The 6th Joint International Conference on Multibody System Dynamics and
The 10th Asian Conference on Multibody System Dynamics
November 1-5, 2020, New Delhi, India

DeNOC based Dynamic Modelling Approach of Planar Closed Loop Robotic Mechanism

Rutupurna Choudhury*, Deep Singh#, Yogesh Singh†

* Department of Mechanical Engineering
National Institute of Technology Silchar
Assam, 788010, Silchar, India
rutupurna.choudhury10@gmail.com

Department of Mechanical Engineering
National Institute of Technology Silchar
Assam, 788010, Silchar, India
deepsingh.0318@gmail.com

† Department of Mechanical Engineering
National Institute of Technology Silchar
Assam, 788010, Silchar, India
yogeshsingh15@gmail.com

Abstract

Closed-loop manipulators possesses various advantages including faster and precise as compared to the open-chain manipulators. The major drawback of an open-loop manipulator is its cantilever like structure which induces vibration at high-speed operation and reduces its accuracy. Whereas, closed-loop structure provides larger stiffness, higher precision and better accuracy. This paper presents the dynamic simulation comparison of a four-bar and hexagon based closed planar chain manipulators. The dynamics of the manipulators have been approached and compared with Euler-Lagrangian [1] and Decoupled Natural Orthogonal Complement (DeNOC) [2] matrices methods. The DeNOC based forward and inverse kinematics helps to simulate the manipulator in a virtual environment. Simulation is efficient to keep track of its control and implement modifications as per necessity. Four-bar mechanism is the simplest closed-loop chain. It consists of four bars (links) connected in a loop within a plane by four revolute joints and termed as planar four-bar mechanism [3]. The dynamic formulation and validation of the manipulators have been approached by Euler-Lagrangian and DeNOC methods under similar conditions. The study presents and clarifies comprehensive dynamic formulations and its comparison. The DeNOC approach eliminates the need for complex partial derivatives thereby making its computation more straightforward. This method results in joint motion equations which are vital for the simulation of manipulators. The simulation results so obtained by DeNOC approach has been compared and validated by the corresponding results of Euler-Lagrangian based dynamics. These manipulators are beneficial for precise positioning and accurate tracking applications within a specified plane of interest. The dynamic simulation of the manipulators also presents a comparison of its behaviour and effectiveness.

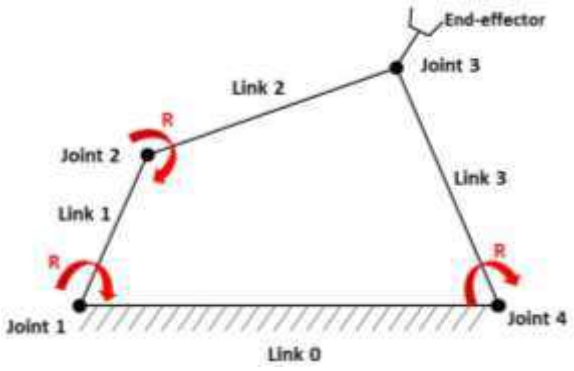

Figure 1: Four bar mechanism based closed planar kinematic robotic system

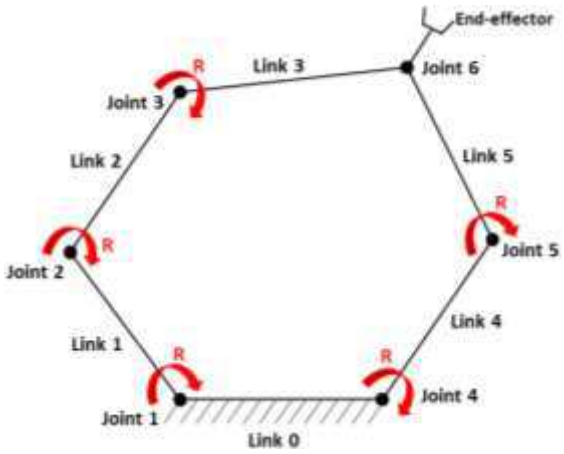

Figure 2. Hexagon shaped closed planar kinematic robotic system

Figure 1 illustrates the kinematic arrangement of a four-bar planar manipulator. Out of the four bars (namely 0, 1, 2, 3), the link 0 is fixed. All the links are connected to its adjacent ones by revolute joints. Figure 2 depicts the kinematic arrangement of a hexagon-shaped planar manipulator. Each links are coupled to its adjacent links by revolute joints (R) and the link 0 is fixed. The position of end-effector has also been depicted in each figure.

References

[1]. Venkatesan, Vinoth, Jayant Kumar Mohanta, Subir Kumar Saha, and Mohan Santhakumar. "Dynamic modelling approaches for a 3-PPR planar parallel manipulator." In *International Conference on Advancements in Automation, Robotics & Sensing*, pp. 41-52. Springer, Singapore, 2016.

[2]. Saha, Subir Kumar. *Introduction to robotics*. Tata McGraw-Hill Education, 2014.

[3]. Yang, Koon-Ho, and Youn-Sik Park. "Dynamic stability analysis of a flexible four-bar mechanism and its experimental investigation." *Mechanism and Machine Theory* 33, no. 3 307-320, 1998.