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DESIGN OPTIMIZATION OF A LIGHTWEIGHT CATEGORY COMBAT ROBOT

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Abstract: The DotBotz Robotics Team develops combat and autonomous robots, and among combat robots, there is a LightWeight category robot (27.2 Kg), developed in 2019 for the *Winter Challenge XV*. During the competition, the project presented problems in your structure, visa what O material was fragile at streaming in movement, that it was not efficient; and in the traction of its wheels, which made locomotion difficult. Based on the obstacles presented the need to optimize the project arose, aiming at greater competitiveness and also learning about concepts such as materials, mass transmission and distribution. To solve the problems to which the robot was submitted, the solutions found and applied at the project were changes at the method in streaming in movement in between at wheels, in the metal alloy of the frame material and in the shape and material of the wheels. The development of projects like this allows greater integration with the external community, spreading knowledge about robotics through initiatives social of the team and also with the exhibition from results and competitions per means in communications virtual.
Keywords: Robotics. Robot. Combat.

INTRODUCTION

In this article, the performance of a combat robot of the LightWeight category (27.2 Kg) will be discussed. in one competition, highlighting problems what project presented at the last event what participated and at improvements proposals

Robot combat is literally a fight between two teams' projects, the winner being the one who it has larger resistance and cause most damage to robot adversary. At fights happen in one arena with floor in steel and walls and roof in polycarbonate, being totally safe to the participants. Also are necessary pilots for you robots, visa what they are controlled via radio control.

According to the rules of RoboCore (2020), the company that organizes the biggest robotics competition in America Latin (*Winter challenge*), you robots are divided in categories in Weight. Each fight occurs with other robot of the same category and has a maximum duration of 2 minutes for robots in the smaller arena (150 g to 1.36 kg), and 3 minutes for robots in the larger arena (5.44 kg to 27.2 kg). If one of the robots does not move during 10 seconds, your opponent It is declared winner of the fight. Although, case you two beworking up until final of the fight, the decision it will be power plug by the judges, where are analyzed several criteria as aggressiveness, damage caused, between others.

In view of this, there are countless possibilities for improvements in a project that has already participated in a competition, in the event it is possible to raise a considerable number of ideas and tips when you want to improve a robot. The efficiency of solutions presented in this article it will be proven theoretically, already what in order to avoid agglomerations, the 2021 competitions continue with undetermined dates so far (August of 2021).

MATERIALS AND METHODS

The execution of this study occurred firstly with researches and lifting in ideas for Enhancement of robot, with objective in increase The competitiveness of project and purchase knowledgeduring the process. Later, some softwares were used for the practical development of the concepts addressed, and it is their SolidWorks 2018, with the goal in design robot (already withyour improvements) into a 3D CAD drawing; o Proteus, for simulating electrical circuits related to the part electronics of robot; and Microsoft Excel, for calculations and organization of information from the project.

The robot can be divided into two major areas, the mechanical and electronic parts. all mechanical part improvement project was carried out in SolidWorks 2018 software, defining the dimensions, materials and shape of each mechanical component. In addition, Microsoft Excel helped us calculations, which made it possible to obtain numerous information such as: final velocity, acceleration time, rotation of engines, kinetic energy, in between others.

Per the end, the software proteus allowed the simulation from circuits electric of robot, for check the efficiency from components electronics used, avoiding so problems what could to emerge during one competition.

RESULTS AND DISCUSSIONS

FEATURES OF ROBOT IN STUDY

The project what it is being object of this article It is a robot of the category LightWeight (27.2 kg) denominated *Ayuwoki*. This one project was developed for to be a robot offensive, what damage to maximum robot adversary. Your strategy for win the fight It consists in to destroy other robot with smaller number that is possible in blows, therefore for this one robot to have most chances in win the fight it is need what you have one good locomotion, with purpose in to hit you blows in manner most efficient, in addition in one good resistance, for no stay damaged and unable in fight before to have the opportunity in strike robot adversary.

COMPONENTS OF ROBOT IN STUDY

For a better understanding of the problems and solutions proposed in the aforementioned combat robot in this article, it is important the understanding in some components basics gifts at the project. At sequence It is introduced a brief summary about the main components and its purposes.

a) Drums: responsible for to provide energy for all you components electric of robot;

b) Engines: responsible per to transform energy electric in energy mechanics, where we use for to spin at wheels and accomplish the robot locomotion. We also use engines for to spin the rotor front of robot responsible for attacking your opponent;

c) Reduction box: it consists of a cylinder with several gears inside and is responsible for per accomplish the reduction of the rotation of motor electric for the wheels increasing the torque.

d) Wheels: are Responsible for to transform the rotation of axle in movement in translation of robot.

e) Belts: they are responsible for transmitting movement from one axis to another axis, and there may be reduction using many different diameters in pulleys.

