modelling maggy in an experiential way

Contents map

developed content units	taxonomy levels
maglev systems	u1, e1

prerequisite content units	taxonomy levels
ODE	u1, e1

Main ILO of lab "modelling maggy in an experiential way"

Derive a series ODEs describing the open loop maglev system by drawing from physical experience that you may gain with playing with the system

Overview of the structure of this lab

- do some testing on how the magnet feels attracted / repulsed by the board, depending on where it is
- do some brainstorming about how the ODEs describing the system may look like

Most important libraries for this lab

- Arduino IDE

Initial recommendations

- work in groups
- disconnect the hardware; you shall work with the *open loop* system (i.e., the electromagnets be off, i.e., work with the autonomous versions of the ODEs)

Assignments

Question 1

Focus just on the vertical axis for now, i.e., use your hands as guides so that the levitating magnet cannot fly laterally but only vertically. Do you note that with the magnet flipped in one way, the magnet feels attracted by the board, while if flipped in the other way, there is a spot where there seems to be an equilibrium (in the vertical direction)? How far is this equilibrium from the plexiglass, more or less? Is this equilibrium asymptotically stable (i.e., attracting the trajectories), marginally stable (i.e., the system keeps wobbling around it), or unstable (i.e., repulsing the trajectories)?

Question 2

Imagine the levitating magnet to be actually constrained – so use your imagination and be driven from the experiences before. Think at a plot drawing all the trajectories of the system (better, the z coordinate of the levitating magnet as time goes). Draw by hand how you think these trajectories $z(t)$ may look like, depending on different initial conditions $z(0)$ (this means drawing a bunch of free evolutions on the vertical direction. Note that this drawing shall be consistent with the compliant with the findings in the previous assignment).

Question 3

Consider the drawing of the free evolutions on the vertical direction made before.
Which autonomous ODE may give you this behavior?

Question 4

Focus now just on the lateral axes, i.e., imagine of removing your hands as guides, so that now the levitating magnet can also fly laterally. Actually now ignore the vertical direction and think only at a lateral one. For simplicity, assume radial symmetry, i.e., imagine that the levitating magnet can fly only along the x axis (indeed, along the y axis the considerations will be the same). The equilibrium (n the vertical direction that you found before, is it also an equilibrium for the x direction? Is this equilibrium asymptotically stable (i.e., attracting the trajectories), marginally stable (i.e., the system keeps wobbling around it), or unstable (i.e., repulsing the trajectories)?

Question 5

Think now at a plot drawing all the trajectories of the system, but now the x coordinate of the levitating magnet as time goes. Draw by hand how you think these trajectories $x(t)$ may look like, depending on different initial conditions $x(0)$ (this means drawing a bunch of free evolutions on the vertical direction. Note that this drawing shall be consistent with the compliant with the findings in the previous assignment).

Question 6

Consider the drawing of the free evolutions on the horizontal direction made before. Which autonomous ODE may give you this behavior?

Question 7

Consider now that the levitating magnet is a mass, and as a mass the ODEs describing it as a system have to be at least second order. Did your derivations in the assignments before consider second order ODEs? If so, ok. If not, re-do everything so that the ODEs are at least second order.

Recap of lab "modelling maggy in an experiential way"

- this lab essentially constructs domain expertise