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Effect of Voltage, Current, and Power on revolutions per minute in the brushless direct 3000-Watt current motor on E-Gokart

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ABSTRACT

The internal combustion engine is a gasoline-powered internal combustion engine that is widely used in the world of transportation. Therefore, everyone is starting to think about developing alternative fuels that are fuel efficient, easy to upgrade, and better in terms of emissions. Vehicles with electric motors are one of the right solutions because they are more environmentally friendly and do not cause pollution when used. In this study, we will discuss the performance of the brushless DC electric motor that is applied to the Go-kart based on the voltage, current, and electrical power that occurs. The method used is measurement using software and experimental simulations. Based on the test results using Votol_V3 Voltage, current, power, and rotation per minute (rpm) have a relationship, the higher the rpm on the mid-drive type electric motor, the greater the current and power required.

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1. INTRODUCTION

In this era, the field of automotive science is growing, especially in the transportation sector. The internal combustion engine is a gasoline-powered internal combustion engine that is widely used in the world of transportation. Gasoline engines are various sources of mechanical power that use heat energy in the combustion system (Laki *et al*., 2012). You can call it an internal combustion engine or ICE (Internal Combustion Engine). For combustion, three elements are needed for decomposition: fuel, oxygen, and heat (Syahrani, 2006).

Internal combustion engines (ICEs) require fossil fuels to do business. Fossil fuels will eventually run out. The latest update proves that 4.17 billion barrels of national oil reserves currently exist, and shows 2.44 billion barrels of oil reserves which are expected to be exhausted in about 9.5 years (Owen *et al*., 2010). Most of the world's energy comes from non-renewable sources. Between 2000 and 2030, the annual growth rate of energy demand in the European Union is estimated to be around 0.5%. It is estimated that around 3% in Asian countries, while at the global level it is estimated at 1.8%.

Therefore, everyone is starting to think about developing alternative fuels that are fuel efficient, easy to upgrade, and better in terms of emissions. Vehicles with electric motors are one of the right solutions because they are more environmentally friendly and do not cause pollution when used (Rahman, 2013). The electric motor application designed by the author is an electric go-kart. Go-kart is a four-wheeled vehicle that looks like a car. Go-kart is a type of four-wheeled vehicle. The frame and displacement are smaller than other four-wheeled vehicles. Usually used as a means of entertainment and in fast-paced competitions such as Formula 1. The electric motor is a change from electrical energy to mechanical energy, and the electric motor is the main driver. In this study, the electric motor used was a mid-drive brushless DC (BLDC) electric motor. The operation of the BLD motor is very simple, using the electromagnetic force created by the repulsion of the electric motor coils and permanent magnets. This electromagnetic force is controlled by a BLCD motor driver or Hall sensor. What distinguishes a BLDC electric motor from a DC motor is the use of a mechanical or Hall sensor to provide a magnetic field to the BLDC electric motor to set the time and supply current to the coil (Nandakumar, 2020). Since electric motors require power to rotate, there is a correlation between voltage, current, and power for each revolution per minute (RPM) of an electric motor.

2. METHODS

The steps and methods in this research are shown in **Figure 1**. Based on **Figure 1** this research begins with a literature study related to BLDC motors and go-karts. After that, it was continued by making an electrical schematic design using the PROTEUS software and also being simulated using the PROTEUS software. After being simulated, the circuit is made and assembled, and then tested. After testing, the data is analyzed based on the input voltage, input current, and input power to rpm on the motor.

