Chapter 6
Effect of Different Parameters on the Controller Performance for a DC Attraction Type Levitation System

ABSTRACT

The basic parameters for electromagnetic levitation systems are inductance and resistance of the actuator, input DC link voltage, mass of the payload (object), air-gap between the pole face of the electromagnet and ferromagnetic guide-way or object, etc. All these parameters are supposed to change in real-life situations. DCALS is inherently unstable and strongly nonlinear in nature. In most cases, a classical controller has been designed for the linear model around an operating point for maintaining overall closed-loop stability. So, the performances of the linear controller with the change in different parameters have been studied. The parameters of the designed controller also vary during experimentation. So, a sensitivity study of the controller for a DCALS is also important.

INTRODUCTION

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guide-way or object etc. All these parameters are supposed to get change in real life situation. DCALS is inherently unstable and strongly nonlinear in nature. In most cases a classical controller has been designed for the linear model around an operating point for maintaining overall closed-loop stability. So the performances of the linear controller with the change in different parameters have been studied (Banerjee & Bhaduri, 2008). The parameters of the designed controller also get varied during experimentation. So a sensitivity study of the controller for a DCALS is also important.

The proposed DCALS has been described already in previous chapters and the basic block diagram of the overall control system is shown in Figure 4 in Chapter 4. In this system a cylindrical rod has been arranged to suspend under E-core electromagnet at different operating air-gaps. The basic parameters for the system have been given in Table 1 in Chapter 4. In this work, a cascade compensation control scheme utilizing inner current loop and outer position loop has been designed and implemented for stabilization of a single magnet based single axis levitation system. The prototype has been successfully tested and stable levitation has been demonstrated at the desired operating gap. The dynamic performance of the controller has been tested by applying different disturbance inputs with increasing magnitudes and frequencies.

As described in Chapter 4 & 5, the transfer-function of the levitated system (given in Eqn.4.9) at 10 mm operating air-gap has been determined experimentally and is given by

$$G_p(s) = \frac{9.237}{(s+35.44)(s-35.44)} \tag{6.1}$$

For the operating air-gap of 10 mm, the plant $G_p(s)$ has one stable pole at s = -35.44 and an unstable pole at s = 35.44. The objective is to design a phase Lead compensator (Ogata, 2000) so that the overall closed loop system becomes stable. The pole and zero are to be placed on the negative real axis and there are many possible pole-zero locations for stabilizing the system. The phase-Lead compensator design procedure in this case is to place the zero of the compensator between 0 and –35.44 on the real axis of the s-plane, while the pole of the compensator is placed about 12 times to the left of the zero position. Simulation studies are carried out to find a pole-zero and gain combination so that the system is stable as well as acceptable performance is obtained. The transfer function of the designed Lead controller for an operating air-gap of 10 mm is given by