ME 410 – Week 4
Christopher Luey

(a) Text Description
This week we moved from sensor-only work to full‑prop operations. After mounting the props on the drone with electronics and the rig (pitch DOF free) and verifying correct orientation/tightness, we flashed the fresh baseline firmware and connected the 3-cell Li-Po (no more USB power). Safety glasses stayed on whenever the battery and props were attached, and we enforced partner readiness before every spin‑test
.
Milestone 1 – Assembly
Quad + props + rig were inspected and signed off.

Milestone 2 – P Controller
With motors enabled at thrust_neutral = 500 and thrust_amplitude = 100, we added a proportional term on pitch error:
pitch_cmd = Pgain × (pitch_des − pitch_meas)
Tuning raised Pgain from 0 to the point where the high-side motors stopped at ≈20 ° tilt, stopping just before oscillation. Safety checks (|pitch| > 45 °, |gyro| > 300 °/s, joystick kill, timeout) remained active.

Milestone 3 – D Controller
We introduced the derivative term on measured gyro rate (pitch_vel) to damp motion. Signs were validated by observing viscous resistance to hand perturbations . With Pgain set to 0 the system felt “buttery” under pure D.

Milestone 4 – PD Controller
Iterative tuning followed the recommended loop: (1) max out P until onset of slow oscillations, (2) raise D until critically damped, (3) repeat. **Final gains: Pgain = 16, Dgain = 3.0**. PD control feels fast with minimal oscillations.

Milestone 4 – Filtering
Change address 0x40 to adjust IMU filtering parameter. Record data to characterize noise of pitch for different levels of filtering. Determined that no filtering has most IMU noise and OSR4 filtering has the least noise.

(b) Task Assessment
Went well
- Prop installation and battery handling followed all safety rules with zero incidents.
- PD gains achieved stable, responsive control

- Optimizations with workflow cut analysis time by 70 %.

Issues & Causes

- Intermittent faults with IMU measurements slowed progress
- Motor wiring was opposite causing command to motor mappings to be wrong

Changes for next class

- Integrate new drone
    - Reverse motor mappings to that shown in the slides
- Add a better logging class
- Use excel

