by wheelchair users in rural areas with uneven and inaccessible terrain [2].

3. Marcelo Becker's research paper, "Suspension system for an all-terrain wheelchair," presented at the RESNA 2000 Annual Conference: Technology for the New Millennium, discusses the importance of a suitable suspension system for all-terrain wheelchairs, ensuring user comfort and mobility [3].
4. Kaydn T. Resar's PhD dissertation, "Design of an Add on Autonomous Navigation and Control System for an Outdoor Electric Wheelchair" (2023)

III. PROPOSED METHODOLOGY

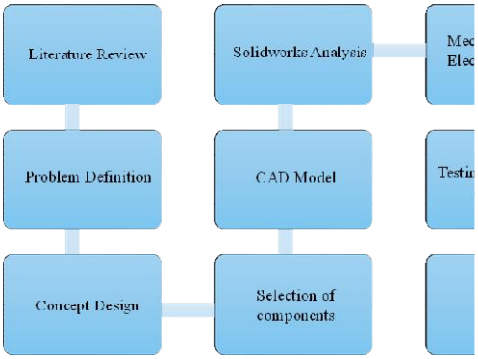

Figure 1: Methodology

Design Objectives

In the pursuit of designing and developing an Off-Road Electric Wheelchair, several key objectives must be met to ensure the successful creation of a versatile and user-friendly product. These objectives are as follows:

Enhanced Stability: The primary objective is to design a wheelchair that provides superior stability on uneven terrain, minimizing the risk of tipping or loss of control during off-road use. This will instill confidence in users and enable them to navigate challenging environments safely.

Improved Maneuverability: A crucial aspect of the design is to develop a wheelchair that allows for agile and precise maneuvering. This includes enabling users to navigate tight spaces and negotiate obstacles with ease, enhancing their overall mobility and independence.

Durable Construction: To ensure the wheelchair can withstand the rigors of off-road environments, robust materials and construction techniques must be employed. This objective aims to create a product that can endure rough terrain and varying weather conditions, prolonging its lifespan and reducing maintenance requirements.

Optimized Traction: Traction-enhancing features, such as specialized tires, treads, or traction control systems, must be implemented to maximize grip and traction on surfaces like gravel, grass, mud, and sand. This objective will allow users to traverse various terrains with confidence and ease.

User Comfort and Accessibility: Prioritizing user comfort and accessibility is essential in the design process. This includes creating ergonomic seating, adjustable components, and intuitive controls to accommodate users with varying needs and preferences. By doing so, the wheelchair will enhance overall user experience and satisfaction, making it a valuable tool for those with mobility impairments.

Methods employed to construct the off-road electric wheelchair:

To develop an efficient and effective off-road electric wheelchair, several methods and techniques were employed throughout the design and construction process. The following outlines these methods and their contributions to the final product:

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Design Cad Model : The wheelchair's design was created using specialized software such as AutoCAD for the chassis and SolidWorks for the overall model design. This step allowed for precise planning and visualization of the wheelchair's components and structure.

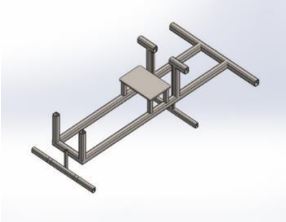

Figure 2. Chassis Design

Model Analysis From Software : Analyzing the model in SolidWorks software provided crucial information on the wheelchair's ability to withstand static loads. The results indicated that the wheelchair could safely support a maximum load of 200 kg, meeting the project's requirements.

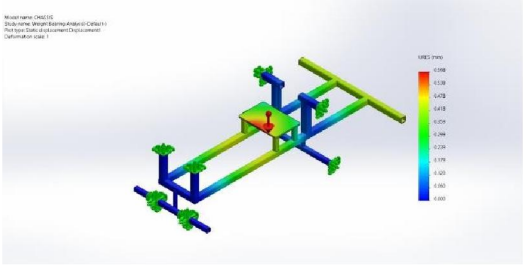

Figure 3. Model analysis

Calculations for selection motor and battery : Calculations were conducted to determine the appropriate motor and battery specifications based on factors like weight capacity, off-roading requirements, and user comfort. The final selections were a 1000W BLDC motor and a 48V, 14A battery

Material Selection with standards: Mild steel (MS) was chosen for the wheelchair's construction due to its strength, durability, cost-effectiveness, weldability, reparability, and corrosion resistance. These properties make it suitable for the project's needs and objectives.

Fabrication of model : After material selection, the wheelchair's fabrication process began with the following steps:

Chassis frame – The chassis was fabricated according to the CAD model design, providing a solid foundation for the rest of the wheelchair's components.

