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The Optimal Design for Grip Force of Material Handling

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***Abstract*—**Applied a mouse's roller with a gripper to increase the efficiency for a gripper can learn to a material handling without slipping. To apply a gripper, we use the optimize principle to develop material handling by use a signal for checking a roller mouse that rotate or not. In case of the roller rotates means that the material slips. A gripper will slide to material handling until the roller will not rotate. As this experiment has test material handling for comparing a grip force that uses to material handling of the 10-human with the applied gripper. We can summarize that human exert the material handling more than the applied gripper. Because of the gripper can exert more befit to material handling than human and may be a minimum force to lift a material without slipping.

***Keywords*—**Optimize, Gripper, Mouse's Roller, Minimum Force.

I. Introduction

HUMAN will move with Optimization with unconscious such as material handling. We will not exert the material handling exceedingly the necessity. All procedure of the body will learn from the experience and all of the five senses from the environment and it will interfere. In the age of technology now, there are many innovations that can search work equally with the human, it is a robot. The technology handling robots are the most popular in the manufacture industry and also in the medical system too. There are systems that the originators was sat up such as the sensor to measure the distance [1], or using a lot of stain gage [2], or use the system photographs for check the change of semicircle material [3], or using pneumatic in the gripper [4]. Although, for the experiment we will spend a lot of budget, but it give us the good effective. It will be better if we can design the gripper that cheaper than we have and can be usable effectively. Thus in this research we try to design the gripper that has the ability in the action of material handling. Use the principle of the friction between the skin of the material with a roller mouse. Then, if the material slips, the gripper will enhance the force to touch continually until it can catch the work with the force that is optimized.

Next we will mention about the design of gripper that is used in this research.

II. The Gripper's Design

We use the mouse's roller to apply with the gripper for check the material slip. By attach the roller mouse to the gripper to use instead of its finger. In this experiment we use a small size of the aluminium roller mouse to structure the gripper and use servo motor to slide gripper to grab material that is shown in Fig. 1.

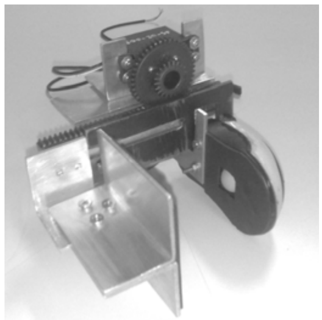

Fig. 1 Roller mouse attached gripper

The gripper uses rubber sheet to increase the friction force when the gripper works. And the design of gripper base is shown in Fig. 2.

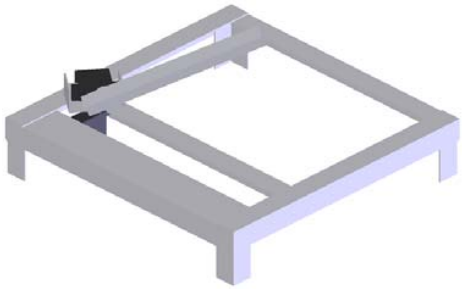

Fig. 2 Gripper installed base

In this work system the gripper will slide to the material and grab it up then the signal will check from mouse's roller, change or not. If the signal changes because of the roller was moved this will make gripper move to the material until the signal is stable, the material doesn't slip.

In the next section is mentioned about motion of equation for robot arm.

III. Motion of Equation for Robot Arm

The arm base that use to attach the gripper is 2R-Robot type, it has angular movement with 2 dimensions which is shown in Fig. 3.

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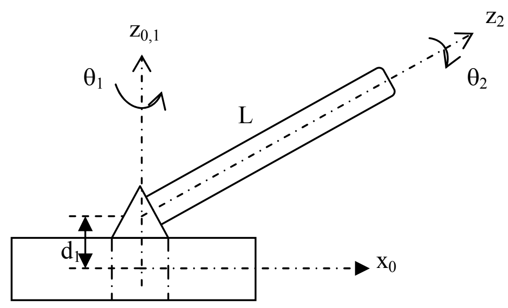

Fig. 3 Simple explanation of 2R-Robot

From Fig. 3, it can solve the motion of equation for robot arm by consider from DH-Parameter [5,6] as the Table I.

