MECH 461 Project Proposal for Winter 2013

Control of a Pneumatic Gantry Robot for Tracking Applications

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INTRODUCTION
In 2007 a pneumatic gantry robot was developed to enable studies in hybrid force/velocity control for contour tracking applications [1]. See Fig. 1. Since that time the robot has been modified and upgraded as it was used by a series of graduate students. The main axis was recently refurbished with a new pneumatic cylinder, as a decrease in performance was observed in the most recent study, which was attributed to uneven wear in the bearing surface and higher than normal friction [2]. Data acquisition and control is PC-based with a dSPACE/DSP® as the data acquisition hardware/software and MATLAB/Simulink®as the control software. Proportional flow control values are used in combination with both rodless and rodded pneumatic cylinders.

SCIENTIFIC BACKGROUND
Much research has been conducted on position and force control with electric robots. By contrast, little research has been conducted on position and force control with pneumatic robots [3]. This is understandable as pneumatic actuators are more difficult to control because of low bandwidth and high nonlinearity due mainly to air compressibility and Coulomb friction effects. However, relative to electrically actuated systems, pneumatic systems are cheaper and easier to maintain. This observation has led to considerable research on pneumatic servosystems [4]. For example, the potential of an adaptive neural network (NN) compensator in combination with a conventional PID has been studied with application to the gantry robot [5]. See Fig 2. After careful tuning, it was found that the adaptive nature of the NN improved performance on the order of 45% to 70% above that of PID without compensation.

Fig. 1. Pneumatic gantry robot with main components labelled [1].
RESEARCH OBJECTIVES
To benchmark the performance of the refurbished pneumatic gantry robot and implement a PID control system for the two major axes. The ability of the robot to track 2D shapes (circles and rectangles) will be used for benchmarking purposes. Time permitting, advanced model based algorithms for contour tracking will be implemented to determine the extent that performance can be improved.

SKILLS DEVELOPED
The student will learn about pneumatic servosystems and will obtain hands-on experience with the implementation and control issues associated with the technology. He/she will learn about advanced model based control techniques for positioning and contour tracking systems. The experience gained with PC controlled servosystems will serve as good background for any experimentally based Masters Thesis in the field of automatic control, if the student chooses to go on to graduate school.

EXPERIENCE REQUIRED
Strong interest in control systems and dynamic modeling. Experience with MATLAB a requirement.

REFERENCES


Fig. 2. Block diagram of PID controller with neural network compensator [4].