

# Development, Performance Analysis and Application of Solar Cell

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**Abstract** – This Paper presents the idea of recently available three-wheelers for people who are disabled and proposes a new improved and advance design of a solar powered three-wheeler. This three wheeler is controlled by solar power and it is suitable for outdoor use. It has components such as Li-ion batteries, BLDC Hub ,Controller Motor and Solar Panel. Battery stores power which is generated from solar panel and transfer it to motor while controller activates motor. All this extra components makes three wheeler very easy to handle and cost efficient for peoples in all countries.

**Key Words:** Solar Powered<sup>1</sup>, BLDC Hub Motor<sup>2</sup>, Controller<sup>3</sup>, Cost Efficient<sup>4</sup>

## 1. INTRODUCTION

Solar handicap tricycles are design in such a way that handicap human beings can go anywhere with the help of tricycles in which batteries are charged by solar panel and driven by electric motor . It can help the people who have disability in their lower limbs. The proposed solar three-wheeler cycle is produced to match and exceed the conventional three-wheeler's facilities with a more intelligent and efficient design. A solar panel is used to generate solar electricity, a battery system which is used for storing electric power, cushion seat, an efficient motor, all terrain tires are been used for this solar three-wheeler. Special attention is given to good mobility, effective use of solar energy, comforts and biomechanics, sophisticated suspensions, ease of use etc. By doing so every disabled person will get advanced solar handicap tricycle.

### 1.1 PROBLEM STATEMENT

Now a days we are facing so many problems from existing tricycle like large amount of effort is required to drive it, vibration exposure injurie, poor braking, safety lighting, suspension system and gearing system. The existing tricycles have very high gear ratio, it makes difficult to pedal in upward direction or start from a standstill. The lack of gearing system and high gear ratio on the existing tricycle models make pedaling passengers incredibly difficult for Tricycle drivers. There are many potential solutions to this problem, ranging from an improved gear ratio to a power assist to aid the driver. To over come the above problems we can develop a solar electric tricycle for handicap person that can give a sustainable alternative for the mobility and chance to travel on there own.

The current tricycle has the following problems that can be work on;

1. Large amount of efforts is required to drive it
2. Strain Injuries by Solar Repetitive
3. Exposure Injuries by the means of Vibration
4. Utilize of Renewable Energy source
5. Environmental Pollution
6. High Cost-

## 2. LITERATURE REVIEW

The following papers are being studied and are referred for the following project. These papers are belongs to different authors who made research papers associated to the solar tricycle.

1. According to Authors Ananda Mani Paudel and Phillipp Kretzmann, in their research article "Design and Performance Analysis of A Hybrid Solar Tricycle For A Sustainable Local Commute", published in Renewable and Sustainable Energy Reviews, Solar energy can be effectively used to power a tricycle and propel it at speed of 25km/hr.
  - A trike was designed and tested in Colorado, USA.
  - Dry and Sunny Climate gives higher potential to use solar trike (tricycle) as alternative mode of transportation.
  - Improvements in design can lower the power losses and increase efficiency.
2. According to research paper "Solar Powered Tricycle For Handicapped Person" published in International Journal for Innovative Research in Science and Technology, Vol. 1 Issue 10 March 2015, Available types of tricycles for handicapped persons are:
  - Simple Pedal Tricycle: requires high efforts to propel the vehicle
  - Motorized Tricycle: consumes fossil fuels and pollutes the environment
  - Electric Tricycle: the battery charge remains limited to few hours, again it needs to be plugged in to get charged

