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Development in Eco-friendly Solar Powered Tricycle for Handicapped Person

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Abstract

It is always a great challenge for the physically handicapped person to move in to the places like bus stops, hospitals, to go anywhere easily hence options are limited as very few form automobile industries. So keeping in the mind the limitations of handicapped person and to reduce his efforts we do development, designed and manufactured solar powered tricycle for handicapped person by giving some other useful features. This tricycle is convenient to a handicapped person as well as affordable to a poor person, as cost is major issue for them.

Key Words: *Tricycle, Solar Panel, Solar charge controller, Eco friendly , Electric motor, physically handicapped*

1. Introduction

Technology is developing fast and every day new developments are being done .Most of the developments are done keeping in view, normal human beings .However very less thought is given for development of means for handicapped person. In order to taking the handicapped with mainstream of society idea of designing vehicle for such person is developed. A conventional mechanical tricycle make it hard to drive in poor road condition or on a gradient. Where as modified scooter require regular maintenance and operating cost is comparatively high. Smart wheelchairs also an option but it is suitable for short distance and cost associated with such chair is too much high.

This project aims to mitigate the above listed problems by doing development designing and

fabricating a solar powered tricycle which will be driven by using solar panel and an electric motor with simplified electric drive system eliminating chain and sprocket mechanisms.

There are different types of vehicle developed for
physically handicapped person like Hybrid Tricycle, Modified scooter, Electric Tricycle which is driven by IC Engine, Solar operated tricycle, Smart wheelchair etc. Cost of Modified scooter is around 70000. Electric tricycle requires electricity, battery charging port which are high in cost and in recent there is no availability of charging station.

[1] Amit Kushwaha & Chetan Nandanwar- They said that how solar power is utilized for providing the power to the tricycle which will reduces the effort of the handicapped person. They give information about the main parts like Solar panel, Brushless DC motor, Battery Charge Controller and their suitable arrangement.

[2] R. Isermann etal- They analyze A photovoltaic module or photovoltaic panel is a packaged interconnected assembly of photovoltaic cell. The photovoltaic module known as solar panel. Lead acid battery is the only variable battery technology for electric vehicle conversion.

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[3] Dhanashri Sonar, Shantanu Sonar and Rohan Katariya etal.,- They said that, there are many difficulties with mobility of physically disabled people in society. They are see that physically disabled people are basically using some accessories like crutches prostheses or artificial legs etc. To overcome their problems use of available resources for components such as pipes for chassis, wheels, bearings etc. from the local market and simplicity in designing result cost economy.

2. Design of Tricycle:

Component	Weight (N)
Frame	392.4
Battery	147.15
Rider	686.68
Front wheel	34.33
Wheel with hub motor	88.48
Wheel without hub motor	55.05
Handle	44.28
Solar Panel	196.2
Accessories	45.35
Total	1805.06 (180 kg)

Table 2.1 Design Calculations

As vehicle is being design for disabled person speed is limited to 25kmph and any vehicle having speed below 25kmph requires no RTO registration. Radius of vehicle is 203 mm (8 inch) thus rotational speed of wheel is limited to 327 rpm.

3. Component Selection

Tricycle consist of various components like motor and controller, chassis, batteries, Voltage converter and speed control and brakes.

3.1 Frame

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Frame is the supporting member of the tricycle and subjected to static and dynamic load. It also takes various load like vertical load, Cornering load, side thrust, acceleration and brake dip. Various Accessories and components are mounted over the frame. A frame should have sufficient strength to stand against all the listed loads. Weight of the frame should be as minimum as possible to reduce the overall weight of tricycle. Cost of the material of frame must be low. We selected the frame by considering available sizes of pipe, maximum stresses developed in the critical component and available factor of safety. Selected hollow pipe has the following specifications.

- Material: AISI 1018
- Outer diameter: 25.4mm
- Inner Diameter: 21.4mm
- Thickness: 2mm
- Length:1900 mm
- Width:900mm
- Handle Height:1050mm
- Seat Height: 640mm
- Handle Length:670
- Sut:440 N/mm^2

3.2 Batteries

To run the motor at full load condition for 2-3 hours it requires energy about thrice of capacity of motor, along with this batteries should provide high energy demand during starting without affecting the further performance. Battery power can be estimated by Voltage and current rating. Batteries must have high voltage in order to provide abundant energy supply and to maintain voltage drop as minimum as possible. Another requirement of batteries is low cost and low maintenance. Lead acid batteries fulfill the second condition. Voltage of system can be increase by connecting it in series. Considering above parameters lead acid battery is suits best.
Selected batteries have following specification