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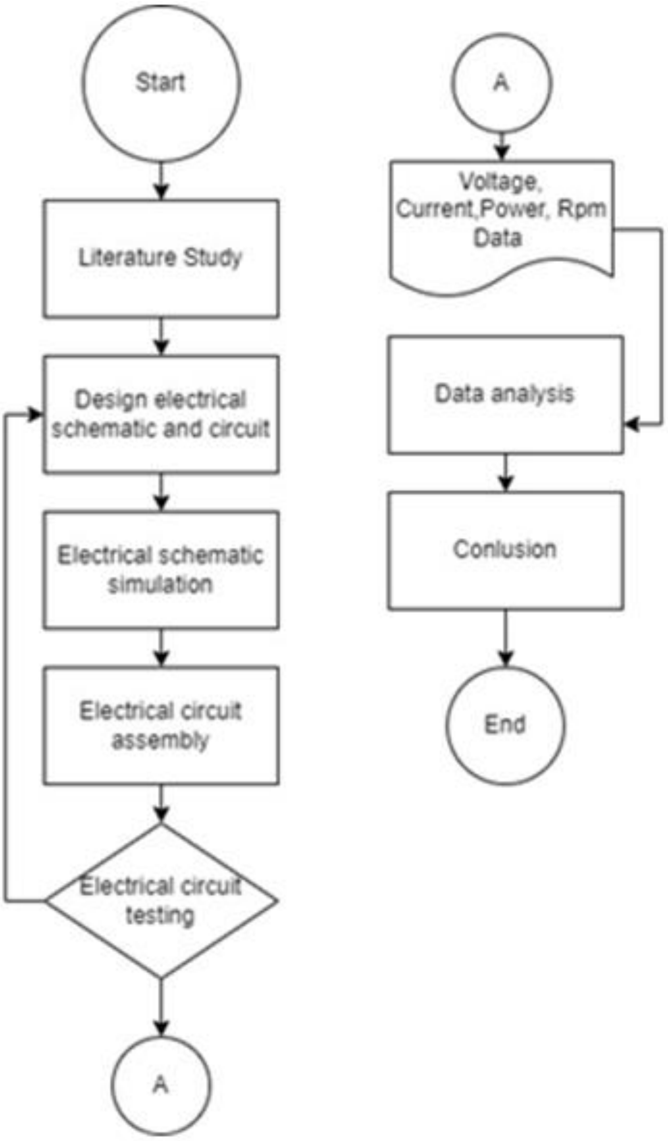

Figure 1. Flowchart of research.

2.1. Preparations

Preparations are made to prepare the availability of components needed to measure or test the effect of voltage (v), current (I), and power in each Revolutions Per Minute (RPM). The components needed in testing this mid-drive type electric motor include.

(i) The mid-drive type BLDC motor is the latest DC motor and the commutation system does not use a brush but uses a hall sensor.
(ii) The votol controller Em-200 functions to control the current and voltage that enters the controller.
(iii) The throttle functions to regulate the rotation of the motor by giving voltage to the microcontroller. This component is the same as in vehicles in general, only in electric vehicles the output produced is in the form of an electronic data signal.
(iv) The battery is a device used to store an energy source of 72V-80ah and uses a lithium-ion battery
(v) USB to TTL is a connecting device with external devices using a USB port.
(vi) The Votol_V3 application is a votol output application for setting the votol output controller.

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2.2. Modeling

In this study modeling using Proteus software. Modeling is carried out to minimize the risk of failure when the test is carried out, and to minimize the estimated cost required to carry out the test (Simonson *et al*., 2020). Process procedures from modeling and simulation among others.

(i) Preparing the Proteus Software. Proteus Software is free to download. After that, it can be installed on the Windows operating system device shown in **Figure 2**.

