Fuzzy Logic Control of a Magnetic Suspension System using xPC Target

Block Diagram

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Introduction

The goal of this project is to use a Simulink-Based xPC Target Box to implement a fuzzy logic controller for a magnetic suspension system. The magnetic suspension system will cause a metal ball suspended in a magnetic field to track a reference input waveform, usually a square wave. The behavior of the controller will be optimized for steady-state error, rise time, settling time, and percent overshoot

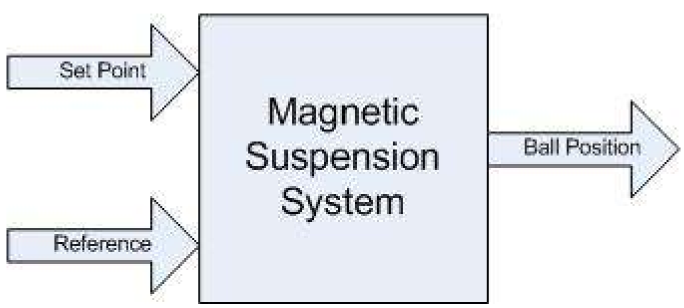
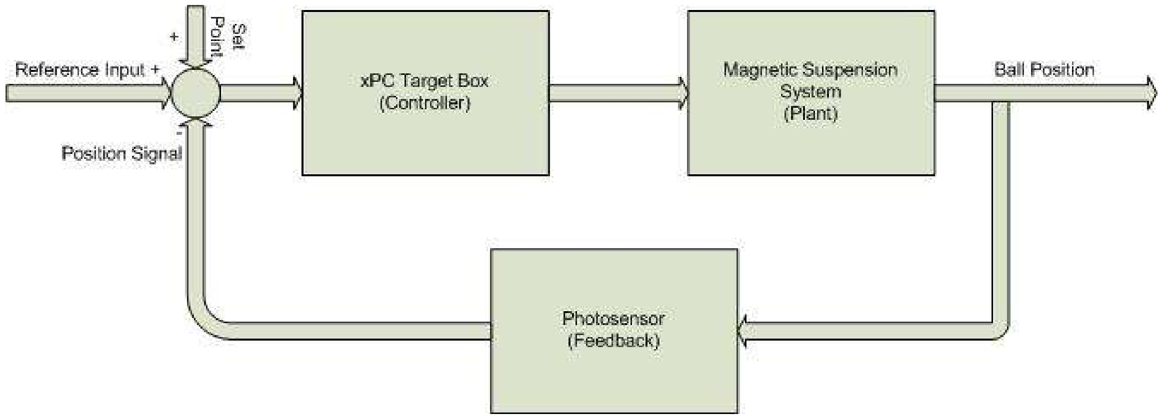


Fig. 1 – Overall System Block Diagram

Block Diagram

Figure 1 shows the overall system block diagram. The set point voltage determines where the ball should hang at steady state. This along with a reference input waveform is entered into the overall system, which changes the position of the ball to match the



reference input.

Fig. 2 – System Internal Block Diagram

Figure 2 shows the internals of the system. The set point, reference waveform, and negative of the ball position are summed to provide an error signal. This signal is fed into the controller, which produces a correction signal for the plant. The ball position changes according to the correction signal, and is fed back to the input via the photosensor.