Steering Mechanism – An ATV steering mechanism was implemented, allowing for easy handling and turning capabilities.

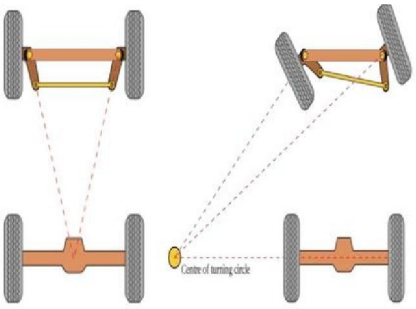

Figure 4. Schematic dig. of ATV steering mechanism .

Suspension system – The suspension system was derived from Hero Splendor motorcycle suspensions, as they were compatible with the wheelchair's weight and off-roading requirements. Analysis of the suspension system was conducted using Adams software.

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IV. COMPONENTS

BLDC Motor Kit – A 1000W BLDC motor kit was used, including components such as the motor, chain, chain sprocket, motor controller, wiring harness, accelerator, speed control switch, light with a key switch, and more.

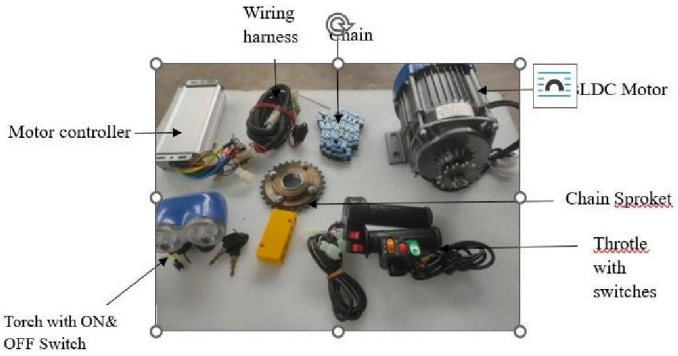

Figure 5. BLDC Motor Kit

Battery Specifications - Lead-acid batteries were chosen over lithium-ion alternatives due to cost considerations..

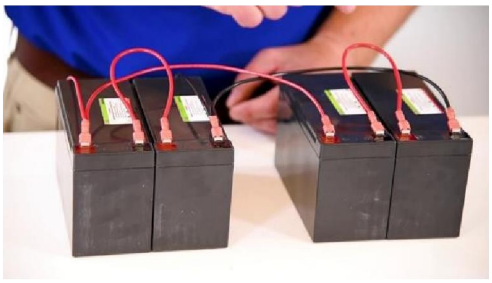

Figure 6. Batteries connected in series

Tyres - The tires selected for this project are sourced from standard bicycles typically used by individuals aged 18. These tires were chosen for their exceptional grip, crucial for navigating diverse terrains encountered in off-road environments. Featuring a robust tread pattern and durable rubber composition, these tires provide enhanced traction and stability, enabling the wheelchair to navigate rough surfaces with assurance. Specifications for the tires include a diameter of 26 inches, a width of 2.1 inches, and a recommended inflation pressure of 30-50 PSI, ensuring optimal support and maneuverability for the off-road electric wheelchair.

Figure 7. Tyers Used

Braking System – To enhance braking performance, we have integrated a Disc Brake system into our wheelchair, facilitating efficient and rapid stopping. Please refer to Figure 7 for visual details.

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Final Model

Figure 8. Final Model Develop

V. RESULTS

After extensive design and fabrication, the off-road electric wheelchair was rigorously tested with individuals with disabilities and on various challenging terrains. The trials revealed exceptional performance, highlighting the wheelchair's robustness and adaptability to off-road environments. The wheelchair demonstrated reliable maneuverability and stability, providing users with a safe and comfortable off-road experience. These results validate the commitment to developing inclusive mobility solutions that empower individuals with disabilities to explore diverse terrains with confidence and independence.

VI. CONCLUSIONS

The design and fabrication of the off-road electric wheelchair signify a significant advancement in accessibility and mobility for individuals with physical disabilities. Through careful engineering and innovative design, the wheelchair offers unparalleled versatility, enabling users to traverse various terrains with ease and confidence. Its robust construction, combined with powerful electric motors, ensures reliable performance in challenging outdoor environments, allowing users to explore and engage with the world around them like never before. In summary, the development of the off- road electric wheelchair represents a technological breakthrough and a testament to our commitment to inclusivity and accessibility. By providing individuals with disabilities the means to explore and experience the outdoors independently, we are not just building a vehicle; we are breaking down barriers and empowering individuals to live life to the fullest. As we continue to refine and improve this technology, it is crucial to ensure that everyone has the opportunity to enjoy the beauty of nature without limitations.

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