Software developed to calculate electric motor power

Software desenvolvido para calcular a potência do motor elétrico

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ABSTRACT
The use of electric motors is common for many types of vehicles, from motorcycles to aircraft or large ships. The electric motor, also called an electric machine, serves to transform electrical energy into mechanical energy. The most commonly used type of electric motor is induction, which is used in almost any application, covering hostile environments, explosives, naval applications, among others. The use of the electric motor is defined from its power. Its determination depends on three important variables, being those the voltage, current, and efficiency. Therefore, the purpose of this work is to produce software for mobile devices to calculate the power of an electric motor. According to the results obtained, it is verified that the parameter analyzed presents several behaviors when related to its dependent parameters.

Keywords: Electric motors. Electricity. Mechanical energy. Power.

RESUMO
O uso de motores elétricos é comum para muitos tipos de veículos, de motocicletas a aeronaves ou grandes navios. O motor elétrico, também chamado de máquina elétrica, serve para transformar energia elétrica em energia mecânica. O tipo de motor elétrico mais utilizado é o de indução, que é usado em quase todas as aplicações, cobrindo ambientes hostis, explosivos, aplicações navais, entre outros. O uso do motor elétrico é definido a partir de sua potência. Sua determinação depende de três variáveis importantes,

que são a tensão, a corrente e a eficiência. Portanto, o objetivo deste trabalho é produzir software para dispositivos móveis para calcular a potência de um motor elétrico. De acordo com os resultados obtidos, verifica-se que o parâmetro analisado apresenta vários comportamentos quando relacionado a seus parâmetros dependentes.

Palavras-chave: Motores elétricos. Eletricidade. Energia mecânica. Energia elétrica.

1 INTRODUCTION

The growth of the world's vehicle fleet reached 1 billion vehicles according to the World Automotive Organization (OICA) in 2007. In Brazil, the fleet exceeds 30 million units, and between 2009 and 2010 the number of car licensing was greater than 6.6 million, meaning a 20% increase in the fleet in two years. In part of this vehicle composition are the electric motors, which have applications from small motorcycles to large ships and aircraft. An important approach was taken to optimize the electric power of a train, considering the energy consumption and the driving comfort of this train [2].

It is understood as an electric motor, a machine that transforms electrical energy into mechanical energy, its use meets several types of motors, taking into account the advantages of electric energy based on simple construction, flexibility and appropriation of loads and efficiency [3]. The performance of the electric motor is given by the interaction between electromagnetic fields, although there are engines based on other electromechanical occurrences such as electrostatic forces.

The efficiency depicts the degree of occurrence in which an energy transfer process is performed. Generally, this parameter is calculated by the relationship between the terms of the desired result and a necessary supply [4]. In the work of [5], we studied the development and validation of an integrated planetary gear system for the permanent magnet electric motor power loss model.

Recently studies were performed on the power efficiency of an electric traction system with use of three phase induction motors [6]. Electric motors have few losses in energy transformation. Due to this, the energy efficiency of these machines is considered high. The induction electric motor stands out among the other types of motors available in the market, and can be used in hostile, explosive environments with dust etc. This type of electric motor has low cost, principle of accessible operation and little need for maintenance [7].

Induction motors are subject to wear and tear that may cause them some faults. These defects can occur due to stator or rotor imbalance, and problems with windings, bars or bearings [8]. Irregularities in electric motors relate mechanical and electrical concepts. The factors that cause mechanical problems are: vibration, thermal expansion, friction, corrosion, mechanical fatigue, fracture, deformation or erosion. The factors that cause electric problems are: partial discharges, thermal degradation, contact resistance, magnetization, electric heating, and electromagnetic induction [9].

The stator and rotor are made of sheet steel and electrically insulated. Therefore decrease considerably the eddy current losses and increase the efficiency of the machine [10] and [11].

Motor power is generally measured by equipment such as dynamometers, using techniques to absorb the power supplied by the motor. Some dynamometers make this process having a mechanical friction brake, but because they are not flexible, they are not suitable for vehicles with a high power rating [12].

The purpose of this work is to develop an application for mobile devices with the purpose of calculating the useful power of an electric motor, in order to be correctly sized. The main parameters that influence motor power are: voltage, current and efficiency.

2 COMPUTATIONAL PROCEDURE

The efficiency of the electric motor is expressed through Eq. 1:

$$Ef = \frac{Pu}{Pt} \tag{1}$$

On what,

P_u: Useful power;;

P_t: Total power.

And, the ideal motor power is given by Eq. 2. That is, the efficiency of this is 100%.

$$P = V . I \tag{2}$$

On what,

V: Voltage (V);

I: Current (A).

For the effective dimensioning of a motor, it is necessary that the power is given in Watts. Therefore, the power with a given efficiency is expressed as shown in Eq. 3:

$$P = V . I . Ef \qquad (3)$$

On what,

P: Motor power (W);

V: Voltage (V);

I: Current (A);

E_f: Efficiency (%).

