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Comparison Design of Electric Motorcycles using Hybrid Systems (BLDC Motor) on 150Cc Motorcycles Based on Parameter Testing

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Abstract. This study aims to know the comparison design of electric motorcycle using hybrid systems (BLDC Motor) based on parameter testing, i.e., with and without load. The design of electric motorcycles is centered on determining a feasibility study comparing engine drive with electric drive. Electric vehicles are the answer to decreasing petroleum supplies and environmental concerns that are worsening every year due to oil-fueled cars' exhaust emissions. The proportion of motor vehicle exhaust as an air pollution source is between 60 and 70 percent. The global decrease of fossil fuels is also a critical issue that has yet to be handled. A descriptive statistic methodology was employed in this work as an analytical tool. The results showed when the speed increases, the efficiency of the BLDC motor would increase; this is, of course, following the principle of Orsted's law and Lorentz force. When compared to the no-load test, the efficiency by using the load will be greater because when the BLDC motor works with a load, it will require greater torque due to an increase in load so that it takes a large amount of power so that it will increase the efficiency of the BLDC motor. When compared in terms of using the battery, the time of using the battery with no load will be longer because it does not require too much current.

INTRODUCTION

Transportation is a critical component of development success, particularly in supporting community economic activity to satisfy daily demands for products and services and increasing socioeconomic life quality [1–3]. Consumer demand for energy rises due to an unregulated automobile population increase, resulting in air pollution from car exhaust emissions [4–6]. According to data collected by the Environmental Management Agency (Badan Pengelola Dana Lingkungan Hidup/BPLDH) from various industries that can contaminate the air, the transportation sector plays a far more significant role than other sectors. In major cities, the contribution of motor vehicle exhaust gas as a source of air pollution reaches 60-70% [7-8]. There has been much research done related to motorcycles, such as the technical aspects [9].

An electric vehicle is a solution to depleting petroleum reserves and pollution problems that increase yearly due to exhaust emissions produced by oil-fueled vehicles [10-11]. From the previous studies, the author tried to design a concept of two-wheeled, three-wheeled, or four-wheeled vehicles with two or more passengers using the VDI method (Verein Deutscher Ingenieur) [12] with a focus on designing the design of the shape and dimensions of a sleek vehicle by using an electric motor that is appropriate so that this electric vehicle can work optimally, efficiently and environmentally friendly. The most dominant modification of this electric vehicle is on its drive; the old drive uses the engine, while the new drive uses an electric motor named BLDC; researchers have widely used BLDC as a drive because it uses an electric motor [13–18]. BLDC electric motor is a motor whose magnetic field generation uses permanent magnet material located on the rotor.

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The purpose of the research is to know the comparison design of electric motorcycle using hybrid systems (BLDC Motor) based on parameter testing, i.e., with and without load.

METHODS

Research Design in this study consists of two steps:

1. Identifying problem
   In this stage, the author gathers information from various sources by sharing questionnaires with 20 respondents. The results of the respondents are then calculated to then describe them as clearly as possible in the requirement list and identify the obstacles faced to achieve the optimal solution.
2. Concept Design
   The results of the analysis of the list of needs above produced abstraction steps in determining the main problems in the design of electric vehicles, namely: Ignoring personal desires or wishes (wishes) that have no direct effect on the functions and constraints that are important in the design of electric vehicle concepts.

The analysis technique used in this study is a descriptive statistic. This study will be conducted an assessment of the technical data that occurs in the calculation of motor speed according to the specified standards and based on parameter testing like with load and without load.

RESULTS AND DISCUSSIONS

This section will discuss the results and research by discussing the design, specifications, and testing conducted on BLDC motors.

BLDC Motor Design and Sketch

The initial stage of this research is to design a BLDC electric motor. BLDC motors work for the main source of electric motorcycle propulsion where the driving source is a DC battery which is raised to AC through an inverter. The design and BLDC motorcycle sketches can be seen in Figure 1.

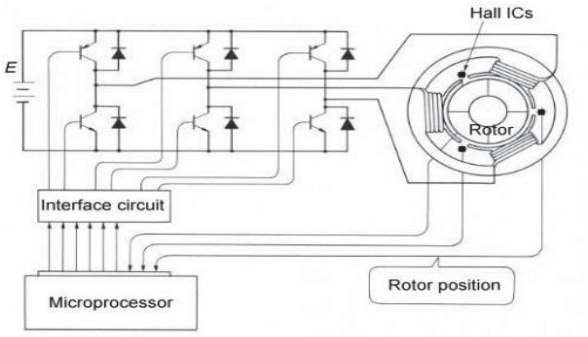


FIGURE 1. BLDC Motor Design and Sketch

BLDC Motor Drawing

After obtaining the BLDC draft, the next step is to design the motor. A series of BLDC motorcycle designs that function to adjust the body frame on a motorcycle. Here is a drawing of the BLDC motor, as can be seen in Figure 2.

