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THE EFFICIENCY ASSESING OF SPECIAL VACUUM PREHENSION DEVICE

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ABSTRACT: *This paper has presented a special vacuum prehension device, which representing the last installation of industrial robot and has function of join together the handling total object from the last element of guide device of robot. Based by the relations set up existed possibility to determined a program of optimization of handling robot program which the prehension phase are also included.*

1. INTRODUCTION

The device of prehension is the last installation of industrial robot and has function of joint together the total handling object (OM) from the last element of guide device (DG) of robot.

In all robotics applications linked by objects handling its very important using prehension device which is correct adapted of work load. The prehension device studying is ones special with one-side prehension and vacuum action. This device is development prehension forces only on a part of handling object. The prehension forces are development by pressured vacuum forces applied from sucker grips.

In general, DP is equipped with of numbers of *n*-sucker grips, in dependence of dimensions, respective mass of handling objects.

The most representatively types of handling objects which used DP are: wood or metallic plates, cartoon gyps plates, sheets of glass, diverse objects from plastic materials, electronics equipments, etc. which can be each non-magnetic.

This paper has presented the influences factors of vacuum prehension forces in handling objects with propose of determining the optimal choice criteria for them.

2. PAPER PRESENTATION

During operation of prehension and handling of objects by a robot, on these is acting a lot of forces and moments which are holding in determination of prehension force and in the end of pressure, respectively of force occurring inside of sucker grips, presented in fig.1.

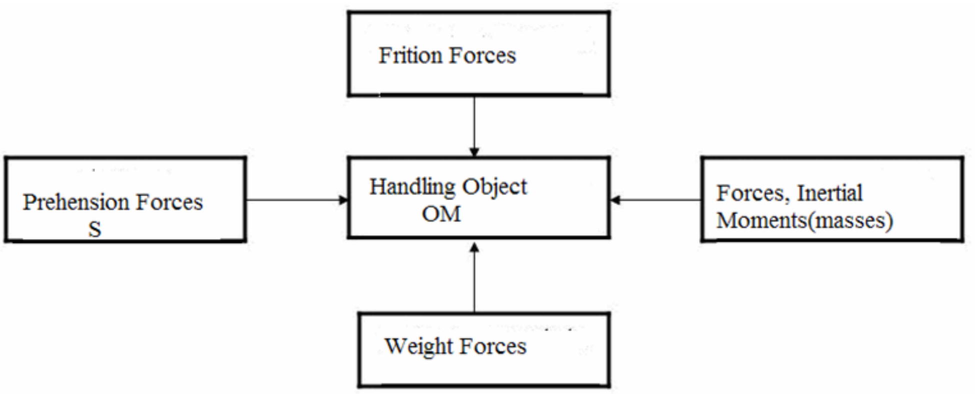

Fig.1. System of exterior forces.

In dependence with architecture of guide device of robot, during handle operation on handling object is acting inertial forces if it's a translation motion, or inertial moments if it's a rotation motion.

Another factor with influences about prehension force size is character of handling object material and quality of prehension surfaces.

A real influence about prehension force size is have the axe position of prehension device to the axe of last element of guide device, which could be parallel or perpendicular.

Also, an important factor is represented the shape of prehension surfaces. From this point of view can be following situations:

a- $S_p \parallel G$
b- $S_p < G$
c- $S_p \perp G$

where: S_p- is prehension force of one sucker grip, G-is weight of handling object.

2.1.The Study of Prehension in Variant $S_p \parallel G$

The study of prehension forces for this variant is done in base of diagram from Fig.2-a,b.

