LEVITATION
DETAILED CONTROL REVIEW

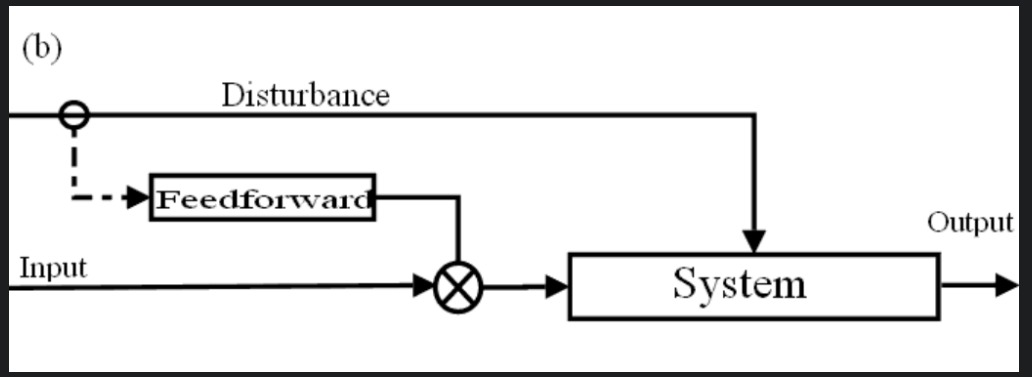
Vertical Control

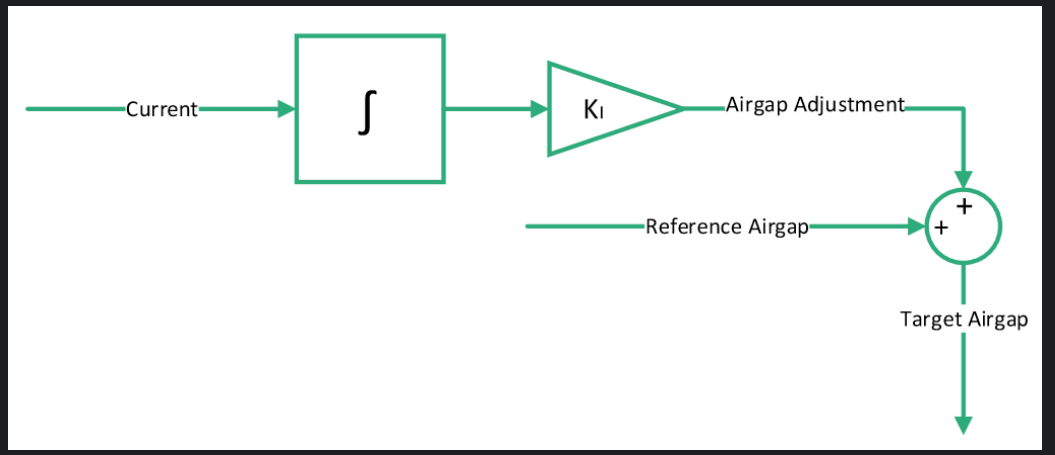
- Centralized controller is chosen
  - Take average air gap based on 4 vertical sensors
  - 3 PIDs for roll, pitch, and average air gap
  - Roll and pitch PIDs output torque, air gap PID outputs total lift
  - Lift force divided equally, forces to perform roll/pitch are added/substracted
  - Next step is to optimze the division of forces
- Optimal air gap finder (from DH07)
- Feedforward is used to account for distrubances
- Adaptive force finder (force mismatch factor)

DELFT
HYPERLOOP

Levitation Control

- Add-ons
  - Cascaded force mismatch
    - Corrective factor found by PID for force control
  - Feedforward input
    - Motor ripples, beam crossing, centrifugal force
  - Optimal air gap (vertical)
    - Minimize integral of current

