

Research Article

Solar Powered Wheel Chair: Mobility For Physically Challenged

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Abstract

Personal mobility means freedom for the physically challenged. One of the best inventions in the medical field that helped both the elderly and the handicapped is the mobility vehicle. The fact that they are no longer depending on someone else to perform daily duties is a big step forward. A large variety of mobility vehicles are available, from which one is to be selected as per requirements. Mobility Vehicles are designed based on the usage, i.e. either indoor or outdoor. They make use of conventional energy for recharging. The cost of the vehicle may not be affordable for a common man. In this paper an attempt is made to fabricate a Solar- powered wheel chair at an optimal cost which can be utilized in both indoor and outdoor environments.

Keywords: Personal Mobility, Wheel Chair, Solar Power, Optimal Cost, Conventional Recharge

1. Introduction

On the journey to mobility and freedom, motorized scooters and wheelchairs are the tools to finish that journey. With scooters and wheelchairs, there is a small inconvenience to mobility independence. The addition of some devices enables persons with physical disabilities a comfortable travel beyond their own homes. Technological advances in mobility scooter have led more options available. In the past, many people disliked the idea of a mobility scooter because of low-life of the battery. Nowadays, batteries have improved and they allow much longer periods of driving without the need for a recharge. People started to purchase a mobility scooter in order to lead a more comfortable and independent existence. Considering a primary method to get around, they are perfect for people with limited or no body mobility. They come in all shapes and sizes, not to mention the multitude of additional features. When it comes to select a mobility scooter, one must take into account the comfort, the available versions (foldable/utility) and the speed. The incredible capacity to adapt to difficult circumstances has led to wonderful inventions, particular beneficial to individuals with mobility problems. Mobility scooters have changed the way in which people in wheelchairs are able to maneuver. The powered scooters of today offer several advantages that were previously unheard of in the mobility world. However, the power scooters also have limitations that a person may not even think to consider. Today, more than half a century later, electric wheelchairs have widened its role in helping the disabled. Besides helping the

permanently disabled to move around independently, it is also used during the physical therapy of injured people who could not walk temporarily. An advantage of electric wheelchairs is that it can be recycled as long as the motors are well maintained. Many do purchase used electric powered wheelchairs as they are cheaper and still have a lifespan of at least 5 years. Electric powered wheelchair is essentially powered by electric motors located at the rear of the wheelchair. The motors run on batteries which can sometimes be a hassle for the user as it requires recharging through a wall outlet. Power ratings for electric wheelchair are around 3 to 6 amperes depending on the environment the wheelchair is used in. Batteries are available either in wet or gel cell, each having its pros and cons.

2. Literature survey

There are different mobility solutions available in the market. There are chairs which can climb stairs, obey voice commands (Scott Elshout *et al*, 2007) or even respond to human thoughts. The costs range from a couple of thousand dollars to tens of thousands of dollars, which comes to be around one to ten lakh Indian rupees or more. The bulk of the market is in a basic design which can provide mobility for a person on indoor level surfaces. It is assumed that the user can see where he is going and can press a few switches and operate a joystick control. Most machines have the capability to go up a short ramp, but not up steps. All conventional powered wheelchairs have two motors; one each; driving one of the main wheels on either side of the vehicle, as in manual wheelchairs. All maneuvering is by varying the relative speed of rotation of the wheels on either side. This is technically called "Differential Steer". In motor wheelchairs the differential

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steer is achieved by properly controlling the speed ratio of the two motors (Kazuhiko Morimoto *et al*). The electronics circuit has to interpret the two components of the joystick displacement and control the motor speeds accordingly. Apart from the main pair of driven wheels there has to be pair of castor wheels for support. These align automatically to roll in whichever direction they are pushed.

2.1 The First Wheelchair

No one really knows when the first wheelchair was invented, although there are plenty who are willing to hazard a guess. What interesting is that wheelchairs weren't always invented for the right reason especially where the Romans were concerned. Some believe it was the ancient Egyptians who were the first to use wheelchairs. These were, however, simple handcarts used to push people around nothing like the sophisticated chairs of today. The Chinese also invented chariot-like wheelchairs around this time, although they were pulled rather than pushed. The Romans, as one could imagine, were not inclined to equal rights for disabled people. Instead they treated disabled people almost as bad as a certain US deputy in Florida. The Romans invented wheelchairs not to extend people's mobility, but so that they could push disabled to the fields to work. They weren't all bad, though. Both Greek and Roman physicians prescribed transport for the sick. After a long time in Spain, Philip II fabricated a wheelchair complete with foot rests, enabling him to enjoy a daily wheel around the gardens.

2.2 Self Propelled Wheel Chair

A young disabled watchmaker called Stephen Farfler built a three wheeled vehicle to transport himself. This was the first self-propelled wheelchair. The next major step forward took place in Bath with the imaginatively named Bath chair. This was invented in 1783. These wheelchairs came in a number of different guises – they could be open or shut, and pushed or pulled. However, in one respect they were a step back from Farflers's invention – none of them were self-propelled. By nineteenth century wheelchair users were propelling themselves by pushing at the outer rim of the wheelchair. Of course, this meant getting their hands dirty.

