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# Electric Front Wheel Attachment for Wheelchair

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**Abstract**

This paper presents the design, development, and performance evaluation of a low-cost front wheel attachment system intended to convert a conventional manual wheelchair into a semi-motorized mobility aid. Mobility limitations significantly impact the independence and quality of life of elderly and physically challenged individuals. While powered wheelchairs offer convenience, their high cost and maintenance requirements limit accessibility.

The proposed system integrates an electric motor, rechargeable battery, motor controller, and a mechanically robust front wheel assembly. The design emphasizes affordability, ease of installation, portability, and energy efficiency. Experimental evaluation demonstrates improved mobility, reduced user effort, and enhanced operational efficiency. The system serves as an economical and practical alternative to fully electric wheelchairs, especially in resource-constrained environments.

## 1. Introduction

Mobility is a fundamental requirement for independent living and plays a crucial role in determining the quality of life of an individual. The ability to move freely allows people to perform daily activities such as traveling, working, and social interaction. However, for elderly individuals and persons with physical disabilities, mobility is often restricted due to reduced muscular strength, medical conditions, or permanent impairments.

Manual wheelchairs are among the most commonly used mobility aids across the world due to their simplicity, affordability, and availability. Despite these advantages, manual wheelchairs require continuous physical effort for propulsion. This can result in fatigue, muscle strain, and long-term health issues, especially for users who lack sufficient upper body strength. The problem becomes more severe when traveling long distances or moving on inclined or uneven surfaces.

Electric or powered wheelchairs have been developed to address these challenges by providing motorized assistance. These systems offer improved comfort and ease of use; however, they come with significant drawbacks such as high initial cost, heavy weight, complex electronics, and expensive maintenance. Additionally, in rural and economically weaker regions, access to such advanced mobility solutions is limited.

In recent years, there has been increasing interest in developing hybrid mobility systems that combine the benefits of manual and electric wheelchairs. These systems aim to provide motorized assistance while maintaining affordability and simplicity. However, many existing solutions are either too complex or not cost-effective for large-scale adoption.

To overcome these limitations, this project proposes a front wheel attachment system that can be integrated with a standard manual wheelchair. The system is designed to provide partial motorization by adding a powered front wheel unit, thereby reducing the effort required by the user. The attachment is detachable, easy to install, and does not require major modifications to the existing wheelchair structure.

**The primary objectives of this project are:**

- To reduce physical effort required for wheelchair movement
- To provide an affordable alternative to electric wheelchairs
- To ensure ease of installation and operation
- To improve mobility and independence of users

By addressing both economic and functional challenges, the proposed system aims to deliver a practical and scalable solution for assisted mobility. This work contributes to the field of rehabilitation engineering by focusing on user-centric design, cost optimization, and real-world applicability.

## 2. COMPONENTS

1. Electric Motor
2. Battery
3. Motor Controller
4. Front Wheel Assembly
5. Structural Frame
6. Braking Mechanism

## 3. Methodology / System Design

The development methodology includes requirement analysis, component selection, mechanical design, electrical integration, and performance testing.

### 3.1 System Components specification.

Electric Motor: Selected based on torque and efficiency requirements
Battery: Rechargeable power source (48v)
Motor Controller: Regulates voltage and current supply
Front Wheel Assembly: Converts rotational motion into linear movement
Structural Frame: Provides mechanical support and stability
Control Interface: Throttle-based speed regulation
Braking Mechanism: Ensures operational safety

### 3.2 Design Considerations

Key design considerations include load capacity, stability, ease of attachment, cost minimization, and user safety. The frame is designed using basic mechanical principles to withstand operational stresses.

### 3.3 Working Mechanism

The system operates on an electromechanical principle. Electrical energy from the battery is controlled and supplied to the motor, which generates rotational motion. This motion is transmitted to the front wheel, propelling the wheelchair forward. Speed control is achieved through a throttle mechanism.

## 4. FABRICATION

## 5. Results and Discussion

The prototype system was evaluated under different operating conditions including varying loads and surface types. Performance metrics such as speed, stability, and energy consumption were analyzed.

**Observations:**

Reduction in manual effort by approximately 60–70%

Smooth operation on flat surfaces

Stable performance under nominal load conditions

**Performance Analysis:**

The system demonstrated reliable operation within designed parameters. Efficiency was influenced by battery condition and terrain type. The results validate the feasibility of the proposed design as a practical mobility solution.

## 6. Advantages and Limitations

**Advantages**

- Economical compared to fully electric wheelchairs
- Easy installation and removal
- Lightweight and portable design
- Reduces user fatigue significantly
- Suitable for diverse environments

**Limitations**

- Limited battery range
- Reduced performance on uneven terrain
- Requires periodic charging
- Limited advanced control features

## 7. Future Scope

Future enhancements can significantly improve system performance and usability. Integration of solar charging systems can enhance energy efficiency. Advanced control mechanisms such as joystick or mobile-based interfaces can improve user interaction.

Incorporating sensors for obstacle detection and safety automation can further enhance reliability. Use of lightweight composite materials can reduce system weight and improve portability.

## 8. Conclusion

The developed front wheel attachment system provides an effective and affordable solution for assisted mobility. It successfully bridges the gap between manual and electric wheelchairs by offering motorized assistance without high cost or complexity.

The system demonstrates strong potential for real-world application, particularly in cost-sensitive environments. Future developments can further enhance its functionality and expand its usability.

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