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DESIGN AND FABRICATION OF SOLAR TRI CYCLE

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ABSTRACT

Tricycle is a widely used vehicle for transportation throughout India. The basic Tricycle is a three-wheeled design, pedaled by disabled persons in the side and seat in the middle for sitting arrangement. Of all vehicles, hand-powered tricycle are the worst affected by the rough, uneven roads in our country. Manual drive tricycle is more affordable than hand driven. We have developed a solar tricycle especially for disable person or handicap person. In this paper, we have discussed how to utilize solar power though the solar panel or photovoltaic cell and drive the brushless DC motor, battery, controller, throttle and all of the component through the reduced human effort.

KEYWORDS: Tricycle, Solar tricycle, Solar powered vehicle, Solar panel

INTRODUCTION

Tricycle wildly used the purpose of the transportation in India and mostly used the handicap person because physically handicap. Basically tricycle is three wheel design and used hand power or manual drive. Most of the people who depend on the type of tri-cycle are daily Bread workers who have to travel long distance daily. The regular tricycle rider are unable to drive tricycle because of some injury and more effort and suffer.

There are several types of tricycle that can be categories that 1 paddle tricycle, motorized tricycle, and electric tricycle. The weakness of the tricycle make people do not like to used tricycle. First, paddle tricycle needs a lot of energy to paddle the tricycle. The user will surely be tired after used the tricycle. Next, motorize tricycle that used fuel as it prime mover. The tricycle use fuel that is costly. Besides that, motorize tricycle will make pollution that can be very bad for our environment especially in this period that global warming happen to the earth.

Electric tricycle that generate by battery can be only be sufficient for about an hour. The user needs to find power supply to recharge the battery or else they need to paddle the tricycle that used more energy compare to the normal tricycle because of the weight. [1] Solar powered vehicle use photovoltaic cell to convert solar rays into electrical energy. Electrical tricycle powered by the battery power is sufficient about an hour's. That's why at the time discharge battery user fined the charge the battery.

OBJECTIVE

To overcome the problem and the weakness, this study need to do some research and studying to develop better technology. To make it success, there are several thing that we need to know such as what will be the prime mover, how to stored it and the advantages of this new vehicle. In that case, these are the list of the objective to be conduct before continue to proceed on this study:

- Reduced the physical effort to drive the tricycle,
- Top speed limit up to 20km/hr and average speed up to 10km/hr,
- To developed tricycle for the longer distance traveling,
- Cost of tricycle does not exist to Rs 25000.

CONSTRUCTION

Components of tricycle are:

- Solar panel,

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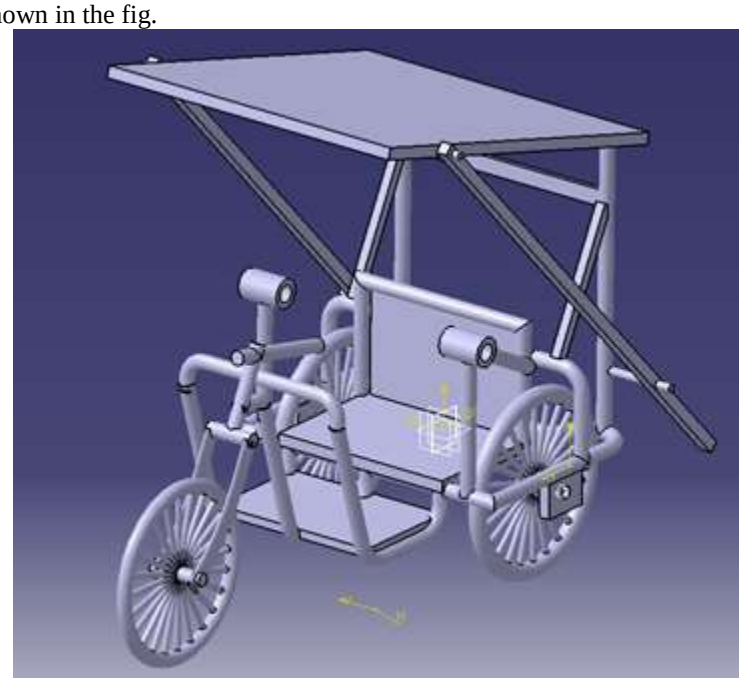
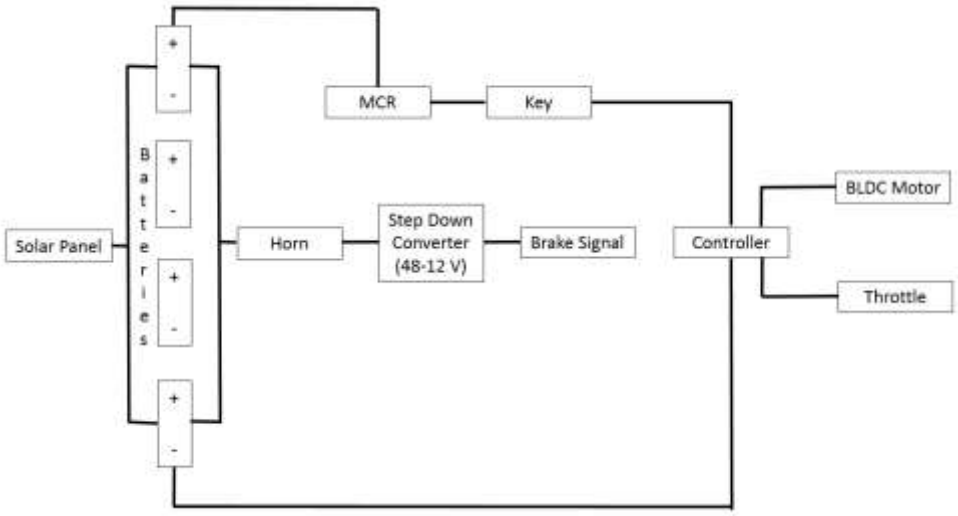
- Battery,
- BLDC Motor (Brushless DC Motor),
- Controller,
- Throttle,
- Battery charger,
- Charge controller.

In order to integrate to electrical system with the tricycle to assist the driver, there are number of modification that had to be made to the tricycle frame. The required modifications in the tricycle frame are done with the help of the CATIA V5 software shown in the fig.



CAD model of Tricycle



Block diagram of solar tricycle

The above mention block diagram gives us a detail about the positioning of the components on the body of the tricycle. The motor which is a prime mover of the tricycle is placed at the bottom of the seat which is connected to

the axle of the cycle. The motor gets the power from the battery which is rechargeable either from the main source of electricity or from the solar panels, which are kept on the top of the tricycle. The solar panel is a module which contains number of solar cells which are connected either in series or in parallel, thus it converts the solar energy into electric energy to charge the battery.

Since the electricity generated by the solar panel is fluctuating therefore it requires a DC charge controller which converts the fluctuating current or electric power into a constant electric supply which is the provided to charge the batter by the charge controller. [1]

Here, we provided four solar panel 40W, 12V, and all panel are in series connection. Total output of the solar panel is 160W, 48V. So that we used four batteries each of 12V and all battery are in series connection. Because of series connection, output of the all batteries is 48V. We used BLDC Motor of 430 rpm and 48V.

Solar panel

As the title suggests, the tricycle is operated by solar energy. The batteries are charged with solar energy with the help of a solar cell. Solar cells convert the energy of sunlight directly into electricity through the use of the photovoltaic effect. The photovoltaic effect involves the creation of a voltage into an electro-magnetic radiation.

The photoelectric and photovoltaic effects are related to sunlight, but are different in that electrons are ejected from a material's surface upon exposure to radiation of sufficient energy in photoelectric, and generated electrons are transferred to different bands of valence to conduction within the material, resulting in the build-up of voltage between two electrodes in photovoltaic.

