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Design and Fabrication of Wheelchair Cum Stretcher

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Abstract- **In this era of changing technology there are many new technologies evolved in medical field. The development in inter disciplinary science give new hopes to physically disabled people. In this project we try to develop a wheel chair cum stretcher economically. This paper reveals the design and fabrication of wheel chair cum stretcher which helps the caretaker to avoid heavy lifting situations that put their back at risk of injury, and allow the caretaker more energy at the end of the workday. This is a friendly assisting device for the physically challenged patients who cannot move from their bed independently. This device consists of simple mechanical and pneumatic control mechanism which doesn't need skilled persons to operate.**

The main objective is to produce a device for transferring patients in an effective and comfortable way for the patient and the caretaker, and have low production cost compared to existing model where the purpose is same.

Keywords:- Wheel Chair cum Stretcher; Mechanical and Pneumatic Control Mechanism

I. INTRODUCTION

All around the world there is a lot of research is going in medical mobility devices. This research brings a drastic change in the field of medical mobility devices in last few decades. Wheel chair is one of the most common mobility devices widely used by disabled people. Mobility aids are useful for patients for transportation and a replacement for walking especially in indoor and outdoor environment. Wheelchairs and bed are the most commonly used medical equipment for the transportation of patients. Transferring the patients from wheelchair to stretcher or to the medical bed is always an issue for the attendant or nurse. Understanding the various issues regarding the mobility equipment and introducing a better design will be an asset for the medical field and a helping hand for disabled individuals. There is a need for a wheelchair cum stretcher to facilitate the disabled patient's mobility and to provide novel medical equipment for use in the hospitals.

Even though the technologies developed, still the disabled people find difficulty when they were shifted to stretcher from wheel chair. It is not only make discomfort to disabled people but also increases the effort of care takers and nursing staffs difficult. We can reduce the difficulties of both disabled people and care taker by implementing a convertible wheel cum stretcher. Since it is convertible it is easier to operate and uses friendly. To overcome all these difficulties we introduce a new concept, the wheelchair cum stretcher to the market. It is less expensive and compact in design. It can be easily operated by the patient himself. This product is used for both purposes of wheelchair and stretcher without any difficulties. The main feature is that, it can transform from wheelchair to stretcher along with patient, as per his need. Comparing with all other products in the market it is more useful in every aspect.

II. LITERATURE REVIEW

The problem of transfer patients exists from ancient times. People who got seriously injured or ill, were carried by others by means of wooden stretcher with cloth or leather tied to it. Later they were carried on wheels which reduced the effort of the people carrying them. Today the problem still exists. Though we have evolved in the field of health care and technology we are not yet able to address the problem efficiently.

Main points from journal which are proposing need of wheelchair cum stretcher are

i. Hospitals having limitations for the use fully automated beds and wheelchair/stretcher.[1]
ii. Propose a new design of wheelchair cum stretcher for patient handling.[1]
iii. Cost of such type of wheelchair cum stretcher will affordable and it will be beneficial for patient handling. [2]
iv. Patients needs to be lifted up and helped to remove the dress and make them defecate. [2]
v. Existing wheel chair creates repetitive stress injury if the patient is sitting for a long time. [3]
vi. No solution in the existing design to make ease of shifting of patient to transportation vehicle. [4]
vii. In recent survey found that, 38% of nursing staffs suffer work-related back injuries. [5]

A. Wheelchairs

Wheelchairs have been around for hundreds of years, but early wheelchairs were intended only to help a disabled individual move from point A to point B. As society progressed and disabled individuals became more integrated, the role of the wheelchair began to change as well. Wheelchairs are now considered not only a means of transportation but also as a way to allow users to express their individuality. Users can find custom-made high quality ultra-light high-performance wheelchairs as well as

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accessories that enable them to individualize their look and style. The move from functionality to individuality is discussed in this article.