- These above types do not give a sustainable means for transport.
3. According to the research paper presented by Mohamed Dahbi, Said Doubabi, Ahmed Rachid "Autonomy Analysis of a Solar Electric Tricycle", International Renewable and Sustainable Energy Conference, Institute of Electrical and Electronics Engineers Publications. The study of tricycle performances was presented in these paper. Opting Marrakech city for instance, what present in irradiation and temperature readings, various solar panels power losses that can takes place were calculated and taken in practical experimentation. To choose the best one in solar panels, the topologies were made. When we connect 2 panels in series with parallel to another 2 panels which are also connected in series gives more performance than 4 panel directly connected in series manner. To get an autonomy from the battery the speed is set to 40 km/hr. The results were 3h and 38mins for battery autonomy, which is a better autonomy for the tricycle for a day.
  4. M. Grandone, M. Naddeo, D. Marra, Rizzo G, International Federation of Automatic Control, November-2016, pg. 497-504. "Development of a Regenerative Braking Control Strategy for Hybridized Solar Vehicle", A prototype is capable for estimating the torque for vehicle braking, aerodynamics, vehicle frictions and engine losses in different gears. All these factors has been developed and measured over road tests, for a hybridized vehicle with wheel motors on rear wheels. The model was used to analyze different braking strategies on real road tests, with and without mechanical brakes on rear wheels, to maximize the recovered energy by wheel motors and to prevent slipping circumstances. To design real-time braking strategies, the initial readings was the best tool if properly use of ABS systems and combined with estimation of slipping coefficient
  5. Paper presented by Nafis Ahmad , Md. Islam Shahidul, Bin Rahman Zaheed , "Designing of Solar Three Wheeler for People who are Disabled", International Journal of Scientific & Engineering Research Volume 3, Issue 1, January-2012: The goal of this project was to combine technology of electric power train and its all controller systems to increase the performance and mobility of existing tricycle. To make these design reliable, inexpensive, sustainable, and functional, the design objectives required a simple and affordable design for the power train and controls. The little modifications was required for designing the Electric Tricycle as adaptable to the current hand powered tricycles. This design was consist of an a drive system, electric motor, motor & steering controls, and power supply. This project design was created to aid for disabled Persons. The tricycle was specifically designed to suit wheelchair occupants of healthy Upper part of body with pelvic to foot restraint.
  6. According to paper presented by Prof. P. R. Jawale, Mr. K. G. Baje, et. al. "A Review paper on Recent Hybrid Tricycle for disabled Person, international research journal of engineering and technology, E-ISSN: 2321- 9637, particular Issue National Conference, 9th April 2017 "mixed 2017": The main motive of this project was to construct a electric motor tricycle which runs on a battery power and which can be used as a simple transportation for disabled one and for economy reasons. A motorized tricycle was a three-wheeled bicycle with an attached motor used to assist with pedaling. Generally considering as a vehicle, tricycles are generally powered by electric motors. Some can be driven by the motor alone if the rider chooses not to pedal; while in others type the motor will only run if the rider pedals. Electric bicycles are generally powered by lithium ion rechargeable batteries. These are basically charged by mains, with maybe the option of using the motor to effect regenerative braking, charging will happened while paddling. Electric motorized bicycles are in demand in which the motor is activated by a handlebar mounted throttle, where the electric motor is controlled by pedaling.
  7. On the report of the paper presented by Jeyaraman .p, Praveen . v. "Fabrication of Solar Electric Tricycle for Handicapped folks ,"International Journal of Pure and Applied Research In Engineering & Technology, ISSN:2319 - 507 X, Volume 3(4): 285 - 292, 1st December 2014. A hand tricycle was originally designed to be used by a disabled person with lower extremity weakness but with power in his or her hands and arms. An electric battery and motor was installed in this tricycle to give power to the vehicle. The functions of the original design were not altered. The battery, motor, speed reducer and clutch were properly arranged. An additional sprocket was attached to the drive wheel. The motor controller could adjust the speed up to five different settings and the tricycle can be driven backward or forward . They rescue a lightweight tricycle whose weight was about thirty pounds from a storage area. It was not in working condition. The wheels are arranged in such a way that drive wheel and two pivoting wheels are fixed in one direction for steering in the rear.
  8. According to the paper published by Wamborikar Yogesh Sunil and Sinha Abhay on "Solar Powered Vehicle" following conclusions were made: The renewable energy is very important for present world as in future the nonrenewable sources that we are using are which will not used in near future and it will get exhausted. The solar vehicle was a step in saving these nonrenewable sources of energy. The basic principle of

this solar car was to use energy that is stored in a battery during and after charging it from a solar panel. The charged batteries were used to drive the motor which serve here as an engine and moves the vehicle in reverse or forward direction. The electrical tapping rheostat was provided so as to control the motor speed. This avoided the excess flow of current when the vehicle was supposed to be stopped suddenly as it is in normal cars with regards to fuel. This idea, in the near future, may help and protect our fuels from getting extinguished.