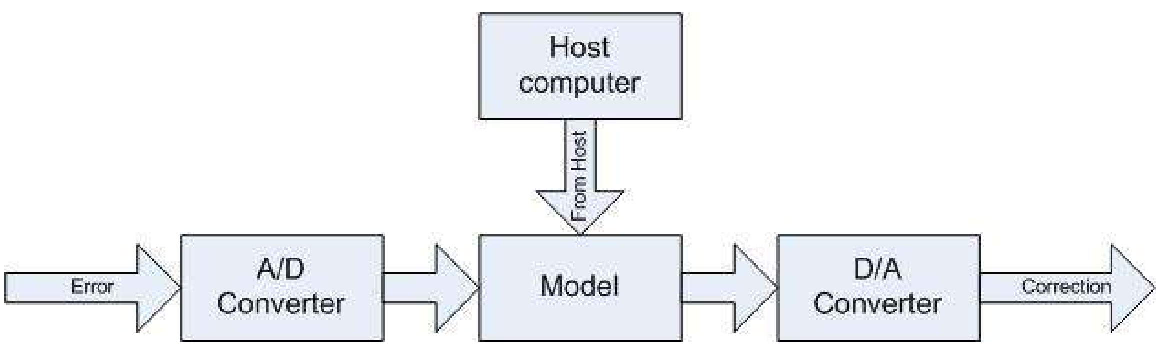


Fig. 3 – Controller Block Diagram

Figure 3 shows the block diagram for the controller. The error signal from the summer is sent through the A/D converter to produce a digital signal for the digital controller in the xPC . The mathematical model of the controller is downloaded from a host PC to the xPC target. The model determines the correction based on the error signal, and the resulting digital signal is turned into an analog signal via the D/A converter. The sampling time of the controller is 1ms. The A/D and D/A converter have ranges of +-10V.

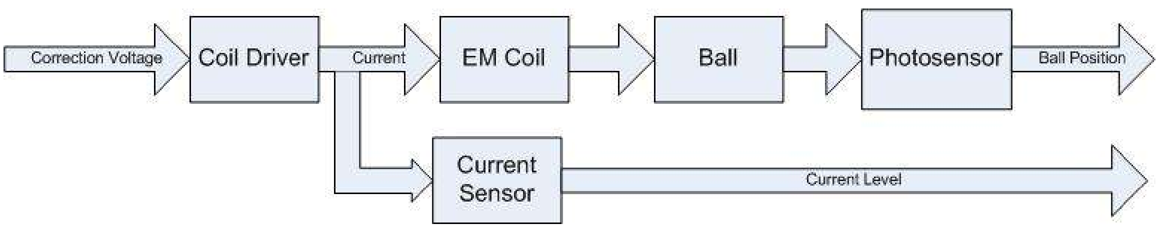


Fig. 4 – Plant Block Diagram

Figure 4 shows the plant block diagram. The correction voltage from the controller is applied to a coil driver which changes the voltage to a current. This current is sampled by a 1 ohm resistor used as a current sensor. The current runs through an electromagnetic coil, which suspends the steel ball in its field. The ball position is measured by a photosensor.

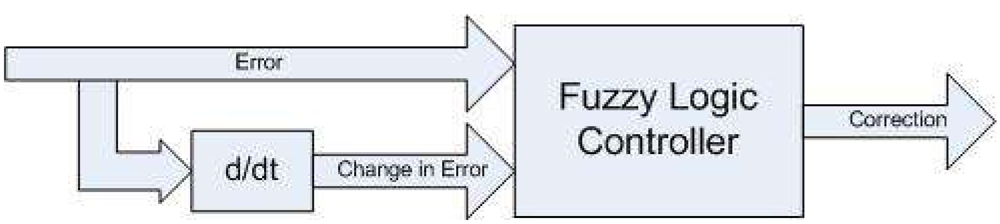


Fig. 5 – Controller Model Block Diagram

The fuzzy logic controller operates as a model on the xPC target box. The system is shown in figure 5. The error signal from the A/D converter is fed into the controller, and the change in error is computed and fed in as well.

The fuzzy logic controller operates as seen in the flowchart in figure 6. The inputs are 'fuzzified' according to the input membership functions defined in the system. The input membership functions are cut off at the maximum level of certainty as expressed by the fuzzified inputs. Then, the certainty of application of each rule is determined using the product method on the applicable inputs. The final value of each output membership function is chosen as the maximum certainty of application among the applicable rules. The final output value is found by finding the value which represents the center of gravity of the new output membership functions..

Fig. 6 – Fuzzy Logic Flow Chart