

Stair-Climbing Wheelchairs: A Literature Review

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Abstract— The main goal of this article is to give information about the different wheelchair designed till now. The aim of this paper is to review the state of the art in the technology for stair climbing wheelchair for people with disabilities. We give review on the research that has been done by difference groups on stair climbing wheelchair. The main goal is to provide the reader that which technology and mechanism can be used to develop the particular wheelchair. By this article reader gets idea about the environment friendly and by this they can easily compare each type of wheelchair. In this paper, we have mentioned various manually operated as well as automated wheelchairs that can travel on both plane terrains and also in the staircases. We also present data comparing their capabilities in terms of step climbing and standard wheelchair functions.

Key words: Assistive Technology, Literature Review, Power Wheelchairs, Robotics, Wheelchairs

I. INTRODUCTION

A chair with wheels designed for walking is known as wheel chair. This is used for movement of physically disabled, elder people, children who have difficulty and are unable to walk. The disabled human are an important part of the society that should be given the humanity help to increase their taking part in the practical and scientific fields. So that it becomes so necessary to work hard to help this part of society to get better live. There are different means of help as the different disability types and the varying needs of daily functions. Many inventions were already done on wheelchair till now. Some are self-propelled, propelled by the motor or with the help of an attendee to push. The wheelchair is one of the most popular means and most activity to give the disabled human they wanted movement. Wheelchairs gives the extra life to the disable person. Because of this they fill like they have legs and they can live their life with happiness. Stair climbing wheelchairs currently available for sale in market are costly for the users and are not easy to afford an automatic Stair-climbing wheelchair can be a good solution for the user and can enhance the mobility to access most of the buildings.

II. LITERATURE REVIEW

Now day's researchers are so advanced and day by day they are inventing the advancement in every sector. Similarly there is huge improvement in the design of Wheelchair. Based on data, there are an estimated millions of wheelchair users over the age of 15 as well as over the age of 65. The World Health Organization (WHO) estimates that 1% of the worldwide population requires a wheelchair [1]. So the requirement of wheelchair is increases. There are many wheelchairs in the market, every one designed for some purpose. In general there are two kinds of wheelchairs,

A. Mechanical (Manual) Wheel Chair

These kinds of chairs requires human effort to move, and if the disabled was tired or couldn't push himself by couching the two big wheels it is available to ask somebody to help him in moving chair. by studies, it indicate that wheelchair skills training for manual wheelchair users is necessary for safety. a. Standard Wheel Chair. b. Folding Light Weight Wheel Chair. c. Rigid frame wheel chair. d. special positioning wheel chair. The manual wheelchair has good indoor maneuverability and it is easy to steer in forward direction but for turning it requires more force also it requires high initial force to move. It may cause the damage in upper body of the patient. It has the disadvantage that it cannot be used for outdoor works. In 2015, R. Suntharamurthy published, The Design of a Compact and Lightweight Wheelchair for Disabled Children. The designed wheelchair in this research is able to reduce the weight approximately by 30%. The wheelchair volume after folding is also reduced significantly[3].

B. Powered Wheel Chair

This type have a base contains the motor and battery and four wheels at least in addition to chair system which connected to the top of base. The power wheelchairs are very advanced chairs that can be used by the person who have more disabilities other than legs. They comes with the facilities like seat elevation tilt, leg elevation, recline and other necessary features. So the people, who cannot move their legs and arms effectively, can use these powered wheelchairs. In 2016, Ananda Sankar Kundu published one article, In this article they have presented design and development of a 4 wheel driven omni wheelchair with reduced wheel slippage and vibration. All the wheelchairs or indoor transporters with holonomic drive are developed with Mecunum wheels or are a three wheeled omni platform. Mecunum wheels are inherently suitable for handling high load but its turn rate is slow compared to omni wheels. 4 wheel platform with omni wheels are difficult to design, mainly because of its unequal ground reaction force[4]. Among wheelchair users, approximately 15% use electric-powered wheelchairs (EPWs)[5]. In 2014, Jyoti Pragyana Satpathy, published one paper on Design Of Motorised Wheelchair. This project involves the design of an ergonomically designed electric wheelchair for domestic use by Indian old aged people. Stair climbing functionality is embedded in the design through its structure and mechanism. The product mainly consists of 3 modules viz. seat, links and frame[6]. In 2002, Lawn, MJ. Study of stair-climbing assistive mechanisms for the disabled, this is Track-based EPW-SC. They performed experiments and optimization work on a prototype and achieved commercialization of the EPW-SC products. Their products include different models with the option of a single section track or dual section track[7]. The TGR Scoiattolo 2000 has a single wheel cluster mechanism with three wheels

and two additional omnidirectional wheels in the front[8]. Also, there are similar mechanisms such as an economic EPW-SC [9] and iBOT 4000[10]. A dual wheel cluster-based stair-climbing mechanism with two wheels on each wheel cluster is used in the “Freedom” series EPW-SC [11]. Generally, compared with the single wheel cluster-based EPW-SC, the dual wheel cluster-based mechanism can reduce the speed fluctuation and improve both stability and safety. However, it also has a larger size and more complex control method. EPWs provide community integration, independence, and increased quality of life for persons with disabilities[12]. Still, powered wheelchair users face challenges when going outdoors, including slopes, steps, uneven surfaces, and other environmental barriers. In 2005, Ding and Cooper published an overview of advanced power wheelchair devices, including some wheelchairs capable of stair climbing, but no comprehensive summary of research in the topic has been published since. The goal of this article is to provide researchers an overview of the mechanisms currently being used in obstacle climbing wheelchair prototypes and to provide some comparison of their capabilities.[13].

Other than these two types many articles are there on wheelchair. In 2012, Control of a Stair Climbing Wheelchair, published by this paper presents investigations into the control of a stair climbing wheelchair particularly for indoor usage. PID control is used to provide appropriate torque to both front and rear wheels as well as at to the wheelchair seat during climbing. Results show that the wheelchair movement can be controlled smoothly and the seat maintained at the desired position with the adapted approach[14]. In 2018, Design & Fabrication of Staircase Climbing Wheelchair using Conveyor Belt Mechanism, published by M.R. Kushte, this paper involves an ergonomically design and fabrication of an stair climbing functionality will be upgraded by changing its structure design and mechanism. The important parts of this product are conveyor belt, frame and driving mechanism climbing wheelchair for regular use by old disabled people[15].



Fig. 1: Track-based EPW-SC (Weijun Tao j. et.al, 2017)



Fig. 2: Single wheelcluster-based EPW-SCs: iBOT (Weijun Tao j. et.al, 2017)



Fig. 3: TGR Scoiattolo 2000 (Weijun Tao j. et.al, 2017)



Fig. 3: EPW-SC: Electric-Powered Wheelchairs with Stair Climbing (Weijun Tao j. et.al, 2017)

III. CONCLUSION

A number of wheelchairs capable of climbing steps are under current development. These devices represent a variety of approaches to the tasks of climbing a single step or continuous stairs. Control systems range from relying on no sensors at all for detecting features of the environment to closely monitoring the position of each actuated structure and estimating features of the environment. The majority of the identified designs are capable of climbing continuous stairs. However, even though all the devices included in the review are helpful for handicapped .the EPWs included in this paper

not all are as efficient as current EPWs when traveling over level ground and their suitability for Most of EPWs require second person for support All the wheelchairs included in this paper having high cost which is not capable for middle class person. Also design is complicated with high cost. So there is need for such kind of wheelchair which can buy all class of people.

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