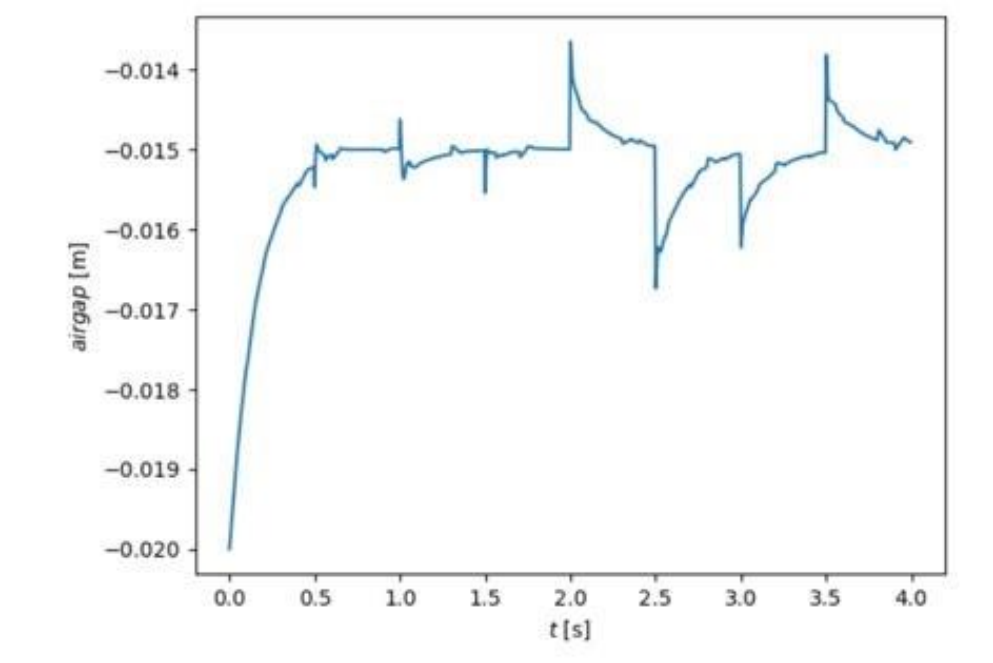


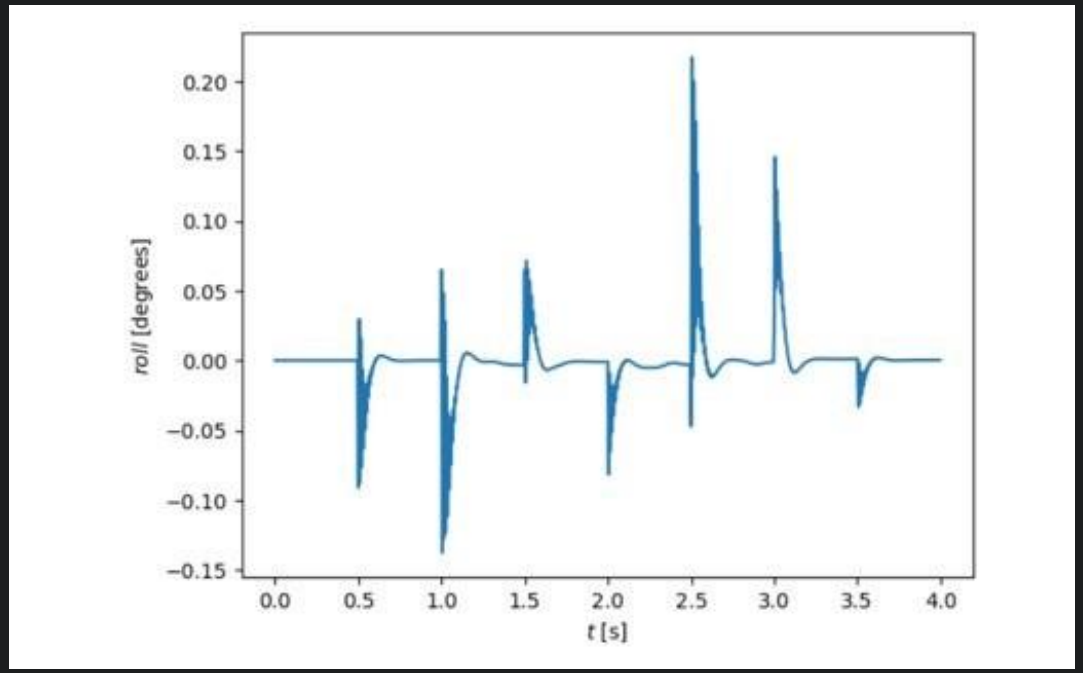


DELFT HYPERLOOP

Vertical Control

- DOF controller results
  - Random beam offsets (-1 to +1 mm) (2 Hz)
  - Random force discrepancy (0.8 to 1.2) (10 Hz)
  - Current saturation causes certain DOFs to lose out on actuator effort