Solar panel used for this study

Solar cells are electrically connected and fabricated as a module with a sheet of glass on top to allow light to pass and protect the semiconductor from the weather. To obtain a desired peak DC voltage we will add solar cells in series, and to obtain a desired peak current, the solar cells are put in parallel position. [2]

Table 1. Electric ratings of solar panel

Parameter	Rating
Maximum power	42.87 W
Open circuit voltage	22.8 V
Short circuit current	2.55 A
Rated voltage	18.80 V
Rated current	3.00 A
Module weight	3.70 kg
Module dimensions	4500 mm x 6750 mm
Operating temperature	-40° C to 80° C

Battery

Battery is a primary storage of the electric power and whenever power required that time battery provides the power of the motor and vehicle is drive. We used four numbers of 12 V 26 Ah batteries in series. All batteries are in series connection that's why the output of the all battery is 48V.A VRLA battery (valve-regulated lead-acid battery), more commonly known as a sealed battery (SLA) or maintenance free battery, is a type of lead-acid rechargeable battery. Due to their construction, the Gel and AGM types of VRLA can be mounted in any orientation, and do not require constant maintenance. [3]

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Battery used for this study

Table 2. Specifications of battery used [4]

Parameter	Rating
Type of battery	VRLA - Valve-Regulated Lead-Acid Battery
Physical dimension (LxWxH) (mm)	167x126x176
Number of batteries	Four batteries connected in series
Voltage	12 V each, total 48 V
Amp-hour rating	26
Nominal voltage (V)	12
Weight (kg)	9 each
Recharging time - 0-90% (Hrs.)	8-10
Float voltage (V)	13.5
Boost voltage (V)	13.8

BLDC hub motor

The hub motor is a conventional DC motor. The rotor is outside the stator with the permanent magnets mounted on inside. The stator is mounted and fixed onto the axle and the hub will be made to rotate by alternating currents supplied through batteries. Hub motor generates high torque at low speed, which is highly efficient and which doesn't need sprockets, brackets and drive chains. This means they are very reliable and have a long life. The main characteristic of Brushless DC Machines is that they may be controlled to give wide constant power speed ranges. [5]

BLDC hub motor used for this study

Table 3. Ratings of BLDC hub motor

Parameter	Rating
Power	250 W
Current	5 A
Speed	430 rpm
Voltage	48 V

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Controller

The controller is used to control the motor voltage and change voltage rating with the time to provide the motor. Motor controller changes voltage DC to AC. The controller is a multi-functional device and the brain of our vehicles. It provides signal to all major electronics components like accelerator, display panel, brakes, etc. It activates when it receives voltage from the battery and supplies power from that battery to the motor on receiving the accelerator signal. Low voltage cutoff monitor the battery voltage and shut down the motor if the battery voltage is too low that time protects the battery from over discharge.

Motor controller used for this study

Throttle

It is used to accelerate the vehicle and maintain the speed of the vehicle. Whenever the throttle is an action, at that time throttle is converted signal and signal is supply to the controller. Controller is supplied signal to motor, and motor starts acceleration.

Battery charger

It is used to charge of the battery externally.

Solar charge controller

It provides stable ratio of the current from the solar panel to the battery. Because of change in solar radiation, change output is vary time to time of the solar panel. We provided two solar charge controller in series connection and because of that continues flow of the current passed to battery.

Solar charge controller used for this study

Table 4. Ratings of charge controller

Parameter	Rating
Power	12/24 V
Maximum power rating	12/24 V
Maximum current rating	10A

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DESIGN CONSIDERATION

As a transport for the physically disabled people the overall safety, stability, reliability, control, comforts etc. are a very much important and taken in to consideration while designing it. However, the general points of consideration during the designing of the solar three-wheeler are: simplicity, strength, stability, safety, corrosion and wear, weight, size, flexibility, ease of control, modularity, efficient extraction of solar energy, effective use of solar energy and energy storage, all terrain tires for all terrain traffic ability/mobility. [1]
Here we considered a total weight of the tricycle is 150 kg including person.

Motor

Power (Watt) = Total weight x g x max. speed x gradient
Here, Total weight of vehicle is 150 kg including person, g = 9.81 m/s^2, maximum speed = 20 kmph (5.55 m/s) and assume gradient is 3%.
Power (Watt) = 245 W
Therefore, power required approximately is 250 W. Thus, a 48 V, 250 W motor is sufficient to run tricycle. [1]

Battery

System voltage = 48 V,
Load current = 250 W/ 48 V = 5.21 A,
Estimate 3.5 hours of use per day
Load current = 3.5 x 5.21 x 1.2 = 21.88 Ah/day,
Assume 20% overall losses,
Size of battery = 21.88 x 1.2 = 26.25 Ah/day,
Energy required for 250 W motor = 26.25 x 48 = 1260 Wh/day.
Therefore 26 Ah/day, 48 Volt power is required for the system which can be supplied with the help of four 12 Volt batteries of 26 Ah/day. [1]

