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FABRICATION OF MOBILE STAIR LIFT

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Abstract: The invention of the wheelchair has greatly benefited and facilitated the transportation of injured and disabled individuals. However, a significant challenge arises when it comes to navigating stairs, which are commonly found in multi-story buildings such as hospitals, schools, and homes. While some places in India have installed lifts, the majority still rely on stairs, making the task of carrying someone with mobility limitations a laborious and stressful endeavor. Motivated by this pressing issue, we embarked on designing a revolutionary wheelchair that addresses this problem. This includes the fabrication of a mobile stair lift designed for two purposes: assisting individuals with mobility impairments on stairs and lifting heavy weights. The lift is portable and maneuverable, providing accessibility in different environments. It incorporates safety features and adjustable platforms for secure transportation. Additionally, it can handle substantial loads for weightlifting purposes, making it suitable for industrial, construction, and fitness settings. This innovative design enhances mobility, independence, and efficiency in stair-related tasks and heavy lifting operations.

Index Terms **- EPWs (Electric powered wheelchair), mobile stair lift, fabrication, mobility assistance, accessibility, portability, safety, ergonomics, dual-purpose**

I. INTRODUCTION

An important mobility assistance device for aged and physically disabled people, wheel chairs has been widely used for many years. Now a days, many patients and users utilize EPWs (Electric powered wheelchair) as their primary means of mobility during indoor and outdoor daily activities. However, it is still a challenging task for a standard to overcome the existing environmental barriers such as the building or civil infrastructure stairs. Especially for some patients living in a building without an elevator, it is difficult for them to travel up and down the stairs using a standard wheel chair. This results in patients staying indoors for prolonged period of time, which is not conducive to their mental health and physical rehabilitation [1-4].

The development of assistive technologies has significantly improved the quality of life for individuals with mobility impairments. One particular innovation in this field is the fabrication of a mobile stair lift that serves a dual purpose: assisting individuals in navigating stairs and facilitating the lifting of heavy weights. This versatile device offers a range of benefits, including enhanced accessibility, portability, and efficiency in various settings. For individuals with limited mobility, traversing stairs can be a daunting and challenging task. While traditional stair lifts have been successful in providing assistance, they are often fixed in place and limited to specific locations. The concept of a mobile stair lift aims to overcome these limitations by introducing a portable and maneuverable solution that can be utilized in different environments. By integrating sturdy platforms with safety features and incorporating motorized mechanisms, the lift enables individuals to navigate stairs of varying inclinations securely and comfortably.

Moreover, the mobile stair lift's functionality extends beyond assisting individuals with mobility impairments. Its design and construction allow for the lifting and transportation of heavy weights, making it suitable for a range of applications. Industries such as manufacturing, construction, and logistics often require the movement of substantial loads, and the mobile stair lift provides a practical solution to this challenge.

By combining accessibility and strength, the fabrication of the mobile stair lift addresses the needs of both individuals with mobility impairments and industries requiring heavy lifting capabilities. The innovative design and multifunctionality of this device contribute to improved mobility, independence, and efficiency in tasks involving stairs and the lifting of heavy objects. In this paper, we will delve into the detailed fabrication process, highlighting the key components, mechanisms, and safety considerations involved. Furthermore, we will explore the potential applications of the mobile stair lift in various settings, emphasizing its impact on improving accessibility and efficiency.

II. LITERATURE SURVEY

Giuseppe Quaglia et al. [4] developed a stair climbing wheelchair capable of traversing both structured and unstructured environments, as well as overcoming obstacles and ascending/descending stairs. This wheelchair exhibits passive locomotion, transitioning from wheel rolling to leg stepping based solely on local and dynamic conditions rather than external commands. The implementation requires only one motor per locomotion unit. To ensure stability and passenger comfort, a four-bar linkage is employed to move and rotate the chair, preventing tipping and maintaining a comfortable posture.

Pravat Kumar Behera et al. [5] presented a simple and innovative mechanism for wheelchairs to facilitate stair climbing. Their design consists of two legs with two degrees of freedom each. The legs are constructed by connecting two four-bar linkages in a specific configuration. Two actuators are integrated into each leg to assist in leg movement as needed. The proposed design offers statically stable leg motion with adjustable height. Inverse kinematics analysis has been conducted to determine the leg positions, and the seating position remains horizontal during climbing, ensuring the comfort of the user. This mechanism addresses balancing issues typically encountered during stair climbing with a wheelchair.

Michael Hinderer et al. [6] reported on an autonomous stair-climbing wheelchair that utilizes leg-based locomotion as an advantageous alternative to conventional caterpillar-based stair climbers, which often suffer from various drawbacks. The leg-based mechanism offers secure and adaptable climbing capabilities while being lightweight and highly dynamic. It ensures at least three, but typically four, supporting points spaced adequately apart to minimize the risk of falling, even in the event of an electrical failure.

