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(RESEARCH ARTICLE)

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Design and application of two-person electric vehicle

Erdal KILIC *

Tekirdag Namık Kemal University, Vocational School of Technical Sciences, Tekirdag, Turkey.

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Abstract

Nowadays, decrease in the oil reserves, effect of the exhaust gas emissions of thermal motor vehicles on air pollution and the increasing environmental problems arising due to air pollution have increased the significance of electric vehicles. In this study, a light and easy to use electric vehicle without power transmission organs has been designed and manufactured by driving the vehicle from the rear via the electric motor on the third wheel being located at the back of the vehicle without using a heavy and space-consuming mechanical gearbox and differential. Absence of powertrains in this vehicle will improve lightness and efficiency in the vehicle. While the vehicle is steered with the two wheels at the front side, the third wheel located at the rear, on which the electric motor is located, acts as driving wheel.

Main power source of an electric vehicle is the battery. An electric vehicle gets its propulsion from batteries.

Keywords: Electric Car Technology; Electric car sub-systems; Electric car design; Turkey

1. Introduction

Since vehicles with internal combustion engines are dependent on fossil fuels, in countries due to the fact that it creates economic and environmental problems, especially as the amount of carbon dioxide released as a result of burning fossil fuels in thermal engines increases significantly in the atmosphere, causing dangerous increase in global warming, increase in interest in electric vehicles and the studies on this subject have also increased. In these studies, the systems and equipment that constitute three-wheeled two-person electric vehicle have been examined and the vehicle has been manufactured.

Electric cars can be manufactured in any size and style [1]. Problems of electric vehicles are comprised of high production costs, short range with full charge and long battery charging time [2]. Mass, energy use and cost effects of weight reduction made by using light materials in the manufacture of electric vehicles in thermal motor vehicles and electric passenger vehicles have been compared. If power transmission in thermal motor vehicles is eliminated in electric vehicles, weight will be reduced. It is emphasized that this situation will reduce the battery capacity used for the same range and performance and that this will significantly reduce the sales prices of electric vehicles as the engine will get smaller [3]

With the widespread use of electric vehicles, it is considered that carbon dioxide emissions from internal combustion engine vehicles will get reduced [4]. With hub motor technologies, four separate motors can be placed on four wheels without the need for power transmission systems in electric vehicles, and vehicles can also be moved with two motors on two wheels. This affects the range of electric vehicles significantly [5].

* Corresponding author: Erdal KILIC

2. Material and methods

In the design of the two-person electric vehicle, firstly, the drive system of the vehicle was determined by driving the vehicle from the rear via the electric motor on the third wheel being located at the rear side of the vehicle, without using a mechanical gearbox and differential, and the stone has been designed and manufactured according to the determined drive system.

3. Design and Production

3.1. Electrical motor

Brushless DC motor (BLDC) is capable of long-lasting high torque. Speed, torque and power change curves of a classical electric motor are shown in Figure 1.

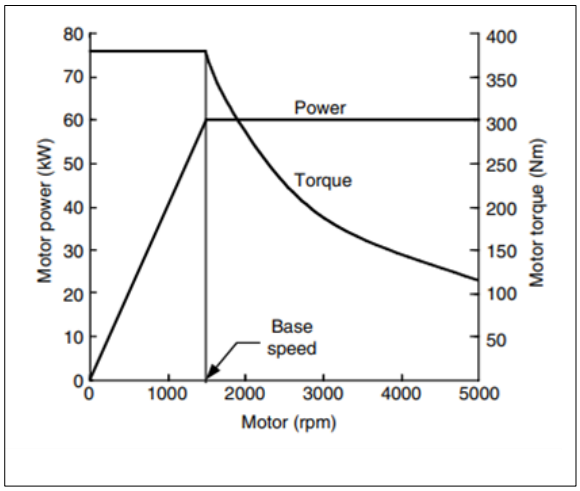

Figure 1 Graph of revolution, torque and power change in electric motors [6]

General technical data of the brushless DC motor (BLDC) used in the designed vehicle are given in Table 1.

