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The Dynamics &Torque and Force-Angle Relation on Velocity of Hammer with Lagrange Equation in Robotic Arm I

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Abstract: *- the dynamic equation of three freedoms is established hammer in robotic arm by Lagrange equation. In the simulation occasion the dynamic equation will be computed in three freedoms according to this study. The force decreases a little with increasing angle3 from 0 to 2N with 0.05m/s while the torque decreases from 0 to 40Nm with the angle. Meantime torque decreases from 0 to 30Nm with the v of 0.2m/s. With increasing speed to the one M2 can reduce from 180Nm to 20Nm with the 0.5m/s meantime it is 240Nm with 0.3m/s. The highest torque M2 has 330Nm at the angle θ2 equals 0. The angel1 torque decreases when θ1 increases from 0 to from 150Nm to 1400Nm with the speed of 0.1m/s.*

Keywords:*- Dynamic Equation, hammering , three freedoms; torque; force; angel; velocity; Robotic Arm, Lagrange Equation*

1. Introduction

The robotic arm shall be studied detail that dynamic equation is established to grasp each parameters to wield its virtual use value. Because it has main two freedoms one is rotation and the other is punch it’s this equation will be established according to these features. The each dynamic equation is plotted then substitute into Lagrange equation to search for the dynamic equation to be established. [1~4] Because it has three parts to move and hammering below equation is to be solved according to each parts movement. After establishing this equation it can be analyzed by related parameters to optimum and cost decreasing. The length and mass of components and position will be control parameters. So in this paper these parameters will be further discussed to look for cost decreasing. [5, 6] It is hopeful to assist designer and related teacher in studying further at factory and university. In this paper the dynamic equation in the three freedoms of mechanical arms is established to satisfy the college research even industrial demand and further study in detail. In mechanical arm what the freedoms is chosen is Most important to robot behavior because the three freedoms is more advanced and complicated than two freedoms. The amount of equation is important so it will be found that it is much or little to its complication to calculation course. Simplification and rapid and efficient computation is our aim.

In modern industry the activity of robotic arm is high as an automatic device. It is an important branch for the Robot. Its feature has been completing anticipated working task by program. It is an automatic device for robot technological field to be gained the most practical applications that is in industry manufacture, medical healing, military, semi-conductive manufacture and space exploring. Its structure and property have an advantage of human and robot respectively especial in exhibiting human intelligence and adaption. Its precision and capability in all kinds of environment is excellent so that it has wide prospects in each field of economy. The punching destruction is often used in destruction applications.

2. Torque and Force Curves

As seen in Table 1 the parameter in robot arm is listed. [6]

Table 1 Parameters of robot arms

items	Value
l1 /m	0.55
l2 /m	0.5
l3 /m	0.3
m1/N	7.7
m2/N	6.6
m3/N	4.0
l4 /m	0.35
l5 /m	0.3
$\dot{\theta}_1$ /°/s	4
$\dot{\theta}_2$ /°/s	4
$\dot{\theta}_3$ /°/s	4
$\ddot{\theta}_1$ /°/s	3
$\ddot{\theta}_2$ /°/s2	3
$\ddot{\theta}_3$ /°/s2	3

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 q_i is an angular displacement it a torque, when q_i is linear displacement it a force;

N is system generalized coordinate.

System generalized force is supposed that F_k(k=1,2,..,m) and M_j(j=1,2,..,n) is force and torque acting on system. Its power is

$$P=\sum_{k=1}^{m}(F_k v_k \cos\alpha_k)+\sum_{j=1}^{n}(\pm M_j \omega_j)$$

(2)

Here ω_j: angular velocity acting on component with M_j;

v_k: the velocity in force F_k point of action; (the syntropy +, reverse direction -)

a_k: angle between F_k and v_k

When generalized coordinates is φ angular displacement generalized force=equivalent torque M_e.

$$\delta W_2 = \sum_{k=1}^{m}(F_k \delta v_k \cos\alpha_k) + \sum_{j=1}^{n}(\pm M_j \delta\omega_j) \quad (3)$$

Here a_K is zero; F_K =; v_K =; ω_j =; M_j =. $\delta\varphi_j$ Is virtual angular displacement; δs_k is virtual displacement.