- Current rating:20Ah
- Voltage:12V
- No. of batteries: 04
- Combination of batteries: Series
- Combined Voltage: 48V

3.3 Motor

To drive the vehicle at a speed of 25kmph and provide a rated torque about 5 N-m a motor having capacity above 200 watt is sufficient. Next Standard available motor is in capacity of 250 watt. Thus we have taken a Brushless DC motor of hero optima electric bike. The motor available in wheel itself i.e. hub motor. Hub motor of this kind is available in authorized workshop of hero motors. Cost of hub motor is below 5000 making it suitable for low cost application. Vehicle having electric power source of more than 250 watt requires RTO registration. Selected motor give us exemption from RTO registration.

Specification of selected hub motor.

- Type: Brushless DC Motor
- Power:250 Watt

3.4 Controller and Voltage Converter

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Motor draw the current from batteries according the need of the driver. Controller takes different input like brake, acceleration and vary the power supply to the motor. We selected standard controller taken from the hero electric's bike and installed it with the given hub motor of same bike model. It has the following specification

- Operating current:19A
- Operating Voltage:48V DC
- Phase angle:120 degrees

Tricycle does have different accessories like horn, Headlight, Indicator lamp, Brake light and all of those operates on 12V. But combined voltage of system is 48V thus it is essential to convert 48V into 12V and DC-DC Voltage converter serves this purpose. Along with voltage conversion it also gives protection from over current, short circuit and low voltage. The converter used in given tricycle has the following specification.

3.5 Solar Panel

Photovoltaics is the field of technology and research related to the devices which directly convert sunlight into electricity. The solar cell is the elementary building block of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon.
A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a photovoltaic module'. Modules are designed to supply electricity at a certain voltage, such as a common 12 volt system.

Specification of Solar Panel
- Solar panel= 100 watt
- Quantity =2
- Voltage = 12v

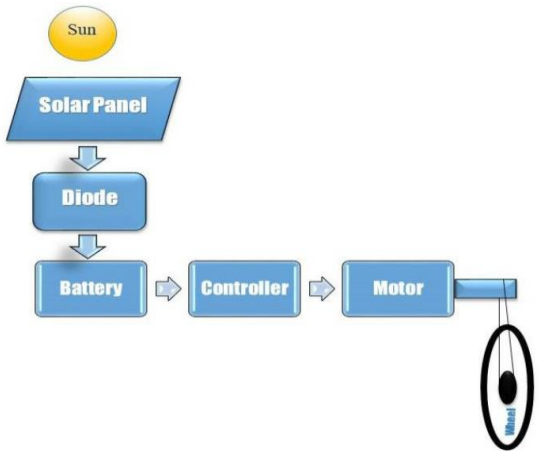

Fig 4.5.1 Power generation system for a tricycle

Motor must overcome following resistances while driving.
Power Calculations :
Weight of Vehicle : 150 Kg
Efficiency – 85%
Wheel Size(radius) – 0.1524m
Length Of vehicle -1.9m
Width -0.9m
Speed – 20kmph
RPM- Total distance covered per hour/liner distance(2*3.14*r)

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RPM = 20000/2*3.14*0.1524*60
= 350 rpm
Power-(Mass in Kg * acc.*velocity*Rr)+(Ar*Cd*area*V^3)
Power =(150*9.81*5.55*0.01)+(0.6465*0.88*1.71*5.55^3)
Power= 250watt.

Torque :

P= 2*3.14NT/60
250=2*3.14*350T/60
T=6.820Nm
Tmax=6.820*1.75(load factor)
= 11.935Nm

Battery :

Battery=3*Power
=3*250
=750watt
12*24*0.83= 240Watt- Single Battery
No of Batteries-4
240*4=960 watt

Solar Calculations-

General Solar Panel – 12volt ,6amp
Loose Wiring connections factors = 10%
At summer approx. sun appears-7Hr
At winter approx. sun appears-5.5Hr
At Rainy season sun appears -4Hr
=7+5.5+4/3
=5.5Hr
Solar panel= (Load/avg.sun sunshine)* correction factor
=(960/5.5)*1.1
=192watt
We select 100watt 24volt 2 panel
Charging time =load/volt*current
= 960/48*6
= 3.30Hr

