A Review on Design and Fabrication of Multiutility Wheel Chair

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Abstract

In this project we propose a design of wheelchair whose backrest and a footrest can be controlled through a switch by the patient which will convert the wheel chair into a stretcher. This helps the patient to rest without getting shifted to a bed. This will also eliminates the efforts of assistant required for handling of handicap patients by providing an arrangement of desk with wheelchair. An arrangement of alarm will provide to make alert the persons nearby if the patient needs any help. We went through a number of designs before arriving on the final design. Our requirement of motion could be achieved either with the help of belt and pulley arrangement or through gear transmission. Belt and pulley arrangement was avoided because of the high speed reduction and the factors like slip and weight involved. The purpose of locking also could not be addressed easily in this arrangement. The idea of spur gear transmission was also eliminated because the requirement of high torque, self-locking could not be satisfied. Also, this arrangement demanded two separate motors. Considering the above mentioned shortcomings, Worm and Worm wheel arrangement was selected. The advantage of this drive was it provided self-locking, since the motion is transmitted only from the worm to the worm wheel and not the other way round. The arrangement was compact too. Chain and sprocket arrangement has been used for transmitting the motion provided by the motor through Worm and Worm wheel arrangement. Another advantage is, it provides high speed reduction.

Keywords: Stretcher, wheelchair, Worm and worm wheel, Chain, sprocket

I. INTRODUCTION

There are lots of handicaps and old aged people in the world. Many of them are not able to move as easily as normal people. It is useful if we develop an automatic wheelchair to help them move more easily. In this project we propose a design of small-area automatic wheelchair to help handicaps or elders are able to move easily in a small area. The most concern in this project is low cost with acceptable performance rather than high velocity or high accuracy. The design integrates several technologies to apply on the wheelchair. Our design of small-area automatic wheelchair can cost very little. The project has three sections - mechanical, electric and electronic. The mechanical section has the frame and adjustable backrest, shaft, wheels, flanges, chain and sprocket arrangement. The electric section has a permanent magnet DC motor of high torque. The electronic section has a remote control to guide the movement of the wheel chair.

II. LITERATURE REVIEW

Numerous wheel chairs have been devised having special features for accommodating the physical needs of the mobility impaired. However the use of conventional wheel chairs has served primarily as transportation vehicles which require significant human assistance. While such use of conventional wheel chairs is well known for accommodating the basic transportation needs of the mobility impaired, a multi featured automated wheel chair and method which maximizes the degree of mobility with no need of human intervention. The present invention relates generally to wheel chairs especially automated multi featured calibration method and wheel chair for the mobility impaired. The invention is intended for use by all segments of the population having such a need, especially infirm adults or the elderly. In 1966, a scientist named Russel Nhlean described an adjustable leg and foot rest for the wheel chair. Pulling the hand crank outwards locks the pinion into meshing teeth to hold the leg rest in place.
In 1973 Laurence Mulholland described a neck rest and shoulder support machine. In 1975, Keith Rodaway described a reclining back wheel chair. In 1990, Theodore Trkla described a self-powered wheel chair. The wheel chair includes a seat with bed pan, a pivoting leg rest, a pivoting back rest and pivoting retractable arm rest. The wheel chair may be converted into a bed and is vertically adjustable to the position of wheel chair at the same height as the bed. A wheel chair includes a motor for driving rear wheels, and a controller which can be positioned on the armrest or on the backrest of the wheel chair. Motion of the wheel chair is controlled by the joystick, and backrest and leg rest and height are controlled by the switches. The front of the wheel chair has a U shaped exercise bar with a trapeze bar suspended from the top to allow the user to pull him up.

Based on the above mentioned inventions we propose to design and fabricate an automated wheel chair bed at an affordable cost.

