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Review Article

The Modelling of Torque and Angular Speed with Time on Hammer by Lagrange Formula in Robotic Arm

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Abstract

Through modelling it is found that the torque value attains 4000Nm with arm and hammer speed of 0.6º/s and 0.05m/s respectively with including arm3 whilst the torque arrives 480Nm with 5º/s and the same hammer speed of 0.05m/s with kinetic energy of only hammer. The torque has been the least of 80Nm at 30º/s with one kinetic system. Meantime the one may be 620Nm at 4 º/s with two kinetic system. That means that the least torque is formed through the biggest speed and hammer kinetic system. For the cost declining the less torque may be adopted and for the security the bigger one may be chosen. In this paper the less one is a factor for the cost declining. It is found that the effect turn is angular speed being bigger than hammer speed. So we shall pay more attention to the former. The angular speed is smaller the torque is higher.

Keywords: torque and angular speed; modelling; five freedoms; hammer; Lagrange formula; robotic arm.

1. INTRODUCTION

The robot is a widely used machine currently in flow line of products at factory. The working part is mainly their mechanical arms so it may be modeled their kinematic equation so as to solve their solution and find their intrinsic relationship. In this paper the hammer robotic machine has been searched which applies to occasions like destroying construction. So it is a very urgent thing to establish their equation. In this paper the Lagrange formula has been used to establish equations of their hammer and two kinetic systems respectively. Because the torque is important in robotic mechanical arms the research must be done for further investigation of mechanical properties [1-4].

This study searches their two kinds of kinematic equations and find the prior turn which affects the one. We adopt the resolved method to separate their connection with two parts. It is found that the role of angular speed and hammer speed. The angular speed has been effective to compare with hammer one so the former is prior to later which is found here. On the other side the two kinetic systems is more sensitive than one system. It is investigated that the big and small angular speed is included to look for intrinsic relation among them. We use Lagrange formula to apply to the hammer terminal and third arm to find deep relation of them. One of them fits to only hammer whilst another fits to both of them in order to observe the difference between them.

2. Modelling

The Lagrange equation is

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

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

$$E_k = \frac{1}{2}\sum_{i=1}^{n}(m_i v_i^2 + J_i \omega_i^2) \qquad (2)$$

$$E_p = g\sum_{i}^{n}(m_i h_i) \qquad (3)$$

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.

Here $J_i = \frac{1}{3} m_i l_i^2$

Due to

$$\begin{cases} F_{31} = m_3(\dot{v} - v\dot{v} + g) \\ F_{32} = m_3(\dot{v} - v\dot{v} + g) + \frac{2}{3} m_3 l_3^2 \dot{\omega}_3 (1-\omega_3) \end{cases} \quad (4)$$

And

$$F_3 = \sum_{k=1}^{m}\left[F_k \frac{\partial s_K}{\partial q_1}\cos\alpha_k\right] + \sum_{j=1}^{n}\left[M_J \frac{\partial \varphi_J}{\partial q_1}\right] \quad (5)$$

This is generalized force equation. Here q is generalized coordinate; $\dot{q}$ is velocity of q.