4. Charging & Discharging Phenomenon

4.1 Charging the Battery

The charging of the battery is done by solar energy. As it takes approximately 6-8 hours from being fully charged, but as solar energy with high intensity is not present for the full time of a day, for this reason charging was done in two different days in the full sunshine. The level of increasing charges by day time is shown in Fig. 5.1, in which level of charges (%) exists in the vertical axis and time of day is on the horizontal axis. Also, the standard deviation is shown in Fig. 5.1

The experimental data were taken on six different days. For charging the battery fully, every time two days were taken. The experimental date for charging the battery was 8th to 10th March 2020. Theoretically, the charging profile should be linear, but not exact in our study because the solar intensity on the panel varies by time of the day. After 60% level of charge, the slope was downward because data was taken on the next day morning. At the end of charging, the rate of charging the battery was slow because the reaction rate of the battery was slow. Also, as Fig. 5 shows the standard deviation too, from

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the graph it was found that the maximum level of standard deviation is only 1.527 which is really small. So finally it can be said that the similar characteristic of charging is found for all the different days.

4.2 Discharging the battery with a solar panel

The battery was connected to the motor that runs the solar tricycle. While running the tricycle discharging was started. Discharging the battery while running the tricycle is a linear phenomenon. Fig. 5.2.1 shows the relation between the levels of charges (%) with a time of the tricycle. It clearly displays the decreasing of the storing energy due to consumption with the increasing of time.

Discharging of the profile of the battery with solar panel is shown in Fig. 5.2.1. On Fig. 5.2.1, the level of charge is reduced from 100% to 15%. Theoretically, the discharge curve should be linear, but on Fig. 6 it slightly deviates from the linear phenomena. It took approximately 3 hours for discharging the battery. It was found from the discharge curve that in the first half hour battery lost its 8% storage energy. But for the next every half hour discharge percentage was 17%, 15%, 11%, 14% and 20% respectively.

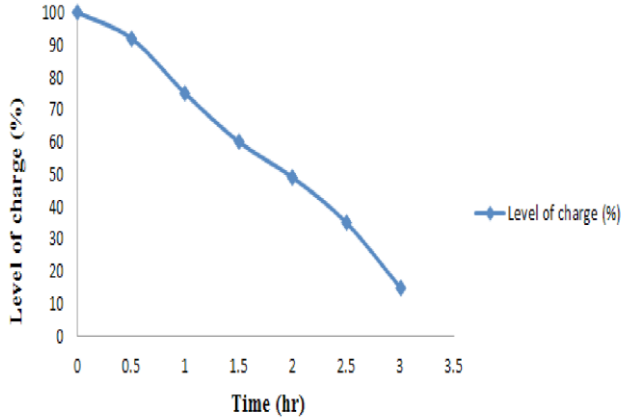

Fig 4.1.1 Level of charge vs Time Curve

5. Feasibility Study

5.1 Costs

The main parts of the constructed solar tricycle are Solar Panel, Battery, Motor, controller and three wheels with equipment. Here the total approx. cost is Rs 23500. This is comparatively lower than other solar tricycle. The cost of solar tricycle available in market is approx. goes to Rs.60,000. So in this cost analysis, it is seen that our tricycle is economical than other solar assisted tricycle.

5.2 Environment

The air pollution that warming the earth as a result of pollutants from the automobiles, which is about 23% of the total air pollution. One of the great problems faced in urban areas throughout the world is the increase in vehicles due to an imbalance between the public transport and the increase in population which, finally results in a huge amount of air pollution.

With the increasing rate of population, the number of vehicles is also increasing due to the imbalance between these two factors and finally the pollution rate is also increased. Over the last two decades, many experiments have been done to control emission from IC engine. So in this respect, this solar tricycle may be one of the solutions because of pollutant free property.

6. Future Scope

- SOLAR PANEL: Use the Ultra Efficient Solar Cell.
- A suspension system can be added.
- Motor of more capacity can be added to increase load carrying capacity.
- Power can be given to both of the rear wheels and in case of failure of one motor secondary drive will be helpful.

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7. Conclusions

[1] The objective of the study was to design an eco-friendly vehicle which will be affordable to poor handicapped person.
[2] We mitigated problems faced by previously designed model.
[3] Tricycle has been fabricated and tested successfully. Different parameters like running range, cost per kilometer, Discharge time of battery has been measured with actual running condition and it delivered better results.
[4] The general solar tricycle don't have any reverse mechanism i.e handicapped person suffers from parking problem.
[5] The maximum speed of the tricycle has been found at 25 km/h. This ensures continuous energy input to the tricycle without any additional cost.

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