Engineering 69(1) 2024

DOI: 10.24193/subbeng.2024.1.8

Simulation of a serial topology robot operation using the 3DEXPERIENCE platform

Razvan-George Olingheru*^(D), Adrian-Bogdan Olariu^(D), Calin-Octavian Miclosina^(D)

Abstract. The paper presents the assembling of a 3D model serial topology robot, the definition of kinematical joints of the guiding device mechanism and the simulation of robot operation, using the 3DEXPERIENCE platform. In the end, there are presented different positions of the robot during simulation.

Keywords: serial topology, robot, 3DEXPERIENCE platform.

1. Introduction

Serial topology robots are widely used in industrial and service applications.

The guiding device mechanism of this type of robots contains an open kinematical chain, the links being connected by the kinematical joints one after another. An example is shown in fig. 1.



Figure 1. Structural scheme of a serial topology mechanism [1].

©2024 Studia UBB Engineering. Published by Babeş-Bolyai University.



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License The mechanism has 7 binary links (0 - 6) and 6 kinematical joints of fifth class (A - F).

The serial topology robot which will be simulated is presented in fig. 2. The components were obtained by 3D printing [2].



Figure 2. The serial topology robot [2].

2. The 3DEXPERIENCE Platform

3DEXPERIENCE (3DX) is a business and innovation platform that provides organizations with a holistic, real-time vision of their business activity and ecosystem. It connects people, ideas, data and solutions in a single collaborative environment [3].

It includes many design applications and modules, as Design with CATIA V5, Part Design, Assembly Design, Design with Solidworks, xDesign, etc.

The files can be created on a PC using a design software as CATIA V5 [4], [5], and then uploaded on the platform, or can be created, edited and saved directly in cloud.

Nowadays, the 3DEXPERIENCE platform is used for various engineering design projects [6], [7].

3. Assembling the 3D Model

The 3D models of the components were uploaded on the 3DEXPERIENCE platform and assembled in CATIA Assembly Design module.

First, the robot base with its motor were inserted in the new file, rigidized one to another, and then fixed in the virtual space using the *Fix* connection type, as shown in fig. 3.



Figure 3. Inserting and fixing the robot base.

Then, the second component with its motor were inserted and connected to the base by a revolute joint with a 360° stroke, as shown in fig. 4.



Figure 4. Defining a revolute joint between the base and the second component.

The third component was inserted next and connected to the second component by a revolute joint with a 180° stroke, as shown in fig. 5.



Figure 5. Defining a revolute joint between the second and the third components.

Next, the fourth component with its two motors were inserted and connected to the third component by a revolute joint with a 248° stroke, as shown in fig. 6.



Figure 6. Defining a revolute joint between the third and the fourth components.

Then, the fifth component with its motor were inserted and connected to the fourth component by a revolute joint with a 360° stroke, as shown in fig. 7.

C Ordend Geometrical S P Imported Body 2 P Imported Body 2 P Imported Body 3	Engineering Convectors Definition
Imported Body:2 Imported Body:3	Engineering Connection Definition
- D Imported Body.3	
	Constraints Constraints Constraints
Imported Body.4	Connection type Sevolute
High Connections of Servo mot	Constraints: 2 our Leerplate
Servo Motor MG996R_r1 A (S	▼ ② Coincidence ! P→+ Driving ▼
+ 🐨 Servo motor micro 9g A (Serv	Aus I Algument 🎝 🕼
# C Fix.1 (Base.1)	AXIS
* B Revolute 2 (Waist 1<->Bas	* Contact P-H Driving *
Revolute3 (Arm 01.1<->V	🐿 Face 🗄 Alignment 🐬 💋 🦓
Revolute 4 (Arm 02.1< SA	Face E
+ S Revolute 6 (Arm 03.1 c.) G	▼ 🖉 Angle : 🚔 Controlled ▼
+ Bigid 7 (Gripper Base 1<-)	M vertices 1
# 3 Rigid 10 (Servo mator mic	1 volane
Rigid. 12 (Base. 1 <-> Servo	a About
🖶 🍘 Rigid. 13 (Servo Motor MG	Lower limit Angle Upper limit
# 💭 Rigid 14 (Servo Motor MG	interior and a constant a
Rigid 15 (Servo motor mic	Of Correl
🗄 🗊 Rigid. 16 (Servo motor mic	UN CINC
Standard Mechanical Systems Design Assembly Te	nois Product Modification View AR-VR Tools Touch

Figure 7. Defining a revolute joint between the fourth and the fifth components.