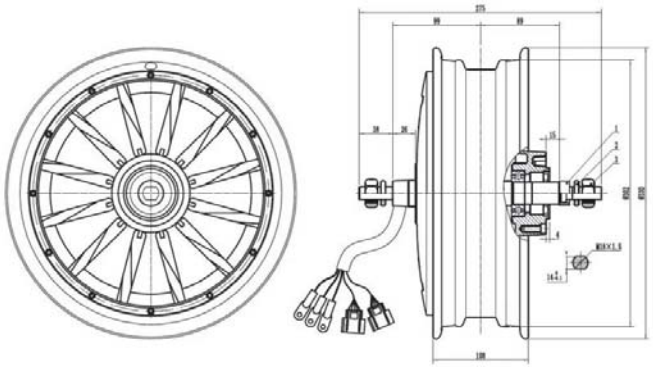


FIGURE 2. Motor BLDC

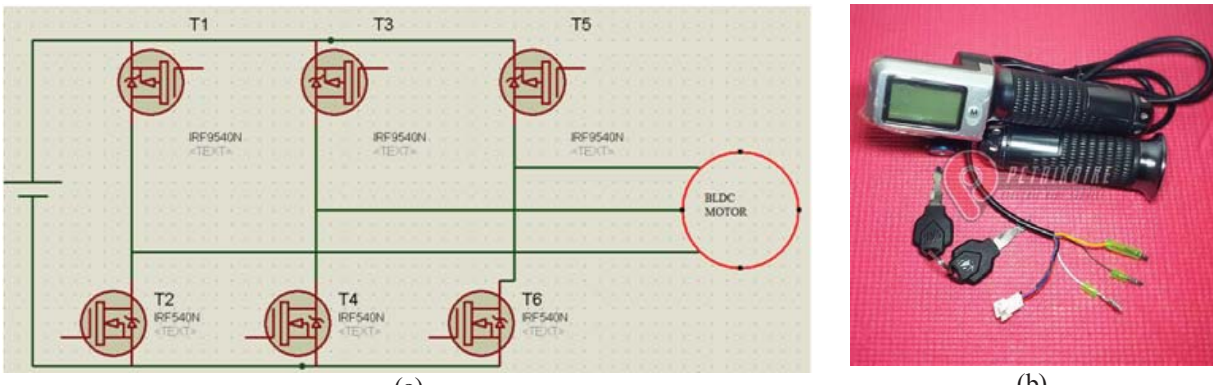
BLDC Bike Specifications

Here are the specifications of BLDC motorcycles:

Motor Type	: BLDC Outer Rotor In-Wheel Hub Motor with Hall Sensor
Brand	: QS Motor,QS MOTOR
Motor Design	: Double axle with 10inch moped rim (integrated)
Rim size	: 10 × 2.15 inch (Narrow Tire as default),
Matched tire	: 3.0 - 10,3.5 - 10 etc 10 × 3.0 inch (Wide Tire)
Magnet Height	: 55 mm, 16 pole pairs
Stator	: Aluminum Core
Rated Power	: 3000 W
Speed	: 707 Rpm Max Torque approx 174 N.m
KV	: 14.7 Max Efficiency approx 91%
Brake Type	: Disc brake (default as), PCD3*80mm-M8, CB 58 mm
Drop-outs	: 200 mm
Dual Halls with waterproof connectors (One for spare, in case of damage) 10 mm² Phase Wire	
Waterproof Grade	: IP 54
Color	: Black (as default)

Phase Inverter Circuit and Throttle

The next stage in this design requires a 3-phase DC to AC rectifier diode circuit. it is used to convert DC voltage into AC voltage. A series of 3 phase inverters that can be seen in Figure 3.



(a) (b)

FIGURE 3. Phase Inverter Circuit and throttle

Throttle

Throttle is a potentiometer as a variable DC source so that the DC source can be adjusted to the size of the inverter. It's like a replacement for hand gas on an ordinary motorcycle. Figure 3(b) shows the throttle image that used in this study.

