Electric Tricycle Carrier with Extended Capacity

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Abstract- *A three-wheeled vehicle with an electric motor that is powered by the same technology as a bicycle or motorbike is known as an electric tricycle carrier. The tricycle's rear wheels are coupled to an electric brushless DC motor. Direct current from the battery bank powers this motor. While this battery bank can be charged using an external charger. The microcontroller acts as the brain of the vehicle, depending upon the inputs given to the controller the output of the vehicle changes. The electric tricycle can be used to transport both people and products. So, the body design had been changed to carry more weight in order to further expand the tricycle's carrying capability.*

The added stability, along with its versatility, means that trikes can be used to fit just about any bill: recreation, shopping, exercise, personal transportation, passenger transport, and carrying commercial freight. They also boast a good amount of storage for carrying all of your stuff, at the same time be a green transporting solution for the environment.

Keywords: Brushless DC motor, microcontroller, versatility

I. INTRODUCTION

In India, the tricycle is a widely used form of transportation. The Basic tricycle has three wheels and is designed for persons with disabilities to pedal on one side while sitting in the middle. Hand-powered tricycles in our country are greatly impacted by the rough, uneven roadways. Frequent trike users are more likely to develop spinal issues since driving demands a lot of physical effort, which puts a lot of strain on the back. The development of the electrical tricycle carrier is a blessing in disguise for these issues because it allows individuals to move around freely without exerting themselves physically. Also, users may quickly recharge these vehicles at home and use them for short trips.

Electric tricycle carrier construction consists of two main sections:

Frame Design: The design of the vehicle is modified in order to carry additional weights and to fit the other electrical components.

The tricycles which are available in market are designed for carrying a single person and are self-propelled vehicles. So, the vehicle has been redesigned in such a way that it can carry two persons. Additionally, the battery bank and controller are attached to the vehicle.

Electrical Components: In this phase accelerator, caliper brakes, display unit, DC motor is connected to the controller. And, the controller also distributes the power across the parts equally as per requirement.

The controller acts as control system which receives input from accelerator and depending upon the level of acceleration the controller transfers the power from battery to the brushless DC motor. The electrical energy is used to rotate the DC motor which intent creates the mechanical force on the wheel and leads to the movement of the vehicle.

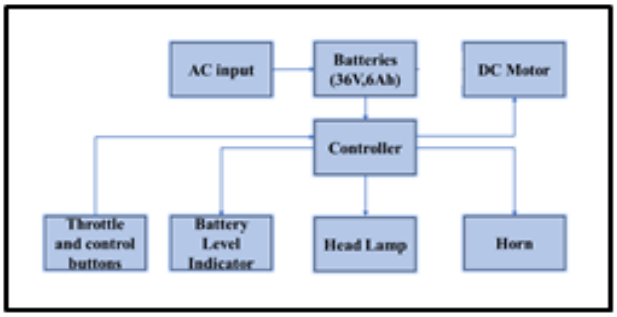

Fig 1: Block Diagram of Electrical components

II. OBJECTIVES

The main objective of the vehicle prototype is:

1. The best feature of electric vehicles is that they are completely eco-friendly. These vehicles represent no environmental risk.

2. The Electric-powered tricycle carrier that can carry a load up to 180 kg.
3. Improved efficiency and high-speed vehicle
4. Design of vehicle with low cost and high efficiency.

III.COMPONENTS AND DESCRIPTION

These are the components which are used to design the electric tricycle carrier:

1.Brushless Dc Motor: The prime mover to be used in this solar tricycle is a permanent magnet D.C. motor. The main reason for using this motor is that it is highly efficient and the flux density does not decrease with time. It's performance characteristics suite very well to the requirement of our solar tricycle. Brushless DC motors use a rotating permanent magnet or soft magnetic core in the rotor, and stationary electrical magnets on the motor housing. A motor controller converts DC to AC. This design is simpler than that of brushed motors because it eliminates the complication of transferring power from outside the motor to the spinning motor.