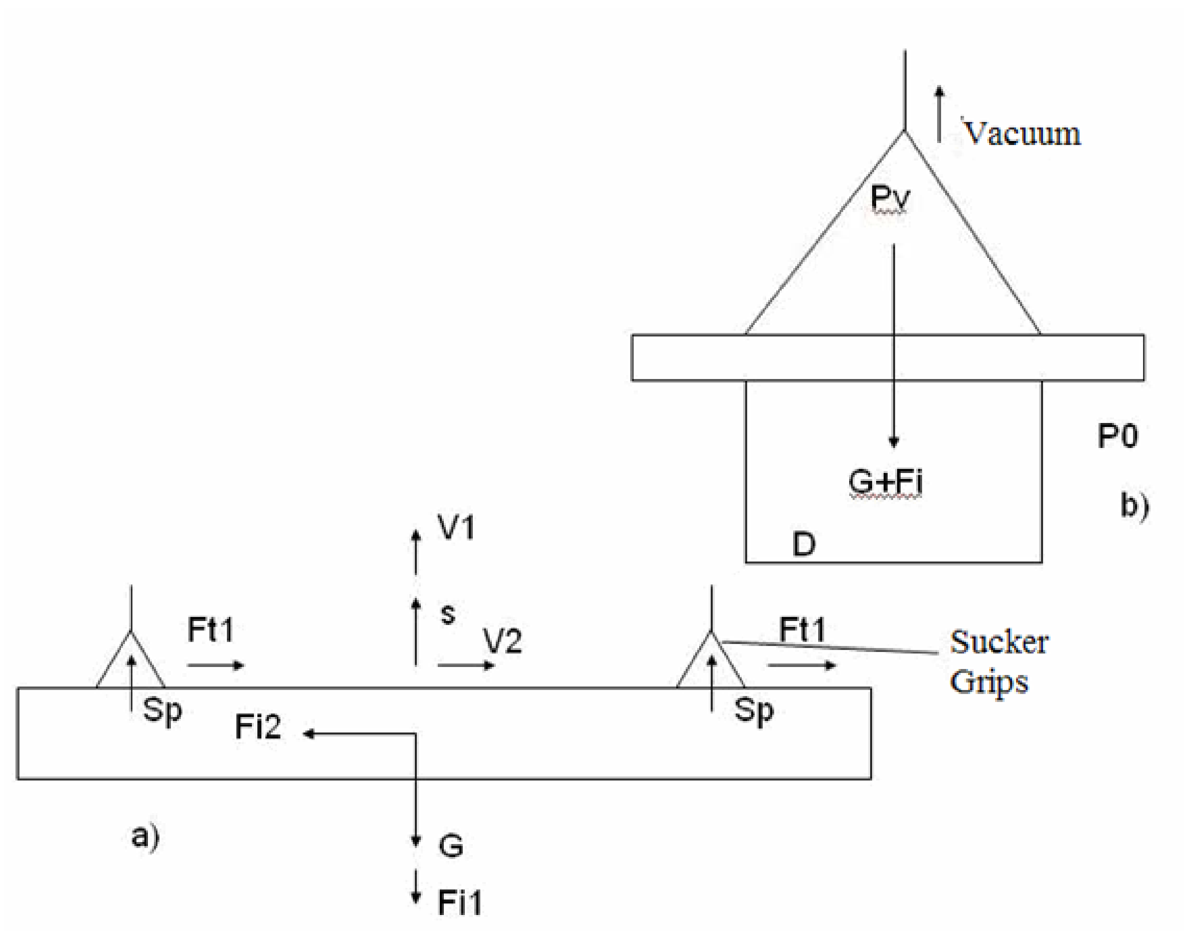

Fig 2. a)-Diagram forces for Variant-1; b) Diagram of sucker grip.

About OM is acting weight force-G, inertial force-F_{i1}, at displacement system with speed-V_1, respectively inertial force-F_{i2}, at displacement system with speed-V_2.