### 3. SYSTEM COMPONENT DETAILS

#### - COMPONENTS INVOLVED

1. Handicap Tricycle
2. Solar panel - 100 watts(1mx.6m)
3. Solar Charge Controller
4. Electric motor - DC Hub Motor(350 Watts)
5. Batteries - Sealed Maintenance Battery
6. Wheel with Hub motor

**3.1 HANDICAP TRICYCLE :** The tricycle for handicap, as available in market is used for the proposed modifications. This existing tricycle is made up of Mild Steel material. The tricycle for handicap person is sometimes manufactured according to the specific requirements of the person. The regular tricycle for handicap is as shown in figure. The existing tricycle design fulfills the basic requirements of the rider. But due to higher weight, it is difficult for the rider to propel the vehicle smoothly and efficiently. Seating and handling experience have a scope to improve by implementing better quality cushions and ergonomic braking mechanism design.



**3.2 SOLAR PANEL:** Photovoltaics' is the field of technology and research related to the device which directly converts sunlight into electricity the solar cell is the elementary building block of the Photovoltaic Technology. [3] Solar cell is made of semiconductor materials such as silicon of the properties of semiconductors that makes them most useful is that their conductivity may be modified by introducing impurities into their crystal lattice for instant in the fabrication of photovoltaic cell, silicon, which has four valence electrons is treated to increase conductivity one of the side cell.



**3.3. SOLAR CHARGE CONTROLLER :** "A battery regulator , charge controller impede the rate at which electric current is added to or drawn from electric batteries. It stops overcharging and may protect against battery aging or overvoltage which can mitigate life span or battery performance. Solar battery charger are cheap, friendly to use, and conversion way to make sure your batteries are always fully `charged and ready to go all the time. The problem with charging a battery from a panel is the sun. It does not shine all the time and cloud get in way. Our eyes adjust to the variations in the variation in the strength of the sun but a solar panel behave differently. The output from solar panel drops drastically when the sun loses its intensity. By these both the output current and the output voltage both decreases. Many of the solar panel drops to below the 13.6v needed to charge a 12v battery and as soon as this occurs, the charging current drop to ZERO. This means as soon as the brightness of the sun goes away they become useless .

**3.4 ELECTRIC MOTOR:** Working principle of a DC motor is an electrical machine which converts electrical energy into mechanical energy. The simple working of the electric motor is that whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force".

**3.4.1 BLDC Hub Motor:** Hub motor electromagnetic fields are supplied to the stationary windings of the motor as shown in fig. The outer part of the motor follows, and tries to follow those fields which are attached to the wheel. In a brushed motor, energy is transferred by brushes which make contact with the rotating shaft of the motor however,

Energy is transferred in a brushless motor is by electronically, which eliminates the physical contact between stationary and moving parts of the motor. However brushless motor technology is more expensive than other motors and most are more efficient and longer-lasting than brushed motor systems



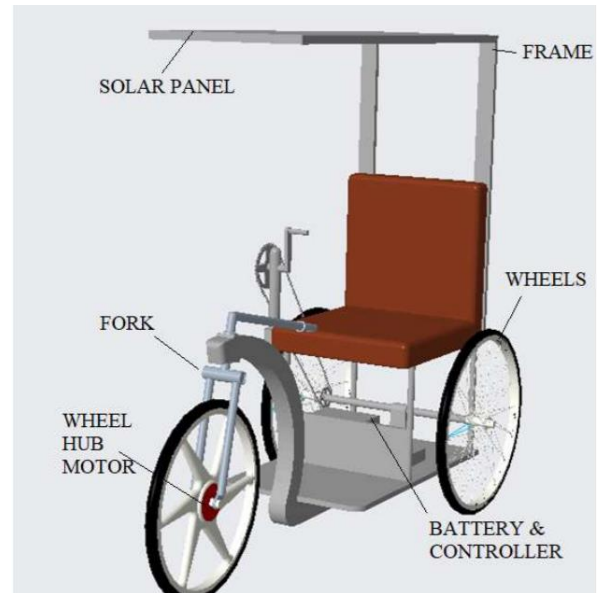
**3.5 BATTERIES:** From the very first beginning , battery technology is continuously changing. Looking back to the first battery, invented in 1800 by Alessandro Volta, technology has advanced greatly. The three major and most significant parts of the electric vehicle depends on the controller , electric motor and batteries . Amongst this three component the batteries are the utmost important; they are the important and restraining factor in any Electric vehicle. Batteries power our daily lives, and the multibillion-dollar industry fuels the worldwide economy. In the absence of batteries our Electric vehicle cannot be run , and we would have no emergency lighting backup , no telecommunications , no electricity in buildings, no security systems, and no EVs. We will learn about different battery technologies and their advantages and disadvantages. We will discuss the many batteries available on the market today and future batteries to come. We will see some of the basic chemistry and makeup of batteries for your basic understanding and knowledge. Then after we will look at the rating of the batteries, basic calculations and capacity.

