DESIGN AND FABRICATION OF TADPOLE MODEL SOLAR POWERED TRICYCLE

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Abstract— solar energy is one of the important sources of renewable energy which can be a feasible alternative to fossil fuels. There are many works done in order to incorporate solar energy to everyday transportation including tricycle. However, most of the tricycle developed are expensive and not feasible for developing countries. In this study, a cheaper solar tricycle with more capability of utilizing the solar energy is designed for developing countries. The main problem identified with the existing delta model (2 wheels at rear and 1 wheel in front) for tricycle is low dynamic stability, inefficient braking and poor aerodynamic suitability. Hence a tadpole model (1 wheel at rear and 2 wheels in front) is proposed in this existing study.

The model is made to a hybrid system in which the power can be obtained from the solar energy and also from a generator with flywheel connected to the shaft. The energy generated by this flywheel is used as a backup when the solar energy is not available.

The expected outcome of this project is a tricycle with a better design and ergonomically well suited for a physically challenged person. Tadpole design will provide better dynamic stability which will avoid slipping of the vehicle and will provide better weight distribution to the vehicle. It will also provide better braking mechanism as tadpole design has two tyres in the front where the weight transfers when decelerating. The tadpole design lends itself better to the aerodynamics tear drop with the correct length to width ratio.

Keywords— Tricycle, solar panel, dynamic stability, aerodynamics, flywheel

I. INTRODUCTION

Since the evolution of human beings, mankind has always been trying to make life easier and vehicles have helped a lot in this process. Due to rapid growth in population and increasing number of vehicles, car designers are required to not only build small and fuel efficient vehicles but they need to inspire the next generation engineers to take interests in rewards from this sector of automotive engineering. In this regard, a lot of small cars are coming into existence and for instance, three wheeled vehicles are gaining popularity for city commuting because of their lower fuel consumption, ease of driving and easy parking in countries. The most important part of a vehicle is the vehicle chassis. It is a physical frame or structure of an automobile to which all other components are attached, and it can be comparable to the skeleton axles, wheels, tires, suspension, a controlling system like braking, steering, etc., and even electrical systems are mounted on the chassis frame of a living organism.

In this report, an electric three wheeled vehicle of tadpole design (two wheels at the front and one in the rear) is introduced which is more stable dynamically, while braking, simple in design and power train selection than the delta design (one wheel at the front and two at the rear). Given that this is a passenger vehicle; in-wheel suspensions are used along with the hub motor in the rear wheel for about 900 N-m torque generation to reduce the complexity of the design and more space for passengers and cargo. In the first step, design of each and every component is discussed. The objective is not limited to design but in such a way that it can revolutionize the way cars are made. This tadpole design of the chassis eliminates a lot of complexities involved in vehicle design which includes transmission system, front and rear axles, differential to name a few. In the next step, the procedure of modeling, kinematics, and analysis in commercial engineering software tools used for CAD, CAE and FEA of the chassis is discussed.

Basically tricycle is a three wheeled vehicle with one rear wheel and two front wheels .This is also called as a tadpole. Back in 1993 some scientists had embarked on a project to design and build a recumbent tricycle. In those days the internet was still a novelty and specific information on recumbent tricycle design was dismal at best. Regardless, he set outto experiment. After 3 unsuccessful designs and 250 lbsof scrap aluminum, he finally built a tricycle that was almost road worthy. During his experimentation, he kept meticulous shop notes and when I wasn’t tinkering in my garage he was spending time at the city library doing research.Further refinements eventually produced a road worthy design which his placed into production. After producing three revisions and two product lines,his recumbent trike was now a force tobe reckoned with. Unfortunately, my passion for recumbent trikes was eclipsed by his engineering career and family. With my closed operations I focused my free time in transforming my shop notes into are cumbent tricycle primer and releasing it free to the world as a resource. The original document was released in 1997. Over the years his have added a few items, but it wasn’t until recently that he took the time to completely clean it up and re-edit the original content. The document is clearly more legible and I’m certain that you will enjoy reading it. This document focuses on the basics of recumbent tricycle design. In order to keep the concept elementary I have simplified many of the terms and explain the technology in detail at a level that most people will enjoy reading. If the explanations contained in this document do not address your concerns or doesn't present the 'big picture', plans for building a tricycle will only teach you how to build one. However, once armed with the information on making a great tricycle ; you will appreciate the compromises and risks associated with designing your own tricycle. If your desire is building a tricycle from a set of existing comprehensive plans.

