

Simulations of a 2R robotic arm with MATLAB program

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Abstract. Today, the simulation with MATLAB is a modern method to optimize a 2R robotic arm. One of the important problems of the 2R robotic arm is the mode of the rotation mode of his links. In the manuscript, an algorithm in MATLAB is proposed for the simulation of two bars that belong to a robot arm. However, the mechanism from this paper is composed of: links, joints, end effector and base. At the beginning the links are in a horizontal position. Furthermore, these links of the mechanism are programmed to counterclockwise rotate after 5 s, 8s and 10s. In finally, after 10s, the links of the system are in a vertical position.

Keywords. MATLAB, angle, mechanism, link, length, robotic.

1. Introduction

The mechanism in engineering means rigid bodies connected by joints in order to accomplish a desired force and motion transmission.

Classification of mechanisms by types:

- Planar: all points on each side move only in one plane (2D).
Example: slider-crank, four bar linkage, cam-follower system, etc.
- Spherical: all points on each part move in concentric spherical shells around a fixed point.
Examples: gyroscope, automotive differential, robotic wrist, etc.
- Spatial: all points on each part can move in any direction in three dimensional space (3D).
Examples: Stewart platform, Hexapteron, Xactuator, etc.

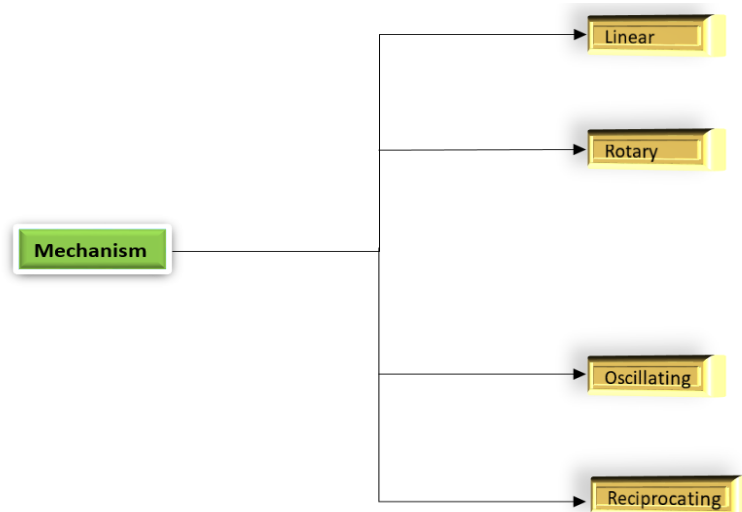


Figure 1. Motions of mechanism

All the mechanisms in the article are studied in the plan, [1].

Orice mechanism poate sa fie format din diverse componente: link, slider, rod, cam, pin, etc.

In any mechanism there is at least one type of motion: linear, rotary, oscillating and reciprocating.

Therefore, the most parameters used in the mechanisms are: coordinates, angle, length, velocity, acceleration, angular velocity, angular acceleration and Coriolis acceleration.

2. 2D robotic arm

In present, the robots works in various fields: research, army, education, construction cars or medicine. Many robots are used in the field of manufacturing operations, [3].

Thus, in manufacturing there are three stages in which robots are used: material handling, process operations and assembly, Figure 2.

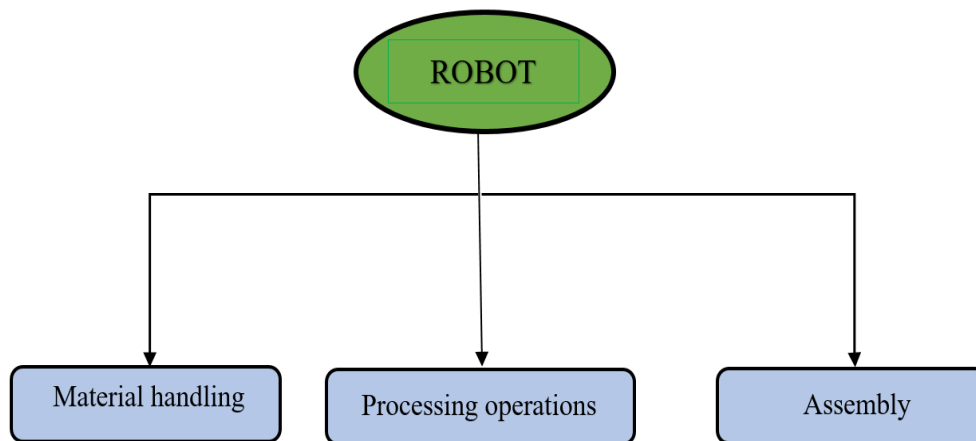


Figure 2. Motions of mechanism

Moreover, in order to perform the three operations, the robot must use one or two arms from the endowment, [4].