OBJECTIVE:

The aim of this project is to enhance the existing design of the planetary system by prioritizing comfort and safety during operation. In order to achieve this, we will take into account fundamental parameters of the track system mechanism. Our objective is to design and develop a mobile stair lift that is not only reliable under various operating conditions but also offers multipurpose functionality, accommodating both wheelchair users and the ability to carry loads. By focusing on these goals, we strive to create a product that provides an improved user experience and meets diverse needs.

III. METHODOLOGY

Based on extensive research and analysis of previous studies and existing technologies, the belt stair lift mechanism was chosen as the primary mechanism for our mobile stair lift. This mechanism is of paramount importance due to its ability to provide smooth and controlled vertical movement along the stairs, ensuring the safety and comfort of users. Building upon this selection, a detailed 3D model was prepared to visualize and refine the design of the mobile stair lift. The 3D model serves as a crucial blueprint, allowing for a comprehensive evaluation of the design and enabling precise adjustments to be made. Subsequently, the fabrication process progresses based on the refined 3D model (fig 3.1), ensuring that the mobile stair lift is constructed with precision and accuracy in accordance with the envisioned design.

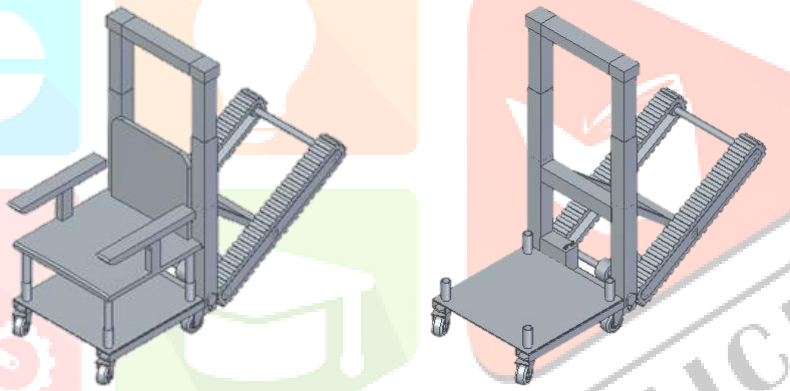

Fig. 3.1: Model of Stair Lift with and without the chair

3.1 COMPONENTS AND DESCRIPTION

The working stair climbing wheel chair model consists of the following components to full fill the requirements of complete operation of the machine.

- Frame with removable chair
- Stair lift mechanism
- Battery

Frame: The frame serves as the foundation and supporting structure for various components of the wheelchair. It consists of four key elements:

Base: The base of the wheelchair frame provides stability and support for the entire structure. It is designed to distribute the weight of the user evenly and facilitate smooth movement.

Supporting Handle: The supporting handle is an essential part of the frame that allows caregivers or users to maneuver the wheelchair. It provides a secure grip and enables easy control and navigation.

Seat: The seat frame is an integral part of the wheelchair frame that provides a platform for the seating arrangement. It offers support and stability to the user while ensuring comfort during prolonged use.

Wheels: The wheels are key components of the wheelchair frame, enabling mobility. They provide traction, stability, and facilitate movement in various directions.

Stair lift mechanism: The stair lift mechanism in this context is a belt rover system specifically designed to aid in climbing stairs. It utilizes two 12-volt, 30rpm DC motors that provide the necessary power and torque for the stair lift's operation. Rubber tracks are the parts of the stair lift mechanism that come in contact with the stairs when ascending or descending. The tracks obtain the power through the motor that is further connected to the shaft. There are two shafts at the end of the structures which are encased in Plummer blocks. The rubber tracks increase the traction between the chair and steps. Therefore, gives better stability and control. The frame of the stair lift serves as a robust and reliable support structure, housing and integrating all the components seamlessly. It ensures the stability and integrity of the system, allowing for efficient and secure operation of the stair lift mechanism. In addition to the components mentioned earlier, the stair lift mechanism incorporates a switch that plays a vital role in controlling the ascending or descending movement. This switch serves as the interface for the user to initiate the desired motion of the stair lift. By conveniently activating the switch, users can safely control the direction and speed of the stair lift's movement. This feature adds an important element of user control and autonomy, allowing individuals to navigate stairs comfortably and with ease. The switch functionality complements the belt rover system and contributes to the overall safety, convenience, and user-friendly nature of the stair lift mechanism.

Battery: In our project, we have opted for rechargeable secondary batteries. These batteries, composed of one or more electrochemical cells, store chemical energy and convert it into electric current. Unlike disposable primary batteries, secondary batteries can be recharged by passing a charging current through them in the opposite direction of the discharge current. This reversibility allows secondary batteries to be charged and discharged multiple times before reaching the end of their usable life. Additionally, the recycling of worn-out secondary batteries promotes environmental sustainability and responsible waste management practices.