Supposing that

$$\delta s_K = \frac{\partial s_K}{\partial q_1}\delta q_1 + \frac{\partial s_K}{\partial q_2}\delta q_2 \quad (4)$$

$$\delta\varphi_K = \frac{\partial\varphi_j}{\partial q_1}\delta q_1 + \frac{\partial\varphi_j}{\partial q_2}\delta q_2 \quad (5)$$

Replace equation below with above two equations

$$\begin{cases} F_1 = \sum_{k=1}^{m}\left[F_k \frac{\partial s_K}{\partial q_1}\cos\alpha_k\right] + \sum_{j=1}^{n}\left[M_J \frac{\partial\varphi_J}{\partial q_1}\right] \\ F_2 = \sum_{k=1}^{m}\left[F_k \frac{\partial s_K}{\partial q_2}\cos\alpha_k\right] + \sum_{j=1}^{n}\left[M_J \frac{\partial\varphi_J}{\partial q_2}\right] \end{cases}$$

(6)

This is generalized force equation.

3. Results and Discussion

In terms of dynamic equations it is calculated that the drawing between two parameters. Here v is the hammer velocity in part 3, it is supposed to be 0.02~0.5m/s. Force Fj and torque Mj could be computed in terms of angle θ and acceleration a. Mj is based on v. Fj is based on equation above. Detailed analysis and drawing between them is as below:

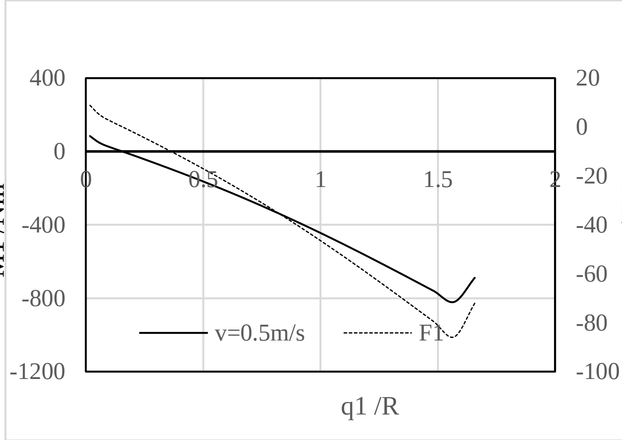

Figure 1 the relations of F1 and Mj & θ1 in robot arm.

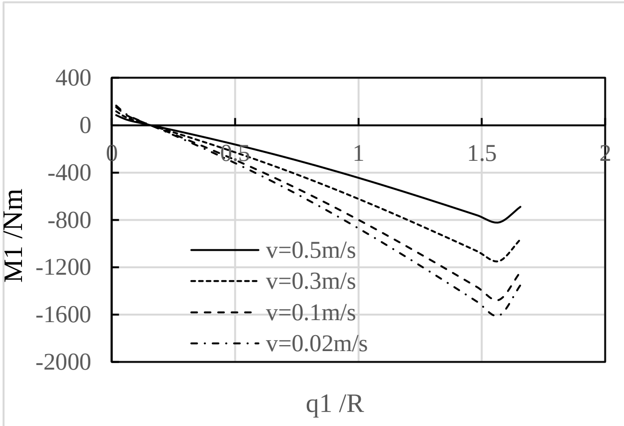

Figure 2 the relations of M1 & θ1 with the speed v in robot arm.

And as seen in Figure 1 the force decreases with the increasing angle θ1 from 12N to 88N. The M1 torque decreases when θ1 increases from 0 to $\frac{\pi}{2}$ from 150Nm to 1400Nm with the speed of 0.1m/s. As Figure 2 with increasing speed to 0.5m/s the torque will reduce to -800Nm with the one of 0.5m/s. It is 1100Nm with 0.3m/s. The biggest M1 is at 0.02m/s which has the one about 1600Nm.

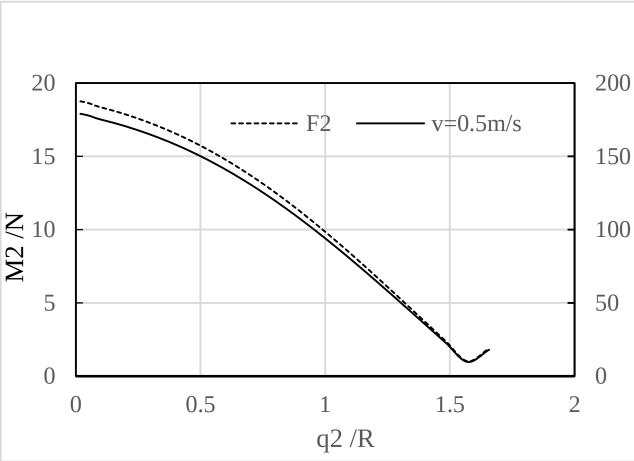

Figure 3 the relations of F2 and M2 & θ2 in robot arm.