2.3 Electric Wheel Chair

The first electric chair was invented in 1890 in US, designed to kill criminals through the application of electric shock. Britain engineers are working on a chair with a different purpose in mind, and the first motorized wheelchair was invented in 1916 which was heavy and expensive. Until 1930's, the wheelchair was rather cumbersome device. They were bulky and while a lightweight wicker wheelchair had been built, even this could not be easily transported, making travelling very difficult for many wheelchair users.

2.4 Modern Wheel Chair

The modern wheelchair began to take shape during late 19th century to early 20th century with the advent of push rims for self-propulsion and slings for seat and backrests. Harry Jennings and his disabled friend Herbert Everest, both mechanical engineers, invented the first lightweight, steel, collapsible wheelchair in 1933. Mr. Everest broke his back in a mining accident. The two saw the business potential of the invention and went on to become the first mass-manufacturers of wheelchairs: Everest and Jennings. Their "x-brace" design is still in common use, albeit with updated materials and other improvements.

2.5 Electric Wheel Chair – Modified

Electric wheelchair is invented after WW2 by George Johann Klein, a Canadian, for the injured war veterans. Electric wheelchair is considered to be one of Canada's greatest inventions that have benefited mankind. George came up with the electric wheelchair while he is with the National Research Council of Canada in 1950s. The invention of electric wheelchair is a result of the need to give independence and mobility. Today, the electric wheelchair has changed the lives of millions by providing them a ray of hope that they can be as independent in movements as normal people and gave them optimism in life. Electric wheelchairs can also be called electric powered wheelchairs, motorized wheelchairs or power wheelchairs. These wheelchairs have some disadvantages too (Frederick Walton *et al*, 2010). Repairing an electric wheelchair consumes money and time. Another drawback is its price. It is not affordable for a common man.

2.6 Recent Developments

A recent development related to wheelchairs is the hand cycle. They are in variety of forms, from road and track racing models to off-road types modeled after mountain bikes. There has been significant effort over the past 20 years to develop stationary wheelchair trainer platforms that could enable wheelchair users to exercise as one would on a treadmill or bicycle trainer (Langbein, W Edwin *et al*, 1993; O'Connor, Thomas *et al*, 2002) Some devices are created that can be used in conjunction with virtual travel and interactive gaming similar to an Omni-directional treadmill.

2.7 World's first solar wheelchair

Haidar Taleb, a 47 year old man from UAE, displayed a rare combination of human spirit and willpower by building a wheel chair for himself which runs on solar power. Being a person with polio since the age of 4 he did not stop from taking up this challenge on this wheelchair, a piece of technological innovation.

2.8 Solar Energy Utilization

Energy is a common Man's daily commodity. The increased population has led to depletion of energy. The process of mankind has influenced the subsequent exploitation of new sources of energy from time to time. The utilization of coal, the development of hydroelectricity, the discovery of oil and gas and the advents of nuclear energy are mile stones in human history. Each new source supplemented the other and brought a performed change in the life style of people. The size of the balance of fossil fuels will be over within a hundred years if not compensated with other sources of energy.

Of all non-conventional energy sources, solar energy holds the greatest promise as it is abundant, renewable and pollution free. Its collection, storage on conversion is also easy. Hence worldwide attention is now focused on various methods of utilization of solar energy. All life on the earth depends on solar energy. The solar energy that falls on India in one minute is enough to supply the energy needs of our country for one day. Man has made very little use of this enormous amount of solar energy.

3. Fabrication of wheel chair

The present work involves in design and fabrication of solar powered wheel chair. A motorized wheelchair, power chair, electric wheelchair or electric-powered wheelchair (EPW) is propelled by means of an electric motor rather than manual power. They can also be used not just by people with 'traditional' mobility impairments, but also by people with cardiovascular and fatigue based conditions. Power chairs are generally four-wheeled and non-folding, some folding designs exist and other designs have some ability to partially dismantle for transit. Manual wheelchairs are fitted with an auxiliary electric power system. This can take one of three forms: integrated with the hub of hand-propelled wheels, so that any force on the push rims is magnified by the drive system, or mounted under the wheelchair and controlled as for a power chair, but with the motive force either transmitted to the main wheels via a friction drive system, or delivered directly through an auxiliary drive wheel.

The electric motors of power chairs are usually powered by 4 or 5 amp deep-cycle rechargeable batteries, similar to those used to power outboard boat engines. These are available in wet or dry options. Dry-cell batteries are preferred for power chair due to shipping problems. Many power chairs carry an on-board charger which can be plugged into a standard wall outlet which is a hassle for the user. In order to overcome this disadvantage an alternative system is designed such that the batteries can be charged even without a wall outlet. Non-Conventional Energy Source is one best alternative.

3.1 Design Considerations

The main factors that are considered for the fabrication of the wheel chair are weight or load, speed, width and height of the wheel chair. The body of the wheel chair is constructed to withstand a load of 80-100kg, including its

self-weight and the speed is limited to 3-5km/hr for safety. The height and width of the chair are slightly modified from that of a conventional model. The solar frame is provided with an adjustable slot so that the height can be adjusted as required.