TABLE I
VALUE OF DH-PARAMETER

Link	a_i	d_i	α_i	θ_i
1	0	25	0	θ_1
2	300	0	-90	θ_2

From Table I it can find transformation matrix value by equation 1:

$$T^{i}_{i-1} = \begin{bmatrix} \cos\theta_i & -\sin\theta_i\cos\alpha_i & \sin\theta_i\sin\alpha_i & a_i\cos\theta_i \\ \sin\theta_i & \cos\theta_i\cos\alpha_i & -\cos\theta_i\sin\alpha_i & a_i\sin\theta_i \\ 0 & \sin\alpha_i & \cos\alpha_i & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

Then represent value from Table I to equation 1 of equation 2 and 3

$$T^{1}_{0} = \begin{bmatrix} \cos\theta_1 & -\sin\theta_1 & 0 & 0 \\ \sin\theta_1 & \cos\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

$$T^{2}_{1} = \begin{bmatrix} \cos\theta_2 & 0 & \sin\theta_2 & 300\cos\theta_2 \\ \sin\theta_2 & 0 & -\cos\theta_2 & 300\sin\theta_2 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (3)$$

Equation 4 will shown the sum of equation 2 and 3

$$T^{2}_{0} = \begin{bmatrix} \cos(\theta_1+\theta_2) & 0 & \sin(\theta_1+\theta_2) & 300\cos(\theta_1+\theta_2) \\ \sin(\theta_1+\theta_2) & 0 & -\cos(\theta_1+\theta_2) & 300\sin(\theta_1+\theta_2) \\ 0 & -1 & 0 & 25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

From equation 4, will create matrix of rotation in equation 5

$$\text{Matrix of rotation} = \begin{bmatrix} \cos(\theta_1+\theta_2) & 0 & \sin(\theta_1+\theta_2) \\ \sin(\theta_1+\theta_2) & 0 & -\cos(\theta_1+\theta_2) \\ 0 & -1 & 0 \end{bmatrix} \quad (5)$$

And equation 4 will shown vector of translation in equation 6:

$$\text{Vector of translation} = \begin{bmatrix} 300\cos(\theta_1+\theta_2) \\ 300\sin(\theta_1+\theta_2) \\ 25 \end{bmatrix} \quad (6)$$

From equation 6 the x-dimension's vector of translation was 300 cos ($\theta_1+\theta_2$), the y-dimension's vector of translation was 300 sin ($\theta_1+\theta_2$), the z-dimension's vector of translation was 25, that can solve the control position of robot arm later.

Next section is about the applied of mouse's roller and how to use it in this experiment.

IV. THE MOUSE'S ROLLER

In this prominent research point that installation a mouse's roller keeps inch of material handling one side for the equipment checks slipping of the material. The reason we select the mouse's roller to use in this case because of the cheapness. And we can audit the slipping by use the principle that a roller has touched the work surface already. When there is the movement of a mouse or the surface touches, the cog of mouse' roller will turn for block a signal that was signaled depart the transmitter reaches signal receiver and will check that how much do a signal change ? [7], which is shown in Fig. 4.

