Review Paper on 3D Modelling and Fabrication of Cost-Effective Three-wheeled E-Cargo

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Abstract— In internal combustion engine vehicle, power is produced by burning the fuel inside the engine. The by-products released due to this process are highly polluting in nature and cause a lot of damage to the environment at the same time. In recent days using conventional vehicles is not sustainable for community as fuel prices are at a peak that is not budget-friendly. Simultaneously non-renewable fuel sources are exhausting. To overcome all of these difficulties, this project introduces a three-wheeler cargo powered by an electric motor that draws its power from its battery pack. To accomplish a vehicle that is specifically developed to provide the driver/goods with maximum efficiency. Also develop a vehicle that holds significantly quieter driving manoeuvres and more fuel-efficiency. Apply battery cooling and heating system to reduce seasonal effects on an electric vehicle. To fulfil electricity needed for the propulsion of electric vehicles and heating, cooling requirement. Employ a brushless dc motor controller to protect the motor from over-current and under-voltage.

Keywords: BLDC Motor, Li-Ion Battery, Controller, Chassis, Three-wheeled E-Cargo

I. Introduction

In the next 50 years, the global population will increase from 6 billion to 10 Billion and the number of vehicles will increase from 700 million to 2.5 billion. If all these vehicles are propelled by internal combustion engines, where will the oil come 3 from? Furthermore, where should the emissions be disseminated? Would the sky be permanently grey? The gloomy answers to these questions compel people to strive for sustainable road transportation for the 21st century. In a world where environmental protection and energy conservation are growing concerns, the development of electric vehicle (EV) technology has taken on an accelerated pace to full fill these needs. Concerning the environment, Three-wheeler electric cargo can provide emission-free urban transportation. Even considering the emissions from the power plants needed to fuel the vehicles, E-Cargo can still significantly reduce global air pollution. From the energy aspect, E-Cargo can offer a secure, comprehensive, and balanced energy option that is efficient and environmentally friendly, such as the utilization of various kinds of renewable energies. The tilting mechanism was an additional feature of E-Cargo that may increase the stability and avoid skidding of the vehicle; furthermore, E-Cargo will have the potential to have a significant impact on energy, environment, and transportation as well as hi-tech promotion, new industry creation, and economic development.

II. Literature review

Since the vehicle's tilting mechanism was an impressive and indefinite phenomenon, some works have been published to explain this phenomenon based on physical laws such as conservation of mass and momentum, laws of inertia. Therefore, several different hypotheses have been reported to describe the energy requirement and the battery's capacity for effective vehicle performance.

1) *Wang G, et al. [1]* investigated EV drivers' eco-driving behaviours and inspirations. This research discloses that, compared to ICEV drivers, EV drivers hold significantly quieter driving manoeuvres and more fuel-efficient driving ways such as trip chaining. The survey data also show that EV drivers are much more willing to save energy compensation for travel time. Furthermore, the survey data indicate that EV drivers are more willing to adopt eco-friendly IVD technologies. All these findings are expected to improve the understanding of some unique behaviour found in EV drivers.
2) *Hao X, et al. [2]* provided a case study on seasonal effects on electric vehicle energy consumption and driving range. The study found that, when the ambient temperature is lower than 10℃, electricity consumption increases 2.4 kWh/100 km for every 5℃ decrease in temperature. When it is higher than 28℃, EC increases 2.3 kWh/100 km for every 5℃ increase in temperature.
3) *Michaelides E, et al. [3]* performed a holistic analysis of electric vehicles and the determination of their benefits and detriments. Starting with an energetic assessment for all road vehicles, this paper determines the electricity needed to propel electric vehicles. When the vehicle's cabin's heating and cooling requirements are included, the range of the vehicles decreases significantly. The electricity requirements of the vehicles are abridged to primary energy sources using the concept of well-to-wheels efficiency.
4) *Shang Y, et al. [4]* stated that preheating is necessary to improve the output power and available capacity of low-temperature lithium-ion batteries in cold climates.

   This study shows increasing the AC-heating frequency at the same RMS current can dramatically improve the heating speed and efficiency due to the increased heat generation of the ohmic resistance and lithium-ion transport, which does not cause further damage to batteries.
5) *Lu M, et al. [5]* Investigated the battery cooling technology for electric vehicles. In this context, several battery thermal management systems (BTMS) are reviewed, including air cooling BTMS, liquid cooling BTMS, and refrigerant direct cooling BTMS in

traditional battery thermal management system; phase change material-based BTMS, heat pipe-based BTMS and thermoelectric element-based BTMS in new battery thermal management system.

6) *Zhang Z, et al. [6]* presented a brushless DC motor controller strategy applied to the electric bicycle control system by analysing some possible problems when electric bicycles are running daily. Functions of over-current protection, under-voltage protection, and helping were accomplished.
7) *Tian Y, et al. [7]* presented an investigation into the optimal coordinating gearshift control of a seamless two-speed transmission for BEVs. Firstly, to achieve gearshift transient behaviour, the mathematical model of the powertrain system is established. Based on available sensor signals, sliding mode observers can estimate unmeasurable torque as feedback information for the optimal controllers in different gear states. Simulation results demonstrate that the devised control approaches can promote gear change performance comprehensively.
8) *Dizqah A, et al. [8]* integrated the fuel-economy of combustion engines, load transformations due to longitudinal and lateral accelerations, and traction efficiency of the off-road conditions into the developed theorem. Simulation results illustrate the optimal strategy as torque distributors of on-road and off-road electrified vehicles with multiple different drivetrains.