FOR A TADPOLE LAYOUT (2 WHEELS ON THE FRONT AXLE, 1 ON THE REAR)

Track: Wide track gives good lateral stability, though being wider than a bike; it limits the places that it can get through without being disassembled. On the road however, that extra width means passing vehicles are further away from the rider. A narrow track can allow a trike to ride through doorways, but makes it easier to tip over in the corners.

Wheelbase: A more drawn out wheelbase gives a smoother ride with less pitching and permits more noteworthy braking execution, yet gives a relatively more slender trike, along these lines bringing down the move over edge. Shortening the wheelbase gives better lateral stability, but could pitch forward under heavy braking.

Centre of Gravity (CG): A rearward weight distribution improves directional stability under braking, but reduces lateral stability Having the weight distribution forward improves lateral stability, but reduces directional stability under braking (as load on the rear gets less) and at the extreme, lifting the rear wheel and tipping the nose to the floor

Components Used For Develpoment

Solar Panel

M220115-18V (18V X 167mA)- 18 volt, 75 W= 2Nos

Solar Charge Controller

BLDC Hub Motor

Disc Brakes

Battery

II. DESIGN AND CALCULATIONS

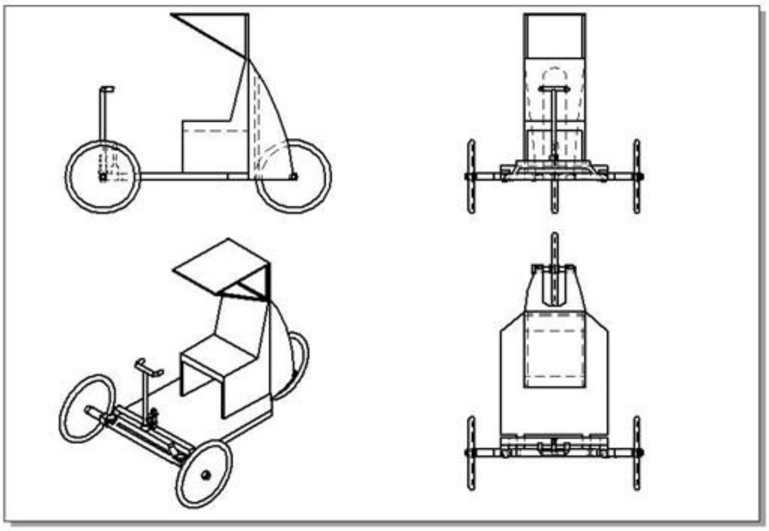

Fig 2.1 General Assembly Drawing of the Tricycle

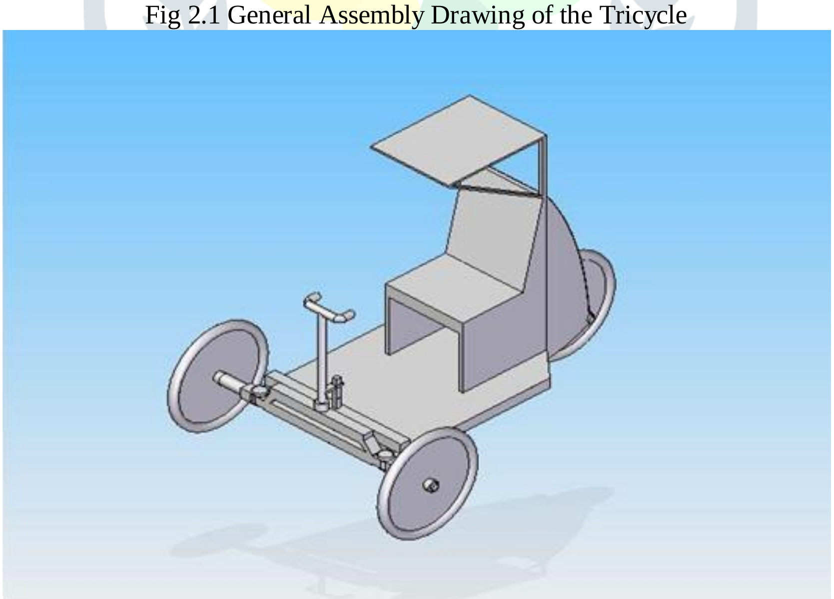

Fig 2.2 3d Isometric View of the Tricycle

III. CALCULATION

3.1 CALCULATIONS FOR ELECTRIC SOLAR VEHICLE

Let us consider the following assumption in Electric Solar Vehicle:
Mass of the Vehicle = 40 kg
Speed = 35 kmh-1
Slope % = 0.1
0.6 m &
Rear and Front Wheel Diameter = 0.5m

