

## Hi-Tech Solar Wheelchair

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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. The objective of this paper is to propose a system which will increase the moving distance of an solar wheelchair by adding one solar powered energy source; a small photovoltaic cell and a fuel cell. Fig 1 Display the running conditions of the proposed wheelchair. The control system will ideally give priority to the photovoltaic cell, next to the fuel cell and finally to the battery. When sufficient sun light is available, the photovoltaic cell on the wheelchair roof is used, when it is limited, the fuel cell or the battery is used. In this paper an attempt is made to fabricate a Solar wheel chair at an optimal cost which can be utilized in both indoor and outdoor environments.*

*Keywords- PV Cell, Photovoltaic System, IR Sensor, Personal Mobility, Wheel Chair*

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### INTRODUCTION

Today the world swiftly changing, there are multiple challenges faced by us. Surly it is the knowledge through technology, which makes us to overcome them. The elderly face many physical challenges, including nerve and muscular degeneration, reduced motor function and balance, impaired mobility, and so on. Thus, the wheelchair is considered an essential assistive device for improving the mobility, living quality, and dignity of the elderly and those with mobility difficulties arising from physical disabilities, accident-related injuries, and so on. Generally existing wheelchairs can be categorized as manual, electric-powered, or power-assisted depending on their mode of propulsion. A wheelchair is a chair with wheels to help people move around. It is used by individuals who have impairments that limit their ability to walk. It typically consist of a seat supported on two large wheels attached towards the back of the seat and two small wheels (casters) in front near the feet, a good braking system, footrests and a cushion. There are often small additional features to prevent toppling or to assist in mounting curbs. The user moves by pushing with his/her hands circular bars on outside of the large wheels, known as the hand-rim or pushing rings. Challenge for individual users because of the strong dependence upon the other. To overcome the limitations of the wheelchairs described, the present aim of this project paper to design and develop a solar power wheelchair featuring a PV cells to convert sunlight into electricity to drive electric motors and a storage battery. The motors used to drive electric wheelchairs run on batteries. As a result, they have a relatively limited travel range and require frequent recharging. Various researchers have investigated the feasibility of overcoming these limitations by fitting the wheelchair with a solar power supply. In their design, the solar panel is fixed rigidly to the back of the wheelchair by a metal frame and

cannot be disassembled at will. Moreover, the wheelchair can only be operated in an electric mode, and thus the potential benefits of the wheelchair as an exercise device are lost. Technological advances in mobility wheelchair have lead more options available. In the past, many people disliked the idea of mobility 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 wheelchair 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 wheelchair, 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 has changed the way in which people in wheelchairs are able to maneuver. The powered wheelchair of today offer several advantages that were previously unheard of in the mobility world. Today, more than half a century later, electric or solar powered 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 solar wheelchairs is that it can be recycled as long as the motors are well maintained. Many do purchase used solar powered wheelchairs as they are cheaper and still have a lifespan of at least 5 years. Solar 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.



Figure1. Hi-Tech Solar wheelchair

### **CIRCUIT DIAGRAM AND CALCULATION**

The present work involves in design and fabrication of solar powered wheel chair. A motorized wheelchair or solar wheelchair 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.

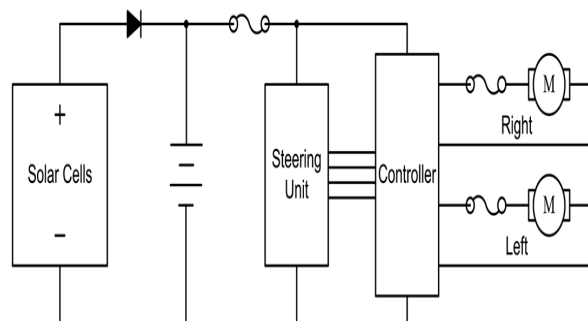


Figure2. Block diagram of Hi-Tech solar wheelchair

#### CALCULATION

Two large wheels

Two small wheels (casters)

Taking Maximum speed of wheelchair = 10 km/hr

RPM of shaft wheel (let say N)

$$10 \times 1000 / 60 \times 60 = (3.14 \times 0.30 \times N) / 60$$

$$\text{RPM} = N = 176.92 = 177 \text{ (approx)}$$

If total weight = 100 kg (Assume)

