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# Application of response surface methodology on finding influencing parameters in servo pneumatic system

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ABSTRACT

Servo pneumatic positioning system is a mechatronics approach that enables to use pneumatic cylinders as multi-position actuators. In the present study, an endeavor has been made to simulate the response of pneumatic cylinder parameters. Response surface methodology based analysis have been conducted to evaluate the influences of system parameters such as external load, supply pressure and cross sectional area of cylinder on the response characteristics such as settling time, maximum overshoot, integral time absolute error and maximum force generated using fuzzy rule base models. From the experimental results, it has been inferred that supply pressure has mostly influent nature on determining maximum overshoot and integral of time absolute error (ITAE). It has been observed that cross sectional area and external load has significantly affected the maximum generated force and settling time respectively.

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## 1. Introduction

Pneumatic actuators are widely used in the field of automation, robotics and manufacturing. The pneumatic technology exhibits many advantages such as high speed, high force generation, better efficiency, less maintenance and low operating costs. Traditionally pneumatic cylinders are used for motion between two hard stops. In order to expand the capabilities of the pneumatic cylinders to be operated as multi-position actuator, servo control techniques are being used. But the pneumatic actuators are difficult to control due to nonlinear characteristics of the system [1,2]. The nonlinearities present in pneumatic actuators are very low stiffness (caused by air compressibility), mass flow rate variations and low damping of the actuator systems, which make it difficult to achieve precise motion control [1]. The main nonlinearities in pneumatic servo systems are the valve dead zone, air flow-pressure relationship through valve orifice, the air compressibility and friction effects between contact surfaces in actuator seals [2].

Over the past decade modelling and control of the servo pneumatic actuators is an interesting topic that has attracted the researchers around the world. Valdiero et al. [2] presented the model of the system with combination of theoretical equations and system identification methods. Sorli et al. [3] analysed the dynamic characteristics of the servo pneumatic positioning system. Takosoglu et al. [4] presented overall theoretical model of the servo pneumatic system using proportional valve. Najafi et al. [5] modelled the cushioning sections of the pneumatic cylinder. Many authors have presented different control approaches and algorithms for accurate control of the pneumatic actuators. Aziz and Bone [6] presented the automatic tuning procedure for the servo controllers for pneumatic systems. Rao and Bone [7] presented novel MISO nonlinear position control

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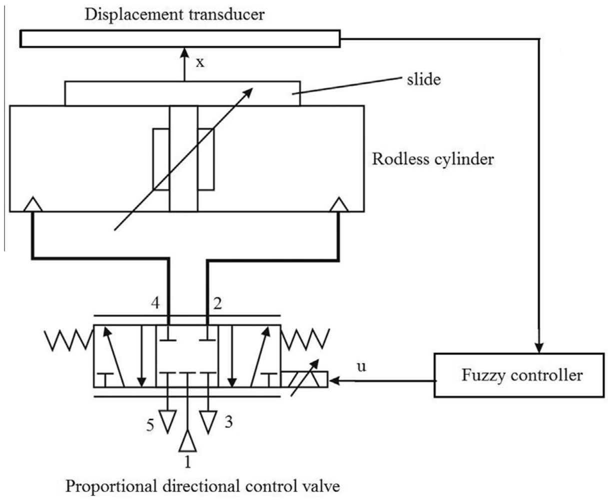


**Fig. 1.** Schematic diagram of pneumatic servo positioning system.

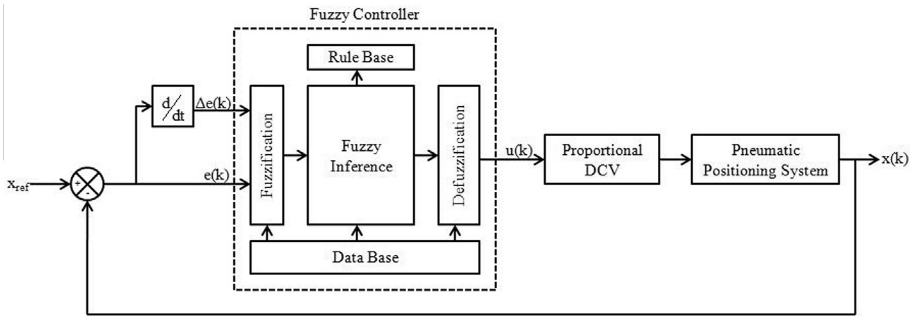


**Fig. 2.** Block diagram of the fuzzy controller for the pneumatic positioning system.

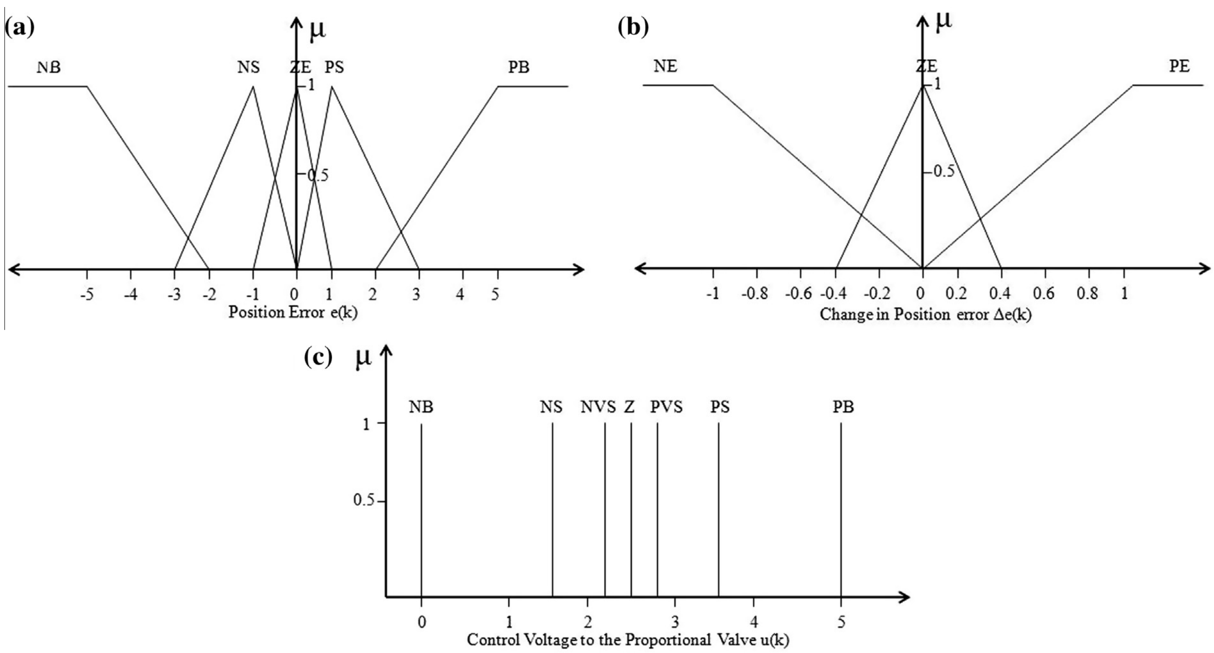


**Fig. 3.** Membership functions of variables of fuzzy PD controller.

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