CALCULATIONS

To perform the robot performance calculations, the following equations were used (HALLIDAY, 2009):

a) Calculation of the energy kinetics of the robot

$$K = \frac{m \times Vf^{2}}{\text{two}} \quad (1)$$

Where:
m = Pasta
vf = Speed Final

b) Calculation of the power

$$P = \frac{W}{\Delta t} \quad (2)$$

Where:
W = Job
vf = variation of time

c) Calculation of the energy of the rotor

$$E = \frac{M.\omega^2}{\text{two}} \qquad (2)$$

Where:

M = Angular moment about the axis of rotation of the rotor

ω = rotation angular

The results of those calculations are presented in the board 1.

Variable	Result
Speed Final of robot	**17.21 KM/H**
Energy kinetics of robot	**310.82 J**
Time in acceleration of robot	**0.0888 s**
Energy of the rotor	**12460.87 J**
Time in acceleration of rotor	**2,769 s**

Painting 1 – Result From calculations.

Source: authorship own (2021).

PROBLEMS PRESENTED

In the last competition in which the *Ayuwoki robot* participated (*Winter Challenge XV*), the project presented three main problems, which resulted in your disqualification:

The first problem introduced he was at part mechanics, most specifically at traction of wheels, what had poor adhesion to the arena's steel floor due to the type of rubber they were made from. manufactured. That defect resulted at difficulty in locomotion of the robot, facilitating you attacks opponents.

The second problem also occurred in the mechanical part, with the fracture of the aluminum alloy 7075-T6, after an impact from the other robot. This material has good mechanical strength, but also a very high hardness, which means that the material may break after an impact due to its brittleness. In addition of those features, O material what we use in specific, no owned one good quality, and, after a crystallographic analysis, it was possible to detect high porosity in its microstructure, as show The Figure 1.

Figure 1 - Analysis crystallographic of aluminum 7075-T6 used at structure of robot.

Source: authorship own (2021).

Finally, there was also a mechanical problem in the transmission part of the wheel movement. to the front ones, which was made with rubber belts and ended up sliding on the pulleys, not effectively transmitting the movement, what caused problems in locomotion of the robot.

PROPOSALS IN IMPROVEMENTS

To solve the problem of the low grip of wheels, it was chosen per to do the exchange of wheels per otherswhat have one rubber with best grip (Rubber vulcanized) and also larger toughness (50 shoreTHE), as show Figure 2.

Figure two – New wheel the to be used at the robot.

Source: Robocore.

For the problem of the material of the structure, it was decided to change the material of the robot to another alloy of aluminum. The alloy to be used is alloy 6061,

a more ductile material, which can absorb impacts better. without if break up. Although The resistance mechanics of that material It is smaller and for compensate that it was decided to do thicker pieces, thus maintaining balance. With this, another problem has arisen, which is the increase in pasta of robot, what it will be sorted out with the elimination of the structure external of robot, and also one decrease of the dough of rotor of robot.

To solve the problem of the streaming, resolved itself use chain bite to instead in belt in rubber, and thus the rotational motion is expected to be transmitted with the least possible amount of Slipping in the pulleys.

RESULTS AND DISCUSSIONS

Some modifications can only be proven effective when tested in practice, which could not be held due to the cancellation of competitions due to the COVID-19 pandemic. The Changing wheels is a case where it is not possible to know what the performance will be like. In the other modifications, possible to get an idea theoretical, validating the improvement at the project.

At the case of the exchange of the belt in streaming per chains cogwheels, as the streaming no It is done per slipping, no It is expected what you have losses in rotation per Slipping. That also It depends in one good execution of project, since one chain bad designed he can to introduce other malfunctions.

About The exchange of the turns on aluminum 7075 for the turns on 6061, second Callister and rethwisch (2012):

> "Ductility is another important mechanical property. It is a measure of the degree of plastic deformation that was supported until fracture. A metal that undergoes a deformation plastic much little or same none deformation plastic up until the fracture It is denominated fragile.".

Following this idea, the lower the ductility of a material, the more fragile it is, being more favorable if break up after an impact, while a material what it has one larger ductility has one greater plastic deformation before failure. According to this author, there is the percentage elongation of the materials selected above, as follows: 30% for aluminum 6061 and 17% for aluminum 7075. these statements, you can to test what for it is application the exchange of turns on in aluminum can bring a best performance for the robot.

CONCLUSION

According to the results presented, it can be said that a better performance of the project in the next competitions, once the problems that were the reasons in your failure in the competitions passed, of that form, O project will reach one larger competitiveness.

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