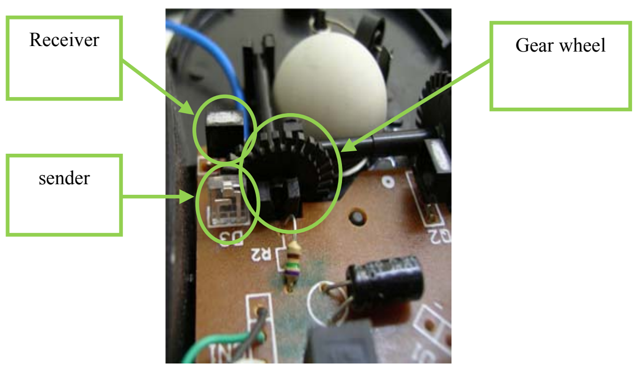

Fig. 4 The system within a roller mouse

But, in this research takes an interest only a signal has change or not. If there is the change happens, there is the movement of a mouse or the surface touches. Thus then have the tow late a signal directly from signal receiver for checks a signal that is or not is the change? For manage in the step next.

Next we will mention about designing system controls that make work handle can work efficiently.

V. Designing System Controls

This research has used a program lab view [8] cooperate data acquisition card. On designing system control, the work step of gripper is shown in Fig. 5.

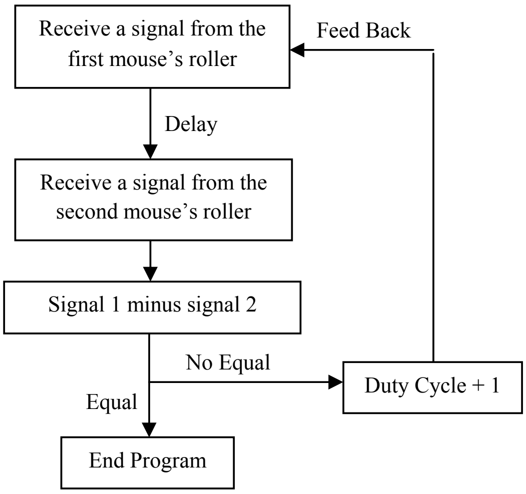

Fig. 5 Block diagram shows work step of the system

From Fig. 5, the system control to begin from taking value a signal from a roller mouse. If a roller is rotating that means the material is slipping. Thus a program will take a signal that comes for the first time. Next, we will take a second signal to compare with the first signal that it equal or not. If doesn't equal, the program will add value expansion duty cycle once again for the gripper will come to catch the work tight again until a roller do not rotate or a signal from a roller mouse has not changed by use a program LabVIEW that is shown in Fig. 6.

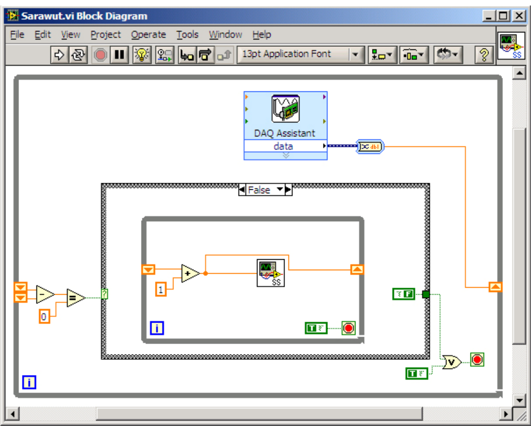

Fig. 6 A program that is used in the work of the system

From Fig. 6 it can be seen that there are sub-programs (Sub VI) which help a program to manage the servo motor. The program will send the PWM signal from the duty cycle which is shown in Fig. 7.

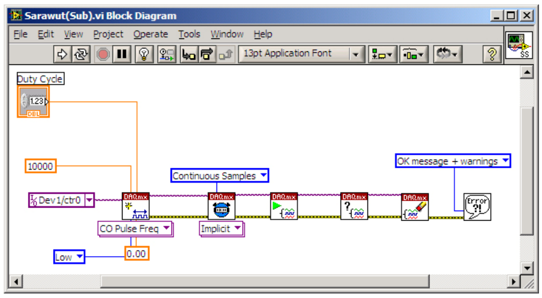

Fig. 7 A sub-program (Sub VI)

After a program of the system control gripper has set up a roller mouse already. Next the designing experiment in order to get the force test that use in the material handling. Gripper has to design that it can exert catch better than human.

