Ain Shams University
Faculty of Engineering
Electrical Power & Machines department

Adaptive Motion Control For DC Drive Robot Manipulator

A Thesis Submitted to The Faculty of Engineering, Ain Shams University in Fulfillment for The Requirement of The Degree of Doctor of Philosophy in Electrical Power Engineering

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APPROVAL SHEET

"Adaptive Motion Control For DC Drive Robot Manipulator"

The above title Dissertation for the Degree of Doctor of Philosophy in Electrical Power Engineering Presented by Eng. **Ashraf Saad Awad** has been approved by the following examiners committee:

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Date: / / 2009

DEDICATION

This thesis is dedicated to my family

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Ph. D. in Electrical Engineering.

The work included in this thesis was carried out by the author in the department of Electrical Power and Machines, Faculty of Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any university or institution.

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ABSTRACT

"Adaptive Motion Control For DC Drive Robot Manipulator"

It is necessary to use a realistic dynamic model for simulation of robot manipulator, considering the effects of friction, disturbance, parameter perturbation and payload variation. Different trajectory generators are employed, like sinusoidal, exponential and cycloidal. Indices like RMS, average, maximum norm and path accuracy of the tracking errors, are applied for system performance evaluation. An index is introduced, by dividing both, the average and RMS, to evaluate the quality of the control signal. Simulation of three different controller algorithms; Adaptive, Optimal, and PID; are implemented and evaluated, using the above mentioned indices, on links 2 and 3 of the unimation PUMA 560 arm, acting as two degrees of freedom planar manipulator. Analytical results are obtained for path accuracy, response, and the efficient use of energy for the three controller's algorithms.

An experimental two link robot is built and autopiloted by a digital control system. The motors are driven by a Darlington transistor in an H-Bridge configuration for control of speed and torque in two directions using CMOS, (Complementary Metal Oxide Semiconductor), switches and PWM (Pulse Width Modulation), technique. ISA (Industrial Standard Architecture) bus is used as an interface between PC and the manipulator control circuits. The inverse kinematic approach is adopted to convert the tool-configuration trajectory to angular joint-space. Three different task space trajectories, straight line (horizontal & vertical), triangular and circular, are generated and implemented as reference trajectories. PID and decentralized adaptive controller algorithms are applied, with QBASIC program, considering position, velocity and acceleration.

An identified model for the robot is obtained with neural network autoregressive architecture, using a Levenberg-Marquardt algorithm.

Good correlation between experimental and simulation results has been confirmed. A Matlab real time GUI program has also been designed to analyze different randomized switching patterns. Harmonic contents and PSD, (Power Spectrum Density), of two chosen patterns namely RPWPM, (Random Pulse Width Position Modulation), and MRPWM, (Modified Random Pulse Width Modulation) are displayed with their mean, RMS and THD, (Total Harmonic Distortion) values.

Building an industrial robotic system capable to perform tasks, like arc welding, spray painting, pick and place, loading and unloading, profile and pattern cutting, applying glues & adhesives, is one of the objectives behind building the prototype. It is intended to establish a basic foundation for developing the national industry in various fields of manufacturing, from scratch. Adopting such an idea will help developing many other fields of industry, such as sensory devices, mechanical joints fits and tolerances, electrical motors and actuators, pc's hardware and software programming, electronic components and circuits design and control systems.

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