International Journal of Research in Engineering
www.engineeringpaper.net
Online ISSN: 2664-8784, Print ISSN: 2664-8776
Received: 03-06-2021; Accepted: 15-06-2021; Published: 29-06-2021
Volume 3, Issue 1, 2021, Page No. 17-19

# A simulation between torque and angle with speed on robot mechanical arm of multibody systems

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**DOI:** https://doi.org/10.33545/26648776.2021.v3.i1a.34

**Abstract**
The effective factor has the turn of M1>M3>M2 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. The biggest torque happens at 5 °/s and 0.5m/s in first robot arm which is 500Nm. The least one is at 11 °/s and 0.1m/s in the third robot one which attains 80Nm. The turn of effective torque is small angular speed and hammer speed.

**Keywords:** torque, simulation, angle, angular speed, robot arm, multibody systems

## 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 proceeded 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.

## Simulation

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; $\omega_i$: angular velocity in i one; $h_i$:.height in i one.

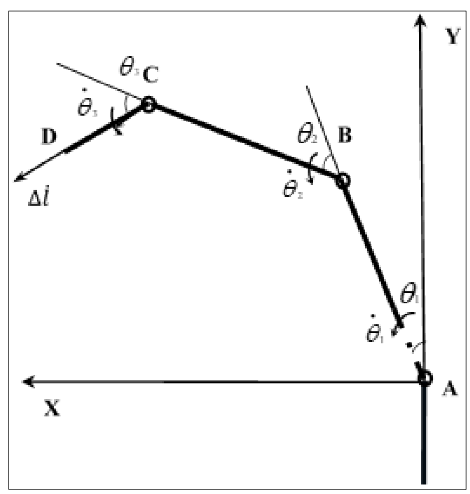



**Fig 1:** principle schematic of mechanical arm in series in robot

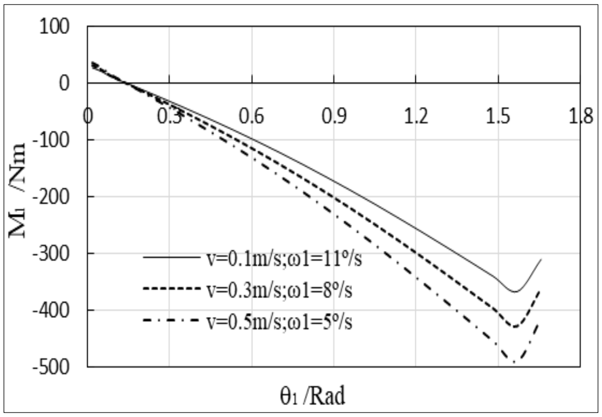
As seen in Figure 1 three freedoms mechanism is shown. Here $\theta_1$ , $\theta_2$ and $\theta_3$ is angle in joints; $\dot{\theta}_1$, $\dot{\theta}_2$ and $\dot{\theta}_3$ is angular speed there; A、B、C and D is the terminal; $\Delta l$ and $\Delta\dot{l}$ is the movement and speed in D point for hammer [5, 6].

**Discussions**

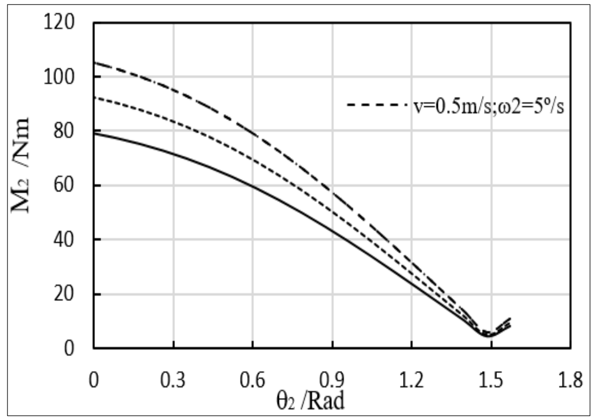
In the modeling of three freedoms in hammer of robotic arm the kinetic formula is established according to Lagrange formula based on two freedoms robotic arm [2]. It compensates the blank in three freedoms and one impulsion on robotic arm. It is found that the force is little and torque is big. Referring 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>M3>M2 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 500Nm. The least one is at 11 º/s and 0.1m/s in the third robot one which attains 80Nm. The turn of effective torque is small angular speed and hammer speed.