DELFT HYPERLOOP

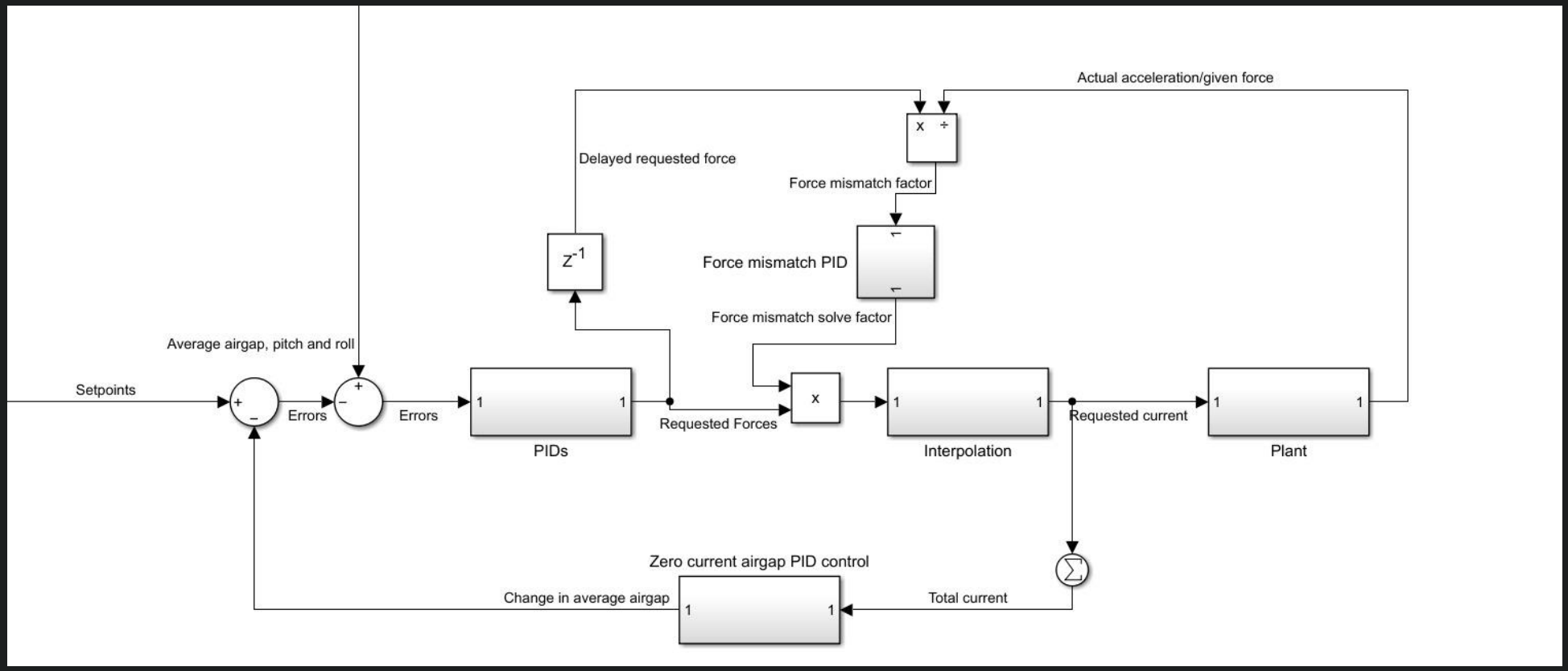
Lookup table

- Requesting force instead of current
- More linear, requires more data
- Look up required current in interpolation tables
- Descripancy between force requested and force given