Table 1 Technical data of the brushless DC motor (BLDC) of the designed vehicle

Motor	
Strength	6KW
Rated operating voltage	72 V
Weight	22 kg
Productivity	%85
Wheel size	130/60-13
Medicine	Brushless DC
Brand	Qs motor, Kelly controls

3.2. Battery Group

By serially connnecting 6 pieces of 12 volt 22 Ah E-bike 6-DZM-22 branded batteries, 72 volt battery package has been created. For the electric car manufactured, there is the battery group consisting of gel batteries, one of the battery types commonly used in electric vehicles. The batteries used in the vehicle manufactured are shown in Figure 1.

Figure 2 Batteries used in the vehicle manufactured

3.3. Electronic control unit (ECU)

It is an electronic unit designed to manage the electrical energy according to the road and load conditions of the vehicle. It constitutes the main unit that regulates the speed of the engine and hence, the speed of the vehicle depending on the gas pedal movements. General technical data of the engine control driver used in the vehicle are given in Table 2.

Table 2 Technical data of motor control driver [7]

Motor Driver	
Adjustable operating voltage	18-90V
continuous current	130 A
5V Sensor Supply Current	40mA
Operating Temperature Range	-40°C and 100°C, (MOSFET temperature)
Brand	Kelly controls
Model	KBS72221E

3.4. Body of vehicle

Body design constitues an important criterion for electric vehicles. Aerodynamic structure of the body reduces the friction force and this will increase the range of the vehicle as it will reduce the total resistance force acting on the electric vehicle. Besides, body manufacturing has been carried out by using aluminum material in order to reduce the total weight of the vehicle.

3.5. Transmission system

Brushless DC motor (BLDC) located on the rear axle of the vehicle with the wheel placed on the outer rotor in the electric motor, electric motor rotates rear axle by charged batteries. In this structure, there is no need for an additional gearbox, mechanical differential or electronic differential.

3.6. Brake systems

Brake system is the most important control component of vehicles for safe driving. In this study, disc brakes are also used on the front and rear wheels to slow down the speed of the vehicle or to stop the vehicle completely. Brake system diagram used in the vehicle is shown in Figure 3.

3.7. Front suspension system

Each of the front wheels has an independent suspension system. Macpherson suspension system has been adapted to the vehicle because it has a simple structure and takes up very little space in the vehicle body. In the single wishbone system connected to the main chassis from below, pneumatic springs were preferred and the system was made lighter and a shock absorber was mounted to the system. The MacPherson Suspension system used in the vehicle manufactured is shown in Figure 4.