(Person = 60 kg, weight of the system = 40 kg)

Weight (on each wheel) =  $m \times g = 50 \times 9.81 = 490.5$  Newton

$$\text{Torque} = \text{force} \times \text{radius} \quad ; \quad (D = 10 \text{ cm}) \quad = 490.5 \times 0.05 = 24.525 \text{ Nm}$$

$$\begin{aligned} \text{Power} &= 2 \times 3.14 \times N \times T / 60 \\ &= 2 \times 3.14 \times 177 \times 24.525 / 60 \\ &= 454.25 \text{ Watt} \\ &= 0.5 \text{ HP (approx)} \end{aligned}$$

Energy of battery = 960 W Hr

Time of charging =  $960 / 370 = 2.60$  Hr

Distance Travelled =  $2.60 \times 10 = 26$  Km

#### SOLAR PANEL CALCULATION

Total voltage of solar panel = 17.0 volts

Ampere = 4.7 to 5 Amp.

Power of panel =  $V \times I = 17 \times 4.7 = 79.9$  Watt = 80 Watt (approx)

#### III. DESIGN CONSIDERATION

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.

#### COMPONENTS OF WHEELCHAIR

The structure of wheel chair consists of Main frame, Solar panel, Steering mechanism, Power source, Wheels, Casters, Chargers 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 cm<sup>2</sup>.

#### SOLAR PANEL

A panel designed to absorb the sun's rays as a source of energy for generating electricity. It will absorb solar energy and convert into electrical energy by p-n junction. They built a

structured frame around the base of the wheelchair to hold the solar panels. One solar panel was attached to a convertible-like structure which rotates back behind the wheelchair. Solar panel consists of 36 cells.

#### SPECIFICATION OF SOLAR MODULE:

Module type: 80W36	
Peak Power Output (P max, Watt)	=80
Current at Peak Power Output (I max, Amp)	=4.71
Voltage at Peak power Output (V max, Volt)	= 17.0
Short Circuit Current (I sc, Amp)	=5.18
Open Circuit Voltage (Voc, Volt)	=21.8
Dimensions (in mm)	=865x665x33

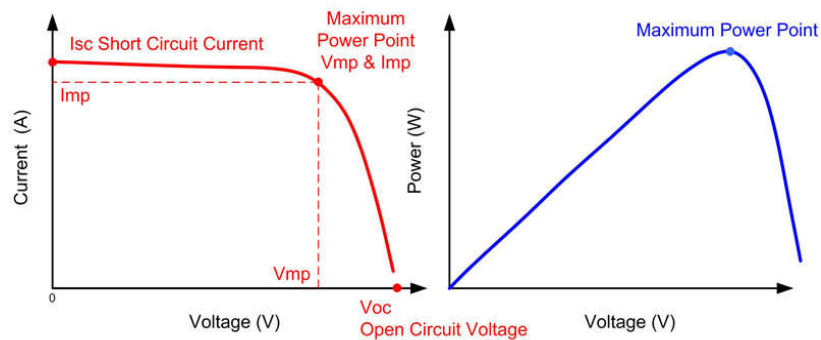


Figure 3. Simulated characteristic curves of solar cell.

The short circuit current,  $I_{sc}$ , is the maximum current from a solar cell and occurs when the voltage across the devices is zero.

The open circuit voltage,  $V_{oc}$ , is the maximum voltage from a solar cell and occurs when the net current through the device is zero.

The maximum power point of solar cell is the point on a power (I-V) curve that has the highest value of the product of its corresponding voltage and current.