DELFT
HYPERLOOP

Levitation Control

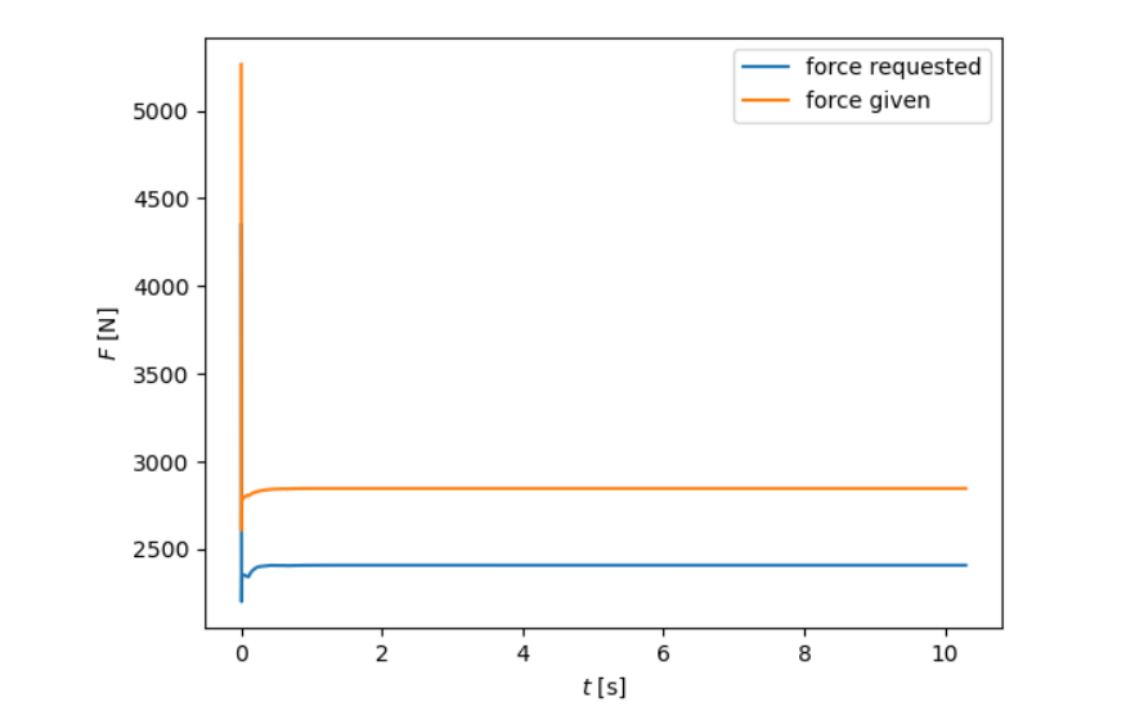
- Add-ons
  - Cascaded force mismatch
    - Corrective factor found by PID for force control



