

CERTIFICATE OF PARTICIPATION

This is to certify that

Keltoum Loukal

presented the Poster face-to-face

“Mathematical Modeling and Intelligent Control of Flexible-Joint Manipulators Using Hybrid ANFIS Architecture”

at

“Computer Science and Technology”

Session during the 9th International Conference of Mathematical Sciences (ICMS 2025)

held in Maltepe University, Istanbul Turkey on 03-07 September 2025



Prof. Dr. Huseyin CAKALLI
Chairman of the Organizing Committee

Mathematical Modeling and Intelligent Control of Flexible-Joint Manipulators Using Hybrid ANFIS Architecture

Keltoum Loukal, Abderrahmen Bouguerra, Samir Zeghlache

LGE Research Laboratory, Department of Electrical Engineering, University of M'sila, University Pole, Bordj Bou Arreridj Road, M'sila 28000, Algeria, abderrahmen.bouguerra@univ-msila.dz

LGE Research Laboratory, Department of Electrical Engineering, University of M'sila, University Pole, Bordj Bou Arreridj Road, M'sila 28000, Algeria, keltoum.loukal@univ-msila.dz

LASS Research Laboratory, Department of Electrical Engineering, University of M'sila, University Pole, Bordj Bou Arreridj Road, M'sila 28000, Algeria, samir.zeghlache@univ-msila.dz

Abstract

This paper presents an intelligent control framework for robotic manipulators with flexible joints, addressing the critical challenges of nonlinear dynamics and parameter uncertainties. We propose an Adaptive Neuro-Fuzzy Inference System (ANFIS) controller and conduct a comparative study with conventional PID control for trajectory tracking applications. The system dynamics are modeled using Lagrangian mechanics with state-space formulation to account for joint elasticity. Simulation results establish ANFIS as a promising solution for high-precision robotic applications requiring adaptability to dynamic operating conditions.

Keywords: ANFIS, PID control, state space system, robotic manipulator with flexible joints.

2020 Mathematics Subject Classification Numbers: First, Second, Third.

References

- [1] D. Wu, J. Li, D. Song, Z. Zhang, K. Wang, C. Shi, Development of a novel ball-and-socket flexible manipulator for minimally invasive flexible surgery, *IEEE Transactions on Medical Robotics and Bionics*, (2023).
- [2] H. Park; M. Hwang, Design of a Multi-bending Flexible Manipulator for Gastrointestinal Surgery, *International Conference on Control, Automation and Systems (ICCAS)*, 1733-1735, November (2022).
- [3] H. An, C. Ye, Z. Yin, W. Lin, Neural Adaptive Impedance Control for Force Tracking in Uncertain Environment, *Electronics*, 12(3), 640 (2023).
- [4] V.B. Nguyen, X.C. Bui, Hybrid Vibration Control Algorithm of a Flexible Manipulator System, *Robotics*, 12(3), 73 (2023).
- [5] W. Gueaieb, Type-2 Fuzzy Logic Control of a Flexible-Joint Manipulator, *Journal of Intelligent and Robotic Systems*, 51, 159-186 (2008).