The mechanism consists of the components from the drawing below, Figure 3:

- Two joints.
- Two links.
- End effector.
- Base.

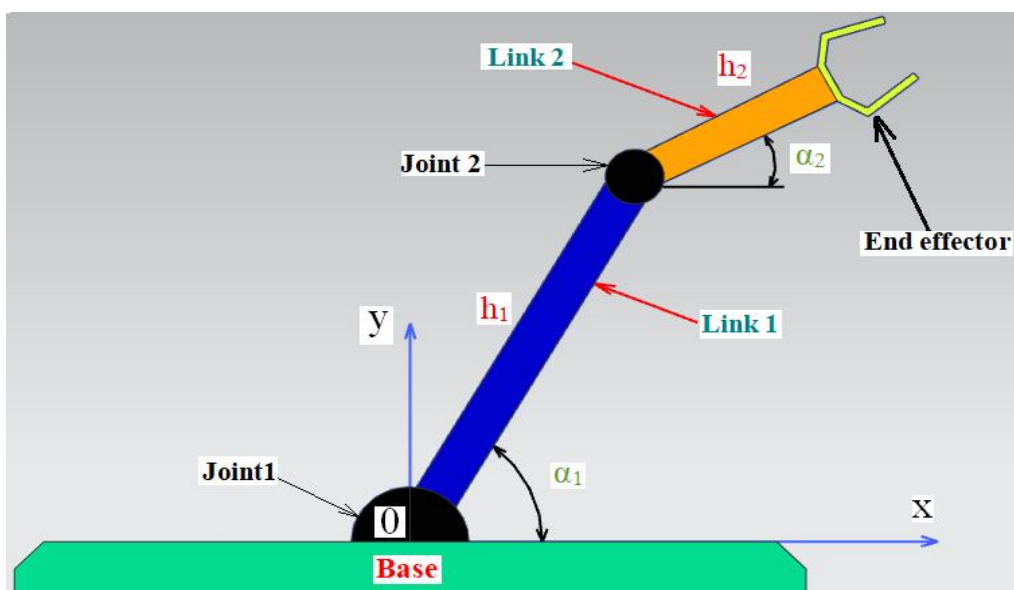


Figure 3. Motions of mechanism

The lengths of the two bars from the system from the mechanism have the following values:

- $h_1 = 3\text{m}$ – length of link attached to the base (Link 1).
- $h_2 = 4\text{m}$ – length of link between the second link (Link 2) and the end effector.

In this paper, we use two matrices for the study of the two links, [5].

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} h_2 \cos(\alpha_1 + \alpha_2) + h_1 \cos \alpha_1 \\ h_2 \sin(\alpha_1 + \alpha_2) + h_1 \sin \alpha_1 \end{bmatrix} \quad (1)$$

Such as the angles for the movement of robotic arms is determined with relationships, [6]:

$$\alpha_1 = \arctan\left(\frac{y}{x}\right) - \arctan\left(\frac{h_2 \sin \alpha_2}{h_1 + h_2 \cos \alpha_2}\right) \quad (2)$$

$$\alpha_2 = \arccos\left(\frac{x^2 + y^2 - h_1^2 - h_2^2}{2h_1 h_2}\right) \quad (3)$$

Where:

- α_1 – angle made by first link with x – axis.
- α_2 – angle made by second link with x – axis.

```

14 % for loop
15 ct = 1;
16 for i = 1:length(alpha1)
17     ALPHA1 = alpha1(i);
18     for j = 1:length(alpha2)
19         ALPHA2 = alpha2(j);
20
21         % coordinates
22         x0 = 0;
23         y0 = 0;
24
25         x1 = h1*cosd(ALPHA1);
26         y1 = h1*sind(ALPHA1);
27
28         x2 = x1 + h2*cosd(ALPHA2);
29         y2 = y1 + h2*sind(ALPHA2);
30
31         % plotting
32         plot([x0 x1], [y0 y1], [x1 x2], [y1 y2], 'LineWidth', 4);
33         axis([-0.1 8 -0.1 8]);
34         pause(1.5)
35         m(ct) = getframe(gcf);
36         ct = ct+1;
37     end
38 end
39
40 % movie
41 movie(m)
42 videofile = VideoWriter('2D robotic arm');
43 open(videofile)
44 writeVideo(videofile,m)
45 close(videofile)

```

Figure 4. Editing a code-only MATLAB script

MATLAB Software is a very powerful tool used for various simulations and tasks, ranging from the most simple algorithms to the most intricate simulations and problems' solving, such as in [2] .