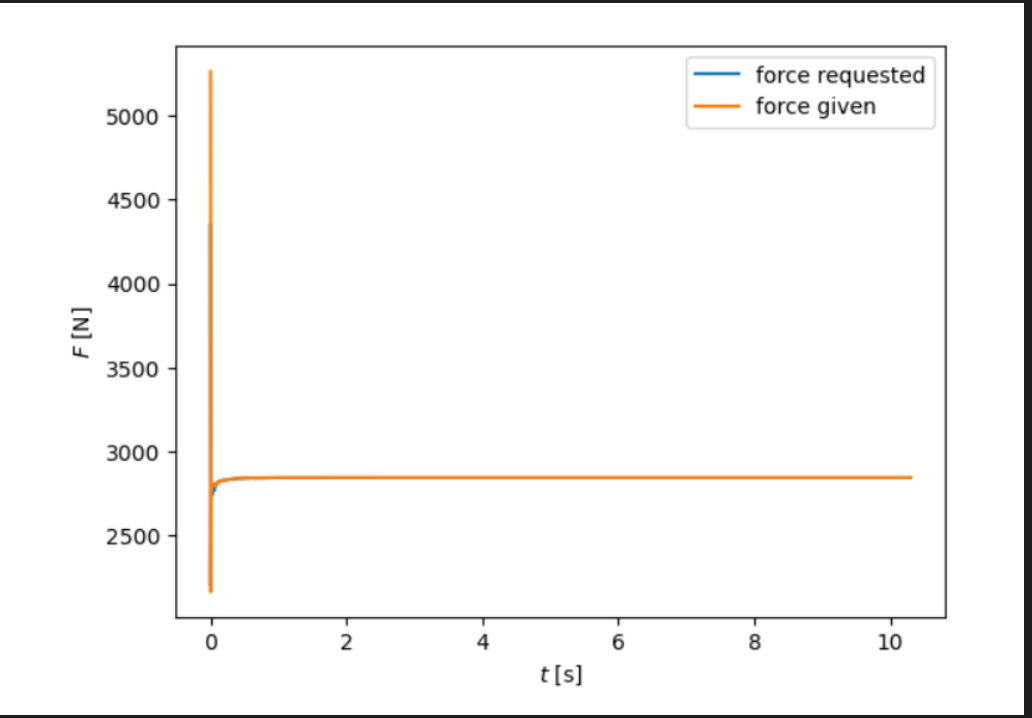
Vertical Control

Adaptive force finder (force mismatch factor)

Corrective factor found by PID for force control to account for real plant and time-varying force output