There were many attempts to connect furniture to wheels dating back to the time of Christ. But perhaps the first wheelchair was invented for King Phillip II of Spain. A drawing of the King dated 1595 shows him in a chair with wheels, armrests and footrests. However, he needed assistance to propel it and the chair resembled more a modern baby's highchair than a wheelchair of today. In 1665 one of the first self-propelled vehicles was invented by Stephan Farfler. But it looked more like a present day hand-bike than a wheelchair as it was propelled by hand cranks attached to the front wheel. The modern wheelchair began to take shape in the late 19th century to early 20th century with the advent of push rims for self-propulsion and slings for seat and backrests. The 20th century saw a rapid development in wheelchairs, from the first motorized wheelchair, to the first folding wheelchair, to lightweight and sports wheelchairs.

The most recent two decades have seen the progress in the modern wheelchair accelerate. They are lighter and perform better than ever before. There are now many possibilities available to improve the ride, from suspension systems which help to remove vibrations and jolts, to ultra-light weight frames which enable better performance, to special designs for every individualized need and taste. The recent trend is towards wheelchair customization. Customized wheelchairs are now being requested for many reasons. They are fitting special physical needs, improving or providing special performance and expressing style and image

A.1. Types of Wheelchairs

Some of the types of wheelchairs are discussed below:

a. Manual wheelchairs
b. Electric-powered wheelchairs
c. Sport wheelchairs
d. Beach wheelchairs

Fig.1. Types of Wheelchairs

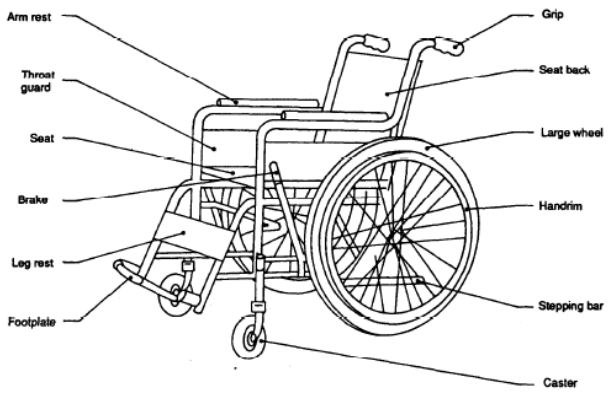

Fig.2. Standard Manual Wheelchair

A basic standard manual wheelchair incorporates a seat and back, two small front (caster) wheels and two large wheels, one on each side, and a foot rest.

Wheelchairs are often variations on this basic design, but there are many types of wheelchairs, and they are often highly customized for the individual user's needs. The seat size (width and depth), seat-to-floor height, footrests/leg rests, front caster outriggers, adjustable backrests, controls, and many other features can be customized on, or added to, many basic models, while some users, often those with specialized needs, may have wheelchairs custom-built.

Various optional accessories are available, such as anti-tip bars or wheels, safety belts, adjustable backrests, tilt and/or recline features, extra support for limbs or neck, mounts or carrying devices for crutches, walkers or oxygen tanks, drink holders, and clothing protectors. Experiments have also been made with unusual variant wheels, like the Omni wheel or the Mecanum wheel. These allow more directional movement options.

The electric wheelchair shown on the right is fitted with Mecanum wheels (sometimes known as IIon wheels) which give it complete freedom of movement. It can be driven forwards, backwards, sideways, and diagonally, and also turned round on the spot or turned around while moving, all operated from a simple joystick.

B. Manual Wheelchairs

Manual wheelchairs are those that 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 using large rear wheels, from 20-26 inches in average diameter, and resembling those of bicycle wheels. The user moves the chair by pushing on the hand rims, which are made of circular tubing attached to the outside of the large wheels.

Light weight and high cost are related in the manual wheelchairs market. At the low-cost end, heavy, tubular steel chairs with sling seats and little adaptability dominate. Users may be temporarily disabled, or using such a chair as a loaner, or simply unable to afford better. Heavy unmodified manual chairs are common as "loaners" at large facilities such as airports, amusement parks and shopping

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centers. In a higher price range, and more commonly used by persons with long-term disabilities, are major manufacturer lightweight chairs with more options. The high end of the market contains ultra-light models, extensive seating options and accessories, all-terrain features, and so forth.