Reverting now to the issue we address in this paper, we wrote in the Editor of MATLAB, the previous algorithm of 45 lines, Figure 4.

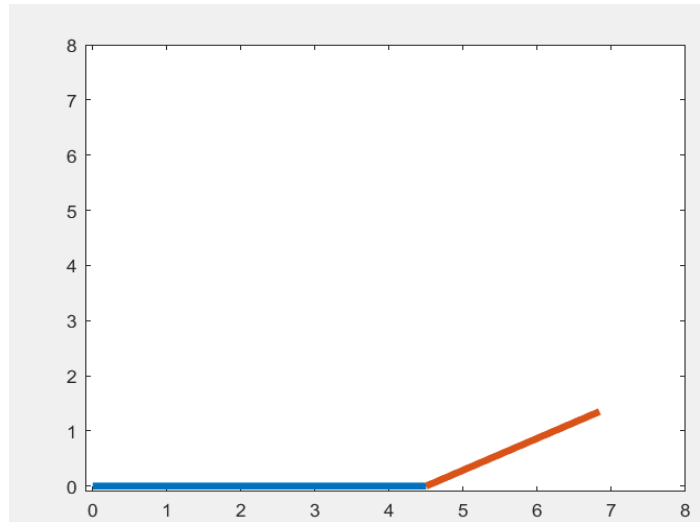


Figure 5. A 2R robotic arm (5s)

First time, the second link rotate counterclockwise after five seconds, Figure 5.

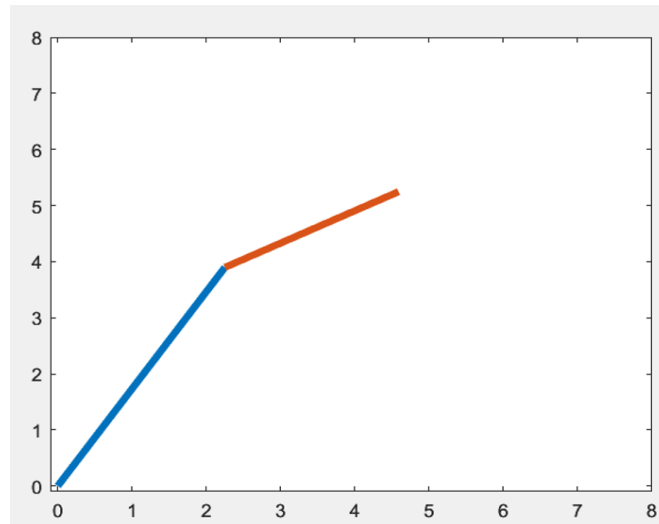


Figure 6. A 2R robotic arm (8s)

Second time, the both links rotates counterclockwise after eight seconds, Figure 6.

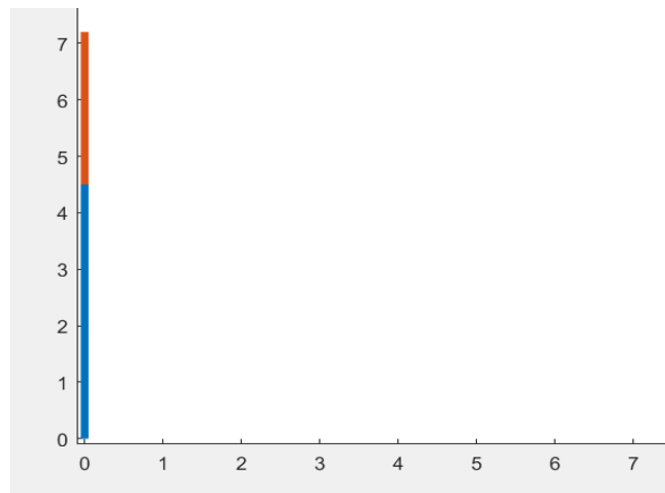


Figure 7. A 2R robotic arm (10s)

Last time, the both links are in a vertical position after ten seconds, Figure 7.

3. Acknowledgment

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4. Conclusions

The simulations considered with MATLAB can be applied in various field of science and technology. In the article an algorithm is proposed to control a gesture based robotic arm

Their big advantage in comparison with other software is invariance showed that in taking into consideration the simulation features, the more optimal solution for the 2R robotic arm.

Moreover, the increasing demands of technological innovation for 2R robotic arm, require new and creative educational initiatives.

For the future, we want to make much more complex simulations in MATLAB. These simulations will be done for industrial robots.

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