Overview:

The objectives of this project are modeling and control of a laboratory scale magnetic levitation system. The magnetic levitation system facilitates the suspension of a hollow steel sphere with the aid of electromagnetism. Figure 1 displays a picture of such a system.
Figure 2: General System Block Diagram

Figure 2 shows a high-level block diagram of the system. The user adjusts the set point potentiometer on the maglev to place the ball at the equilibrium point. A reference input signal is applied at maglev input. An position error signal is generated from the maglev corresponding to the difference between the reference, set point and actual ball position. This error signal is fed into a microcontroller that generates a control signal to place the ball at the desired vertical position. Disturbances act on the system such as power supply fluctuation, coil temperature changes that change the set point value.

There are six major subsystems in this project. These subsystems are as follows:

I. **Error Generator Subsystem**

The first subsystem generates an error signal for the microcontroller. This subsystem, shown in figure 3, accepts three inputs: set point, reference input signal and actual ball position to produce the error signal.
II. Amplifier and Protective Circuitry

This subsystem amplifies the error signal and provides any protective circuitry needed for the microcontroller. This subsystem includes a level shifter circuitry to correspond to the microcontroller voltage range. Figure 4 shows the block diagram.

Figure 4: Subsystem II

III. Microcontroller

The position error signal is sent to a microcontroller through a multiplexed A/D converter. A PC is used to develop, debug and compile the control algorithm code. The compiled code will be downloaded to an 8051 microcontroller for execution. The microcontroller computes the control signal and sends it through the D/A, as shown in figure 5.

Figure 5: Subsystem III
IV. Coil driver and electromagnet

The control signal, produced by the microcontroller, is amplified and fed to a coil driver to produce a current. This current is fed to an electromagnet, which produces the required force to suspend the ball at the desired position. A subsystem block diagram is shown in figure 6.

![Subsystem IV](image)

Figure 6: Subsystem IV

V. Sensor

The photo-emitter/detector sensor is used for detecting the vertical position of the ball. It generates an analog signal, corresponding to the actual ball position; which gets fed back for closed-loop control. A block diagram for this subsystem is shown below in figure 7.

![Ball position sensor](image)

Figure 7: Ball position sensor

The overall closed-loop system block diagram with subsystems is shown in figure 8:

![Overall system](image)

Figure 8: Overall system