

# Trajectory Tracking Analysis of Planar End-Effector Upper Limb Rehabilitation Device



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**Abstract** Rehabilitation devices have become one of the more sought-after focus areas among researchers in the robotics field, where it could be used to assist patients in the process of stroke recovery. Therefore, the motivation of this thesis is to further investigate the planar end-effector upper limb rehabilitation device as a viable solution for patients with movement disorders, instead of the more expensive alternative of exoskeleton robots. This paper illustrates the mathematical modelling and simulation of a planar end-effector rehabilitation device for the upper limb. The rehabilitation device is of two degrees of freedom, and is used in this research due to its cost effectiveness and practicality. The derivation of the forward and inverse kinematics of the robotic system is established by using the Denavit-Hartenberg algorithm, which is proceeded to be used in the trajectory tracking of the end-effector of the device, as well as the programming of the feedback control system to control the actuators used in the system. The results of the simulation suggest that the mathematical modelling of the system is able to predict the behaviour of the system, which is to be implemented in this robotic device for upper limb rehabilitation.

**Keywords** End-effector · Planar · Upper-limb rehabilitation

## 1 Introduction

The number of patient population with movement disorders are on the rise in this fast-paced world, and there are many causes of the disorders, such as sports-related injuries or accidents, chronic diseases like arthritis, children with special needs, muscle sprains, stroke, and more. Physical rehabilitation is one of the main solution

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