For joint together of object, respectively its prehension is applied prehension forces-S. Between sucker grips and OM is occurring friction forces-F_f. The prehension condition is:

$$S \geq G \tag{1}$$

$$n \cdot \frac{\pi \cdot D^2}{4}(p_0 - p_v) \geq G + F_{i1} \tag{2}$$

where: S-is total prehension forces, n-number of sucker grips, D-diameter of sucker grip, P_v-internal pressure of sucker grip (depression), P_o-external pressure (atmospherically pressure), G-weight force of object, F_{i1}-vertical inertial forces.

By considering the atmospheric pressure, reference pressure ($P_0 = 0$), and holding by the relations:

$$G = m \cdot g; [N] \tag{3}$$

$$F_{i1} = m \cdot a_1; [N] \tag{4}$$

Resulting:

$$P_v \geq \frac{4m(g + a_1)}{\pi \cdot n \cdot D^2}; (N / m^2) \tag{5}$$

Depression which had to assured is direct proportional with handling object mass and with moving acceleration and inverse proportional with square diameter of sucker grips and numbers of sucker grips.

If handling object is moving in vertical plan with speed-V_2 is can be written the balanced equation of forces on this direction:

$$\sum F_{f1} \geq F_{i2} \tag{6}$$

where:

$$\sum F_{f1} = n \cdot F_{f1} = n \cdot S_{p.} \cdot \mu = S \cdot \mu \tag{7}$$

it's representing friction forces between sucker grips and OM.

$$F_{i2} = m \cdot a_2 = m \cdot \frac{dv_2}{dt} \tag{8}$$

it's representing inertial force due to this moving. Is calculated:

$$P_v \geq \frac{4 \cdot m \cdot a_2}{\pi \cdot n \cdot D^2 \cdot \mu}; (N / m\ \ ) \tag{9}$$

From relations (5) and (9) is keeping maximal depression for assuring a well prehension.

2.2. The Study of prehension in Variant $S_p < G$

If the axes of sucker grips are forming an angle-α with direction of weight forces-G and inertial forces-F_{i1}, the forces is decomposed after directions. The items which participated at prehension force will be the projections of forces on direction of forces mentioned before, in conformity with fig.3.

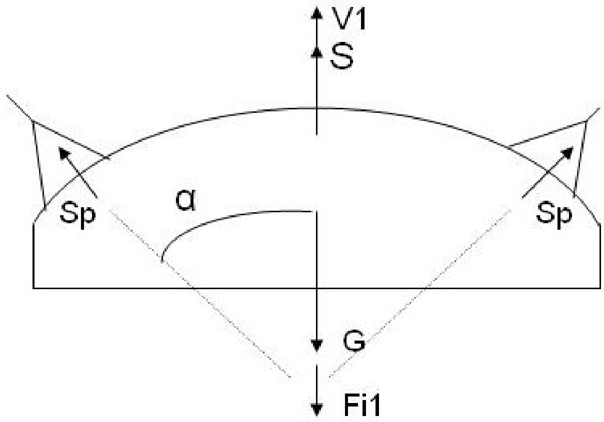

Fig. 3 Diagram of forces-variant 2.

It's resulting:

$$S = n \cdot S_p \cdot \cos\alpha \qquad (10)$$

In conformity with relation (2) can be written relation (5) in this variant:

$$P_v = \frac{4m(g + a_1)}{\pi \cdot n \cdot D^2 \cdot \cos\alpha}; \left[\frac{N}{m^2}\right] \qquad (11)$$

Because, $\cos\alpha \leq 1$, it's resulted that in this situation necessary depression is more big.

2.3 The Study of Prehension in Variant $S_p \perp G$

In this variant about OM is acting and its rotation moment which is going to extract OB in a zone and then clamped in opposite zone, in conformity with fig.4.

