Solar Powered Wheel Chair

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***Abstract*—Solar plays a very important role in our day to day life. We have developed the solar wheelchair especially for the handicapped person. In this work it is discussed that how solar power is utilized for providing the power to the wheelchair, which will reduce the efforts of the handicapped person. The solar wheelchair mainly consists of Solar panel, Brushless DC motor, Battery, Charge controller and Throttle. This work includes all the information regarding the solar powered wheelchair and its main components used in it. 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 report 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.**

***IndexTerms*—Battery, Brushless DC Motor, Charge Controller, Solar Panel, Wheel chair**

I. INTRODUCTION

A manual wheelchair needs manual efforts to set it into motion. A handicapped person for day to day activities has to be dependent on someone. A wheelchair minimizes the dependency up to some extent i.e.; for mobility they can be self relent. But as we know normal wheelchair requires physical efforts to move, the user will surely be tired after sometime. As time passed, wheelchairs went under revolution, motorized wheelchair's were introduced which would run on battery utilizing supply from utility [1-3].

Solar power wheelchair is a step forward to generate and utilize the energy itself and also helps in reducing the dependency on utility supply which is further going to help us in reducing carbon emission by utilizing renewable energy. Basically the solar panels are going to generate power which is to be stored in battery and further utilized by motor for mobility purpose. This perhaps is going to be an emerging trend n the world of wheelchairs, which can lead to invention of more user friendly and eco friendly wheelchairs.

II. OBJECTIVES

A list of objectives need to be conducted before continue to proceed on this project, to ensure that it overcomes the problem and weakness. Following are the objectives:

- A wheelchair that is powered with renewable energyis environment friendly and cheap should be developed.
- A wheelchair that is easy to handle and user friendly for handicapped people should be developed.

III. CONSTRUCTION AND WORKING

Following are the components for development of wheelchair:

- Solar panel
- Brushless DC motor
- Battery
- Charge Controller
- Throttle

The components stated above works in the sequence as shown below:

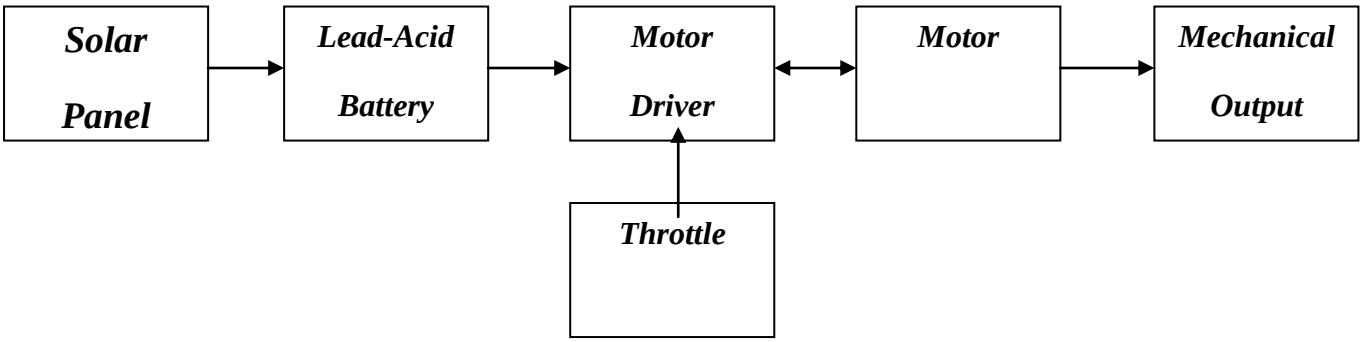

Fig.1. Block Diagram

The block diagram mentioned above shows details about the positioning of the components used in solar powered wheelchair. The motor is the prime mover of the wheelchair; it is places at the bottom of the seat which is connected to the shaft of the wheels.
The motor gets power from the battery, which is rechargeable from the solar panels which are mounted on the top of the wheelchair. The solar panel is a module which contains number of PV cells which are connected either in series or in parallel, thus it coverts the solar energy into electric energy to charge the battery.
Since the electricity generated by the PV panel is fluctuating therefore it requires a DC charge controller which converts the fluctuating current into a constant electric supply which is provided to charge the battery [10-13].

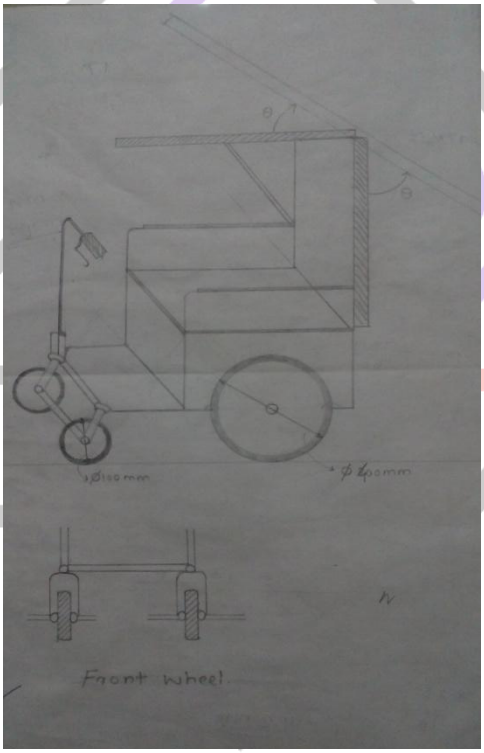

Fig. 2. Design of Solar Powered Wheelchair.

a. **Solar Panel:** Solar panels generate electricity which is used to charge the batteries. Solar cells convert the energy of sunlight directly into electricity by the phenomenon of photovoltaic effect. The solar panel absorbs the photons from sunlight. The photons are absorbed by silicon material present on the panel. When sunlight is absorbed by silicon material the electrons get excited and they dissipate energy to the other electron, these electrons are moving in single direction. These generated electrons gets transferred to different bands of valance to conduction, resulting buildup voltage, hence the solar cell convert solar energy into electricity.

