# DESIGN OF A NOVEL WHEELCHAIR LIFT

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#### ABSTRACT

Disable Chair Lift is an electric lift which carries the handicaps' chairs. In this paper we investigate the design and manufacturing of a disabled wheelchair lift. It consists of a rail stacked in the wall with a base formed as L and a motor stacked in the base.

Keywords: Wheelchair, Lift, Disabled, Wheels, Dc motor.

#### INTRODUCTION

Accessibility refers to the design of devices for people who experience disabilities.[1]. Accessibility can be viewed as the "ability to access" and benefit from some system or entity [1]. Assistive technology is the creation of a new device that assists a person in completing a task that would otherwise be impossible. A wheelchair is a chair with wheels and it comes in variations allowing either manual propulsion by the seated occupant turning the rear wheels by hand, or electric propulsion by motors[2]. There are often handles behind the seat to allow it to be pushed by another person. Wheelchairs are used by people for whom walking is difficult or impossible due to illness, injury, or disability. Generally there are two types of wheelchairs [2]:

The first type is the manual wheelchairs and those require human power to move them. Many manual wheelchairs can be folded for storage, or placement into a vehicle, although modern wheelchairs are just as likely to be rigid framed. Manual or self-propelled wheelchairs are propelled by the occupant, usually by turning the large rear wheels, from 20–24 inches (51–61 cm) in average diameter, and resembling bicycle wheels.

The second type is the electrical powered. An electric-powered wheelchair is a wheelchair that is moved via the means of an electric motor and navigational controls which is usually a small joystick mounted on the armrest, rather than manual power. For users who cannot manage a manual joystick, headswitches, chin-operated joysticks, sip-and-puff or other specialist controls may allow independent operation of the wheelchair [2].

The major aim of this paper is to design and manufacture a disabled chair lift to easily transfer disabled people at multi-floor places. A wheelchair lift, also known as a platform lift, or vertical platform lift is a fully powered device designed to raise a wheelchair and its occupant in order to overcome a step or similar vertical barrier [3]. Wheelchair lifts can be installed in homes or businesses and are often added to both private and public vehicles in order to meet accessibility requirements laid out by disability acts. These mobility devices are often installed in homes as an alternative to a stair lift, which only transport a passenger and not his/her wheelchair or mobility scooter.

In the US, under the Americans with Disabilities Act of 1990, new public and private business construction generally must be accessible. Many states in the US have their own disability laws. In the UK, the Equality Act 2010 has numerous provisions for accessibility. In Palestine, the number

of disabled people has dramatically increased [4]. The number of paralyzed patients who are dependent on others due to loss of self-mobility is growing with the population, especially in the Palestinian Territories. Mobility is the most prevalent disability and affects 48.4% of disabled individuals in Palestine [5].

Unfortunately most buildings in Palestine do not have elevators and therefore comfortable life should be provided to handicapped people. Manufacturing the proposed wheelchair lift allows for disabled people and disabled rehabilitation organizations one to overcome their disability.

People with full upper limb functionality tend to desire a lightweight wheelchair [6]. The light weight of their wheelchair minimizes their mobility efforts as well for any assistance they desire to risk outside their world. To such persons, adding any weight to their wheelchairs is often inconceivable. On the other hand for persons who use a powered wheelchair, usually due to limited upper body functionality, the concept of adding stair climbing or a high step capable mechanism to their already heavy but very stable wheelchair has typically been received in a very positive light [7].

## LITERATURE REVIEW

Lifts are the most widespread means of providing access between floors. They are very expensive and consume large space. Compact lifts which can be electrically or manually operated and they are targeted for residential are available as shown in [8-11].

The company in [12] has been able to design and commercialize a portable platform lift which provides a practical and flexible solution where wheelchair access is required on a temporary basis. The compact lift folds down easily for transportation and storage. It is the perfect solution for stages and mezzanine levels in schools, theatres, village halls and other public buildings [12]. The same company in [12] has managed to make a new design when wheelchair access is obstructed by steps, as a ramp is not always a feasible solution. Their wheelchair step can provide safe, reliable and easy to use for travel up to 50 cm and 1 m. They can be supplied with bridging steps to ensure easy access for both disabled and pedestrian users. An upper level gate protects the landing when bridging steps are not provided [13].

Another company [14] had designed and commercialize a Multilift Vertical Platform Lift. The Multilift is a vertical platform lift, designed for low-rise travel indoors or out. With its durable design, the Multilift is popular for accessing decks and porches even in demanding climates.