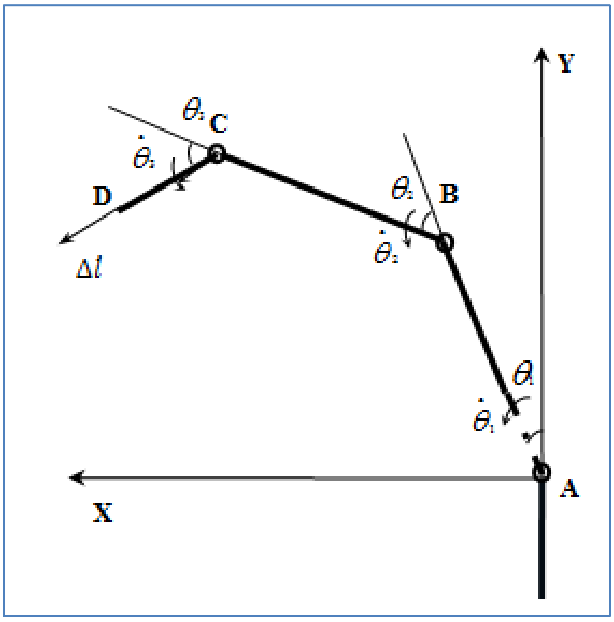


Fig-1:The schematic of mechanical arm in series in robot

As seen in Figure 1 three freedoms mechanism is shown. Here θ_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].

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. [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 Figure 2 expresses that the force through model has been about 70~45Kg with hammer kinetic one. When the hammer speed inclines the force may be inclining