

Control of a One-Dimensional Magnetic Levitation System

Background

There are many ways to levitate things without any noise or the need for petrol or air, for instant, by using electromagnetic fields. Levitating train is one typical of electromagnetic levitation system. Another typical example using electromagnet is the attitude control of small-size satellites, such as the first Danish satellite – Ørsted satellite (<http://www.control.aau.dk/orsted/>) and the current AAU student satellite - AAUSAT-II (<http://aausatii.aau.dk/wiki/index.php/Home/News>). Using forces generated from the interaction between the on-board (controlled) electromagnetic field and the earth magnetic field, the satellites can efficiently (with consuming very few energy) control their attitude in the space such that to carry out some specific tasks, e.g., measuring the earth magnetic field, observations of the Solar eclipse etc..

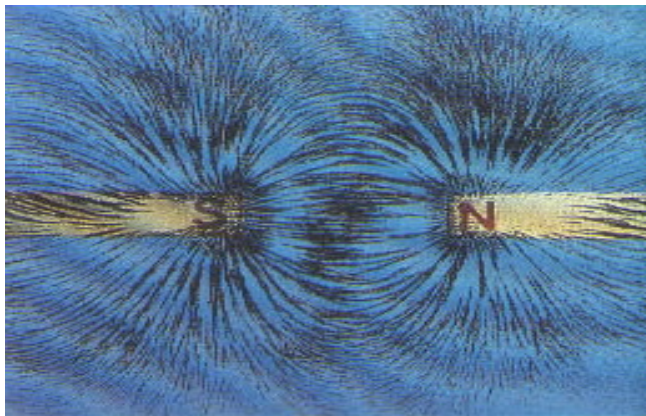
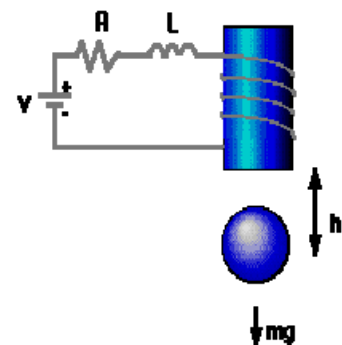


Figure 1 Visualized Magnetic field and the principle of levitation system



In recent years, one dimensional magnetic levitation system as shown in the following Figure 2 is developed in AAUE. We succeeded in levitating a light ball at some specific point by using control of the solenoid current and an optical sensor system consisting of a photo-diode array and LEDs. However, there are still many issues can be further improved/extended.



Figure 2 AAUE Levitation System

Objective and Contents

The project can improve/extend the current system with respect to the control strategy and the hardware issue as well. For example, some of the following items can be considered into the project:

- Classical Control development and implementation using one solenoid
- Usage of a second solenoid at the bottom of the framework so as to increase the levitating power (then the system becomes two-input one-output control system);
- The previous work only used one diode of the photo-diode array for distance measurement, the extension to use full range of the photo-diode array (app. 3 cm measurable range) could be very interesting also;
- The control of the dynamic movement of the ball within the sensor's operating range would be interesting from the real-time control point of view, such as the levitated object could track some slow harmonic music once we "map" the melody into the sequence of set-points.

Remarks

The physical setup is available in the AAUE E-laboratory, and relevant previous documents/reports are also available for reference as well.

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