Fall 2024 6.3102 Graduate Feedback System Design Problem

Due: December 11 at 4:00pm

Your task is to design an **observer** to control a simplified, simulated version of the magnetic levitation environment (MaglevEnv). In this MaglevEnv, there is only one electromagnetic coil that we need to control.

Provided for you are:

- `MaglevEnv.py`: physics simulator of magnetic levitation system dynamics.
- `animate.py`: utility function to create animations of experiments.
- `constants.py`: a number of physical constants which govern the system. **Do not change these constants.**
- `observer_template.py`: a template file to implement an observer. You may use as much or as little of it as you would like.
- `pd.py`: a working proportional-derivative (PD) controller for the MaglevEnv. Demonstrates expected names and usage of variables.
- `requirements.txt`: required Python libraries.
- `state_space_template.py`: a template file to implement a state-space controller. You may use as much or as little of it as you would like.

Deliverables:

- Your implemented observer, as a `.py` file.
- An animation of your observer in action, as a `.gif` file.
- A report detailing the design considerations of your implementation, as well as any supplementary materials, compiled into a single `.pdf` file.

Design considerations to report about your controller:

- Maximum amplitude of a square wave that the floating magnet can track.
- Amount of time needed to settle around the desired height.
- Amount of overshoot of desired position.
- Maximum `noise_factor_i` and `noise_factor_y` that your controller can tolerate and stably control the floating object.

Recommended course of action:

- Create a Python virtual environment and install the required libraries.

  ```
  python -m venv venv/
  source venv/bin/activate
  pip install -r requirements.txt
  ```

- Familiarize yourself with the MaglevEnv and working PD-controller.

  ```
  (venv) python pd.py
  ```

- Implement a state-space controller using LQR; you have already worked through the complete process in Lab 5.
- Determine the desired observer poles. You may find it useful to measure the frequency response of the system.
- Implement your observer.