Here we have used two solar panels generating 40 watt each.

Fig. 3. Solar Panel

b. **Brushless DC Motor:**Basically brushless DC Motors are synchronous motors, which have armature winding permanent on the stator and magnets on the motor. The stator has stacked steel lamination with windings placed in its slots. And these windings can be arranged in star or delta pattern. The star pattern gives high torque at low RPM while the delta pattern gives low torque at low RPM.

The advantages of BLDC motor are

- Better speed-torque characteristic, higher speed ranges, long operating life, high dynamic response, and high efficiency.

. Fig. 4. Brushless DC Motor with Gear Box

In BLDC motor hall sensors are embedded into the stator of motor. These hall sensors are connected to hall sensor magnet, which helps in detection of the rotor position. In order to generate trapezoidal waveforms the phase windings in the BLDC motor are distributed in trapezoidal fashion. The commutation technique used is trapezoidal commutation, for which only two phases will be conducting at any given point of time. BLDC motor has three phase winding, which are either star or delta connected and it needs three phase inverter bridge for the electronic commutation. Generally the inverter bridge is a three phase power semiconductor bridge. For providing power commutation sequence to turn on the power devices in the inverter bridge motor requires a rotor position sensor. The reason behind using this motor in our project is that it is highly efficient and the flux density does not decrease with time. Its characteristic suits very well as per requirement of solar wheelchair.

c. **Battery:** Battery used in solar powered wheelchair is lead-acid battery, as this is the only viable battery technology for electric vehicle. The electricity generated by solar panel is stored in this battery and further it is utilized as required. The battery is being selected considering three factors

- **Voltage:**Voltage required for motor is 24V, so we have used two units of lead acid battery of 12V each.
- **Ampere-Hour-Rating:**This rating denotes the capacity of battery. We have 40AH of total AH rating.
- **Discharge rate:** It can be stated as the minimum length of time during which the battery gets discharged to meet specified AH rating.

d. **Charge Controller:**The electricity generated by solar panels is continuously varying in nature this is because the sun rays are never constant on the panel. This varying voltage can affect the performance of battery; hence we require a device which can provide a constant DC output. A charge controller is a device which is used to obtain constant DC output.A charge controller is a device which limits the rate at which electric current is added or drawn from batteries. Charge controller prevents over charging and protects against over voltage. This helps to protect the battery. The rating of charge controller used in this project is 24V, 10Amp.

Fig.5. Charge Controller

IV. SPECIFICATIONS OF PROPOSED WHEELCHAIR

- Solar panel: 12 Volt, 60 W (610 x 660 mm) = 2 Nos.
- Charge controller: 24 Volt, 10 Amp
- Brushless DC motor: 24 Volt, Power rating is 160 W, 1500 rpm.
- Battery: 12 Volt, 20AH = 2 Nos.
- Maximum load capacity: 150 kg.

V. CONSIDERATIONS AND CALCULATIONS

A. The total weight of the wheelchair is 150 kg (including person)

B. Motor:

Initial velocity = 0
Final velocity = 1 m/s
Acceleration = dv/dt = (1-0) / (2-0) = 0.5 m/s^2
Force = Mass * Acceleration = 150 * 0.5 = 75 N
Speed required = 1 m/s
Radius of wheel = 150 mm (15 cm)
Linear distance covered by wheel in 1 minute = 1*100*60 = 6000 cm
Circumference of wheel = 2*pi*radius of wheel = 2*3.14*15 = 94.24 cm
Wheel rpm = 6000 / 94.24 = 63.66 rpm
Torque = Force * radius of wheel = 75*0.15 = 11.25 N.m
Therefore, motor having following specifications has been chosen to satisfy the above requirements:
BLDC motor: 24 Volt, 160 Watt, 1500 rpm , 1 N.m
Voltage = 24 volt DC
Power = 160 watt
Rated speed = 1500 rpm

Rated torque = 1 N.m
By using suitable gear ratio , the above requirements can be met.

C. Battery:
Motor current = 6.67 amp
Backup time = 3 to 4 hours
Total AH required = 4*6.67 = 26.68 AH
Since, battery cannot be discharged fully,
Total AH requirement is extended to 40 Ah (Assuming 70% duty requirement)
Therefore,
Battery = 12 volt, 20 AH, 2 Nos. (Series connected)

D. Solar Panel:
Solar panel = 60 watt, 12 volt, 2 Nos. (Series connected)
Let, Charging current of battery =10% of AH rating = 4 amp
Output current of panel = 3 to 4 amp
Charging time = 40 / 4 = 10 hours

E. Charge Controller:
Charge controller = 24 volt, 10 amp

Fig.6. Designed Solar powered wheelchair

VI. Future Scope

1. The design of the wheelchair if modified can accommodate a mechanism for climbing the stairs.
2. By increasing the capacity of battery, the backup time can be increased.
3. As the technology evolves, more compact solar panels can be employed, battery will be charged at a faster rate.
4. As the use of solar energy is increasing day by day, the cost of solar panel will be reduced in future, thus reducing the overall cost.

VII. Acknowledgment

We are very thankful to our guide Prof. Prashant Kumar to carry out this research work and for his continuous support.

VIII. CONCLUSION

The paper describes a way of building a solar powered wheelchair for physically handicapped people. It is an environment friendly approach to build a wheelchair with ease of use to the physically challenged. Theproposed wheelchair achieves the desired torque and speed and can provide a journey of 4 to 5 hours on a run. This environment friendly approach helps a physically challenged to perform day to day and basic activities in a way that has not been proposed before.

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