Linear Optimization of Solenoid-based EM Levitation

Anderson Ang, Jamie Cho, Anne Ku

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Project Description

This project aims to investigate the use of mathematical optimization to achieve stable levitation through *attraction* in an electromagnetic system.

Specifically, this is to be achieved by:

1. Characterisation of all factors (e.g. gravitational, magnetic) critical to the system's function
2. Selection of a variable (i.e. current flow through the EM coil) for optimization
3. Creation of a simulation model that tracks the system's performance over an optimization path.

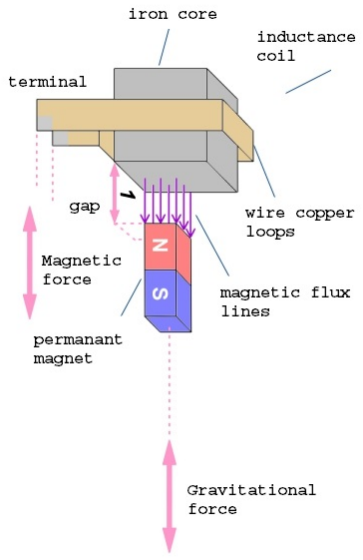

Figure 1: System diagram of our proposed levitation model

By modelling the forces in the proposed system (*Figure 1*), an equilibrium should be attained with the *minimum* amount of current flowing through the ferromagnetic coil. The equilibrium must be inherently stable, with minimal oscillations.

Relation to Linearity

We are modelling a system of interactions between magnetic objects; in particular, vector calculus is heavily involved with the equations that govern magnetic systems: the fundamental concepts – such as flux, divergence and gradient, to name a few – all reside at the core of these problems, to name a few.

Even though fully characterizing a magnetic system is known to be complex and potentially only solved through numerical methods, tackling this problem would provide a compelling real-world application of, as well as a deeper pursuit of, the concepts we have learned in class throughout the semester.

Deliverables

At the very least, we plan to deliver a functioning model that describes the interaction between an electromagnet and a permanent magnet, each of known parameters, a basic control algorithm in response to changes in the position of the magnet.

If we finish our Minimum Viable Product in time, we plan to model a two-dimensional system that involves two electromagnets with one permanent magnet.

Work Plan

We are going to meet two times a week and share our work through github. We also plan to achieve the following goals by their due dates:

- **December 4th**: Finalize the components(formulas, forces, etc.) in the levitating magnet system
- **December 9th**: Develop and perfect the rudimentary control and optimization algorithms
- **December 9th to 12th**: Improve the model and work on the Technical Report
- **December 12th**: Show report draft to Aaron and start filming the video
- **December 15th**: Turn in the project/ Demo day