too. They may become a equal parallel line after 0.25s. The relationship is the same as the two kinetic one in terms of this study.

The effective factor has the turn of angular speed >hammer speed in robotic arm that may be seen from Figure 3 &4. So we shall think angular one firstly and then hammer one. The former is almost 10 times to compare with the later.

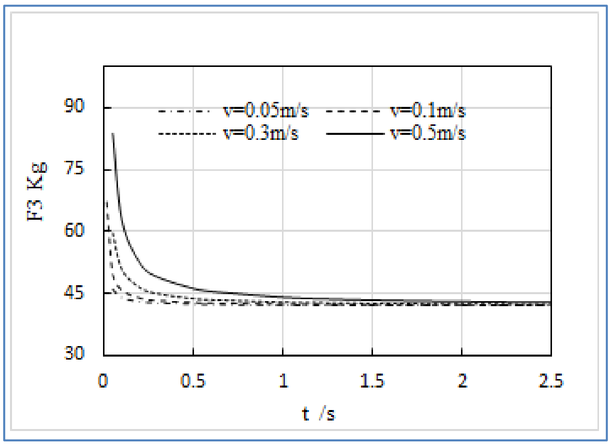
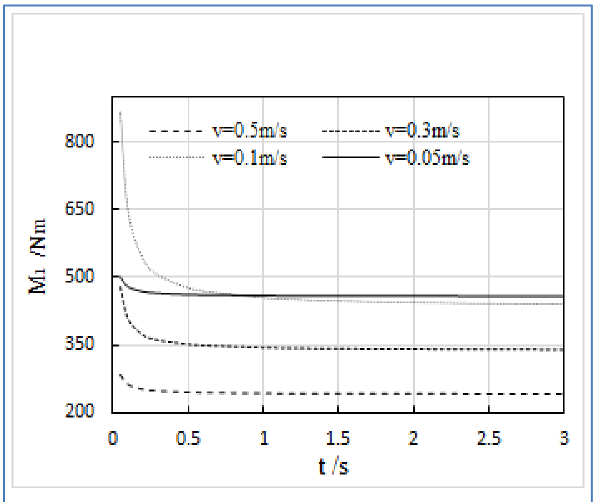
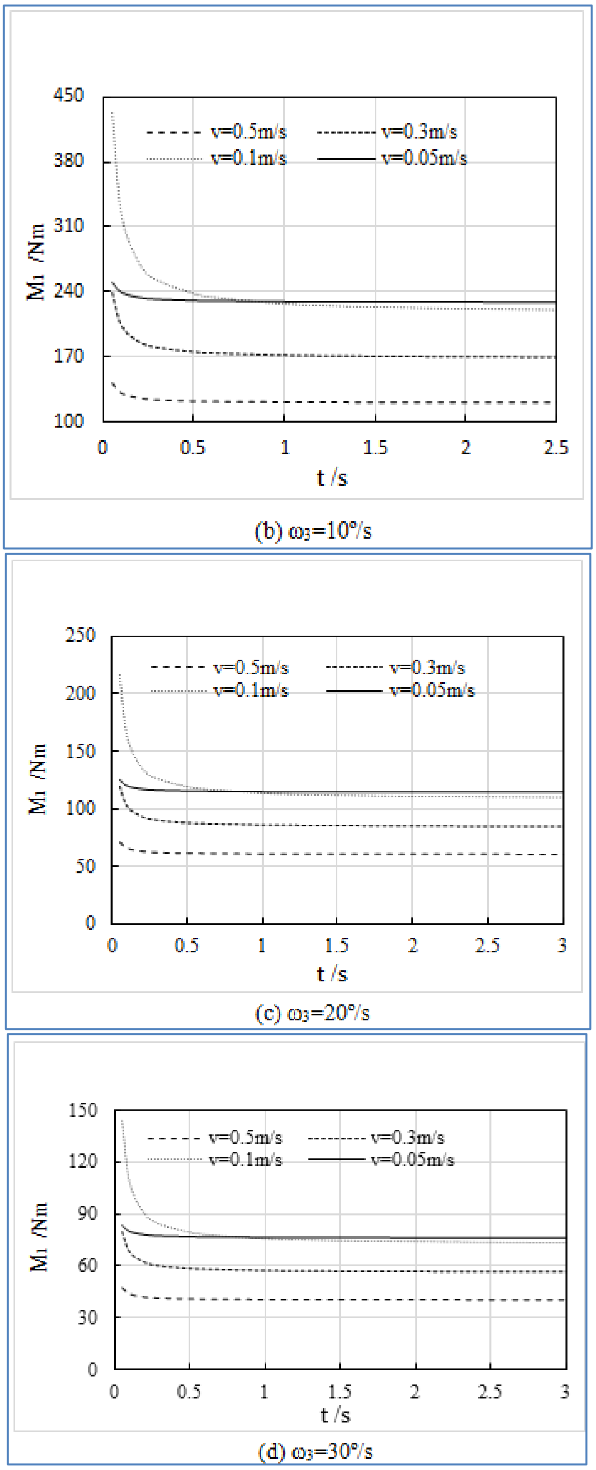