The sixth component (the end effector) with its motor were inserted and connected to the fifth component by a revolute joint with a 180° stroke, as shown in fig. 8.

Pypera Presentationness y A Generation Series motor mices by A Generation Series motor Series Commentation Series motor Series Commentation Series Motor Commentation Ser	Expressing Connection Unifolds Connection type Sendences & Connect Connection type Sendence & Connection type Connection type Sendence
#*® Servo motor micro 8g A (Sen #*® Servo Mozor M0598r (1 A 6 #*® Servo Mozor M0598 A (Sen #*® Servo Mozor moto 8g A (Sen #** Servo Mozor moto 8g A (Sen #*********************************	Constraints 200 Use Trenglate
C (Fact Base 1) C (Fact Base 1) C (Fact Base 1) C (Fact Base 1) Foreints 3 (Am 2) (-> 2) Foreints 3 (Am 2) (-> 3) Foreints 3 (Am 2) (-> 3 Foreints 5 (Am 2) (-> 3 Foreints 6 (Am 2) (-> 3	Consolutor C
Regid 12 Gase 1 - Sano Regid 12 Gase More More Mo Regid 14 Gase More More Regid 15 Gase moder me Regid 15 Gase moder me	Improv Improv<

Figure 8. Defining a revolute joint between the fifth and the sixth components.

4. Simulation of the Robot Operation

The simulation of the 3D model of the serial topology robot operation was accomplished using the Mechanical Systems Design module.

Different positions of the robot during simulation are shown in fig. 9, 10 and 11.



Figure 9. Horizontal position of the robot.



Figure 10. Intermediate position of the robot.



Figure 11. Vertical position of the robot.

4. Conclusions

The 3DEXPERIENCE platform represents a powerful tool for engineering design and simulation.

Using the steps presented in this paper, the operation of different types of mechanical systems can be done.

References

- 1. C.O. Miclosina, *Roboți Industriali și Linii Flexibile*, Editura Eftimie Murgu, Reșița, 2009.
- A.B.Olariu, R.G. Olingheru R.G., C. Sandor, D.D. Ardeljan, *Realizarea unui* robot cu topologie serială, SSING 2024 - Cercetare şi inovare în inginerie mecanică, Apr. 18-19, 2024, Transilvania University of Braşov, Scientifical Coordinator - Assoc. Prof. Dr. Eng. Calin-Octavian Miclosina.
- 3. The 3DEXPERIENCE Platform, https://www.3ds.com/3dexperience (downloaded on 7.05.2024)
- 4. I.G.Ghionea, *CATIA V5. Aplicatii in Inginerie Mecanică*, Editura Bren, Bucuresti, 2007.
- 5. C.O. Miclosina, *Bazele Proiectării Asistate de Calculator*, Editura Eftimie Murgu, Reșița, 2018.

- S.M. Kumar, B.S.D.Sagar, V. Prema, A.R.A.Chandra, B.G. Suhas, Modelling and Simulation of Bifurcated Winding Induction Generator using 3DEXPERIENCE, 2022 IEEE 4th Global Power, Energy and Communication Conference (IEEE GPECOM2022), Jun. 14-17, 2022, Cappadocia, Turkey, pp. 216-221.
- C.R. Rao, V. Prema, A.N. Nagashree, R.S. Geetha, *Development of virtual lab* module for wind and solar energy systems using 3DEXPERIENCE platform of Dassault Systemes, International Conference on Sustainable Materials, Manufacturing and Renewable Technologies (I-SMaRT), Apr. 22-23, 2021, Materials Today Proceedings, vol. 7, part 15, pp. 4978-4987,

Addresses:

• Stud. Razvan-George Olingheru, Faculty of Engineering, Babeş-Bolyai University Cluj-Napoca, Romania, Piața Traian Vuia, nr. 1-4, 320085, Reșița

razvan.olingheru@stud.ubbcluj.ro
(*corresponding author)

• Stud. Adrian-Bogdan Olariu, Faculty of Engineering, Babeş-Bolyai University Cluj-Napoca, Romania, Piața Traian Vuia, nr. 1-4, 320085, Reșița,

adrian.olariu@stud.ubbcluj.ro

• Assoc. Prof. Dr. Eng. Calin-Octavian Miclosina, Department of Engineering Science, Faculty of Engineering, Babeş-Bolyai University Cluj-Napoca, Romania, Piața Traian Vuia, nr. 1-4, 320085, Reșița calin.miclosina@ubbcluj.ro