TORQUE ANALYSIS AND SELECTION OF ROBOTIC ARM'S MOTORS

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Introduction: Nowadays, motors became an essential part of robotic arms that are used for too many fields. During motor selection, the parameters like motion type, motor sizes and torques must be considered. In this study, ninety-degree rotary motion of robotic arm which is articulated type and works with six servo motors, is examined and torque analysis is made for a servo motor by using Solidworks software. **Goal**: Engineers and designers must know which motor should be equipped in projects. To make a healthy motor selection, some parameters must be considered and motor torque is the one of them. This study is run to consider motor torque and make healthy motor selection to create safe machines. **Scope**: This consideration concerns all designers and engineers who works for manufacturing machines, also students who want to make robotic projects. Briefly, this study is to manufacture a several machines which has motors. **Limitations:** To make an analysis for motors, we need to select some motion. Solidworks is a software and we cannot trust it carelessly. We also need to know Solidworks software can give us incorrect results. To make sure, in this study, ninety-degree rotary motion which starts when robotic arm is parallel to the ground and finishes when robotic arm is upright to the ground, is considered. We select this motion because we know after this motion, when robotic arm is upright to the ground, level arm is zero so torque value must be zero. After the results which Solidworks gave us are checked, we are going to be able to make sure we get correct results or not. On the other hand, at the first position which is robotic arm is parallel to the ground, level arm has maximum value so torque value must be maximum. Thus, we have two limitations. The motions we select, starts when torque value is maximum and finishes when torque value is zero. **Method:** Before make an analysis, there must not be any assembly problem and material selection must be done. First Solidworks motion tab need to be activated in Solidworks add-ins and at the bottom panel, motion study is selected. Animation tab in the motion study panel is changed to motion analysis. There is a critical point. If Solidworks motion tab is not be activated, motion analysis tab does not appear. In the next step, the servo motor which provides a motion we need, is defined. Click on the motor button and select the motor location and go down in the motor panel and switch to segments tab from constant speed tab and apply the page after defining a linear ninety-degree motion in a second. Apply the segments page and motor panel. Now, we have a servo motor which provide a ninety-degree rotary motion in a second. Before the get results, the gravity must not be forgotten else we get incorrect results. To define a gravity, click on the gravity button and apply the page after set the direction of gravity. After defining the motor and gravity, everything is ready to get results. Click on the calculate button. When calculating is over, click on the results and plots button. In the opening panel, select the results type as forces-motor torque-magnitude and the RotaryMotor1 which we defined. If the page is applied now, the graphic which has motor torque and time plots, is

going to appear but in this study the second plot is selected as angular displacement instead of time. To change the second plot, switch to new plot tab from time tab and select the angular displacement of RotaryMotor1 in the opening tab. After setting the parameters of the graphic, apply the results page then the motor torque graphic appears. **Conclusions:** In the beginning, we predict that the torque which our motor must carry, is zero after this ninety-degree rotary motion because level arm is zero just as robotic arm is upright to the ground. So, when we look at the torque graphic, torque value is zero when robotic arm at the ninetieth degree and it means we have correct results. Likewise, we predict that at the first moment when robotic arm parallel to the ground, torque value which our motor must carry is maximum and it is 226 N-mm. **Results:** Consequently, in this study, the maximum torque value of the motor which is used, must be more than 226 N-mm to work safely and motor selection must be done based on that. Other way to reduce the motor torque value is shortening the arm length but it causes the space which robotic arm can reach, to be limited. Thus, all the parameters must be optimized based on budget. In this study, PowerHD-1160A servo motor is used and when the data sheet of this motor is examined, maximum torque value that the motor can carry is noticed as 2.7 kg-cm. When the transformation is done, the maximum torque value we get from graphic 226 N-mm equals to 2.3 kg-cm and it is less than 2.7 kg-cm so our robotic arm is going to work safely.

Key Words: Robotic, Arm, Torque, Solidworks, Analysis, Motion, Motor