C. Electric Powered Wheelchairs

The electric-powered wheelchair was invented by George Klein who worked for the National Research Council of Canada, to assist injured veterans during World War II. The user typically controls speed and direction by operating a joystick on a controller. Many other input devices can be used if the user lacks coordination or the use of the hands or fingers, such as chin controls and puff/sip scanners for those with C2-3 spinal cord lesions or head injuries (the user blows into a tube located near the mouth, which controls the movement of the chair). This controller is the most delicate and usually the most expensive part of the chair. EPWs can offer various powered functions such as tilt, recline, leg elevation, seat elevation, and others useful or necessary to health and function.

D. Sport Wheelchairs

Disabled (and, often, other participating) athletes use streamlined sport wheelchairs for disabled sports that require speed and agility, such as basketball, rugby, tennis and racing. Each wheelchair sport tends to use specific types of wheelchairs, and these no longer look like their everyday cousins. They are usually non-folding (in order to increase solidity), with a pronounced angle for the wheels (which provides stability during a sharp turn) and made of composite, lightweight materials. Sport wheelchairs are not generally for everyday use, and are often a 'second' chair specifically for sport use, although some users prefer the sport options for everyday.

E. Stretcher

A stretcher is a medical device to carry patients for a short duration of time. A stretcher contains a surface which support for carrying patients, and has handles on either side along its length to help carry it.

Stretchers have been used since antiquity, on battlefields and in emergency situations, where wheeled vehicles are hindered by rough terrain. In their simplest form, they generally consisted of a canvas sling with long edges sewn to themselves to form pockets through with wooden poles could be slid. Today there are a wide variety of stretchers available, involving light weight materials, attachments so that it can be fitted to other contraptions.

Fig.3. Standard Stretcher

E.1. Types of Stretchers

Some of the types of stretchers are explained below:

E.1.1. Basket Stretcher

A basket stretcher is used in situation when an injured person needs transportation by foot to medical attention. The stretcher disassembles in two halves, and if needed for rescue assembles in seconds.

E.1.2. **Ambulance Stretcher**

An ambulance stretcher, also known as a little or gurney, consists of a solid frame and a heavy-duty cloth that stretches across it. The ambulance often gives a rough ride. This type of stretcher absorbs part of the impact to prevent further injury. Ambulance stretchers often adjust in position, aiding the paramedic in tending to the injured person's needs.

E.1.3. Folding Stretcher

A folding stretcher is used to transport the injured from the inside of a building to an ambulance stretcher. It is portable and folds in half for convent storage. This stretcher is also light weight when carried, and made of high strength materials. They are available in several sizes to fit people of various sizes.

E.1.4. Pole Stretcher

The military often used pole stretchers to transport the wounded to a medical facility. The stretcher have heavy-duty poles that extend on each side so two men can carry it. Pole stretchers also are lightweight, and have no-slip handgrips for firm control while handling.

III. COMPONENTS AND DESCRIPTION

Design and fabrication of wheelchair cum stretcher consists of the following components to fulfill the requirements of complete operation of the machine.

1) Wheel
2) Pneumatic Cylinder
3) Solenoid Valve
4) Control Unit
5) Gate Valve

A. Wheel

A wheel is a circular device that is capable of rotating on its axis, facilitating movement or transportation or performing labour in machines. A wheel together with an axle overcomes friction by facilitating motion by rolling. In order for wheels to rotate a moment needs to be applied to the wheel about its axis, either by way of gravity or by application of another external force. Common examples are found in transport applications. More generally the term is also used for other circular objects that rotate or turn, such as a Ship's wheel and flywheel.

Fig.4. Wheel

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The wheel is a device that enables efficient movement of an object across a surface where there is a force pressing the object to the surface. Common examples are a cart drawn by a horse, and the rollers on an aircraft flap mechanism.

The wheel is not a machine, and should not be confused with the wheel and axle, one of the simple machines. A driven wheel is a special case, that is a wheel and axle. Wheels are used in conjunction with axles, either the wheel turns on the axle or the axle turns in the object body. The mechanics are the same in either case. The normal force at the sliding interface is the same. The sliding distance is reduced for a given distance of travel. The coefficient of friction at the interface is usually lower.

B. Pneumatic Cylinder

Pneumatic cylinder (sometimes known as air cylinders) is mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. In our project is used to change the positions of Back and leg supports.

Fig.5. Pneumatic Cylinder

Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved.[1] Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. For example, in the mechanical puppets of the Disney Tiki Room, pneumatics is used to prevent fluid from dripping onto people below the puppets.