III. PROBLEM STATEMENT

In recent days using conventional vehicles is not sustainable for community as fuel prices are at a peak that is not budget-friendly. Simultaneously non-renewable fuel sources are exhausting. Due to such fuel engines, many difficulties occur. An engine which is in work eject unhealthy gases through it. These gases give rise to air pollution; (for example, air pollution levels in Delhi, showcased by CPCB, are at the lowest quality index). Ejection of heat from conventional vehicles leads to global warming. To overcome all of these difficulties, this project introduces a socially favourable and cost-effective E-cargo and will overcome the drawbacks in conventional vehicles.

IV. DESIGN AND FABRICATION

A. Chassis:

The load-bearing framework of an artificial object, which structurally supports the object in its construction and function.

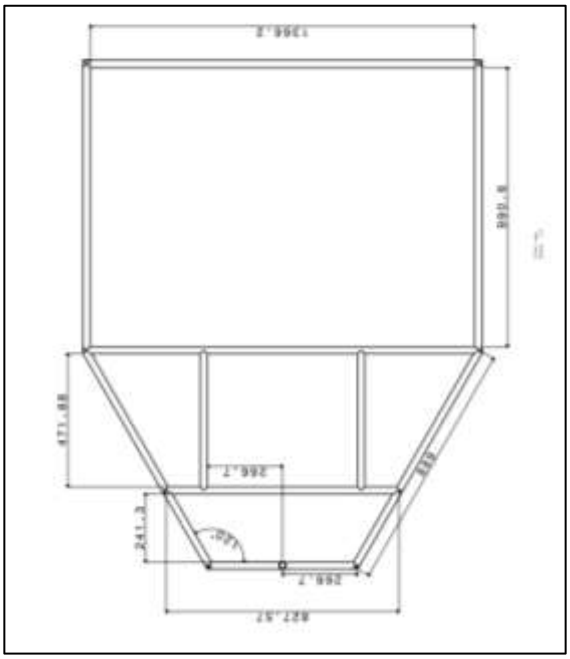

Fig.1: Chassis

B. Tilting Mechanism:

Sharp steering movements throw your weight with the turn and upsets the stability of the trike. The only way to model a three-wheeler's margin of safety against rollover is to construct a base cone using the centre of gravity height, its location, along the wheelbase.

Fig. 2: Tilting Mechanism

C. Electric Engine or Motor:

Unlike a gasoline engine with lots of moving parts, an electric engine or motor only has one moving part. This makes it a very reliable source of motive power. Choosing an electric engine depends on your car's system voltage. They can be structured to use either AC or DC.

D. Battery:

The battery of an electric car can be charged through ordinary grid electricity at a specialized power station.

1) Lithium-Ion Batteries:

This battery technology gives extra performance and range. However, it also carries the highest price tag. Lithium-ion batteries are lighter than Lead-acid and Nickel-metal.

2) Lead Acid Batteries:

This battery technology is the most popular. It is also the cheapest among the battery technologies.

E. Regenerative Brakes:

As the electric car moves, the electric motor generates a forward momentum, and it can be used to charge the batteries when you apply the brakes, which is commonly referred to as regenerative braking.

F. Drive System:

The function of the drive system is to transfer mechanical energy to the traction wheels, generating motion. An electric car does not require a conventional transmission.

G. Controller:

The controller of an electric car administers its complete operation and the distribution of its power at any given moment. It acts as a floodgate between the motor and batteries. It helps monitor and regulates all key performance indications such as the vehicle's operator, motor, battery, and accelerator pedal.

V. Specification of Three Wheeled E-Cargo

Motor Specification	
Max Power	1500 watt
Max Torque	45 N-m
Voltage	72 volt
Battery Specification	
Max Power	1500 watt
Max Ah	45 Ah
Voltage	72 volt

Table 1:

Dimensions & Weight	
Length	2133.6 mm
Width	1219.2 mm
Height	1524 mm
Ground Clearance	170 mm
Kerb Weight	150 kg
One Person & Goods	100+50 kg
Total Carry Weight	300 kg
Total weight of E-Cargo	150 kg
Weight of battery	10 kg
Weight of electric motor	7 kg
Weight of chassis	25 kg

Table 2:

Suspension, Brakes & Steering	
Suspension Front	None
Suspension Rear	Coil Spring Shock Absorbers
Front Brake	Drum
Rear Brake	Drum
Minimum Turning Radius	4.4 metres
Front Wheel	2.50*17.4
Rear Wheel	80/100-18

Table 3:

VI. Conclusion

This study aimed to design and fabricate a prototype three-wheeled battery-operated electric cargo of highly compact to be used in several applications. An electrical three-wheeler cargo was propelled by brushless electric motors, using electrical energy stored in Lithium-ion battery. Electric motors give electric cargo the required instant torque. The cargo vehicle was made with weight (150 kg) in order to increase its range. The vehicle was designed with special dimensions for the suitability of rural and urban roads. A prototype of this vehicle was fabricated and tested in workshop of Adarsh Institute of Technology and Research Centre Vita. It has many beneficial features such as low weight, stiff frame, energy efficient. Three wheeled electric cargo has reasonable stability and drum brakes for better braking performance. It also produces zero emissions hence reduce the health hazards and environmental pollution also reduces the global warming.

Acknowledgement

We would like to acknowledge group members who played role in our project accomplishment. We are extremely grateful to our institute, Adarsh Institute of Technology and Research Centre, Vita for the Confidence bestowed on us and entrusting our project “3D Modelling and Fabrication of Cost-Effective Three-wheeled E-Cargo.” We would like to express our special thanks of gratitude to our project guide Prof. P. P. Gavade sir for their able guidance and support in completing our project. We would also like to extend our gratitude to the Hon. Principal Dr. D. K. Mahadik and Mr. N.M. Patil Head of Department of Mechanical Engineering for his kind, constant guidance, valuable support and providing us with all the facility’s that was required.

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