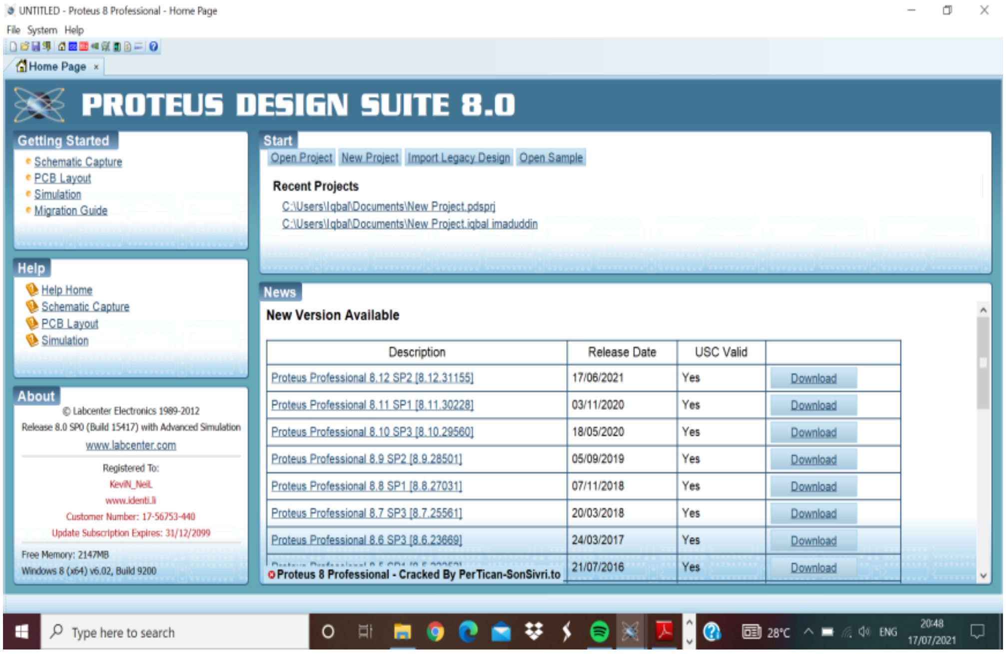

Figure 2. The initial view of proteus software.

(ii) Making *Wiring Diagrams.* Making *wiring diagrams* using Proteus software is done to facilitate the installation of electricity later. The following is the wiring diagram used (see **Figure 3**).

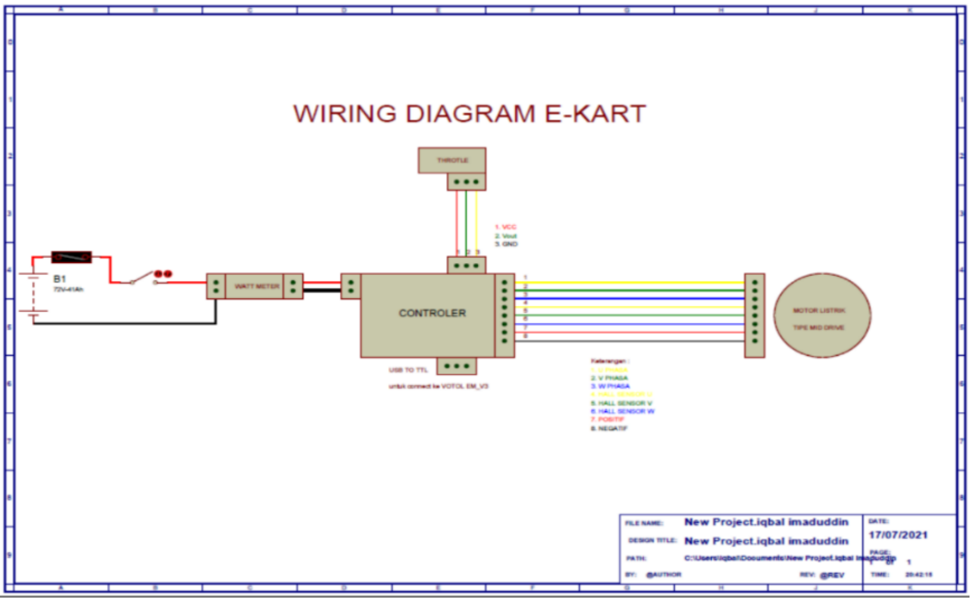

Figure 3. Wiring diagrams.

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2.3. Testing

After the wiring is made or the required components are complete then the assembly is carried out first so that the electric motor can function and can be tested, here are the steps for assembling the wiring diagram:

(i) Assemble the circuit using as shown in **Figures 1 and 3** wiring diagram
(ii) connect the battery socket to the controller
(iii) connect the throttle socket to the controller
(iv) connect the phase wire from the controller to the electric motor
(v) Connect the hall sensor cable from the controller to the electric motor
(vi) after all the same as in the wiring diagram then connect the USB to TTL to the laptop.
(vii) After USB to TTL is connected to the laptop then use the votol_V3 application.

Tests were carried out using the Votol EM_V3 software. by connecting the *controller* to the computer using USB to TTL after which Votol EM_V3 reads RPM, voltage, and current (see **Figure 4**).

Figure 4. Trial stage.

3. RESULTS AND DISCUSSION

Process Tests were carried out to determine the effect of voltage, current, and power on *Revolutions Per Minute* (rpm), determining the power in each revolution by testing an electric motor of the mid-drive type without a load. The test is carried out utilizing a *throttle* on the gas until it reaches the desired RPM, then the current and voltage are obtained.

3.1. Test results and calculations

The following data is the result of measurements using the Votol_V3 application shown in **Table 1**. *mid-drive* type electric motor test, shows that there is a relationship between voltage, current, and power in each *Revolutions Per Minute* (rpm) that works on the electric motor.

Table 1. Electric motor test results.

