CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

B.J. Kim

Project Number

S0913

Project Title

The Effect of Control Mechanisms on the Stability of an Electronically Reproduced Meissner Effect Levitation System

Abstract

Objectives/Goals

Current systems of magnetic levitation transportation are restricted by its high costs, its inability to become compatible to conventional tracks, and the weight of the large electromagnets on the maglev trains. My aim of my project was to produce a working, stable levitation system which was capable of levitating an object clear of any support on the same level of elevation with the levitated object. Then I experimented to investigate various configurations of electromagnets in order to achieve stable magnetic levitation.

Methods/Materials

I modified the system known as the "magnetic cradle" desgined by Bill Beaty which electronically produces a Meissner-like effect. Instead of applying a switched current control, I worked to develop a magnetic levitation system that would use continuous current control to the elctromagnets. I first tested the control circuitry and the Hall Effect sensor system. Then, I worked to duplicate this system for each electromagnet necessary for the levitation system. From that point, the control circuitry was designed, added, and modifed as necessary to the system. Thus, I created an improved version of the magnetic levitation system from the one with which I began with.

Results

At the completion of my project, I was able to achieve complete stable magnetic levitation. My current system was able to perform stable levitation of a bar magnet with support in the lateral direction. However, various configurations to the control circuitry created an effective electronically simulated Meissner effect. Furthermore, driving of the electromagnets using the continuous current control method provided a relatively simple solution to integrating control circuit.

Conclusions/Discussion

There were two designs used throughout the development of this project - one using a single opamp summer circuit and one with the addition of a phase lead network for speed and position information. However, taking into account the time required for the construction of the system, modifying the control circuit, and the maintenance, the inital single opamp design is more effective. Its results aligned with expectations and it becomes simpler to work with as the system becomes increasingly complex.

Summary Statement

I electronically reproduced the Meissner Effect through five different types of circuitry and linked it to a negative feedback loop in order to create stable bottom-held magnetic levitation of an alnico bar magnet.

Help Received

Father helped with conceptual physics and circuitry. Received help from Professor Konstantinos Michail at the Cyprus University of Technology.