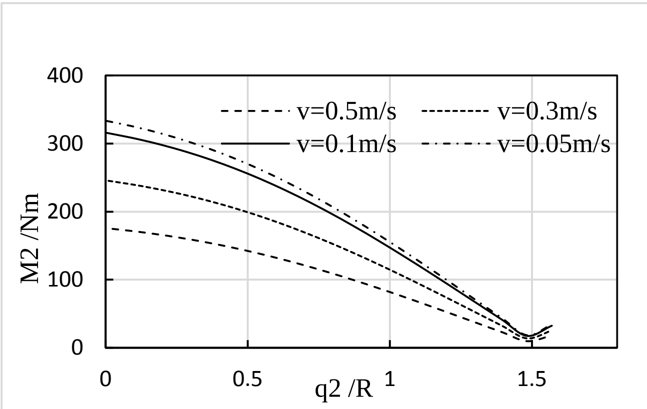

Figure 4 the relations of M2 & θ2 with the speed v in robot arm.

As seen in Figure 3 F2 reduces when angle changes from above value. The M2 decreases from 180Nm to 20Nm with the same speed above as Figure 4. With increasing speed to the one M2 can reduce from 180Nm to 20Nm with the 0.5m/s meantime it is 240Nm with 0.3m/s. The highest torque M2 has 330Nm at the angle θ2 equals 0.

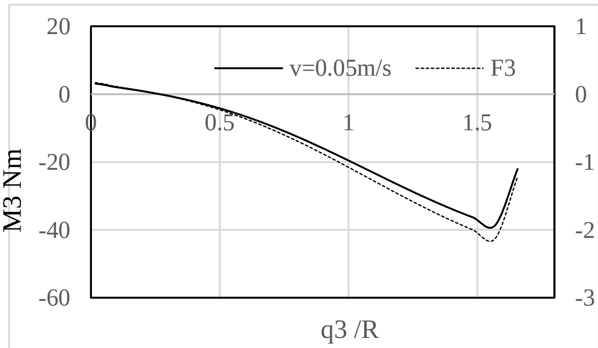

Figure 5 the relations of F3 and M3 & θ3 in robot arm.

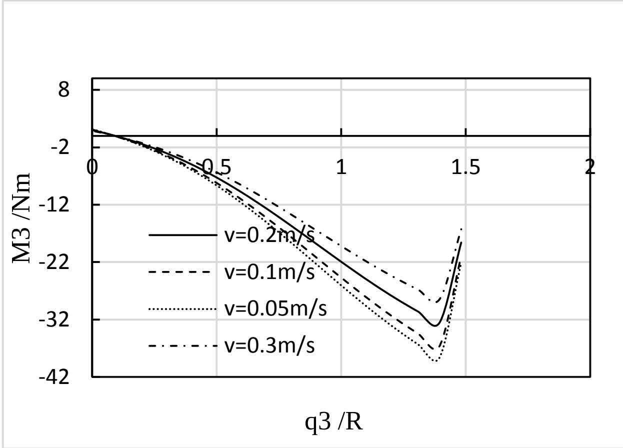

Figure 6 the relations of M3 & θ3with the speed v in robot arm.

As Figure 5 the force decreases a little with increasing angle3 from 0 to 2N with 0.05m/s while the torque decreases from 0 to 40Nm with the angle. Meantime in Figure 6 torque decreases from 0 to 30Nm with the v of 0.2m/s. The torque raises in terms of speed decreases. The biggest one is at 0.05m/s which has been 38Nm.

4 Conclusions

In the modeling of three freedoms in hammer of robotic arm the kinetic equation is established according to Lagrange equation based on two freedoms robotic arm. It compensates the blank in three freedoms for robotic hammer arm. It is found that the first and second item is complicated and long besides others is concise. In the simulation occasion the dynamic equation will be computed on three freedoms according to this study. The force decreases a little with increasing angle3 from 0 to 2N with 0.05m/s while the torque decreases from 0 to 40Nm with the angle. Meantime torque decreases from 0 to 30Nm with the v of 0.2m/s. With increasing speed to the one angle2 can reduce from 180Nm to 20Nm with the 0.5m/s meantime it is 240Nm with 0.3m/s. The highest torque M2 has 330Nm at the angle θ2 equals 0. The M1 torque decreases when θ1 increases from 0 to $\frac{\pi}{2}$ from 150Nm to 1400Nm with the speed of 0.1m/s.

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