C. Solenoid Valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports.

Fig.6. Solenoid Valve

Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. Besides the plunger-type actuator which is used most frequently, pivoted-armature actuators and rocker actuators are also used.

D. Gate Valve

A gate valve, also known as a sluice valve, is a valve that opens by lifting a round or rectangular gate/wedge out of the path of the fluid. The distinct feature of a gate valve is the sealing surfaces between the gate and seats are planar, so gate valves are often used when a straight-line flow of fluid and minimum restriction is desired. The gate faces can form a wedge shape or they can be parallel. Gate valves are primarily used to permit or prevent the flow of liquids, but typical gate valves shouldn't be used for regulating flow, unless they are specifically designed for that purpose. Because of their ability to cut through liquids, gate valves are often used in the petroleum industry.

Fig.7. Gate Valve

For extremely thick fluids, a specialty valve often known as a knife valve is used to cut through the liquid. On opening the gate valve, the flow path is enlarged in a highly nonlinear manner with respect to percent of opening. This means that flow rate does not change evenly with stem travel. Also, a partially open gate disk tends to vibrate from the fluid flow. Most of the flow change occurs near shutoff with a relatively high fluid velocity causing disk and seat wear and eventual leakage if used to regulate flow.

E. Control Unit

In our project the main device is micro controller. It is help to control the whole unit of this project. In this we are using three motors to run the vehicle and move the lifting arrangement on up and down all the motors are connected to the control unit. The movement of vehicle forward and reverse, turning left and right and moving up and down are controlled by keypad in the control unit so the control unit is the main part of this equipment. The control unit is connected with the battery.

Microcontrollers are destined to play an increasingly important role in revolutionizing various industries and influencing our day to day life more strongly than one can imagine. Since its emergence in the early 1980's the microcontroller has been recognized as a general

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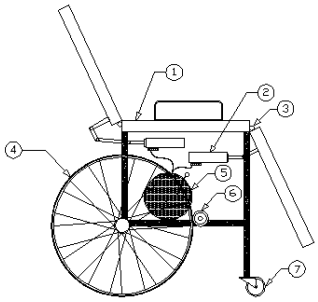
purpose building block for intelligent digital systems. It is finding using diverse area, starting from simple children's toys to highly complex spacecraft. Because of its versatility and many advantages, the application domain has spread in all conceivable directions, making it ubiquitous. As a consequence, it has generate a great deal of interest and enthusiasm among students, teachers and practicing engineers, creating an acute education need for imparting the knowledge of microcontroller based system design and development. It identifies the vital features responsible for their tremendous impact; the acute educational need created by them and provides a glimpse of the major application area.

IV. WORKING PRINCIPLE



S NO:	PART NAME	S NO:	PART NAME	S NO:	PART NAME
1	SEAT	4	WHEEL	7	FRONT WHEEL
2	CYLINDER	5	AIR TANK		
3	HINGE	6	MOTOR		

Fig.8. Model of Equipment

The equipment is operated through the mechanical and electronic setup. Pneumatic cylinder with solenoid control valve is provided at the back and leg support of the model. The model can be folded at the particular time as our requirement. This equipment can be used for mainly two purpose one for stretcher and another one for wheel chair model. Basically the equipment is spitted in to three parts one is back support, Leg support and center plate. These three are linked through the mechanical hinge. The compressed air tank is connected to the cylinder. The stretcher can easily change to the wheel chair by controlling air flow from pneumatic cylinder using solenoid valve.

SOLENOID VALVE

Volt: 12v/24v DC
Type: 5/2
Pressure: Max 10 bar
Thread size: 1/4"