The platform used to develop the application is supported by the Massachusetts Institute of Technology (MIT). For this, a program with open language code formed by Google is available. The developed software, produced in MIT App Inventor 2, becomes quite feasible to be available to all devices with Android Operating System.

Fig. 1 shows the initial screen of the software developed in this work. The application has the following input data: 1) Voltage, 2) Current and 3) Efficiency.

Figure 1: Application Home screen.

3 RESULTS AND DISCUSSIONS

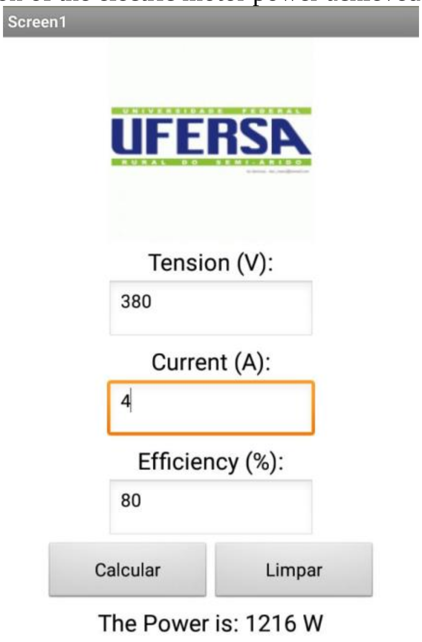
Table 1 shows the data used to calculate the power of an engine having 380 V.

Table 1 - Initial data for calculating the power of a motor.

Tension (V)	Current (A)	Efficiency (%)
380	4	80

When the above mentioned values were added in the initial screen, the application was calculated by the electric motor power, which was 1216 W. Fig. 2 shows the result of the calculated parameter.

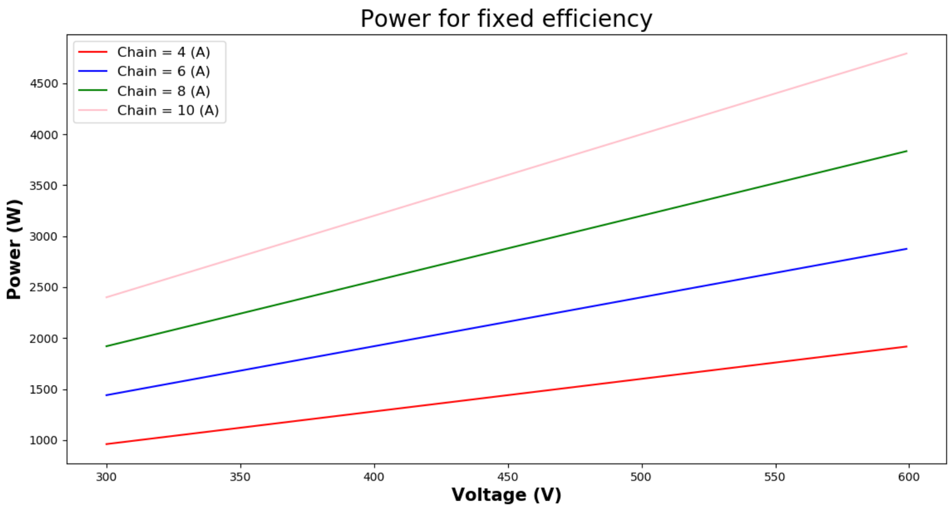
Figure 2: Calculation of the electric motor power achieved by the application.



Four graphs were plotted to analyze the influence of the dependent parameters on the power of the electric motor.

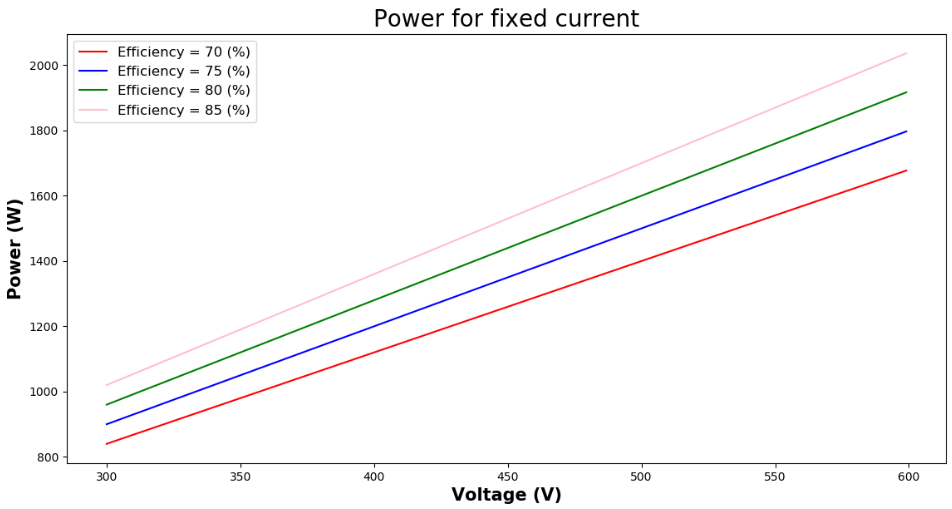
The first graph, Fig. 3, shows the electric motor voltage variation, followed by plotted curves with different values for the system current. According to Eq. 3, because the power varies directly with the current and voltage, there are increasing curves.