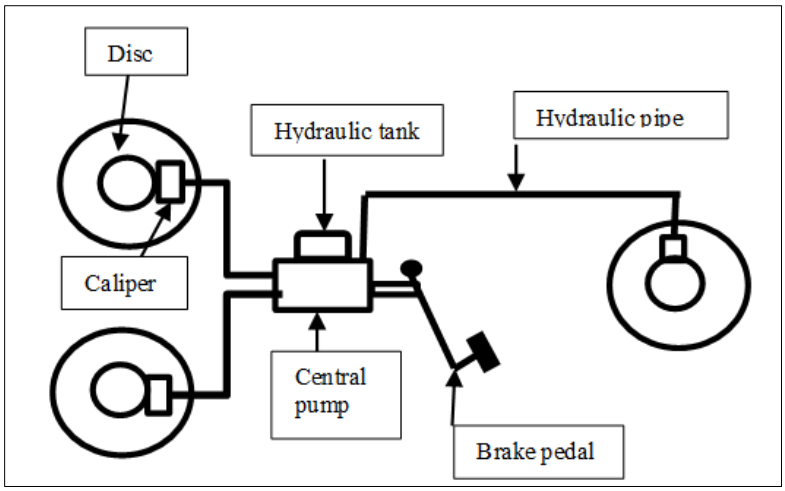

Figure 3 Diagram of the braking system used in the vehicle

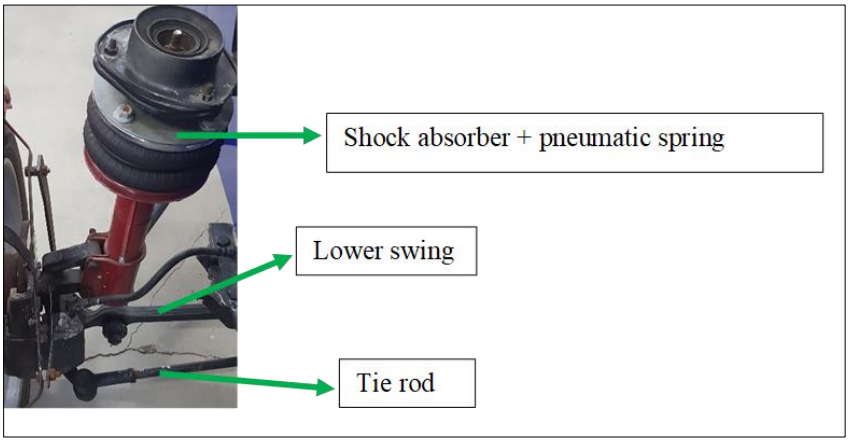

Figure 4 MacPherson Suspension system used in the vehicle

3.8. Rear suspension system

Rear drive section of the vehicle is configured by mounting DC motor on the suspension system, which is formed by using a total of four shock absorbers, one swing arm connected to the main body and two shock absorbers on both sides of the swing arm. Figure 5 shows the engine and rear suspension system used to drive the rear wheel.

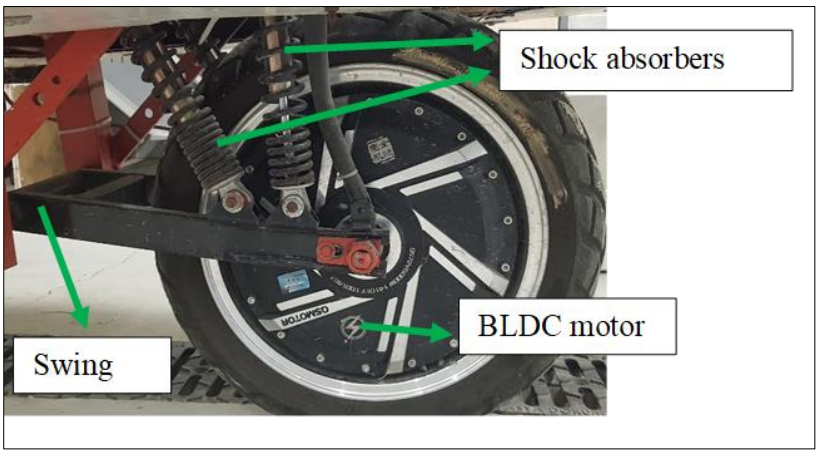

Figure 5 Engine and rear suspension system used to drive the rear wheel

3.9. Steering System

In order to direct the vehicle in the desired direction and to ensure road stability while driving, a rack-pinion type gearbox is used, which converts the circular motion from the steering wheel to linear motion by transferring it to the rack gear via the pinion gear. Rack and pinion steering system used in the vehicle is shown in Figure 6.

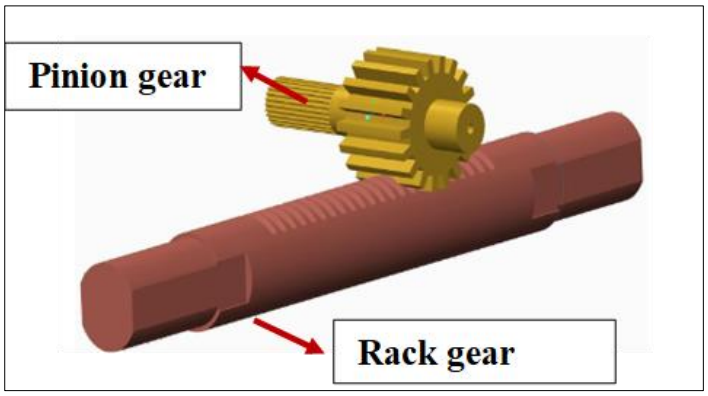

Figure 6 Rack and pinion gear steering system used in the vehicle [8]

3.10. Chassis

When designing the chassis, which is the basic structure of the electric vehicle, mounting points must be provided to fit the different components, such as the battery pack, electronics, suspension parts, braking system, steering system, driver and passenger cabin that can meet the requirements of robustness and safety in all load conditions. The basic structure and dimensions of the electric vehicle of the vehicle designed considering these parameters are given in Figure 7.