According to Sumedh J. Suryawanshi, Dr. K. Janardhan Reddy,[1] Different methods like FL, DARE analysis and Pugh concept selection method for converting the needs of the customers into a conceptual product are discussed in detail. The role of feedback from the wheelchair has played an essential role in the development process and helped in developing the product satisfying their needs. This wheelchair developed can easily help the people disabled in legs to transfer themselves to bed without any assistance. The main criteria considered for this concept is the convertible wheelchair and stretcher. So in order to convert the wheelchair into stretcher, some sort of mechanism needs to be added. In this concept, a sliding tubular frame is attached to the back rest of the wheelchair. A handle is provided in the back rest so that the user can be pulled it easily and can be converted to stretcher easily. So a proper balance should be maintained in the back side because the centre of gravity of human body will be lying in between the seat and back rest portion. A caster wheel support is given so that proper balance will be achieved. A pair of bigger wheels is provided in the middle of the wheelchair, so that more strength will be attained and front caster guides the wheelchair according to the direction. The provision for oxygen cylinder is another demand which has observed during the user study and the drip holder location is provided by the sides of the wheelchair. The hand rest is designed in such a way that, it can be rotated and a removable type so that it will act as a support side for transferring the patients.

Rajeev V.R. Ramjith Krishnan R .Prof. K Gopalakrishna Pillai says,[2] Wheelchair is the most commonly used mobility aid used especially by amputees and those affected by lower extremity paralysis. These wheel chair bound handicapped always need external help when they have to lay down for taking rest. Most of the sophisticated electric wheel chairs available in the market are costlier and do not facilitate lying down for rest. So there was a need for an advanced patient friendly wheel chair system. There are mainly two types of wheel chairs; manual and electric wheel chairs. Electric or powered wheels chairs are self-propelled type wheel chairs which uses electric motors for tractions. It consists of a driving unit, steering unit, lifting unit and power supply in addition to the parts of a normal wheel chair. With electrically powered motors and patient friendly controls the wheelchair can be converted to a stretcher by disabled at will. The driving or traction unit is used for forward and backward movement of the wheel chair, while the steering unit is used for turning. The lifting unit change the front leg support and back rest into a stretcher. A common power supply is used for all the above units. Ergonomically placed control switches can be activated by the person both in sitting and laying modes.

According to Jyothish K Sunny, Kiran P Karunakaran, Thomas Paul, Bibin Varkey ,[3] The main components involved in this project consists of hydraulic jack, screw rod, wheel, free wheel, waste lid and braking lever. In this project, we provide two lead screw setup with hinge joint is used to form the stretcher or bend to wheel chair. At the present position this model is a wheel chair type. Below the chair we provide two lead screw setup to connect the right or bottom side plate and left or top side plate by using hinge joint. For movement of bottom side plate, rotate the screw handle in counter clockwise direction then hinge goes inward to form a flat plate. For movement of top side plate, rotate the screw handle in clockwise direction then hinges go outward to form a flat plate. Now obtain the stretcher. To attain wheel chair we must rotate the lead screw handle in to reverse direction. At the middle part port with lid is provided to eliminate the human waste. Hydraulic jack is provided at the centre to vary the height of stretcher or wheel chair. The purpose of free wheel is to balancing the weight acting on the right and left side plates. Brake lever is provided to stop the wheel chair movement.

According to Rashid Ahmed, Safar Abdul Razack, Vishnu Prasad, [4] A prototype of the pneumatically powered stretcher-chair device for a patient weight of 100kg was designed and fabricated. The chair to bed conversion feature of this device makes patient transfer easier. This enables the user to have two fold utility and satisfaction. The pneumatic components used herein have simple operation principles. Therefore, fault detections are simple. Also pneumatic system proves to be non-hazardous. Then the convertible feature was included to the design at a conceptual level and tremendous amount of brainstorming was done. Since the fundamental aim of is to provide comfort to the patient as well as his/ her caregiver, powered conversion of the device between chair and stretcher was given focus. In the second phase, the power source was to be selected. Though hydraulic actuators are the best in terms of load handling and stability, the relatively high cost and the bulkiness of the units hindered their choice for our purpose. Electric motors have good load carrying capacity, speed control characteristics, precision etc. But their implementation necessitates the use of gears, belts or pulleys making the over unit becomes bulky and heavy.