Fig 2: BLDC Motor

2. Battery: Given the current market, Lithium-ion battery is the only viable battery technology for electric vehicle conversion. Voltage of the battery used in the vehicle is 36V units. The advantage of using Lithium-ion battery is:

- 50-60% less weight than lead-acid battery
- Greater number of charge and discharge cycles
- Higher voltage than other rechargeable batteries
- Constant power

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Fig 3: Lithium-ion battery

3. Controller: Controller is a device which controls the whole unit (motor, accelerator, Brake, headlights, horn, etc.). It is the main component that connects the battery with the BLDC. It is responsible for controlling the acceleration of the vehicle. Controller is the brain of Electric tricycle. It performs the following functions:

- Battery Low voltage
- Over voltage protection
- Over Heat protection
- Robust cabinet with better cooling system. Electronic braking system
- Throttle Error Protection

Fig 4: Controller

4. Electrical Accelerator: The accelerator used is nothing but a potentiometer which is used to vary the speed of the motor. In a nutshell, the controller takes input when we twist the accelerator and that tells it how many watts of electricity to send to the motor. So, the controller has to also convert the direct current (DC) from the battery to the alternating current (AC) for the motor. So, basically the twisting position determines how much electricity to shove into the motor. More electricity, more torque and speed. Twist the accelerator, controller sends power from the battery to the motor, motor turns the wheels.

Fig 5: Electrical accelerator

5.Braking System: The braking system which is using in our project it acts like a clutch or an electrical brake which runs on the electric supply provided by the DC battery with the help of controller when operator pressing the brake the push button get release and it cuts the power supply of motor (motor get stop) and support to this we have use the mechanical brake.

6.Dispaly unit and ignition switch: The vehicle can be turned ON by using the ignition key which in turn supplies the required power for LED and battery charging indicator.

Fig 6: Display Unit

IV. CONSTRUCTION AND WORKING OF TRICYCLE CARRIER

A battery box is placed underneath the seat of the vehicle which consists of both battery and microcontroller. And the battery box consists of an external socket where one end of the battery is connected to it. By connecting a charger to this external socket of the battery box we can charge the vehicle. The charger rated voltage is 220v and produces an output DC current 3A. The battery takes approximately 2.6 hours to be fully charged. The power from the battery is supplied to the controller which distributes it to the BLDC motor, battery level indicator and horn. So, the controller receives the input from the accelerator and depending upon the strength of the signal received the electrical energy is supplied to the DC motor which intend rotates the motor and creates a mechanical force on the wheel. While the vehicle can be operated in three modes (i,e Mode-1,Mode-2,Mode-3),so depending upon the modes power dissipated changes and the speed of the vehicle changes. In mode 1, the speed of the vehicle obtained is 15 kmph, in mode 2 the speed obtained is 20 kmph and in mode 3 maximum speed obtained is 30 kmph. The braking system of this vehicle is divided into two parts, which are mechanical and electrical brakes. While the electrical brakes which are also called as cut off brakes are used to cut down the supply to BLDC motor and the motor stops rotating. On other hand to restrict the mechanical force on the vehicle we use caliper brakes which stops the motion of the wheel and brings the vehicle to rest position.

As the battery starts to drain upon usage, the in-built charging level indicator sends live feed to charging indicator. The battery indicator starts to drain from 100% to 0% and emergency battery symbol pops upon complete drain of the battery. Apart from these features it also consists of a horn and an LED. The ignition key is used to switch ON the vehicle and also it acts as an anti-theft locking system.

Fig 7: Electric Tricycle Carrier

V OBSERVATION

The tricycle has been tested under different conditions in the real-world environment. The analysis has been noted down.

A.Battery Life Analysis

Case I: The tricycle have been loaded with a load of 70 kgs and has been tested in three different modes (Mode1, Mode 2,Mode3)