Battery Weight = 30 kg
Average Speed = 35 kmh-1
Range = 50 km

3.2 CALCULATION FOR ANGULAR VELOCITY OF THE WHEEL

Considering Linear Velocity = 35 kmh-1
Speed = 35 x (5 / 18) ms
= 9.72 ms-1
Diameter of wheel = 0.6 m
Radius = Diameter / 2
= 0.6 / 2 m
0.30 m
Using the Relation
Linear Velocity = Angular Velocity x Radius
Angular Velocity = Linear Velocity / Radius

= 9.72 / 0.30
From the Relation, = 32.4 rad.s-1
Angular Speed = 2 x π x frequency
Frequency = Angular Speed / (2 x π) RPS
= Angular Speed x 60 / (2 x π) RPM
= 32.4 x 60 / (2 x 22 / 7) RPM
= 309.39 RPM

3.3 CALCULATION FOR PEAK TORQUE REQUIRED MOVING THE VEHICLE

Peak torque power required = (Mass of Vehicle + Battery) x Acceleration due to gravity x Wheel Radius x Slope%

= (40+12) x 9.8 x 0.30 x 0.1 N-m

= 15.28 N-m

= Torque x Angular Velocity

= 15.28 x 32.4 Watt

= 495.3 Watt

3.4 CALCULATION FOR AIR RESISTANCE

Using the formula,

Air Resistance = (5 / 100000) x mass of vehicle x (Average Speed)3

= (5 / 100000) x 40 x 353
= 85.75 Watt

3.5 CALCULATION FOR ROLLING RESISTANCE

Using formula,

Rolling Resistance

0.092 x mass of vehicle x average speed
= 0.092 x 40 x 35

= 128.8 Watt

3.6 CALCULATION FOR CONTINUOUS POWER REQUIRED

Using the Relation,

Power Required (Continuous) = Air Resistance + Rolling Resistance

= 85.75 + 128.8
= 214.55 Watt

3.7 CALCULATION FOR CONTINUOUS SPEED

Using the Formula,
Continuous Speed = Average Speed x 60 /(2 x π x Radius of Wheel)

= 35 x (5 / 18) x 60 /(2 x π x 0.30)

= 309.46 rpm

3.8 CALCULATION FOR CONTINUOUS TORQUE REQUIRED

Using the Relation,

Torque Required (Continuous) = (Air Resistance + Rolling Resistance) x 60 / (2 x π x Continuous Speed)
= (214.55) x 60 / (2 x π x 310)
= 6.60 N-m

