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Review Article

A Simulation between Torque and Angle with Speed on Five Freedoms of Robot Mechanical Arm in Multibody Systems

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Abstract

The effective factor has the turn of M1>M2>M3 in robotic arm. It has too turn 0.5m/s, 5º/s> 0.3m/s, 8º/s> 0.1m/s, 11º/s within conditions. That says that the speed is larger than angular speed about its effect to torque. The biggest torque happens at 5 º/s and 0.5m/s in first robot arm which is 1800Nm. The least one is at 11 º/s and 0.1m/s in the third robot one which attains 9Nm. The turn of effective torque is small angular speed and hammer speed. When the angular speed arrives 3º/s and hammer speed attains 0.5m/s the 3000Nm torque may be formed.

Keywords: Torque; simulation; angle; angular speed; robot arm; multibody systems.

1. INTRODUCTION

Robot is a automatic machine used to industrious factory for a certain process which can save much time to human. Its mechanical arm is the most important system to operate in difficult place like movement、welded and distinguished products. The simulation has been preceded in this study which includes torque and angle and other parameters like speed, angular speed. Because the parameters are important in robotic mechanical arms the research must be done for further investigation of mechanical properties [1-4].

This study investigates the mechanical behavior of torque in the condition of different other parameters. It will find the intrinsic relationship between them through the comparing with each other to all the parameters. If torque has big one the capacity may be inclined but the machine size can be inclined too which cause the manufacture cost to be high. If torque has small one the capacity may be declined so the cost will be declined too. So this study will establish equation through Lagrange formula to search the torque size to compare with them and criterion in order to find the best capacity and size.

2. Simulations

The Lagrange equation is

$$\frac{d}{dt}\left(\frac{\partial E_K}{\partial \dot{q}_i}\right) - \frac{\partial E_K}{\partial q_i} + \frac{\partial E_P}{\partial q_i} = F_i \text{, (i=1,2,,...,n)} \quad (1)$$

Here E_K is kinetic of system; E_P is potential energy of system; q_i is generalized coordinate, it is a group of independent parameters that can define mechanical system movement; F_i is generalized force, when qi is a angular displacement it is a torque, when q_i is displacement it is a force.

The system kinetic energy is

$$E_k = \frac{1}{2}\sum_{i=1}^{n}(J_1\omega_1^2 + J_2\omega_2^2 + \cdots + J_n\omega_n^2) \quad (2)$$

$$E_p = g\sum_{i=1}^{n}(m_1h_1 + m_2h_2 + \cdots + m_nh_n) \quad (3)$$

Here m_i: mass in i component; J_i: rotary inertia in i component relative to center of mass; ω_i: angular velocity in i one; h_i: .height in i one.

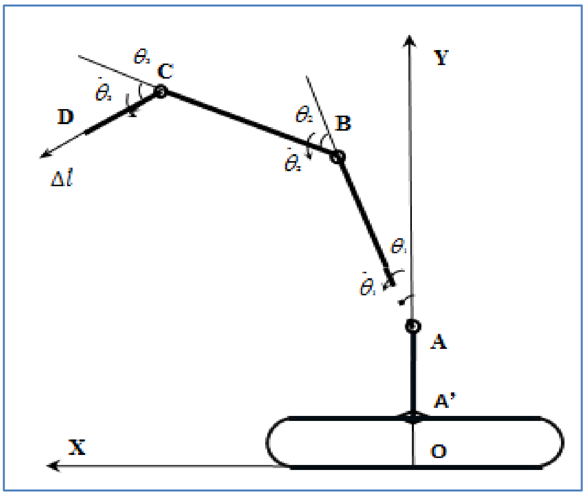


Fig-1: Principle schematic of mechanical arm in series in robot

As seen in Figure 1 three freedoms mechanism is shown. Hereθ_1 , θ_2 and θ_3 is angle in joints; $\dot{\theta}_1$, $\dot{\theta}_2$ and $\dot{\theta}_3$ is angular speed there; A、B、C and D is the terminal; Δl and $\Delta \dot{l}$ is the movement and speed in D point for hammer [5, 6].

3. DISCUSSIONS

In the modeling of three freedoms in hammer of robotic arm the kinetic formula is established according to Lagrange formula based on two freedoms robotic arm [5, 6]. It compensates the blank in three freedoms and one impulsion on robotic arm. It is found that the force is little and torque is big. Referring to the important occasion the kinetic formula will only be computed on three freedoms according to this study.

The effective factor has the turn of M1>M2>M3 in five freedoms of robotic arm. It has too turn 0.5m/s, 5°/s> 0.3m/s, 8°/s> 0.1m/s, 11°/s within conditions. That says that the speed is larger than angular speed about its effect to torque. The biggest torque happens at 5 °/s and 0.5m/s in second robot arm which is 1800Nm. The least one is at 11 °/s and 0.1m/s in the third robot one which attains 9Nm. The turn of effective torque is small angular speed and hammer speed.

In Figure 2(a) the arm1 torque decreases when θ_1 increases to near 500Nm with the speed of 0.5m/s and5°/s. The highest torque is about 700Nm at the angle equals 1.5 and at speed 0.5m/s and angular speed 5°/s in arm 1 in Figure 2(a~c). In Figure 2(b) in arm 3 it has been 9Nm whose value is the least among them.