At the heart of the Multilift is the reliable operation of the ACME screw drive which delivers precision movement and performance. Handling up to 750 lb this lift can carry a passenger in a wheelchair with ease. An array of safety features ensures safe operation including sensors to stop the lift if it senses an obstruction. There are several models of the Multilift available including a mobile version, an enclosed unit and one clad in stainless steel. This lift is available for commercial applications in the U.S. and home use anywhere. The following section focuses on the design of a mechanism optimized for wheelchair use and targeted at overcoming a number of shortcomings in available commercial wheelchairs.

## METHODOLOGY



Figure 1: The proposed design

The proposed design is shown in Fig.1. The design consists of the following parts and functionalities:

1) Railway

The railway is the most important main part in the device. It is manufactured of an 4/8 iron profile and it is considered as a path to the platform device as shown in Fig. 2.



Figure 2: The railway



Figure 3: rack and pinion

2) Rack and pinion (serrated railway)

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion [15]. At the top of the rail, three wheels are installed, another two wheels are installed at the bottom of it, and (Rack and Pinion) serrated railroad fixed with the rail. It's installed in the stairs with certain inclination angle (28.3  $^{\circ}$ ) and certain height as shown in Fig. 3.

## 3) Fixed pillars

Fig. 4 shows the fixed pillars used. It is manufactured of 4/8 iron profile, it is used for fixing railway in the stairs wall to distribute the load on the railroad.



Figure 4: Fixed pillars



Figure 5: Barrier arms

## 4) Barrier arms

Fig. 5 depicts the barrier arms. They are manufactured of galvanized iron and designed with U-shape. They are mainly used for protection purpose as a safety element.



Figure 6: Base surface

#### 5) Base surface

It's manufactured of 4/4 iron profile as a rectangular shape with certain dimensions. It is covered with aluminum sheet metal and mounted with a set of screws to rough the base for protection purpose. The base is shown in Fig. 6.

#### 6) Bascule pillars

The bascule pillars are shown in Fig. 7. It is manufactured from iron, it's a bascule (mobile) element on the device mounted with the base, it is connected with barrier arms by steel wire to control the upward and downward movements of the device.



Figure 7: Bascule pillars

7) Top /Bottom Wheels with Ball Bearing

Wheels are shown in Fig. 8 and they are mounted with bearing to facilitate the movement on the railway. They are mainly used to reduce the load on the pinion of the motor.



Figure 8: Wheels7) Micro switches

LXW5-11G type switches are shown in Fig. 9. A micro switch is an electric switch that is actuated by very little physical force, through the use of a tipping-point mechanism. Switching happens reliably at specific and repeatable positions of the actuator, which is not necessarily true of other mechanisms[16]. They are very common due to their low cost and durability, greater than 1 million cycles and up to 10 million cycles for heavy duty models[16]. They are considered as protection elements to stop the device when reaching the parking place. We have used 2 switches as sensors.



Figure 9: LXW5-11G switches

#### 8) Push Buttons

Fig. 10 shows the push button used in the design. A push-button is a simple switch mechanism for controlling some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal.[17] The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, though even many un-biased buttons require a spring to return to their un-pushed state.[18] It's considered as a control button to move the device upward and downward along the stairs or to stop the device.



Figure 10: Push buttons

#### 9) Motor

It is where the mechanical power is produced, it a special type of three-Phase, double-speed motor, operating at appropriate rate of rotation (1400/900 rpm). It is installed inside the upper part of the base, with small gear (Pinion) installed for the movement operation.

## 10) Gear box

It is used to change the speed, direction, or torque of mechanical energy. A gearbox provides controlled application of the power and provide speed and torque conversions from a rotating power source to another device [19-20]. It can reduce the speed of the motor since speed ratio equal to  $N_1/N_2$  and it can increase the torque of the motor. N1/N2 = (1400rmp /1630rpm) = 0.8

## RESULTS

The control and power circuit is a circuit that controls all the processes in the device and receives commands from the use. A control circuit is a special type of circuit used to control the operation of a completely separate power circuit [21]. Figs. 11, 12 and 13 show the control and power circuits used in the proposed design.



Disabled PlatForm Project ...... Control Circuit





Disabled PlatForm Project ..... Power Circuit

Figure 12. Power circuits diagram



Figure 13: Control setup

## **CONCLUSIONS**

The purpose of this research focused on increasing the autonomy of persons reliant on mobility assistive devices and to reduce the load on care workers in providing such mobility.

We have designed a semi-autonomous practical disabled lift wheelchair employing track based technology. This proposed model is affordable to the low income people of countries like Palestine.

## ACKNOWLEDGEMENTS

The authors would like to thank the academic staff of the engineering department for their support and helpful discussions and for their appreciation of the benefits to be gained from this research.

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