Angular Velocity	32.4 $rad.s^{-1}$
Frequency	309.39 RPM
Peak Torque	15.28 N-m
Power Required (Peak)	495.3 Watt
Air Resistance	85.75 Watt
Rolling Resistance	128.8 Watt
Power Required (Continuous)	214.55 Watt
Continuous Speed	310 rpm
Torque Required (Continuous)	6.60 N-m

IV. RESULTS AND DISCUSSIONS

4.1 Powertrain

The delta design has more disadvantages when selecting your drive wheel. If you go with front wheel drive, you risk putting too much weight at the front of the vehicle. If you choose the back, you need to add a differential gear to the rear wheels. In each configuration you have a disincentive to have too much weight on the front driving wheel, so you miss out on potential traction. A tadpole with one rear wheel drive gets the best of both worlds. No differential is necessary and you can keep 30% of the vehicle weight on the drive wheel to maintain good traction.

4.2 DETAILS OF THE WORK CARRIED OUT

After procuring the materials for the work to be processed, chasis has been constructed. Then, aluminium sheet was welded to the chasis. Next tyres were fitted to the chasis. Then we constructed a seat for the tricycle. Steering was constructed with a simple mechanism and welded to the front two tyres. BLDC hub motor was fitted to the back wheel and it is connected to the throttle, batttery, motor controller and to the disc brake. Then we constructed the roof of the tricycle and solar panel was placed and connected to the battery. By providing ignition switch the motor on/off has done. Then the model was designed.

4.3 Outcomes

The adopted tadpole design will provide better dynamic stability which will avoid slipping and will provide better weight distribution to the tricycle than the existing delta type tricycle.

The tadpole model which is having two front wheels will provide better braking effect.

The adopted tricycle model will exhibit a hybrid effect which will generate power from both solar energy.

V. CONCLUSION

Electric vehicles are the upcoming technology in the modern Automobile sector, for their better efficiency, handling, structure and braking system than the normal vehicles . There is a wide range of feasibility to incorporate better technology in it, Example implementing more power, and better design and many more.

The electric vehicle has many advantages and benefits over the internal combustion engine and hybrid vehicle. It is cleaner and much more efficient; however, it also has disadvantages. It is heavier, limited to the distance it can travel before recharge, and costs more. The future of the EV relies on its battery. If researchers can produce or find the “super battery”, the EV’s future is promising. As of today, each vehicle has its own characteristic that makes it better than the other. Only time and technological improvements will tell which vehicle will excel in the future.

This tricycle works on solar source and employs BLDC hub motor to drive the tricycle. The average and maximum speed was obtained as 20 kmph and 35 kmph respectively.

We can achieve our aims, and we believe that we have a system that will be effective in providing mobility for persons who have disabilities.

The ride is noise free , eco-friendly and cheaper than e bike or motor cycle.

This is most useful and economical as compared to the traditional handicapped cycle. This tricycle is made of material which is easily available and low cost material. This tricycle is useful for both old age people as well as handicapped people. Design and Construction of this tricycle is simple. The main advantage of this tricycle is force input to ride this tricycle is less when compared to the existing propulsion systems. Cost of this tricycle is very less when compared to the traditional handicapped tricycle.

VI. FUTURE ENHANCEMENT

Allowing the operation to be conducted via an electric motor run by batteries that can be recharged, the efficiency can be increased. Moreover can be controlled. And above all the whole innovative enterprise has lowered the cost of the electric vehicle are now considered to be the most economic vehicles across the globe.The conventional tricycle can be innovated by installing a regenerative system for converting the vehicle in to a hybrid one which will generate power through solar and by the generator connected to a flywheel mechanism. By implementing the above system we can attain better efficiency.

By improving the design parameters we can implement a vehicle structure that is lightweight which will help to decrease the vehicle load and to increase initial torque of the vehicle. By inculcating low weight material we can attain the above advantage and we can include more safety features like seat belt ,threat alarm in the tricycle which will ensures the safety of the physically challenged people who is using the tricycle for mode of transportation.

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