**3.5.1 MAINTENANCE FREE BATTERY:** A valve-regulated lead-acid battery (valve-regulated lead acid battery) sometimes called sealed lead acid, gel cell, or maintenance free battery is shown in fig. Due to their construction, the Gel and Absorbent Glass Mat types of valve-regulated lead acid battery can be installed in any direction, and it is maintenance free battery . The term "maintenance free" is the wrong name of valve-regulated lead acid battery because it require regular functional testing and cleaning. In the movable electric devices maintenance free battery are widely used but it require big storage at cheap price than lithium -ion.

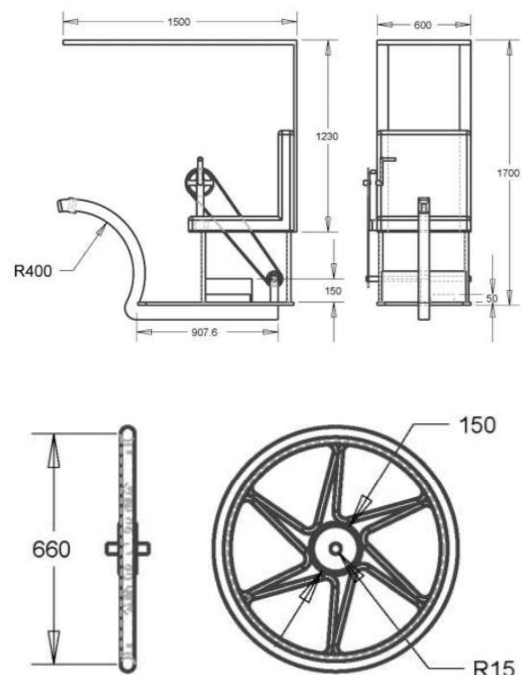
**3.6 BATTERY CHARGE INDICATOR :** As shown in fig. 12 the device indicate availability of charge in the batteries. Accordingly charging it indicates whether the charge is low

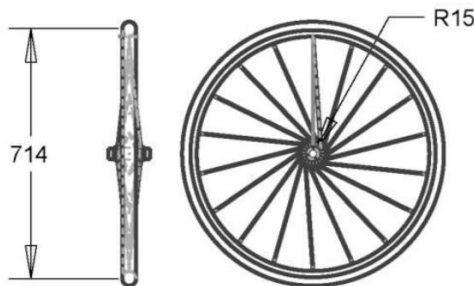
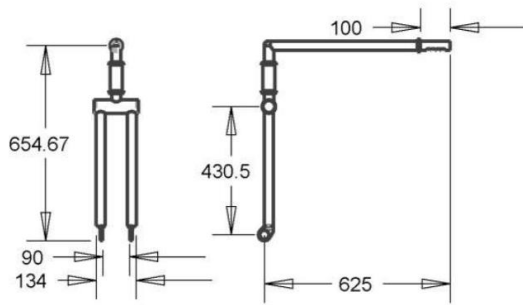
or full