Solar Panel

A 4 cm x 15.7 cm solar cell's electricity output is likely rated at 0.52 to 0.63 volts with 3 amps. Here, in the module, 36 cells are connected (in series) together so that in all operating conditions a PV module gives well above 12 volts, which is the required to charge a 12 V battery. We have totally used four solar panels to generate adequate power to run solar tricycle. [1]

Fig. Working model of solar tricycle

Above figure shows the working model of a solar tricycle. The solar panel mounted on the carriage charged the battery & which in turn drive the hub motor. When the tricycle is idle during the day, the solar panel will charge the battery. The system will make tricycle operate more efficiently.

RESULTS AND DISCUSSION

Speed measurement

We have used the android application to measurement the speed of the solar tricycle. Maximum speed, minimum speed, and average speed are measured by this application. We have considered two places in different trial runs. Results of them are shown below in table 5.

Table 5. Results of the trail run

Sr. No.	Trip	Distance	Time Taken	Average Speed	Maximum Speed
1	CGPIT to Tarsadi	1.6 km	3.31 min	12.81 kmph	20 kmph
2	CGPIT to Mahuva	6.7 km	35.41 min	11.35kmph	20 kmph

We have compared our solar tricycle with other vehicles available in India. Comparison is show in table 6.

Table 6. Comparison of various vehicles

Parameter	Solar Tricycle	Moped[6]	Bicycle[7]
Max speed (kmph)	20	50	20
Pedaling requirement	No	No	Yes
Initial cost	24500	27343	4000
Operating cost	Nil	Re. 1/km	Nil
Weight - Vehicle only (kg)	80	66	9
Max. traveling distance at a stretch in km	40-45	198	15-20
Fuel used per 100 km	Nil	1.5 L	Nil
Charging time (hr)	3.5 – 4	NA	NA
Type of energy used	Solar	Petrol	Muscle power
Driving noise (dB)	Noiseless	65-70	Noiseless
Driver's license required	No	Yes	No
Helmet required	No	Yes	No
Age limit	No	Over 18	No
Engine size (cc)	NA	69.90	NA

CONCLUSION

The solar tricycle was successfully developed as per the design for disabled community. This tricycle works on solar source and employs BLDC motor to drive the tricycle. The average and maximum speed was obtained as 12.8 kmph and 20 kmph respectively. Various vehicles of same category available in India was compared for different parameter and it was concluded that solar tricycle proved to a complete blessing to the disable community compared to other vehicle using various sources of energy. Due to limited solar energy during cloudy/rainy days provision is made to charge the battery using external electric power source.

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REFERENCES

[1] Snehal Bali, Amit Kushwaha, Pratik Dhote, ChetanNandanwar, SandeshUghade, "Fabrication of Solar Powered Tricycle for Handicapped Person", International Journal for Innovative Research in Science & Technology, Volume 1, Issue 10, March 2015, ISSN (online): 2349-6010

[2] M. ReddiSankar, T. Pushpaveni, V. Bhanu Prakash Reddy, "Design and Development of Solar Assisted Bicycle", International Journal of Scientific and Research Publications, Volume 3, Issue 3, March 2013 1 ISSN 2250-3153

[3] David Linden, Thomas B. Reddy,"Handbook of Batteries", 3rd Edition, McGraw-Hill, New York, 2002 ISBN 0-07-135978-8, pp. 24.1

[4] Installation and operating instructions, Amara Raja Batteries, Ref. No. ARB-MAN-Quanta-13-001

[5] ChetanKumaarMaini, "Development of a next generation Electric Car for World Markets", Journal of EVS 24, Stavanger, Norway, May13-16,2009
[6] Bikewale, TVS, Heavy Duty Super XL, (May, 2016), http://www.bikewale.com/tvs-bikes/heavydutysuperxl/
[7] Atlas Cycle Co., Roadsters, Goldline plus 55/60 CM, (May, 2016), http://www.atlascycles.co.in/product/roadsters.html?view=detail