#### BATTERY CHARGER

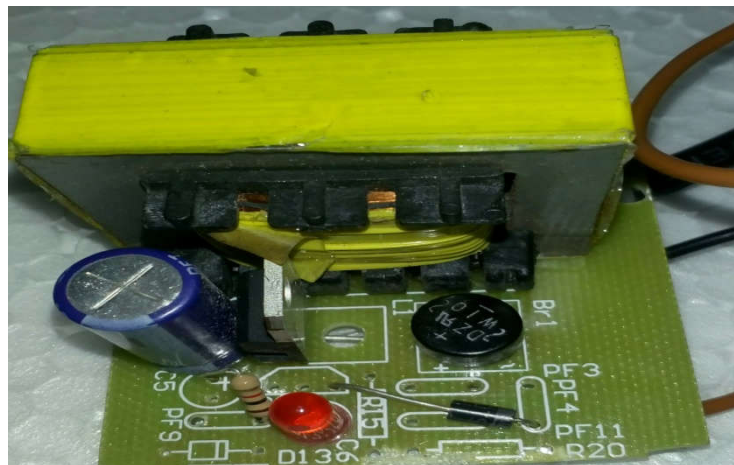


Figure 4. Battery Charger Circuit

Output of the solar panel is variable. The output from solar PV module mounted on a structure depends, among others, on the angle at which the irradiations reach the module surface. In order to make the optimum use of solar energy for electricity, these solar charge controllers are designed to extract the maximum amount of power available from the solar panel and deposit it in the battery. These solar charge controllers also protect your panel from discharging through the batteries after the sun goes down. Solar charge controllers are necessary to protect your PV battery investment. In this charger perform both in AC and DC

to charge the batteries. The simple diagram of 12 volt battery charger for 12 v lead acid battery. It gives 12 volt and 5 Amps current for quick charging of the battery. The circuit uses a 0- 12 volt 5 Ampere Step Down transformer and bridge rectifier module to convert AC to DC. Since pulsed DC is good for lead acid battery, a low value smoothing capacitor is used. The current not exceed their limit to use current limiting resistor. LED act as the charger on status.

#### BATTERY

It will store energy in chemical form and again convert into electrical form. Use 12 Volts, 7.5AH lead-acid batteries. Lead acid batteries are one of the most popular types of battery in electronics. Although slightly lower in energy density than lithium metal, lead acid is safe, provide certain precautions are met when charging and discharging. This have a many advantages over other conventional types of battery, the lead acid battery is the optimum choice for a solar assisted cycle. The current supplied from battery indicates the flow of energy from the battery and is measured in amperes (or Amps). The lead-acid batteries were chosen due to their low cost and proven reliability. The development team believed the weight savings was not significant enough to justify the increase in cost by using a lithium ion battery. The range of the wheelchair on a full battery is approximately 4.5 hours varying by the total number of amps used. Charging the battery to full capacity after using 30 percent of its power would require approximately 3.5 hours of direct sunlight..

#### DC WIPER MOTOR

The dc Wiper motor is used as the drive motor for vehicle. The wiper motor is a permanent-magnet direct current (DC) one. It is equipped and welded on the bottom base of wheelchair with mechanical parts of the gear. The gear function is to slow down and increase torque.

#### WHEELS

A wheel, most commonly wire wheel, designed for a wheelchair. A steel hub, a fixed steel axle (bearing were located in the fork ends), aluminum spokes and a shrink fitted iron rim. A typical modern wheel has a metal hub, wire tension spokes and a metal or carbon fiber rim which hold a pneumatic rubber tire. Wheels will rotate with the axle which is driven by chain gear arrangement and cover distance.

#### 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, aluminum, 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.

MOTOR INSTALLATION- Motor installation with wheels will rotate with the axle which is driven by chain gear arrangement and cover distance.

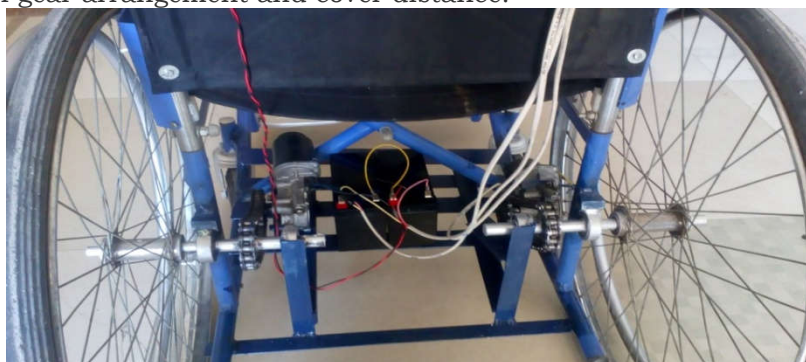


Figure 5. Motor installation

#### INFRARED SENSOR

Infrared sensors can be passive or active. Active infrared sensors consist of two elements: infrared source and infrared detector. Infrared sources include an LED or infrared laser diode. Infrared detectors include photodiodes or phototransistors. The energy emitted by the infrared source is reflected by an object and falls on the infrared detector.