**4. CONCEPT MODEL -**



**5. COMPONENT DRAWINGS:**





**6. CALCULATIONS:**

**6.1.**

	<b>Weight Estimation</b>	<b>KG</b>
<b>1</b>	Rider Weight	<b>80</b>
<b>2</b>	Vehicle Weight	<b>20</b>
<b>3</b>	Battery and Charge Controller	<b>15</b>
<b>4</b>	Motor	<b>05</b>
<b>5</b>	Solar Panel	<b>08</b>
<b>6</b>	Canopy	<b>07</b>
	<b>Total Weight</b>	<b>140</b>

Assume the Average Speed of vehicle to be 15km/hr.

i.e.  $V=4.1666\text{m/s}$

Total force required to propel the vehicle= Total vehicle load+ Rollingresistance+ Grade resistance

$$=140*9.81+140*9.8*0.012+10*9.81*\sin18\dots(\text{Assume } Crr=0.012)$$

$$=1814.284\text{N}$$

Torque=Total force required to propel the vehicle\*Diameter of shaft

$$=1814.284*0.015$$

$$=27.21\text{Nm } N(\text{rpm})=(\text{Velocity}*60)/(2*3.141*\text{Wheel radius})$$

$$=(4.166*60)/(2*3.141*0.356)$$

$$=111.8 \text{ rpm} \sim 110 \text{ rpm}$$

POWER REQUIRED=  $2*3.141*\text{Torque}*RPM / (60*\text{Motor Efficiency})$

$$=2*3.141*27.21*110 / (60*0.9)$$

$$=348.311 \text{ Watts}$$

Standard motor rating available are 25w, 350w, 500w, 750w

**Therefore the optimum choice is 350 Watts motor.**

**CONCLUSION:**

Development of the solar three wheeler is a boon for the paraplegic people and will have most important change in their life. Due to limited energy storage we can't travel for long distance by solar three-wheeler and it is also difficult to travel in rainy days. This problem can be over come by using large size solar panel so that it can observe more energy from sun and also big batteries to storage electricity. Sustainable All calculations are done and component is selected well .

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**REFERENCES**

1. Ananda Mani Paudel, Philipp Kreutzmann "Design & performance analysis of a hybrid solar tricycle for a sustainable local commute," Renewable and Sustainable Energy Reviews, 473-482, 27th August 2014.
2. Amit Kushwaha, Pratik Dhote, Chetan Nandanwar et.al. "Solar Powered Tricycle For Handicapped Person", International Journal for Innovative Research in Science and Technology, Vol. 1 Issue 10 March 2015,
3. Said Doubabi, Mohamed Dahbi, A. Rachid "Autonomy Analysis of Solar Electric Tricycle ", International Renewable & Sustainable Energy Conference, Institute of Electrical and Electronics Engineers Publications, December - 2015
4. M. Grandone, M. Naddeo, D. Marra, G. Rizzo, "Development of a Regenerative Braking Control Strategy for Hybridized Solar Vehicle", International Federation of Automatic Control, November - 2016, pg. 497 - 504.
5. Zaheed Bin Rahman, Md. Shahidul Islam, Nafis Ahmad "Designing Solar Three Wheeler for Disable People",

International Journal of Scientific and Engineering Research  
Volume-3, Issue-1, January-2012.

6. Prof. P. R. Jawale, Mr. K. G. Baje, et. al. "A Review on Modern Hybrid Tricycle for Handicapped Person,"IJRAT, E-ISSN:2321-9637, Special Issue National Conference "Convergence 2017,"09th April 2017.

7. P. Jeyaraman, V. Praveen, et. al. "Fabrication of Solar Electric Tricycle for Handicapped Person,"International Journal of Pure and Applied Research In Engineering & Technology, ISSN:2319-507X, Volume 3(4):285-292, 1st December 2014.

8. Chaitanya Kanumilli, Amit Singh, Akshatha Ganesh, Madhurya Srinivas "Plug In Electric Solar Vehicle",Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE), March- 2016.

9. Qi Li, Yang Liu, et. al. "Solar Energy Storage In The Rechargeable Battery," Nano Today, Nantod-615, 23rd August 2017.

10. A Solar Car Primer, Eric Forsta Thacher, Postdam, New York, USA, DOI 10.2007/ ISBN 978-3-319-17494-5.

11. Carl Vogel, "Build your own Electric Motorcycle," Mc Graw Hill

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