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DEVELOPMENT OF PNEUMATIC ROBOT ARM CONTROLLER FOR INDUSTRIAL APPLICATION

A thesis submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
Degree of Master of Science

by

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DECLARATION

The work submitted in this thesis is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any other degree, and is also not being concurrently submitted for any other degree.



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Abstract

This research study focuses on developing a pneumatic robot arm for industrial applications, where the discussion here is narrowed down to the application of Pneumatic Artificial Muscles (PAM) on bicep configuration. When compared with other robotic actuators Pneumatic muscles have several advantages such as lower power to weight ratios, high strength, lightweight and easiness of employment. Hence pneumatic artificial muscles have become more attractive actuators in industrial robotics applications. A pneumatic muscle analysis was carried out with the help of practical results which were obtained with a prototype experiment. It was realized that the muscle behaves in a non-linear manner which is the main disadvantage. The system equation is linearised in order to derive the state space model. With this the system would be linearised only within a small range of inputs, where it is impossible to use it as a general model with whole range of inputs.

A simulation study has been carried out for the system using Matlab/Simulink environment for various categories of inputs and it is experienced that the system responded to linear input signal, as per anticipated output of the theoretical analysis. Even though the above paradigm is discussed for single pneumatic sub-systems, it is emphasized, that the same approach can effectively be extended without any major conceptual breakthrough to any number of muscles. Depending on the application the pneumatic muscle may require different contraction profiles, where the controlling task of the muscle contraction would be vital.

To obtain the desired tracking of the actual performance, Inversion Based Control (IBC) concept has been employed. Simulated results showed the proposed methodology could be effectively applied. Further, investigations need to be carried out to model the complete system with other perturbations and apply the inversion based control concept for precise control of the tip of the arm.

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