III. HOSPITAL SURVEY (IN I.G. MEDICAL COLLEGE, NAGPUR)

We have visited the Indira Gandhi medical college, Nagpur. We have seen the conventional wheel chair and stretcher used.
IV. INTERNET SURVEY

Electric wheelchair Cost: 41,499/- (Indiamart)

Mechanical wheelchair with pneumatics Cost: 64,650/- (Indiamart)

V. WORKING PRINCIPLE

The structural design is basically a modification of a conventional wheel chair. It consists of three main parts:
- Back rest
- Main rest
- Leg rest

Out of these backrest and leg rest are movable, whereas the main rest is stationary. The positions of the backrest and leg rest are not exactly perpendicular to the main rest but at an angle of 100 degree and 80 degrees respectively. These panels have been made out of Steel sheets supported by angle plates or steel plates. The panels have been connected to each other with the help of rods inserted through them and their motion is supported by bearings. The main rest consists of hand rest on either side. Sprockets are mounted on the ends of the above mentioned rods.

The motor is mounted centrally below the main rest. The speed reduction is obtained through the worm gear drive of which the worm is mounted on the shaft of the motor and the wheel is mounted on a shaft perpendicular to the shaft of the motor. On
the shaft of the worm wheel two sprockets are mounted, one of which provides motion to the back rest and the other to the leg rest. Roller chain moves over the sprockets. All the sprockets are of the same size since there is no speed reduction caused by the chain drive.

The legs of the chair are kept inclined so as to overcome the toppling effect thus giving the lower end of the chair a trapezoidal shape.

Wheels are mounted at the base of the legs which gives it the required mobility.

VI. DESIGN PARAMETE

![Fig. 1. Worm and worm wheel motor](image1)

![2. Chain and sprocket](image2)

![3. Shaft](image3)

First we have to calculate the load i.e. the weight of human body which is to be lifted during the conversion of stretcher to wheel chair. As per the weight of human body the power which is required for lifting can be calculated. Then from the power we can calculate the design of worm and worm wheel. After this the design of chain and sprocket can be done as per the requirement of power transmission.

VII. COST ESTIMATION

<table>
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<tr>
<th>PARTICULARS</th>
<th>QUANTITY</th>
<th>COST</th>
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</thead>
<tbody>
<tr>
<td>Material (S.S. 40 mm x 20 mm rectangular c/s pipe)</td>
<td>7 kg (13 mts)</td>
<td>3000/-</td>
</tr>
<tr>
<td>Fabrication (Worm and worm Wheel and frame)</td>
<td>-</td>
<td>4000/-</td>
</tr>
<tr>
<td>Chain</td>
<td>2</td>
<td>200/-</td>
</tr>
<tr>
<td>Sprocket</td>
<td>4</td>
<td>200/-</td>
</tr>
<tr>
<td>Worm and Worm wheel DC motor</td>
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<td>6000/-</td>
</tr>
<tr>
<td>Battery</td>
<td>2</td>
<td>500/-</td>
</tr>
<tr>
<td>Wheels 16”</td>
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<td>1000/-</td>
</tr>
<tr>
<td>Cushioning</td>
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<td>3000/-</td>
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<tr>
<td>Caster wheels</td>
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<tr>
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<td>7000/-</td>
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VIII. CONCLUSION

The paper was purposed for making a review on design and fabrication of multi utility wheel chair that can prevail over the conventional wheel chair. By adopting various research methods helped to identify the various issues of the topic, importance of safety and hygiene and significance of materials and manufacturing process involved in the whole product. The project mainly focuses on cost effectiveness and easily acceptance. This Design of Wheel Chair cum Stretcher enables the easier transferring and handling of patients in hospitals without producing any damage to patient’s body externally and internally. Thus, the time and effort required for moving the patient is greatly reduced. Modelling software such as cad has helped in visualising the product.

REFERENCES

[1] Sumedh J. Suryawanshi, Dr. K. Janardhan Reddy,“Conceptual Product Development of Wheelchair for People Disabled in Legs” Volume 1, Issue 2, October-December, 2013, pp. 01-10