RPM	Voltage (V)	Current (I)	Power
500	80	11	880
1000	80	11	880
1500	80	13	1.040
2000	80	15	1.200
2500	80	16	1.280
3000	80	17	1.360
3500	80	18	1.440
4000	78	18	1.404
4500	78	21	1.638
5000	78	32	2.496
5500	78	32	2.496
6000	78	34	2.652
6500	78	34	2.652
7000	79	35	2.765

3.2. The effect of voltage in each *revolution per minute* (rpm) on an electric motor of the *mid-drive type*

Based on **Table 1** and **Figure 5**, the magnitude of the voltage from the no-load test using the Votol_V3 software for a mid-type electric motor from different rpm variations. From 5000 RPM to 4000 RPM, there is no change (80 V from 400 to 7000 rpm). Specifically, it is 78-79 V. In mid-rotation, the voltage changes or decreases but is not significant, due to the decrease in the length of the test voltage on the battery.

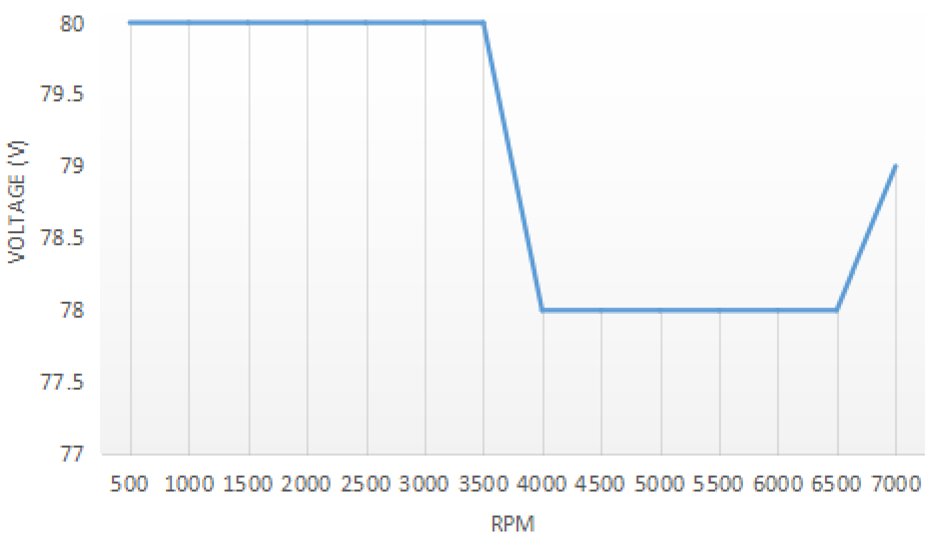

Figure 5. Graph of the influence of V in each rotation of the motor angle

3.3. Effect of current in each *revolution per minute* (rpm) on an electric motor of the *mid-drive type*

Based on **Table 1** and **Figure 6**, the current test results for *mid-drive electric motors* from different rpm variations are 11-35A. the graph above shows that at 500-7000 rpm the current issued by the Votol EM-200 is getting bigger. It can be concluded that the higher the RPM on the *mid-drive type electric motor* correlates to the greater the working current.

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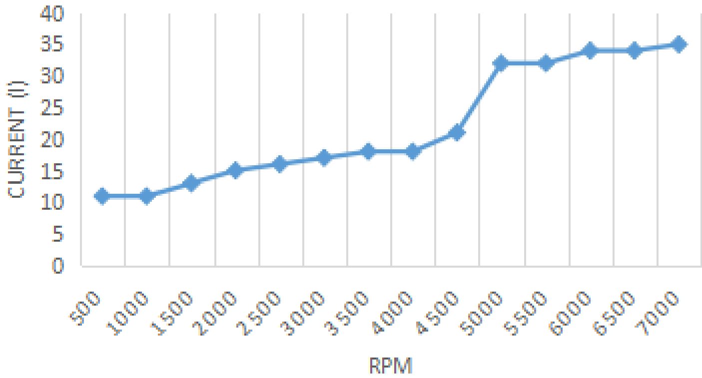

Figure 6. The effect of the current in each corner rotation of the motor.