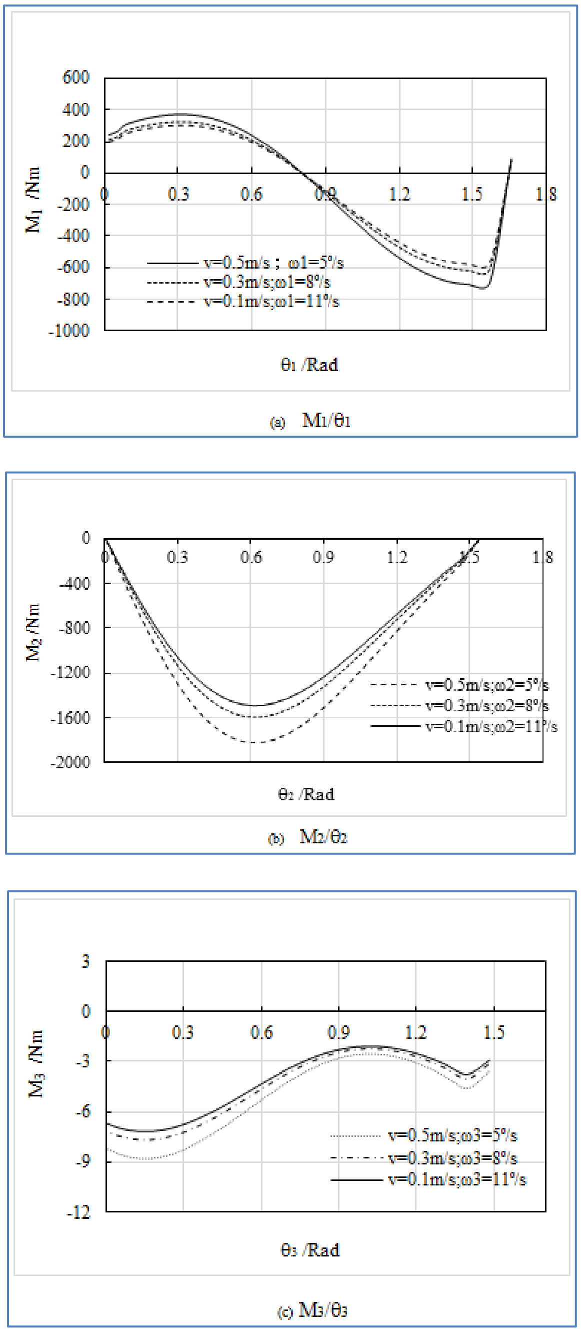
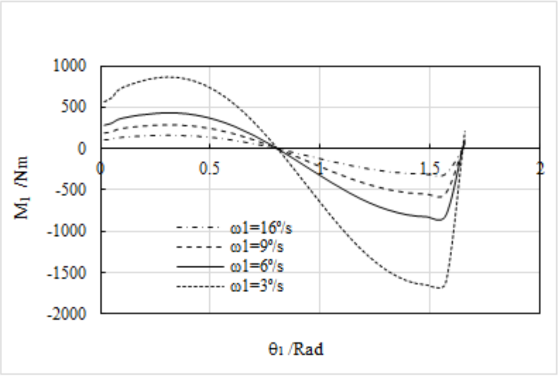
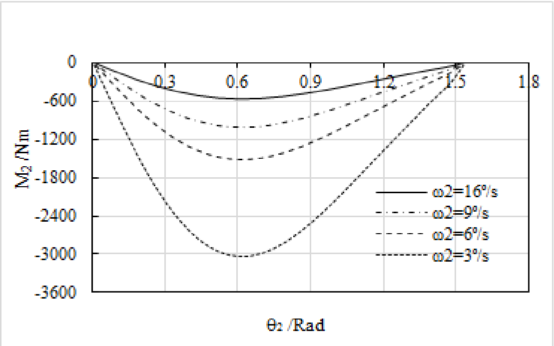


Fig-2: The drawing of torque and arm angle with various hammer & angular speed in robot mechanical arm

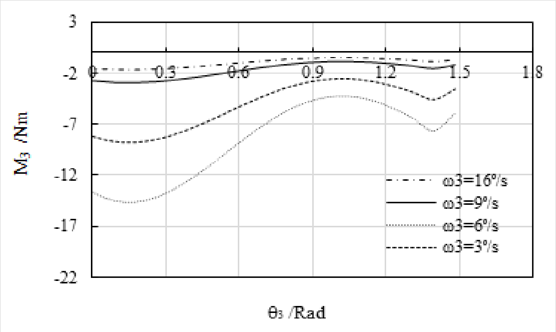
As seen in Figure 3(a~c) the highest one happens in arm 2 as 3°/s and 0.5m/s whilst the second one and third one is 1600Nm and 15Nm in arm 1 & 0.3m/s and arm 3 & 0.7m/s resepctively. As the angular speed becomes lower the torque is bigger from this figure.



(a) v=0.3m/s; M1/θ1



(b) v=0.5m/s; M2/θ2



(c) v=0.7m/s; M3/θ3

Fig-3: The drawing of torque and arm angle with various angular speed in robot mechanical arm

In general for the security the biggest one will be checked to ensure the available status which is not destroyed under heavy load. In this paper the condition of small angular and big hammer speed is the key for their securities. It must be checked for satisfactory property seperately.

4. CONCLUSIONS

1. The torque has the highest one with 1800Nm at 0.5m/s and5°/s whilst the one of lowest is 9Nm at 0.1m/s and 11°/s in hammer of robotic arm.
2. The torque has the highest one with 3000Nm at 0.5m/s and 3°/s. It may be declined when angular speed inclines.
3. The effective factor has the turn of M1>M2>M3 in robotic arm. It has too turn 0.5m/s, 5°/s> 0.3m/s, 8°/s> 0.1m/s, 11°/s within conditions. That says that the speed is larger than angular speed about its effect to torque.

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