The weight force-(G), respectively inertial force (F_i), in most unfavorable conditions (conf.fig.4) is introduced a rotation moment-(M_r), all of them is acting in mass center (C_s). This moment is going to rotating OM around point (A), respectively of linear segment which pass through (A), in such way that in this zone OM had its contribution at prehension In opposite zone OM is going to go away by sucker grips. It can be written the moment equations around point (A):

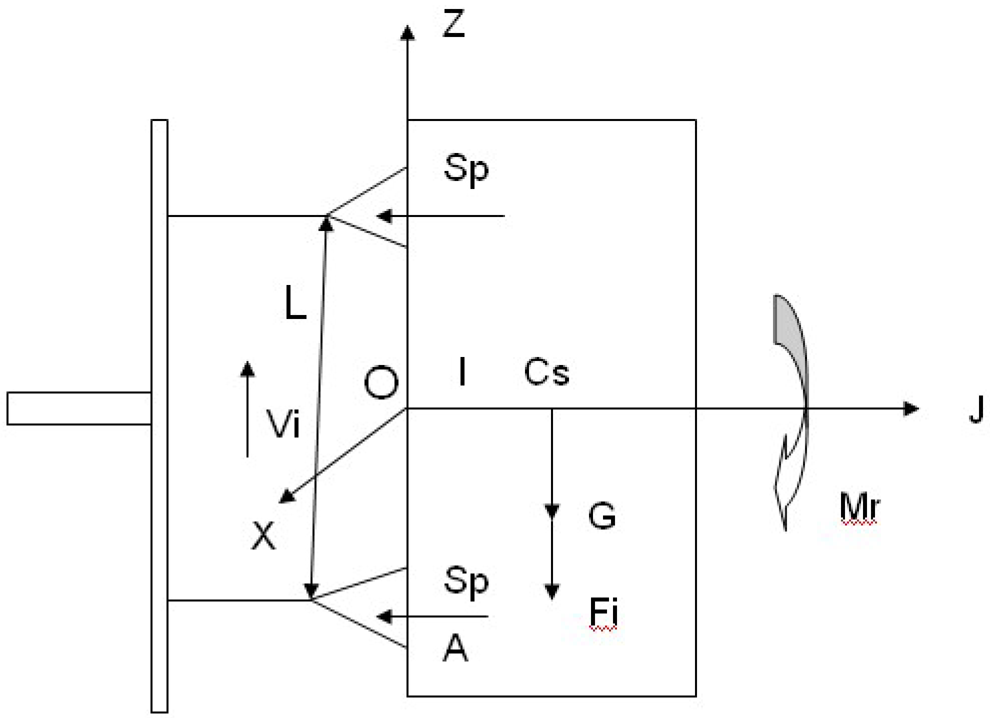

Fig. 4. Diagram of forces variant 3.

$$n^{'} \cdot S_p \cdot L \geq (G + F_i) \cdot l \quad (12)$$

$$S_p \geq \frac{(G + F_i) \cdot l}{n^{'} \cdot L};[N] \quad (13)$$

$$\frac{\pi \cdot D^2}{4} \cdot (-P_v) \geq \frac{(G + F_i) \cdot l}{n^{'} \cdot L} \quad (14)$$

$$-P_v \geq \frac{4 \cdot m \cdot (q + a) \cdot l}{\pi \cdot n^{'} \cdot D^2 \cdot L};\left[\frac{N}{m^2}\right] \quad (15)$$

Where:

$n^{'}$-is number of superior sucker grips of point A;
l-is distance from prehension surface at mass center OM;
L-is distance between sucker grips.

And in this variant is can be meet the situations when axe of sucker grips is forming a angle-α with axe of handling object (with axe-y or axe-x) and is obtained a similar relation, in which resulted the influence of angle-α:

$$-P_v \geq \frac{4m(g + a) \cdot l}{\pi \cdot n^{'} \cdot D^2 \cdot L \cdot \cos\alpha};\left[\frac{N}{m^2}\right] \quad (16)$$

3. CONCLUSIONS

On the base of relations determining can be realized the optimization of vacuum pressure in dependence with mass of handling object, working program of robot, the position of handling object to prehension devices.

Also, in conformity with these relations its can be found optimal values of diameters for sucker grips used.

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