Electrical and Battery Installation of BLDC Motor

The electrical installation of the BLDC motor is designed and installed in accordance with the planned installation, starting from calculating battery requirements, designing the size of the inverter and controller. Design according to motor power requirements. The electrical installation of the BLDC motor can be seen in Figure 4. A series of parallel series battery preparation where per 2.6-volt DC battery is stacked to produce 60 Volt DC as needed.

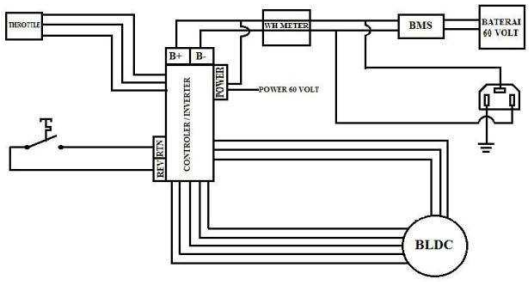


FIGURE 4. Electrical Installation of BLDC Motor

Electric Vehicle Frame and Chassis Design

Before carrying out the test, it is necessary to design the vehicle frame and chassis. where it is used to design the size and specifications of the body that adjusts the load, passenger weight, goods weight, and others. The vehicle frame and chassis design can be seen in Figure 5.

FIGURE 5. Chassis Design

BLDC Motor Testing

This section will be delivered BLDC Motor Tests starting from the initial testing stage until the final stage of testing. Table 1 shows the test variables. After setting the variables, BLDC Motor tested based on two parameters: with load and without load.

TABLE 1.Test Variables

No	Test Variables	Description
1	Battery	50 Ah
2	Voltage 3φ	60 V
3	Speed BLDC	80 Km / Hour
4	Power Hood	3 Kw

Load less Testing

The load less test results can be seen in Table 2. Based on Table 2 above, it can be seen that when the speed is increased from 33 Km/hour to 61 Km/hour so from the table above, it can be concluded that when the speed increases, the efficiency of the BLDC motor will increase, this is of course following the principle of Orsted's law and Lorentz force where the working principle and rotation of the BLDC motor are also following Orsted's law and Lorentz force wherein Orsted's law When a conductor is given a voltage source it will produce a magnetic field where the speed of the BLDC motor is regulated from the size of the supply current from the battery so that the greater the electric current supplied. Then the magnetic field will get bigger, and when the magnetic field gets more extensive due to the addition of the amount of current, the efficiency of the BLDc motor will also increase.

TABLE 2.Test Results Without Load

Speed (km/h)	Voltage (V)	Current (A)	Efficiency (%)	Battery Life (Min)	Description
33	58.39	25.3	49.2	157	Efficiency obtained : P out / P in
41	58.51	30.9	60.2	154	
52	57.76	41	78.8	106	
61	55.94	49	91.3	82	

From the efficiency formula, when the input current to the motor is enlarged, it produces a large motor rotation because the magnetic field generated in the motor also enlarges so that the efficiency of the BLDC motor will also increase, because it is known that changes in current are directly proportional to changes in the power of the BLDC motor (Brushless Direct Current).

Load Testing

The test results with loads can be seen in Table 3. Based on Table 3.3 above, it can be seen that when the speed is increased from 10 Km/hour to 40 Km/hour so from the table above it can be concluded that when the speed increases, the efficiency of the BLDC motor will increase, this is of course in accordance with the principle of Orsted's law and Lorentz force. when compared to the no-load test, the efficiency using the load will be greater because when the BLDC motor works with a load, it will require greater torque due to the increase in load so that it takes a large amount of power so that it will increase the efficiency of the BLDC motor, and when compared in terms of the time of using the battery, the time of using the battery without a load will be longer because it does not require too much current.

TABLE 3. Load Test Results

Speed (km/h)	Load (kg)	Voltage (V)	Current (A)	Battery Life (Min)	Efficiency + 1 Passenger (%)
10	240	58.39	25.3	157	53.16
20	240	58.51	30.9	154	64.4
30	240	57.76	41	106	85.2
40	240	55.94	49	82	-

CONCLUSION

The results showed when the speed increases, the efficiency of the BLDC motor would increase; this is, of course, following the principle of Orsted's law and Lorentz force. When compared to the no-load test, the efficiency by using the load will be greater because when the BLDC motor works with a load, it will require greater torque due to an increase in load so that it takes a large amount of power so that it will increase the efficiency of the BLDC motor. When compared in terms of using the battery, the time of using the battery with no load will be longer because it does not require too much current.

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