VI. Designing Experiment

In this experiment, we test with 10 human and the gripper that set up a roller mouse. We do the experiment of material by use the differential weight 100, 200, 300, and 400 gram for five times per each weigh. And use strain gage to measure the force while human catch the material handling and include the force of gripper also. Then take the experiment data about force of handling from strain gage to value average of force. After that compare the forces that use in material handling between gripper and human in the experiment that which force will be the most appropriate. And which one can use the force less more.

Next the experiment of 10 human will be shown. The experiment from gripper has set up a roller mouse.

VII. Experiment

This is the experiment by 10-human for material handling with weight 100 gram which is shown in Fig. 8.

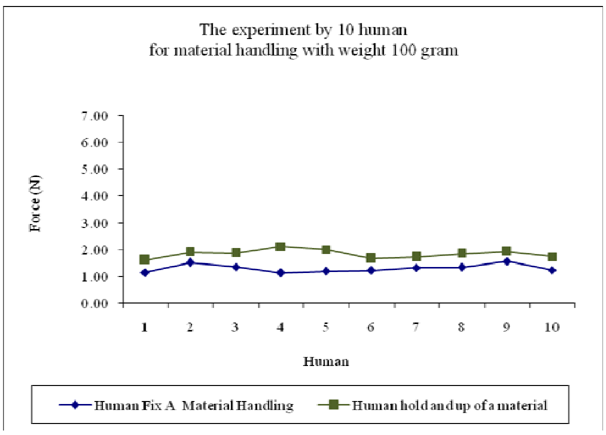

Fig. 8 The experiment with weight 100 gram

The experiment by 10 human for material handling with weight 200 gram which shown in Fig. 9.

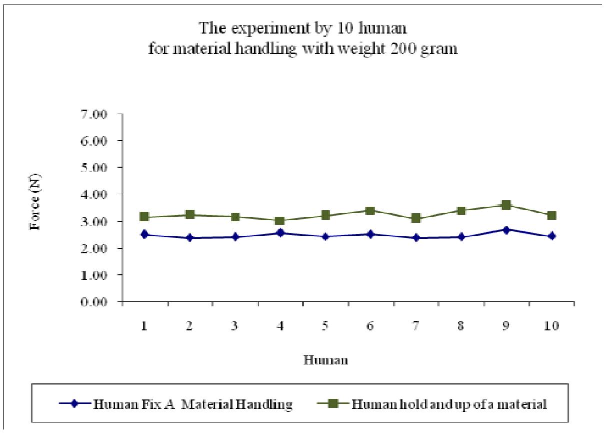

Fig. 9 The experiment with weight 200 gram

The experiment by 10 human for material handling with weight 300 gram is shown in Fig. 10.

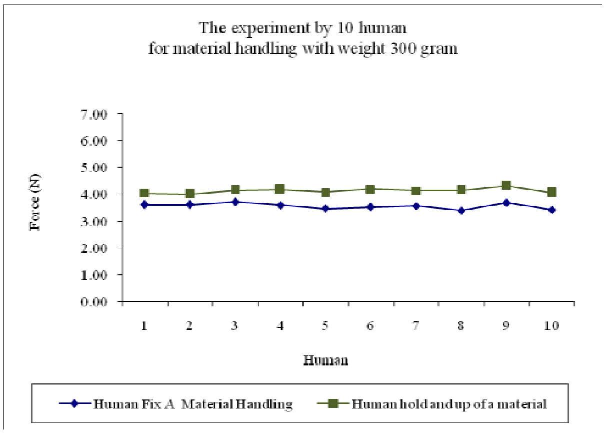

Fig. 10 The experiment with weight 300 gram

The experiment by 10 human for material handling with weight 400 gram is shown in Fig. 11.

