Sirindhorn International Institute of Technology
Thammasat University

Thesis ME-MS-2008-01

MODELLING AND CONTROL OF PNEUMATIC ARTIFICIAL MUSCLE ACTUATOR

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A Thesis Presented

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Master of Science
Mechanical Engineering Program
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May 2009

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Submitted to

Sirindhorn International Institute of Technology

Thammasat University

In partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

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May 2009

Acknowledgements

This thesis arose in part out of two years of research that has been done since I came to Sirindhorn International Institute of Technology (SIIT). During that time, many organizations supported me in different ways and I have worked with many people whose contribution in assorted ways to the research and the making of the thesis deserve special mention. It is a pleasure to convey my gratitude to them all in my humble acknowledgment.

In the first place I would like to record my gratitude to my advisor, Associate Professor Dr. Thananchai Leephakpreeda for his supervision, advice, and guidance from the very early stage of this research as well as for giving me extraordinary experiences and knowledge throughout the work. Above all and the most needed, he provided me unflinching encouragement and support in various ways. His true scientific, engineering and teaching intuition have made him a constant oasis of ideas and passions in many areas, which exceptionally inspire and enrich my growth as a student and the researcher I want to be. I am indebted to him more than he knows.

I would like to express my sincere thanks to Associate Professor Dr Supachart Chungpaibulpatana and Associate Professor Dr. Bundit Limmeechokchai for devoting their time, valuable suggestions and kindly serving as members of the thesis committee.

A grateful acknowledgement also extends to my external examiner, Associate Professor Dr.Suwat Kuntanapreeda, for spending his precious time in making a rigorous review of my thesis.

I would like to express profound gratitude to Sirindhorn International Institute of Technology, Thammasat University for giving me an opportunity to continue my study as a graduate student and this great opportunity for me to put one step towards my life goal to be a researcher.

In addition, thoughtful thanks are extended to the secretaries of Mechanical Engineering Program, Ms. Mayuree Phan-On and Mrs. Wanna Teerapokin and all the staff members of SIIT registration division for their kind cooperation and services all the way through this study.

I gratefully thank Borwon Chompooborisuth and Panupong Chutikanon for their assistance in experiments.

I am deeply indebted to the Asian Development Bank (ADB) for providing me full scholarship to study in Sirindhorn International Institute of Technology and also I gratefully acknowledge Thailand Research Fund: TRF Research scholars-RSA5180011 for providing me financial support for this research.

Honest thanks are due to my friends for their help and encouragement and also I would like to thank everybody who was important to the successful realization of thesis.

Finally, the most important thanks are to my family for their moral support and great encouragement.

Abstract

Pneumatic Artificial Muscle (PAM) actuators yield natural muscle-like actuation with high force to weight ratio, soft and flexible structure, and adaptable compliance for rehabilitation and prosthetic appliances for the disabled as well as humanoid robots in industry. The present study is to develop the empirical models of the PAM actuators in order to both describe and simulate their dynamic behaviours for practical control design and efficient usage. Different characteristics of dynamic behaviour of the PAM actuators are vary from one to another due to not only the structures of the PAM actuators themselves but also the variations of their material properties in manufacturing processes. These inherent complexities still limit the viability of existing analytical models obtained from the physical principles or laws. To overcome the difficulties, the proposed empirical models are experimentally derived from real physical behaviours of the PAM actuators, which are being implemented.

Further, PAM system control is not easy with its high nonlinearity due to its construction and mechanical properties and hence it is difficult to control using linear controllers. Fuzzy logic control is an effective method to handle the nonlinearity of the actuators. The controller is designed by using the data and the models obtained from the PAM system to overcome its controlling difficulties.

In case studies, the simulation results have good agreement with experimental results, which shows that the proposed methodology can be applied to describe the dynamical behaviours of the real PAM actuators available in industry for effective use and control design.

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