FPGA Implementation of a PID Controller with DC Motor Application

By
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Outline

• Overview and Top-Down Design
• Previous Patents and Standards
• Functional Description
• I/O of Subsystems
• Quantitative Specifications
• Preliminary Lab Work
• Equipment Needed
• Division of Labor
Introduction

- Implementation of a controller in an existing DC motor system
- Minimize cost
- Overcome non-linearity of DC motor
- DC motor speed variations

Top-Down Design

- Speed Command Signal
- Digital PID Controller
- PWM System
- DC Motor System
- Frequency to Digital
- Motor Shaft Velocity
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Previous Work

- Brett Marshall – 2000/2001 Senior Project
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System Inputs and Outputs

Inputs

- Speed Command Signal

Outputs

- Motor Shaft Velocity
- System Display
Modes of Operation

- Full Speed
- Off
- 0 to 800 RPM via user

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Digital PID Controller

Error Signal $\rightarrow$ Digital PID Controller $\rightarrow$ PWM Command Signal

- Error Signal combination of desired input and motor shaft velocity
- PWM Command Signal computed based on Error signal to ensure linearity

PWM System

PWM Command Signal $\rightarrow$ PWM System $\rightarrow$ PWM Signal

- PWM Command Signal used to create desired percent duty cycled signal
DC Motor System

- PWM Signal used with hardware to control DC Motor System
- Motor Shaft Velocity produced by encoder

Frequency to Digital Converter

- Motor Shaft Velocity sent from encoder on DC motor
- Digital Speed Signal is a digital representation of motor shaft velocity
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Specifications

• Steady State error = 0 for command inputs
• Percent Overshoot = 5%
• Phase Margin > 50 degrees
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Preliminary Lab Work

• DC Motor Modeling
• PWM System Design
• Complete System Block Diagram
• Investigation of non-linear look-up table implemented in block diagram
Complete System Block Diagram

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Equipment for System

- FPGA Development Board
- Personal Laptops

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Division of Labor

• Due to highly theoretical nature of project, most parts will be completed together.

• Possible division of labor:

  Paul Leisher
  • VHDL Framework
  • Test System Method and Development

  Christopher Meyers
  • VHDL PWM Subsystem
  • Reliable Speed Display System