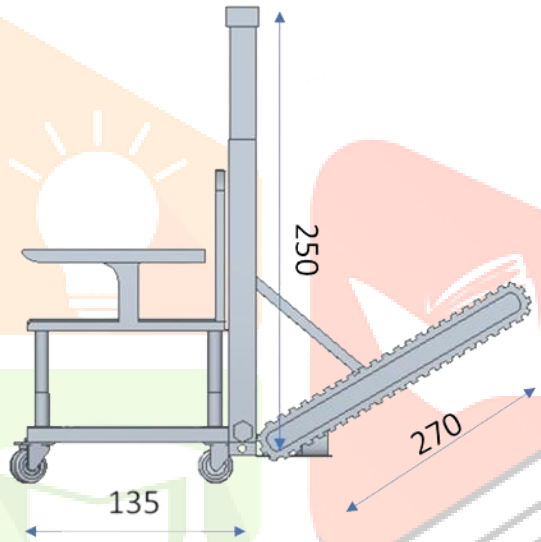

Fig. 3.2: Prototype Dimensions

Construction: Chassis and Frame Assembly: The main chassis and frame were constructed using carefully selected materials, prioritizing stability, strength, and durability. This involved techniques such as fastening, and integration of structural elements to ensure structural integrity.

Stair Lift Mechanism Installation: The stair lift mechanism was mounted onto the chassis in accordance with the manufacturer's instructions. This included the installation of the motor, drive system, and necessary sensors or control mechanisms to enable smooth and reliable operation.

Removable Chair Design and Installation: A removable chair was designed or acquired, considering safety standards, support, and comfort. It was securely attached and detached from the stair lift, incorporating secure locking mechanisms to ensure user safety.

Trolley Functionality Implementation: Trolley functionality, including folding handles, additional wheels or casters, and effortless maneuverability when the chair is detached, was designed and integrated into the system for enhanced convenience and versatility.

Safety Features Installation: Essential safety features were installed to prioritize user well-being. This included seat belts, emergency stop buttons, anti-tip mechanisms, and secure locking systems for both the chair and trolley modes. Adherence to relevant safety regulations and guidelines was ensured. Wiring was meticulously connected and routed for the motor, controls, and other electrical components. The fully constructed model is shown in fig. 3.3.

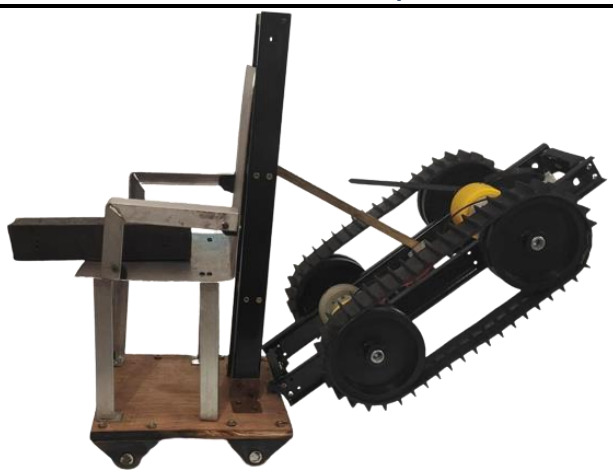

Fig. 3.3: Fully fabricated mobile stair lift

Working Principle: The working principle of the crawler stair-climbing wheelchair is based on its crawler mechanism, which enables it to navigate and overcome obstacles, particularly when climbing stairs. The continuous movement of the crawler mechanism provides excellent traction and attachment, minimizing the risk of slipping. When ascending stairs, the wheelchair follows a straight path parallel to the edge of the steps (fig. 3.4). This ensures stability during the ascent, reduces the swing of the center of gravity, and enhances its adaptability to stairs with irregular shapes. Overall, the straightforward operating system of the crawler stair-climbing wheelchair allows for efficient and stable movement, enhancing user safety and comfort.

Fig. 3.4: Wheelchair climbing the stairs

IV. RESULTS AND DISCUSSION

The project yielded successful results with the development of a fully functional prototype of the mobile stair lift. This prototype effectively demonstrates the desired features and functionalities, showcasing its ability to climb stairs, function as a wheelchair, and transform into a trolley as intended. The implementation of the mobile stair lift addresses the mobility challenges faced by individuals with limited mobility, offering a safe and convenient solution for navigating stairs. By enhancing their independence and accessibility in diverse environments, the mobile stair lift significantly improves mobility and enables individuals to overcome obstacles with ease.

V. CONCLUSION

In conclusion, the development of the mobile stair lift has been a successful endeavor. The project resulted in the creation of a functional prototype that effectively addresses the mobility challenges faced by individuals with limited mobility. The mobile stair lift demonstrated its ability to climb stairs, function as a wheelchair, and seamlessly transform into a trolley, showcasing its versatility and practicality.

The primary objective of this project was to design a wheelchair that provides optimal comfort during stair ascent and descent. To achieve this, we introduced the rubber track mechanism as a superior alternative to the planetary wheel design. The rubber track mechanism offers enhanced stability, comfort, and efficiency when navigating stairs, as well as smooth operation on regular surfaces. Furthermore, our design incorporates a removable chair feature, allowing the wheelchair to be transformed into a transportation device for carrying objects such as boxes. This added functionality expands the usability and practicality of the mobile stair lift. The materials used in the construction of the mobile stair lift are readily available and can be machined to meet specific requirements, making the product affordable and accessible. Additionally, the availability of replacement parts ensures that long-term maintenance is convenient and hassle-free.

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