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Simulation of Mechanical Transmissions for Base Translation of an Industrial Robot

This paper presents the simulation of 2 chained mechanical transmissions used to obtain the base translation of an industrial robot: worm - worm gear transmission and motion screw - nut transmission. For simulation, CATIA V5 software was used.

***Keywords**: simulation, mechanical transmission, industrial robot*

1. Introduction

For certain practical applications, a base translation of an industrial robot is needed. The paper presents the possibilities to define kinematics joints and to simulate the functioning of worm - worm gear transmission and of screw - nut transmission.

2. "DMU Kinematics" Module

In CATIA V5 software the simulation can be made using "DMU Kinematics" module. It can be accessed following the menu path: Start → Digital Mockup → DMU Kinematics [1], [4]. The simulation can be made by direct command on the kinematics joints or by defining command laws. The "Kinematics Joints" and "DMU Kinematics" toolbars are shown in fig. 1.

a)

b)

Figure 1. "Kinematics Joints" and "DMU Kinematics" toolbars.

The "Kinematics Joints" toolbar offers the possibility to define the following types of kinematics joints (fig. 1, a, from left to right): revolute joint, prismatic joint, cylindrical joint, screw joint, spherical joint, planar joint, rigid joint, point curve joint, slide curve joint, roll curve joint, point surface joint, universal joint, constant velocity joint, gear joint, rack joint, cable joint, axis-based joint.

The „DMU Kinematics" toolbar contains (fig. 1, b, from left to right): simulation with commands and simulation with laws, mechanism dressup, kinematics joints, fixed part, assembly constraints conversion, speed and acceleration, mechanism analysis.

3. Simulation of Mechanical Transmissions

First, the base of the industrial robot is defined as fixed part.

The defined motions are represented with arrows.

The input motion from the electric motor is the same with the worm's, as shown in fig. 2.

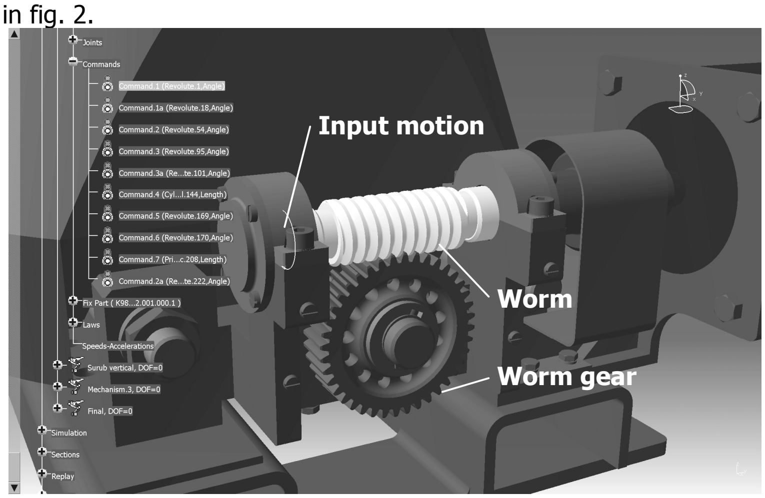

Figure 2. Input motion in the worm - worm gear mechanical transmission.

The transmission ratio for the worm - worm gear transmission is:

$$i_1 = \frac{\omega_m}{\omega_1} = \frac{400}{10} = 40\,, \qquad (1)$$

where: ω_m - the angular speed given by the electric motor;

ω_1 - the angular speed of the worm gear linked with the screw.

For simulation, the transmission ratio (1) was defined using the command with laws option; a dependence between the input motion of the worm and the output motion of the worm gear, solidarized with the screw, was imposed.

The rotation motion of the screw is presented in fig. 3.

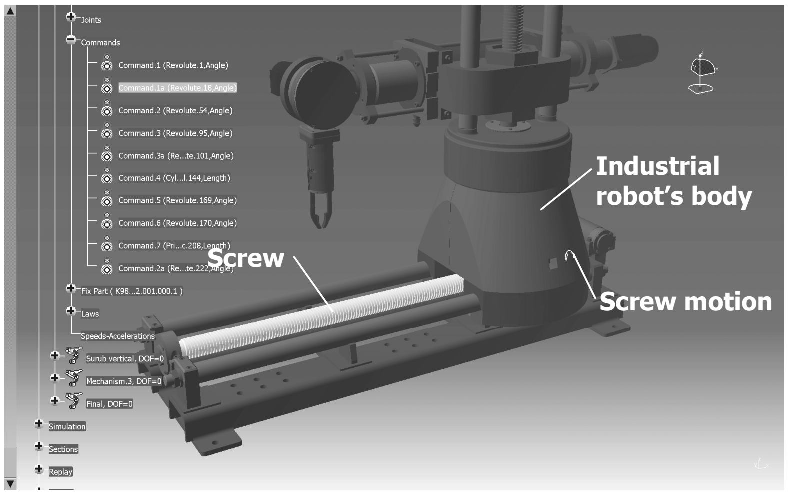

Figure 3. Screw motion.

As a result of screw motion, the nut, solidarized with the body of industrial robot, moves along the screw axis, as shown in fig. 4, 5 and 6.

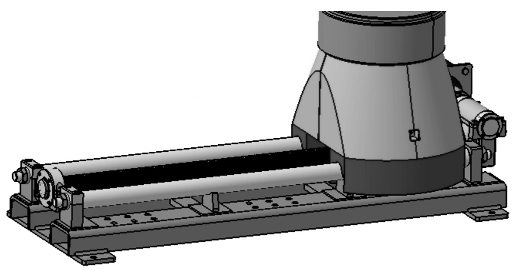

Figure 4. Initial position of industrial robot’s body model.

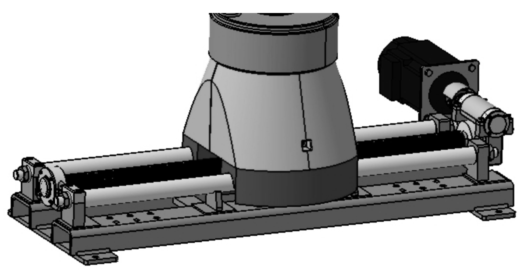

Figure 5. Intermediate position of industrial robot’s body model.

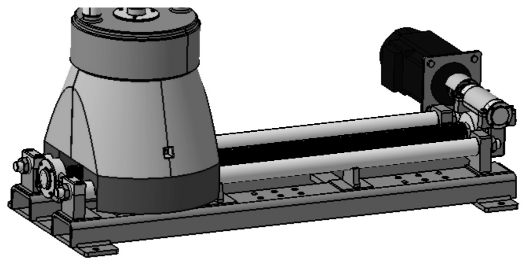

Figure 6. Final position of industrial robot's body model.

For a backward motion, the input motion is reversed.

4. Conclusions

The simulation of mechanical transmissions for the base translation of an industrial robot was presented: worm - worm gear transmission and motion screw - nut transmission. The simulation was realized for an existing source system, an educational industrial robot [3].

In the general case, any mechanical transmission can be simulated using CATIA V5 software by defining kinematics joints and commanding them.

References

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[3] Vela I., Micloşină C. *Cercetări în domeniul Roboticii la Universitatea "Eftimie Murgu" Reşiţa*, Robotica & Management, Vol. 7, No. 1, June 2002, p. 53-62.

[4] *** *CATIA V5 Online Documentation*.

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