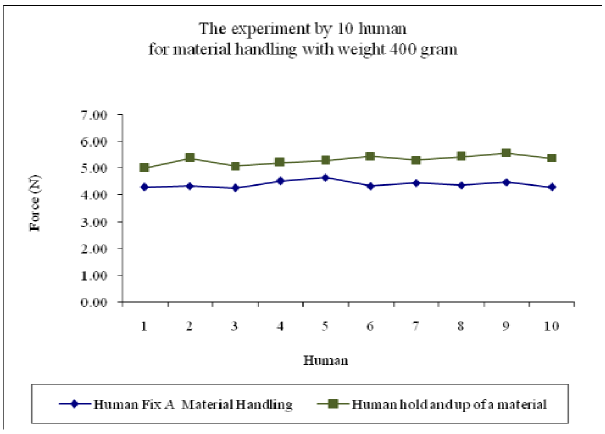

Fig. 11 The experiment with weight 400 gram

Conclude from the average force of 10-human about experiments with human fix a material handling, human hold and up of a material and handling from gripper set up a roller mouse that is shown in Fig. 12.

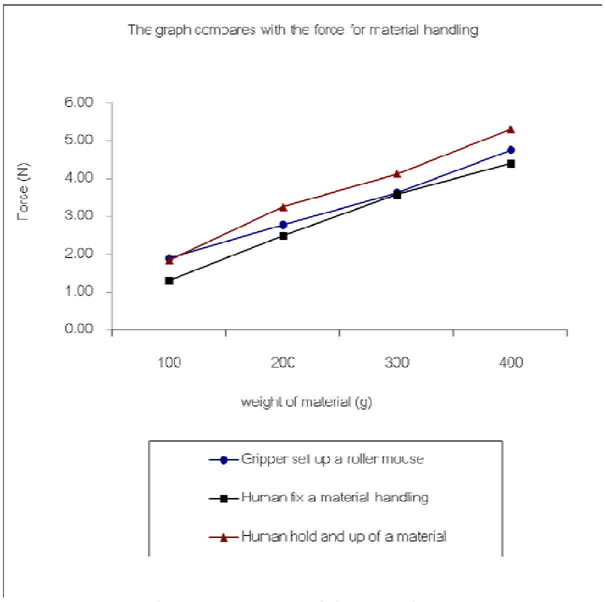

Fig. 12 Summary of the experiment

Next experiment summary from 10-human with gripper set up a roller mouse.

VIII. Summary

From the experiment grip force of material handling with the optimization by compare with holding material of a human is gripping for material handling. Gripper has designed to optimal force for material handling with weight 100, 200, 300 and 400 gram. The gripper is measured force with 1.90, 2.78, 3.63 and 4.75 N respectively. The material handling for gripper can move up and down and can grip with a force less than human material handling of the experiment that have material touch move up and down. But gripper uses the force to keep the material handling more than human in the experiment if there are no movement up or down of the material. Because of human can choose the optimal force and minimum force to handling of material when the material does not move up and down. But human can’t handle the material with the optimal force and minimum force while the material moves up and down. As the environment around and our thought must order the body control the force to handle. The result of the measure is the exceeding force because the gripper can handle and move the material with not interest about the environment. And sometime will have the little movement of the gripper because the robot arm has the vibration when movement but it is a minimum force when compare the force form human and the handling of material.

After they finished the experiment of the first group, they have to relax for a while. Because of the human’s hand will sweat which cause the friction between a hand and the work are down make the force is use handling more than the truth and the arm will exhaust. Moreover this research about gripper has set up a roller mouse just the original gripper. This gripper has the vary limitation, about weight that use to experiment, or the size of the material.

If you want the gripper handle with delicate and control for the minimum force. You can control servo motor spin with delicate, or change the system controls, or change the gripper system to be stable and have meticulousness more than its, or enhance the flexibility of gripper while touching the material. So you can test for gripper set up a roller mouse of the material handling. Example hold the egg, wine glass, or until a robot can hold a blood vessel.

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