دانشگاه شهید باهنر کرمان

Shahid Bahonar University of Kerman

Faculty of Engineering
Mechanical Engineering Department

Title:

Modal Approach to Modeling of Hyper-Redundant Robot Manipulator Dynamics and Design of Fuzzy Controller for the System

by

Seyed Reza Ahmadzadeh

Supervisor

Dr. Mohamad-Ali Hajabasi

A Dessertation Submitted in Partial Fulfillment of
The Requirements for Master's Degree in
Mechanical Engineering

January 2004

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Seyed Reza Ahmadzadeh, *Member, IEEE,*

Abstract

Hyper-redundant manipulators having degrees of freedom much more than required, have many advantages and important capabilities. Efficient and proper industrial usage of these robots is depended on their controller ability and a deep knowledge of the system dynamics is required to design the controller. In this thesis, modeling of the manipulator dynamics is done using a special curve called 'backbone curve', modal method, Lagrangian mechanics and geometric transformation between variables spaces of backbone curve and manipulator joints. To identify the backbone curve that captures all global geometric characteristics of the hyper-redundant manipulator features, harmonic modes are used for curvature function. The dynamics equations of the hyper-redundant manipulator are derived in the joint variables space by Lagrangian mechanics and transformed to the backbone curve variables space. The dependency of the Nonlinear and coupled terms of the dynamics model to joint variables makes some difficulties in classical methods to controller design. To overcome this problem, fuzzy controllers that have appropriate efficiency in complex and nonlinear systems are used. To evaluate the fuzzy control method based on dynamics model, some traditional and fuzzy controllers are designed for single and two degrees of freedom manipulators and their efficiency investigated. The results show the desired condition of the fuzzy controller compared to the other controllers. For hyper-redundant manipulators which are high order multivariable nonlinear systems and have coupled states, the fuzzy controllers indicate some advantages when compared to the other classical controllers. For demonstrating this matter, dynamics modeling of 10 degrees of freedom manipulator is done. Then a fuzzy controller is designed with attention to the dynamics behavior of the system. Manipulator behavior through various and noisy inputs are evaluated by simulation of the model including fuzzy controller. The results show very small error in manipulator motions and suitable condition of the designed fuzzy controller based on the dynamics model.

Keywords

Robot, Control, Hyper-redundant, Fuzzy, Dynamics, Manipulator.

I. List of Publications

The research presented in this thesis has led to a series of publications [1], [2].

References

[1] S. R. Ahmadzadeh, "Modeling of hyper-redundant manipulators dynamics and design of fuzzy controller for the system," in *IEEE International Conference on Integration of Knowledge Intensive Multi-Agent Systems, (KIMAS 2005).* IEEE, 2005, pp. 248–253.

[2] S. R. Ahmadzadeh and M. A. Hajabasi, "Controller design for hyper-redundant manipulator using backbone curve," in *8th International Conference of Mechanics*. Tehran, Iran: Tarbiat Modares University, 2003.

S. R. Ahmadzadeh is with the Department of Mechanical Engineering, Bahonar University, Kerman, Iran e-mail: reza.ahmadzadeh@iit.it