3.2 Components of Wheelchair

The structure of wheel chair consists of Main frame, Steering mechanism, Power source, Wheels, Casters, Indicators and other accessories

Main frame

This is the skeleton of the wheel chair. This carries entire load of the person using the chair. This is made up of hollow cast iron rods of 35mm diameter. The rods are cut into different lengths, and are arc welded so that it gains the strength to withstand the load as well as the capacity to resist the vibrations during the travel. The height of the frame is 105cm, width is 57cm, and seating area is 41X41 cm²

Wheels

These are called wheel hub motor, (also called wheel motor, wheel hub drive, hub motor or in-wheel motor) an electric motor that is incorporated into a hub of a wheel and drives directly. Hub motor electromagnetic fields are supplied to the stationary windings of the motor. The outer part of the motor follows, or tries to follow, those fields, turning the attached wheel. A purported advantage of this design is that no additional transmission system is needed, increasing the efficiency of the drive system. The wheels used are alloy wheels with a diameter of 50 cm and a thickness of 7.5 cm. The capacity of the motor is 240 W and speed 500 rpm at no load.

Caster

A caster (or castor) is an un-driven, single, double, or compound wheel that is designed to be mounted at the bottom of a larger object (the "vehicle") to enable the object to be easily moved. They are available in various sizes, and are commonly made of rubber, plastic, nylon, aluminium, or stainless steel. Casters are found in numerous applications, including shopping carts, office chairs, and material handling equipment. High capacity, heavy duty casters are used in many industrial applications, such as platform trucks, carts, assemblies, and towlines in plants. Generally, casters operate well on smooth and flat surfaces. The diameter of the caster used is 15cm and thickness is 3.5 cm

Power Source

The Power required to run the motor is supplied through a rechargeable battery. Rechargeable batteries are available in many different shapes and sizes, ranging from a button cell to megawatt systems connected to stabilize an

electrical distribution network. Different combinations of chemicals are commonly used in these cells. They include lead-acid, nickel cadmium (NiCd), nickel metal hydride (NiMH), lithium ion (Li-ion), and lithium ion polymer (Li-ion polymer). Rechargeable batteries cost less with minimum environmental impact than disposable batteries. Some rechargeable batteries types are available in the same sizes as disposable types.

Steering Mechanism

It is designed to enable hemi-pelagic wheelchair users to drive, brake and steer a single-lever wheelchair entirely through the two drive wheels. It is unlike all other single-lever chairs that include a separate mechanical linkage to one caster for steering control.

The steering mechanism consists of a pipe with a concentric solid shaft. Two forks fitted into the ball bearings in the pipe are used for attaining the steering motion. Two forks are welded to the caster clamps, and connected together with a solid rod to the handle.

Solar Panels

A solar panel (photovoltaic module or photovoltaic panel) is a packaged interconnected assembly of solar cells, also known as photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. A photovoltaic installation typically includes an array of solar panels, an inverter, batteries and interconnection wiring. Photovoltaic systems are used for either on- or off-grid applications, and on spacecraft. The capacity of each solar panel used is 18W and 4 such panels are connected in series to support a battery of 48 volts. The size of the panel is 500X340 mm

4. Result

To provide a cost effective mobility vehicle for the disabled, a solar powered wheel chair is fabricated with the indigenous materials like iron bars, hub motors, casters, bearings forks, accelerator and brakes. The wheel chair is powered by the rechargeable battery of capacity 48V i.e.) 12X4 in series. A solar panel of 18V capacity 4 numbers is provided for charging the battery on grid. The cost of the wheel chair is Rs.25000. The cost can be further minimized by using optimization techniques and improved design methodology. A right hand steering mechanism is provided, which can be even made a left hand depending upon the requirement. The entire body of the wheel chair is given a rust free coat and is painted in metallic silver to give aesthetic look. The height of the solar frame can be adjusted by using the fasteners provided at the back rest. The speed is limited to 3km/hr for safety and to avoid vibration of the solar frame. A charge indicator is provided for checking the battery levels. Reverse horn is also provided for safety purpose.

The fabricated solar powered wheel chair is presented in the figure below.



Fig.1 Solar Powered Wheel Chair

Conclusions

The attempt made in fabricating a Solar Powered Wheel Chair with the available indigenous material is successful. The working of the wheel chair shows the indigenous infrastructure and the capabilities of the wheel chair. The Recharging capacity of the panels is satisfactory. The desired functionality of the Steering Mechanism is achieved. The wheel chair can provide an uninterrupted journey of 8KM or it can travel up to 4 hours continuously.

Thus the attempt made in fabricating the Solar Powered Wheel chair is successful. However the following limitations are observed:

- The recharging time can be minimized by increasing the capacity of the Solar Panels.
- The Panels are sensitive to vibrations.
- Flat surfaces are more preferred than steep ones.

Future scope

The design of the chair if modified can accommodate a mechanism for climbing the stairs. By increasing the capacity of the battery, a single panel can replace smaller ones.

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