CYLINDER

Material used: Cast iron
Assuming internal diameter of the cylinder: 40 mm
Ultimate tensile stress: 250 N/mm² = 2500gf/mm²
Working Stress: Ultimate tensile stress / factor of safety
Assuming factor of safety: 4
Working stress (ft): 2500 / 4= 625 Kgf/cm²
According to 'LAMES EQUATION'
Minimum thickness of cylinder (t) = ri $\{\sqrt{[(f_t + p) / (f_t - p) - 1]}\}$
Where,
ri: inner radius of cylinder in cm.
f_t: Working stress (Kgf/cm²)
p: Working pressure in Kgf/cm²
Substituting values we get
t= 2.0 $\{\sqrt{(625 + 6) / (625 - 6) - 1}\}$
t= 0.019 cm= 0.19 mm
We assume thickness of cylinder= 2.5 mm
Inner diameter of barrel= 40 mm
Outer diameter of barrel=40 + 2t
= 40 + (2 x 2.5)= 45 mm

PISTON ROD

Force of piston Rod (P)= Pressure x area
= p x Π/4 (d²)
= 6 x (Π / 4) x (4)²
= 73.36 Kgf
Also, force on piston rod (P)= (Π/4) $(d_p)^2$ x f_t
P= (Π/4) x (dp)² x 625
73.36= (Π/4) x (dp)² x 625
dp²= 73.36 x (4/Π) x (1/625)
= 0.15
dp= 0.38 cm= 3.8 mm
By standardizing dp= 15 mm

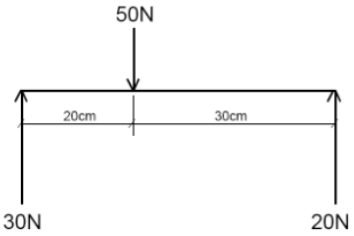


Fig.9. Load on Rear Wheel

Load on Rear Wheel

Frame weight= 25/2= 12.5 kg= 125 N
Considered Human weight = 50Kg
Human effective weight on rear= 30kg= 300N
Total weight= 125+300= 425N
Force acting on each wheel= 425/2= 212.5 N = 21.25 kg

Load on Caster Wheel

Frame weight= 25/2= 12.5 kg= 125 N
Considered Human weight = 50Kg
Human effective weight on rear= 20kg= 200N
Total weight= 125+200= 325N
Force acting on each caster wheel= 325/2= 162.5 N = 16.25 kg

V. RESULTS

Fig.10. Model as Stretcher

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Fig.11. Model as Wheelchair

VI. ADVANTAGES AND DISADVANTAGES

Advantages

1. Easy to operate
2. Very less maintenance
3. No stress for handicapped peoples
4. Low cost
5. Up and down movement can be achieved

Disadvantages

1. Compare with hydraulic system it is less efficient.
2. The battery should be charged often.

VII. APPLICATIONS

1. It is very useful in hospitals.
2. It is very helpful for physically handicapped people.

VIII. CONCLUSION

This research work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. The **"**Design and Fabrication of Wheelchair cum Stretcher" system is working with satisfactory conditions. This product will help hospitals to improve the comfort of patient during their required movement for CT scan, X-ray etc. It is expected that production of low cost trolley cum wheelchairs for patient handling will relive patient and nursing staff from a lots of physical discomfort. This model is designed with the hope that it is very help full to physically disabled person in homes and hospitals, etc.

REFERENCES

[1] Ranjit P. Katkar, M. V. Nagarhalli, Pankaj S. Desle; " A Review on Development of Wheelchair cum Stretcher "; International Journal of Research in Advent Technology, Vol.3, No.2, February 2015 E-ISSN: 2321-9637.

[2] Ehsanullah Khan, Dr. C.C.Handa, Dr. R.D.Askhedkar; "Systhesis of trolley cum wheelchair for patient handling "; Ehsanullah Khan et al. / International Journal of Engineering Science and Technology (IJEST) ISSN : 0975-5462 Vol. 3 No. 8 August 2011 6311.

[3] Sreerag C S, Gopinath C, Manas Ranjan Mishra; "Design and development of conceptual wheelchair cum stretcher "; sastech 28 Volume 10, Issue 2, Sep 2011.

[4] Mohan Kumar R., Lohit H. S., Manas Ranjan Mishra, Md. Basheer Ahamed; "Design of Multipurpose Wheel Chair for Physically Challenged and Elder People"; sastech 107 Volume 11, Issue 1, Apr 2012.

[5] P. A. Vaghela, V. D. Ramanuj, B. D. patel; "Stretcher cum wheelchair for patients"; International Journal of Futuristic Trends in Engineering and Technology, ISSN: 2348-5264,