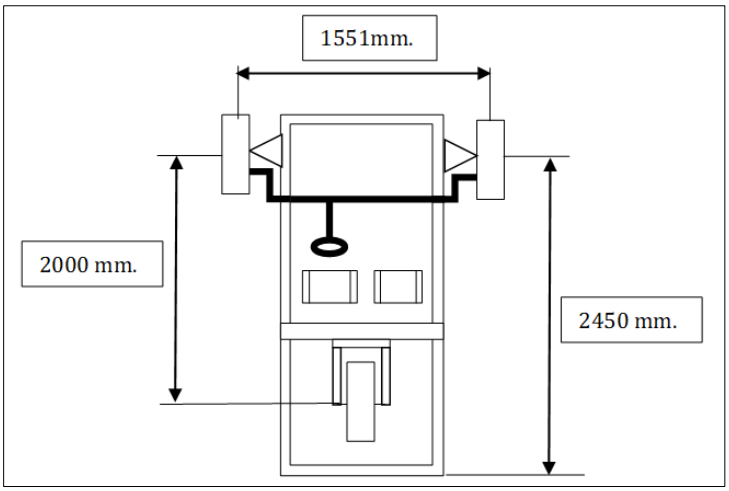

Figure 7 Basic chassis structure and dimensions of the electric vehicle

3.11. Main Components of Electric Vehicle

In terms of the general structure, the control logic of electric vehicles is basically the same. The components of the designed electric vehicle, which are simple to choose in terms of control, but do not compromise on efficiency and meet all demands, are given in Figure 8.

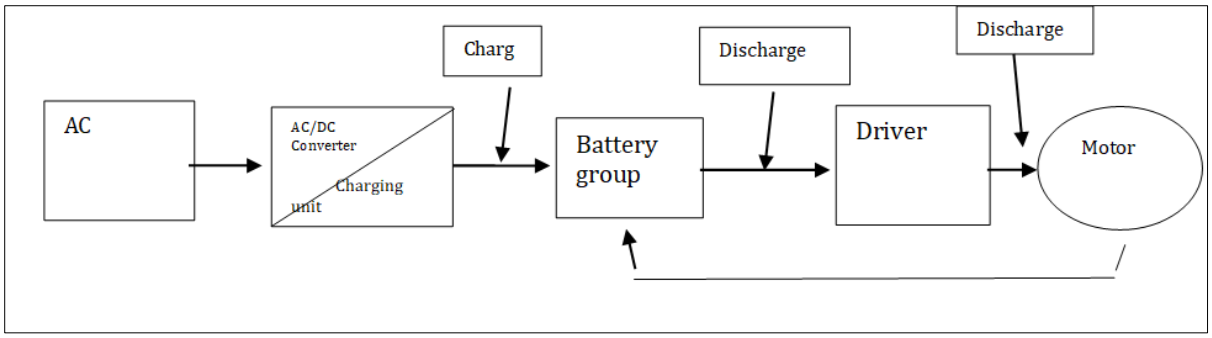

Figure 8 Main components of electrical vehicle

4. Conclusion

We can list the advantages of the vehicle designed by using an electric motor as follows.

- Because of the small size of the car in city life, it takes up less space and provides ease of parking.
- It minimizes the air pollution problem.
- It reduces exhaust gas emission in residential areas.
- It reduces dependence on petroleum product fuels.
- It provides ease of maintenance compared to thermal motor vehicles.

This study can create a roadmap for the applied studies where thermal motor vehicles can also be converted to electric cars, thus eliminating the negative effects of thermal motor vehicles caused on the environment.

Compliance with ethical standards

Acknowledgments

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