Figure 3: Power of an electric motor subjected to voltage variation with 80% efficiency.



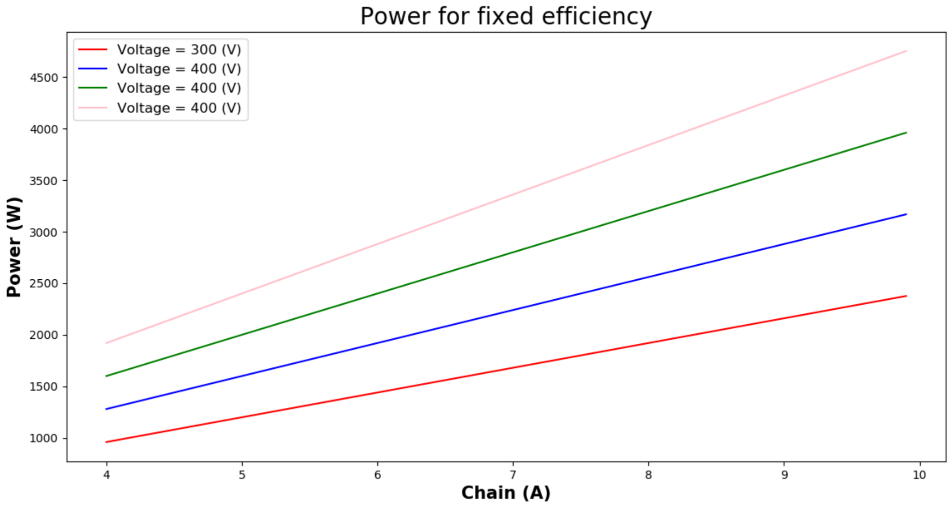
The second graph, Fig. 4, shows variation in the voltage of the electric motor. Curves with different values were plotted for engine efficiency. By Eq. 3, as power varies directly with the motor voltage and efficiency, there are increasing curves.

Figure 4: Power of an electric motor subjected to voltage variation with current of 4 A.



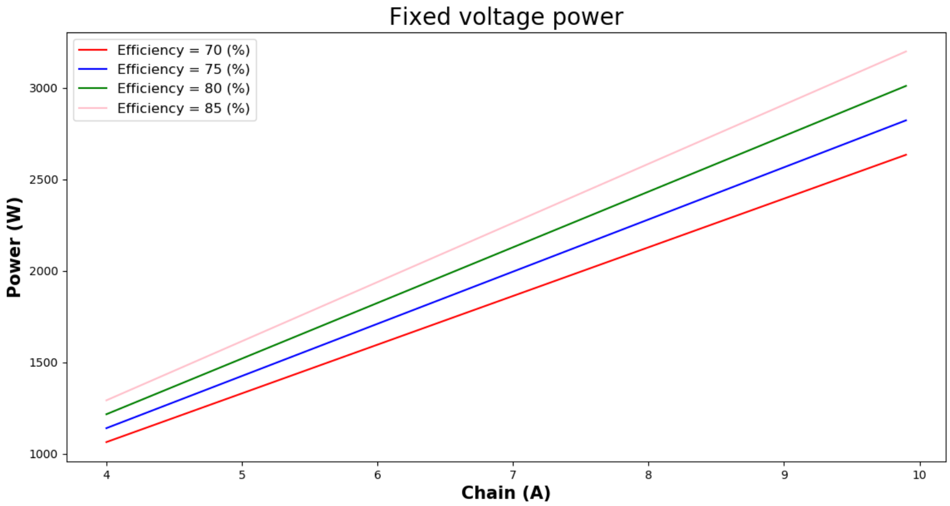
The third graph, Fig. 5, shows variation for the electric motor current and curves with different values for the voltage. According to Eq. 3, the power varies directly with the current and voltage, so increasing curves are formed.

Figure 5: Power of an electric motor subjected to current variation with 80% efficiency.



The fourth graph, Fig. 6, shows variation in the current passing through the motor. Curves with different values were plotted for the efficiency of the electric motor. According to Eq. 3, the power varies directly with the current and the efficiency of the motor, so there are increasing curves.

Figure 6: Power of an electric motor subjected to the change in current with a voltage of 380 V.



4 CONCLUSION

The developed application has great applicability for the correct dimensioning of the electric motor to be used, so that it can inform a fundamental requirement provided by the electric motors. It is important to note that from the power of the engine, several other elements of the system influence its performance, such as its efficiency.

With the results obtained, it was possible to perceive that the power of an electric motor exposes different behaviors in relation to voltage, current and efficiency. The results of the parameter analyzed, presented in the developed graphs, agree that the power of the electric motor is modified in a way directly proportional to all the values of the dependent parameters.

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