Environmental Engineering and Management Journal

February 2026, Vol. 25, No. 2, 257-263
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu
http://doi.org/10.30638/eemj.2026.020

"Gheorghe Asachi" Technical University of Iasi, Romania

OPTIMAL SYNTHESIS OF THE FIVE-BAR LINKAGES WITH SYMMETRICAL STRUCTURE BY USING IMPOSED TRAJECTORIES FOR HOME TRAINING

Tivadar Demjen[1], Alexandru Oarcea[1]*, Elida-Gabriela Tulcan[1], Erwin-Christian Lovasz[1], Dan Cristian Silaghi-Perju[1], Liana Maries[2]

[1]Universitatea Politehnica Timişoara, Piaţa Victoriei 2, 300006 Timişoara, Romania
[2]Universitatea de Medicina si Farmacie „Victor Babes" Timisoara, Eftimie Murgu 2, 300041 Timisoara

Abstract

The five-bar mechanism is widely recognized for its high precision, structural rigidity, and versatility, being extensively applied in robotics, medical rehabilitation, agricultural machinery, and automated sampling systems, including emerging uses in environmental monitoring. Post-stroke rehabilitation of the limbs requires equipment with controlled-constraint movement. The paper proposes a rehabilitation system for the upper limb, which is usable in medical facilities but also in home training, based on a five-bar linkage structure. The synthesis method allows the analytical computation of the links length of a symmetrical five-bar linkage in order to avoid the singularities in an imposed dexterous trajectory. The type synthesis of the five-bar linkage shows that the number of symmetrical structures of five-bar linkage is limited to 8 structures, from which the structure 5-RRRRR, 5-RTRTR and 5-TRRRT are application relevant. This study shows the optimization of the novel synthesis method by considering a maximal minimum transmission angle and a maximal manipulability along an imposed trajectory. The minimum transmission angle and the manipulability index value of a linkage can be directly linked to the kinematic performance of a robotic structure and, since the five-bar linkage is widely used in rehabilitation and training devices, the proposed synthesis method will further contribute to the development of experimental devices.

Key words: five-bar linkage, home training, maximal transmission angle, maximal manipulability, optimization, rehabilitation,

Received: November, 2024; Revised final: June, 2025; Accepted: June, 2025; Published in final edited form: February, 2026

* Author to whom all correspondence should be addressed: e-mail: alexandru.oarcea@student.upt.ro; Phone: +40722420095