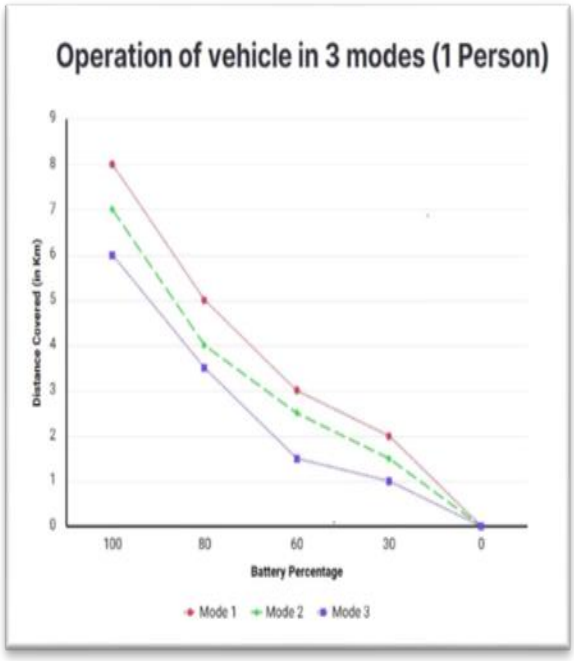

Fig 8: Distance Covered Vs Battery Percentage

Case II: The tricycle have been loaded with a load of 130 kgs and has been tested in three different modes (Mode1, Mode 2,Mode3)

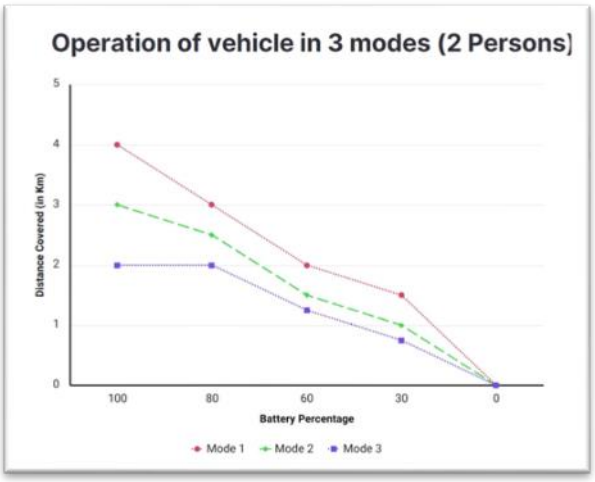

Fig 9: Distance Covered Vs Battery Percentage

In the above figures, the author has attempted to showcase how the battery percentage decreases with the distance covered by the vehicle.

B.Perfomance Analysis

The three different modes in the vehicle are used to operate vehicle at different speeds. Depending upon the mode of the vehicle, the power derived from the battery differs. And depending upon the power derived the speed of the vehicle changes.

Table 1: Maximum speed attained by the vehicle

	Mode 1	Mode 2	Mode 3
Load(70kgs)	19 kmph	24 kmph	29 kmph
Load(130kgs)	16 kmph	22 kmph	26 kmph

VI. MATHEMATICAL CALCULATION

From the obtained average speed of the vehicle, the torque has been calculated and also the power of the battery can be determined.

Table 2: Estimated weight of the vehicle

Weight Estimation	**Kg**
Rider weight	130
Vehicle Weight	20
Battery and Controller	6
Motor	4
Total Weight	**160**

Assume the average speed of the vehicle to be 15 km/hr. (V=4.1666m/s)

Total force required to propel the vehicle=

Total Vehicle load + Resistance+ Grade Resistance

$=mg+ mgCr + mgSin(\theta)$

= 160*9.81+ 160*9.8*0.012+ 160*9.81*sin18… (Assume Cr=0.012)

= 2073.44N

Here, m= mass of the vehicle

g=gravitational force

Cr=Rolling Resistance

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

=f*d

= 2073.44*0.015

= 31.1016Nm

Here, f= force applied on the vehicle

d=diameter of the shaft

N(rpm)=(Velocity*60) / (2*3.141*Wheel radius)

= (4.166*60) / (2*3.141*0.356)
= 111.8 rpm~110 rpm

Power required= 2*3.141*Torque*RPM
/ (60*Motor Efficiency)
= 2*3.141*31.1016*110 / (60*.9)
= 389.344 Watts

Standard motor ratings available are 25w, 350w, 500w, 750w.Therefore, the optimum choice is a 350 Watts motor.

VII. CONCLUSION

The electric tricycle carrier has been successfully tested and operated. It could serve as a preferable substitute for the typical tricycle used for short distance transportation. When compared to a motorbike, the vehicle is less expensive and more environmentally friendly. It also requires less maintenance. The battery's efficiency is around 92%, and for charging it takes 2.15 hours. The battery can run for a hour after being fully charged. The vehicle's 5.6 A battery can only provide 20 kilometers of range. While employing a 12 A battery will allow us to get around this issue and increase the vehicle's range. Yet, the price of vehicles would rise. Thus, the vehicle's parts have been chosen to reduce the costs.

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