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HANDLING BALL ROBOTIZED MECHANISM - STUDY OF THE THEORETICAL MODEL, CONTROL AND MECHANICAL SIMULATION

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ABSTRACT

This paper describes in detail how was developed the study of the handling ball system in the ambit of the Middle Size League (MSL) competition, and the final purpose is to implement the developed system in the Minho Team robots. Beginning with the study of the state of the art, analyzing the systems already in use by other MSL teams, and taking in consideration the limited time to develop a completely new system, do a process of inverse engineering with base in the dutch team system, TechUnited, which was considered as the best option.

Taking the system above mentioned as the starting point, it was only used as base to develop a theoretical study. After several years developing their own system, they needed to conclude which factors have more significance and knowing which factors are important to develop the study the best way and quickly as possible. After the theoretical study, an analysis of the control system for the mechanical design to Minho's Team case has been taken place. Posteriorly the mechanical system was simulated and it was found to be the more appropriate solution to the studied case. The simulation was done using SimWise 4D software, iterating the parameters of the system and simulating until a good response of the system was verified for all the cases, considering them as the ones with the most importance and necessity. Concluding, all the variables that may be considered to the overall final design as well as the control final equations are presented.

Keywords: inverse engineering, handling ball systems, robotics.

INTRODUCTION

Middle Size League is a robotic football league that began in 1997. Since the beginning, one of the greatest challenges of the teams that participate in this league is designing a system capable of handling the ball well enough to perform simple and complex movements. However, as in many other competitions, there is a regulation that dictates the rules of the game. Regarding the mechanism that handles the ball the regulation states that:

- The ball handling must be done holding only one third of the balls' diameter;
- During the reception, it's allowed holding the ball till half of its' diameter;
- Any mechanical system for ball handling is allowed as long as it is safe;
- During the ball handling, the ball must have a natural rolling movement over the floor (ball dragging is not allowed).

Obviously, the main objective of this system is to receive the ball and maintain it during the maneuvering movements of the robot while satisfying the rules presented above. Many teams did their process of developing this system with the goal of obtaining the best solution

possible, being this solution composed by two handles with electric motors on their end further away from the robot, a system that we named “Grabbers”. To achieve the solution used today, many years of study were required, so, from that state of the art, designing a solution for our robot and studying the best control system will be the main objective of this article.

RESULTS AND CONCLUSIONS

In the end, after all the study work developed we can conclude that in terms of system control, the angular speed imposed in radians to the grabbers will be given by expressions 1 and 2:

$$\omega_{gE} = \frac{2v_{LS}\cos(45º - DS) + \sqrt{2}v_{RS}}{Rg} + \frac{\pi f(Pp_E)}{180} \quad (1)$$

$$\omega_{gD} = \frac{2v_{LS}\,\mathrm{sen}(45º - DS) - \sqrt{2}v_{RS}}{Rg} + \frac{\pi f(Pp_D)}{180} \quad (2)$$

Expression 1 would be for the left grabber and expression 2 for the right grabber. In these expressions refers to the translation speed of the robot given by the parameter LS, DS is the angle of the component LS relating to the front of the robot, corresponds to the angular rotation speed of the robot relating to itself given by the parameter RS, lastly, the functions $f(Pp_E)$ and $f(Pp_D)$ represent the adjust function regulated by the handle angle, this function was created and studied in the simulation of the mechanical mechanism. From this simulation, we can calculate all the different parameters in the scheme of figure 1.

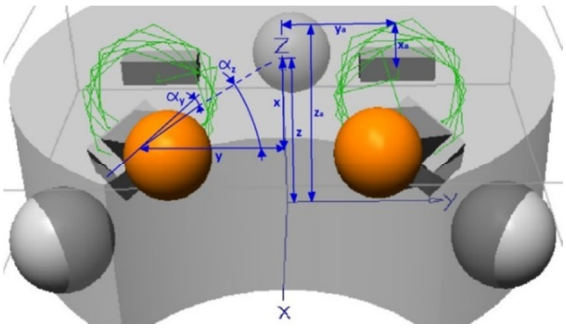

Fig. 1 - Scheme of the parameters used in the SimWise 4D simulation model

Based on the calculated values, the final design will be developed as well as its’ manufacturing process so that we can obtain the desired system in the simplest and economical way, incorporating the system then on the robot performing the necessary tests achieving thus the design validation.

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