Fig-2: The relationship between hammer force and time with its speed in hammer kinetic of 3-2 of system



(a) ω_3=5°/s



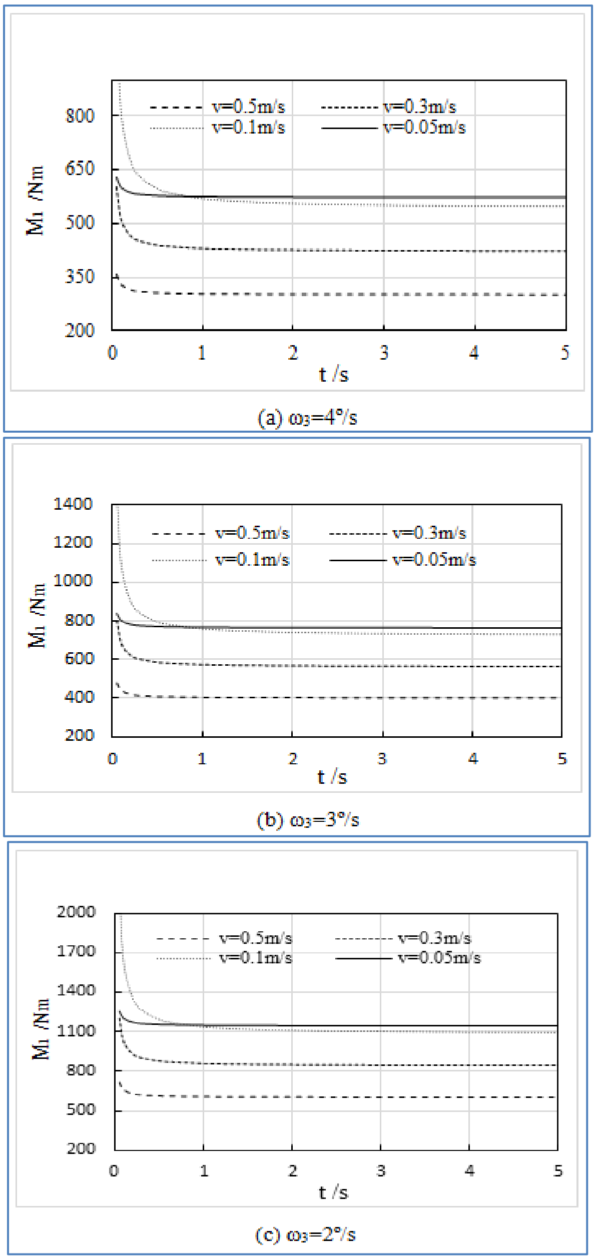
(b) ω_3=10°/s

(c) ω_3=20°/s

(d) ω_3=30°/s

Fig-3: The relationship between torque$_{3\text{-}1}$ and time with peedangular speed in hammer & arm$_3$ kinetic of system

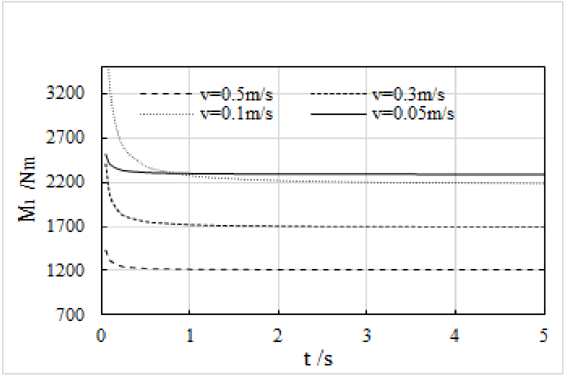
As seen in Figure 3(a~d) the torque with three-one hammer is 480Nm at arm3 of 5°/s and hammer speed of 0.05m/s. As seen in Figure 4(a~e) the torque with hammer and arm$_{3\text{-}2}$ is 4000Nm dominantly which is about 10 times of former at arm$_3$ angular speed of 0.6°/s and the same as hammer speed. It explains that the torque attains the biggest under the least arm and hammer speed. The step of torque with angular speed 1°/s will incline steeply in three-two kinetic system to compare with three-one hammer system which is observed in this study.



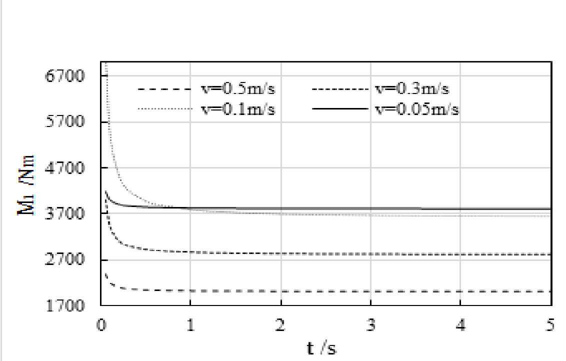
(a) ω_3=4°/s

(b) ω_3=3°/s

(c) ω_3=2°/s



(d) ω_3=1°/s



(e) ω_3=0.6°/s

Fig-4: The relationship between torque$_{3\text{-}2}$ and time with speed &angular speed in hammer & arm$_3$ kinetic of system respectively

In short two kinetic systems are investigated and find two kinetic one is more sensitive than three-one system. The least torque happens at 4°/s in three-two system whist that one happens at 30°/s in one system. To seperate the three-two with movement and hammer it seems that the three-two system is more effective than one since the angular speed is small. The angular speed is smaller the torque is higher.

3. CONCLUSIONS

The torque with three-one hammer is 480Nm at arm$_3$ of 5°/s and hammer speed of 0.05m/s. The torque with hammer and arm$_3$ is 4000Nm dominantly which is about 10 times of former at arm$_3$ angular speed of 0.6°/s and the same as hammer speed.It explains that the torque attains the biggest under the least arm and hammer speed.

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