#### Obstacle sensing circuit or IR sensor circuit



An IR sensing circuit is shown below.

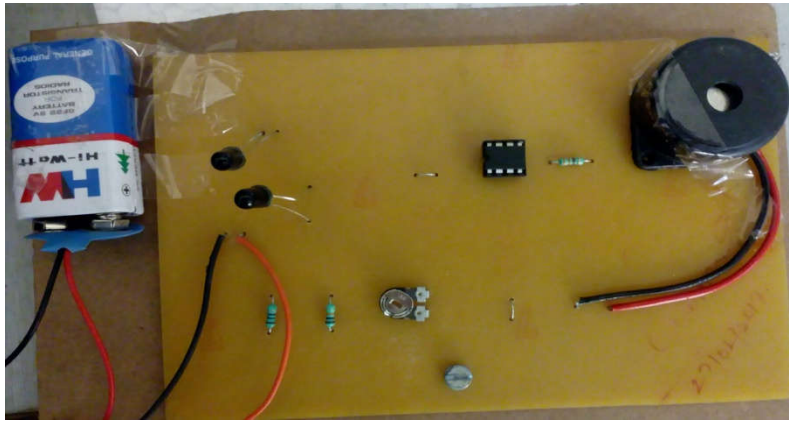


Figure 5: IR Sensor Circuit Diagram

It consists of an IR LED, a photodiode, a potentiometer, an IC Operational amplifier and an LED.

IR LED emits infrared light. The Photodiode detects the infrared light. An IC Op-Amp is used as a voltage comparator. The potentiometer is used to calibrate the output of the sensor according to the requirement. When the light emitted by the IR LED is incident on the photodiode after hitting an object, the resistance of the photodiode falls down from a huge value. One of the input of the op – amp is at threshold value set by the potentiometer. The other input to the op-amp is from the photodiode's series resistor. When the incident radiation is more on the photodiode, the voltage drop across the series resistor will be high. In the IC, both the threshold voltage and the voltage across the series resistor are compared. If the voltage across the resistor series to photodiode is greater than that of the threshold voltage, the output of the IC Op – Amp is high. As the output of the IC is connected to an LED, it lightens up. The threshold voltage can be adjusted by adjusting the potentiometer depending on the environmental conditions.

The positioning of the IR LED and the IR Receiver is an important factor. When the IR LED is held directly in front of the IR receiver, this setup is called Direct Incidence. In this case, almost the entire radiation from the IR LED will fall on the IR receiver. Hence there is a line of sight communication between the infrared transmitter and the receiver. If an object falls in this line, it obstructs the radiation from reaching the receiver either by reflecting the radiation or absorbing the radiation.

#### ADVANTAGES

- **Independence:** With a solar wheelchair, you don't have to depend on someone else to push the chair, allowing you the independence of moving about.
- Meets the user's needs and environmental conditions.
- Provide proper fit and posture support.
- Is safe and durable.
- Maintained and services at affordable price.
- **Minimal effort to mobilize:** The steering/control system is simple to operate and enables both the speed and direction of the wheelchair to be precisely controlled.

#### APPLICATION

- The elderly and disabled people use the power wheelchair.
- Independent mobility, children may develop learned helplessness and experience delays in both physical and cognitive domains.
- To place a barrier sensor (IR sensor) to sense the obstacles and it also convenient for blind persons.

#### RESULTS

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 24V i.e.) 12X2 in series. A solar panel of 18V capacity is provided for charging the battery

on grid. The cost of the wheel chair is Rs.15000. 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.

## CONCLUSION

The vehicle which we are introducing by doing this project will be help full for many of the people who are disabled mentally as well as physically can make use of this vehicle without the requirement of relying up on any external aid. So this is a multifunctional medicinal aid focusing on the improvement and self- reliability of multiple disabled people. Modifications made in the prevailing equipment meant for the disabled ones will be great use in upcoming time. And we were able to apply our theoretical knowledge into practice. All data provide are precise to the best of our ability.

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