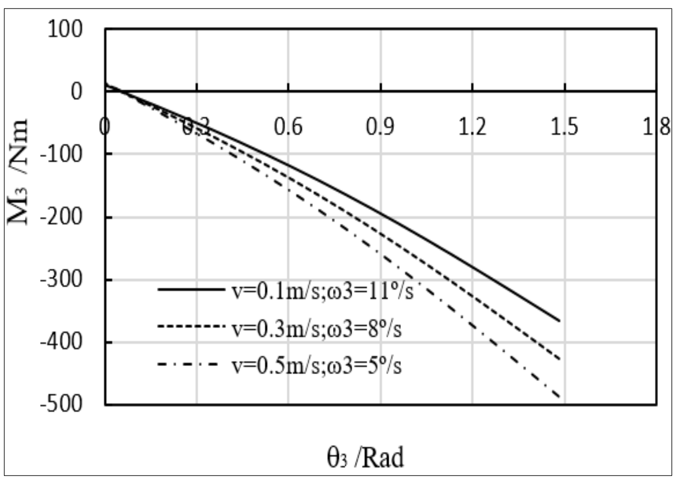
In Figure 2 (a~c) the arm1 torque decreases when $\theta_1$ increases to near 500Nm with the speed of 0.5m/s and5º/s. The highest torque is about 500Nm at the angle equals 1.5 and at speed 0.5m/s and angular speed 5º/s in arm 1 in Figure 2(a) and Figure 2(c). In Figure 2(b) in arm 2 it has been 110Nm whose value is the least among them. As seen in Figure 3 (a~c) the highest one happens in




A. M1/θ1

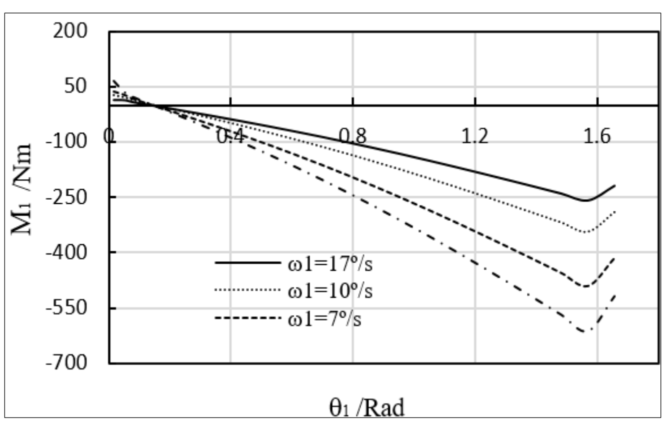



B. M2/θ2

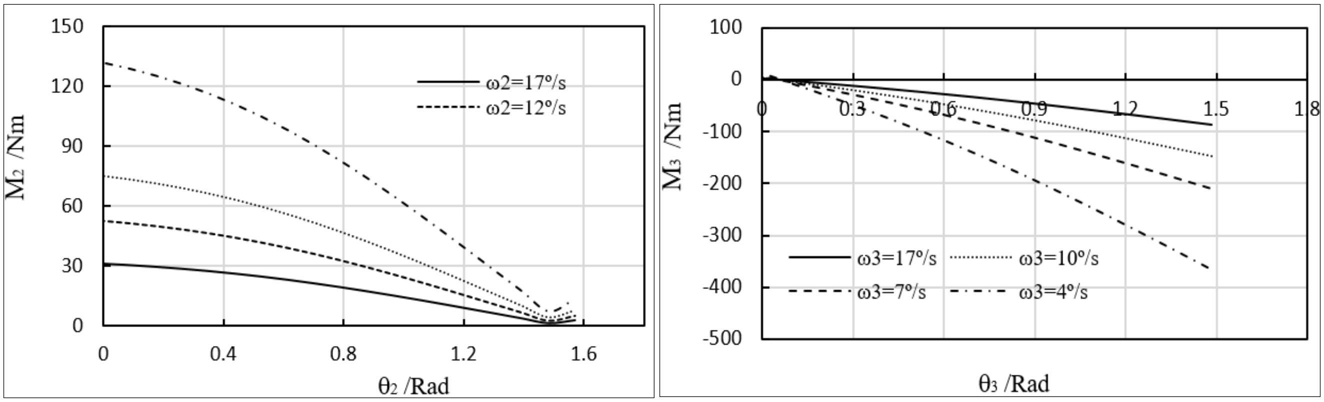



C. M3/θ3

**Fig 2**




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 angle with various angular speed in robot mechanical arm.

Figure 3(a) with 600Nm under 0.5m/s and then in Figure 3(c) with 380Nm under 0.7m/s at angular speed of 4º/s and 1.5rad. The least one may happen with 130Nm under 0.5m/s in Figure 3(b).

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.

## Conclusions

1. The torque has the highest one with 600Nm at 0.3m/s and 4º/s whilst the one of lowest is 130Nm at 0.5m/s and 4º/s in hammer of robotic arm.
2. The torque has the highest one with 500Nm at 0.5m/s and 5º/s. It may be declined when speed and angular speed inclines.
3. The effective factor has the turn of M1>M3>M2 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.

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