With 20% force mismatch



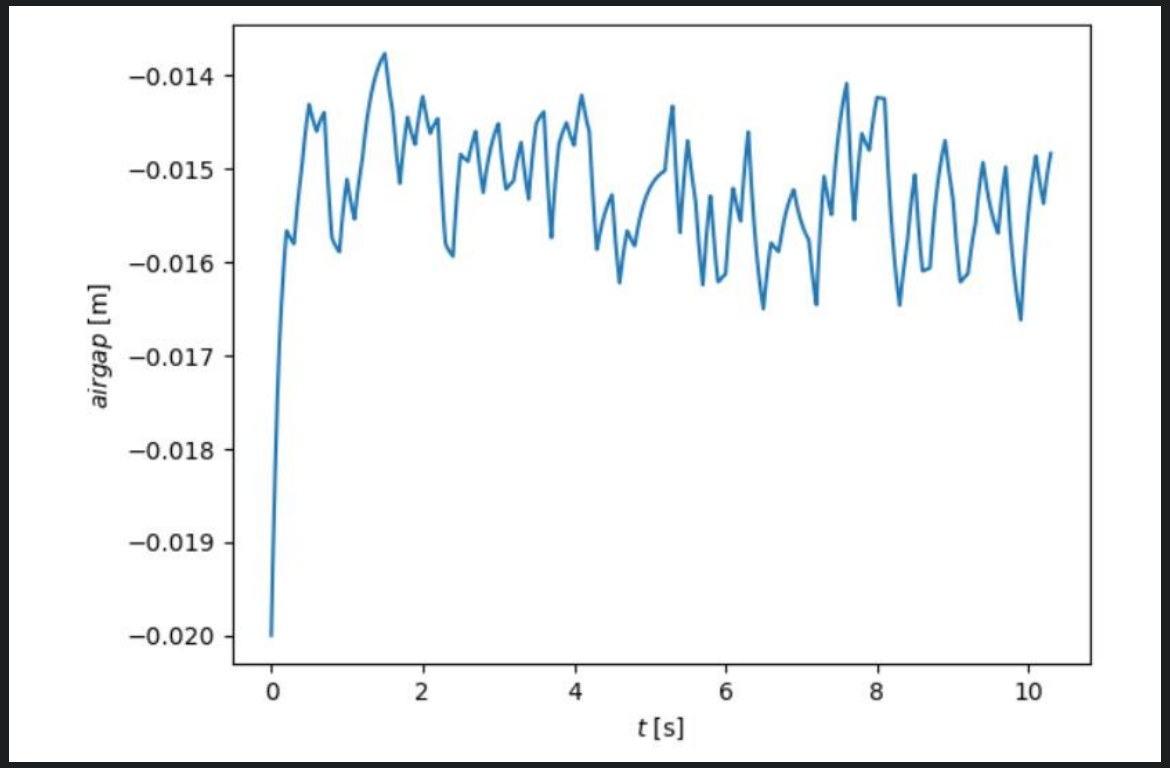
After correction

DELFT HYPERLOOP

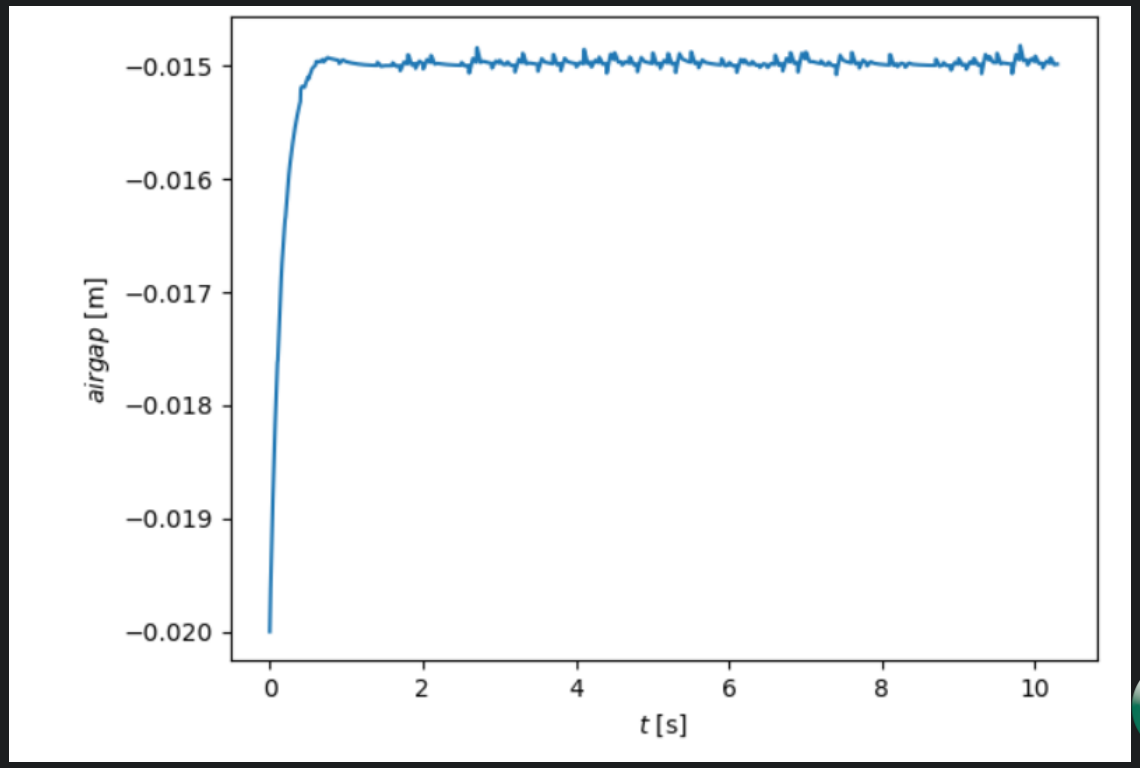
Vertical Control

Adaptive force finder (force mismatch factor)

Corrective factor found by PID for force control to account for real plant and time-varying force output



Time-varying given force



After correction

DELFT HYPERLOOP

DELFT

HYPERLOOP