3.4. Power effect in each lap

Based on **Figure 7**, the higher the rotation that occurs in the mid-drive electric motor resulted the more power. After testing using the Votol_V3 software, the Votol EM-200 controller only controls the current so that there is a variation in the RPM or power required by the electric motor. When working, the voltage controlled by the Votol EM-200 entering the electric motor is not far from 80 to 78V. It can be concluded that the Votol EM-200 controller controls the current entering the electric motor. Thus, different RPM variations occur**.**

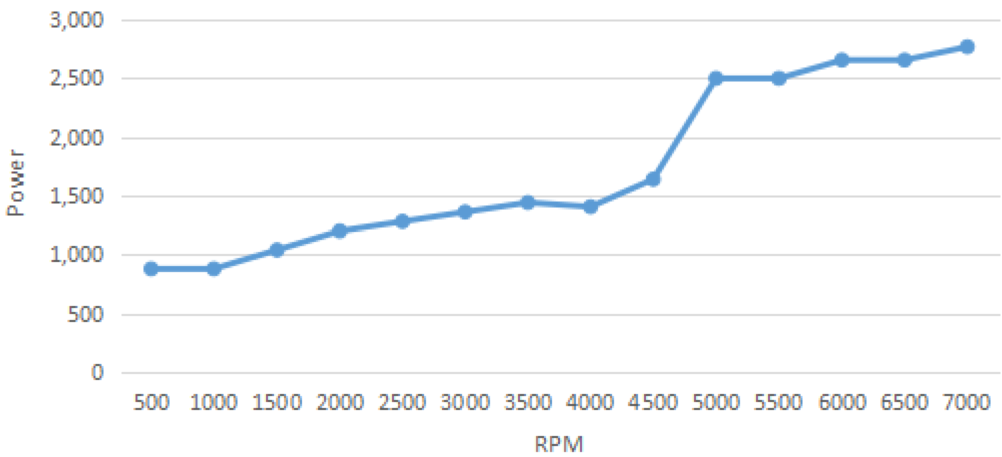

Figure 7. Effect of power in each round.

3.5. Effect of Voltage, Current, and power at each rotation of an electric motor

Based on trials using the Votol_V3 Application, it is found that Voltage, Current, and Power to *Revolutions Per Minute* (rpm) as shown in the graph and previous discussion. Due to the Votol EM-200 controller, the current transfer controller, the controller functions to direct the rotation of the rotor. After conducting the test, it can be concluded that current and power are directly proportional to the greater the rotation needed to do work or the greater the rpm, as power is the amount of electrical energy transferred by a closed electrical circuit. A conductor with a potential difference and current in a specific time.

4. CONCLUSION

Based on the test results using Votol_V3 Voltage, current, power, and rotation per minute (rpm) have a relationship, the higher the RPM on the mid-drive type electric motor,

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the greater the current and power required. This is because the greater the effort to eat, the greater the energy required to do work.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Laki, R. F., Gunawan, H., and Gede, I. N. (2013). Analisis konsumsi bahan bakar motor bensin yang terpasang pada sepeda motor Suzuki Smash 110cc yang digunakan pada jalan menanjak. *Jurnal Poros Teknik Mesin Unsrat*, *2*(1), 1-10.

Nandakumar, M., Ramalingam, S., Nallusamy, S., and Rangarajan, S. S. (2020). Novel efficacious utilization of fuzzy-logic controller-based two-quadrant operation of PMBLDC motor drive systems for multipass hot-steel rolling processes. *Electronics*, *9*(6), 1-18.

Owen, N. A., Inderwildi, O. R., and King, D. A. (2010). The status of conventional world oil reserves—Hype or cause for concern?. *Energy policy*, *38*(8), 4743-4749.

Rahman, M. A. (2013). Making electric cars for environmentally friendly transportation solutions (Baskara Cars). *Regional Research Journal*, *12*(2), 1819-1837.

Rangkuti, P. A., Hasbullah, R., and Sumariana, K. S. U. (2012). Uji performansi mesin penepung tipe disc (Disc Mill) untuk penepungan Juwawut (Setaria italica (L.) P. Beauvois). *Agritech*, *32*(1), 66-72.

Simonson, T., Gaillard, T., Mignon, D., Schmidt am Busch, M., Lopes, A., Amara, N., Polydorides, S., Sedano, A., Druart, K., and Archontis, G. (2013). Computational protein design: the Proteus software and selected applications. *Journal of computational chemistry*, *34*(28), 2472-2484.

Syahrani, A. (2006). Analisa Kinerja Mesin Bensin Berdasarkan Hasil Uji Emisi. *SMARTek*, *4*(4), 260-266.

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