(c) Team Member Effort

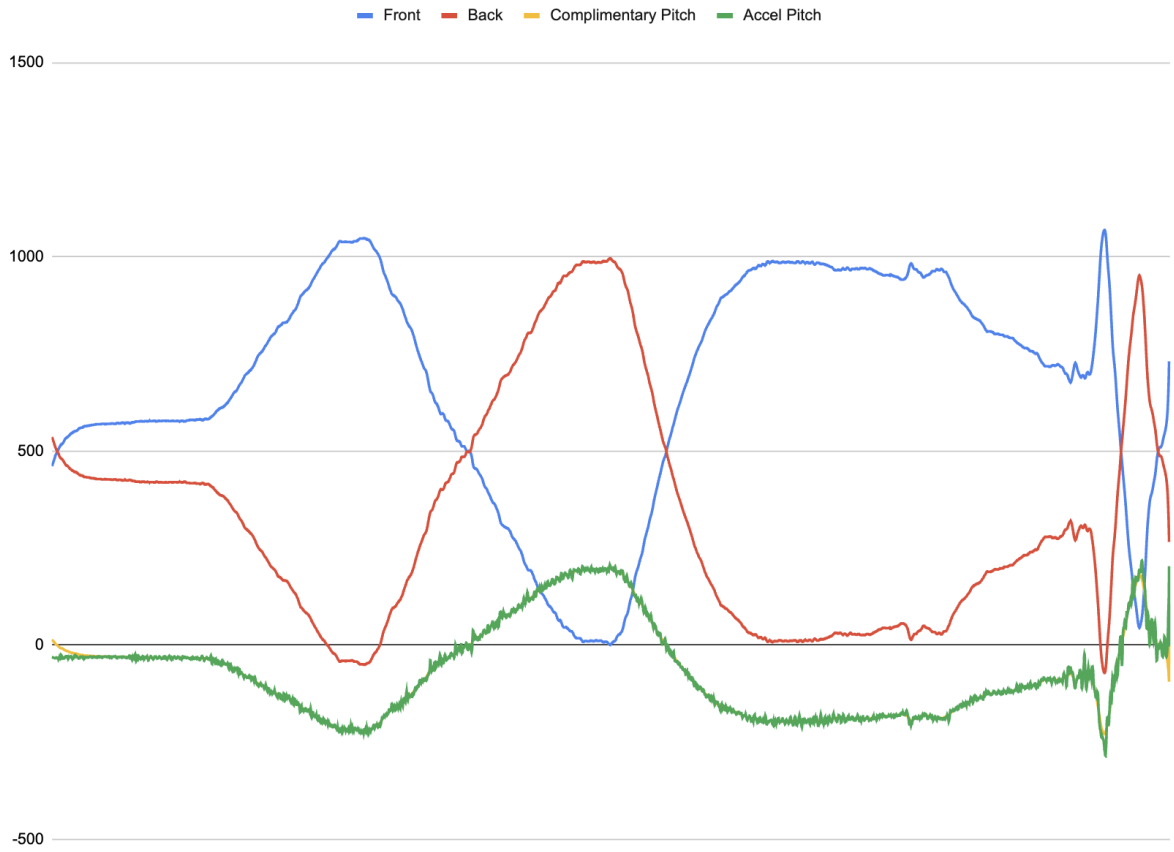
Jason – 50 %

- Assembled props, drone and rig.
- Implemented P, D, PD control loops and tuned gains.
- Both members co-tested on hardware and shared debugging sessions.

Christopher – 50 %

- Assembled props, drone and rig.
- Implemented P, D, PD control loops and tuned gains.
- Both members co-tested on hardware and shared debugging sessions.

Milestone 2

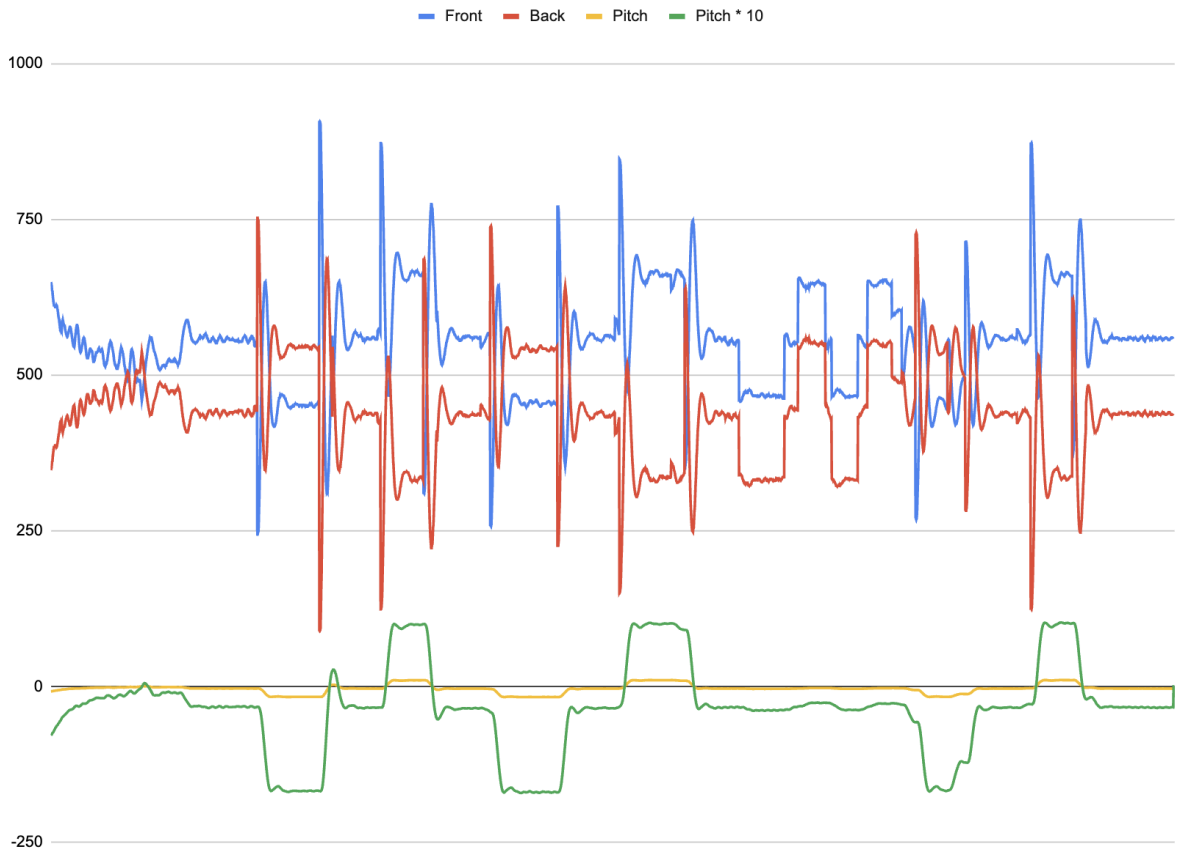


Front (blue) and back (red) motor power respond directly to pitch angle: negative pitch angle drives back motor down / front motor up and vice-versa confirming proportional action in correct direction.

Milestone 3

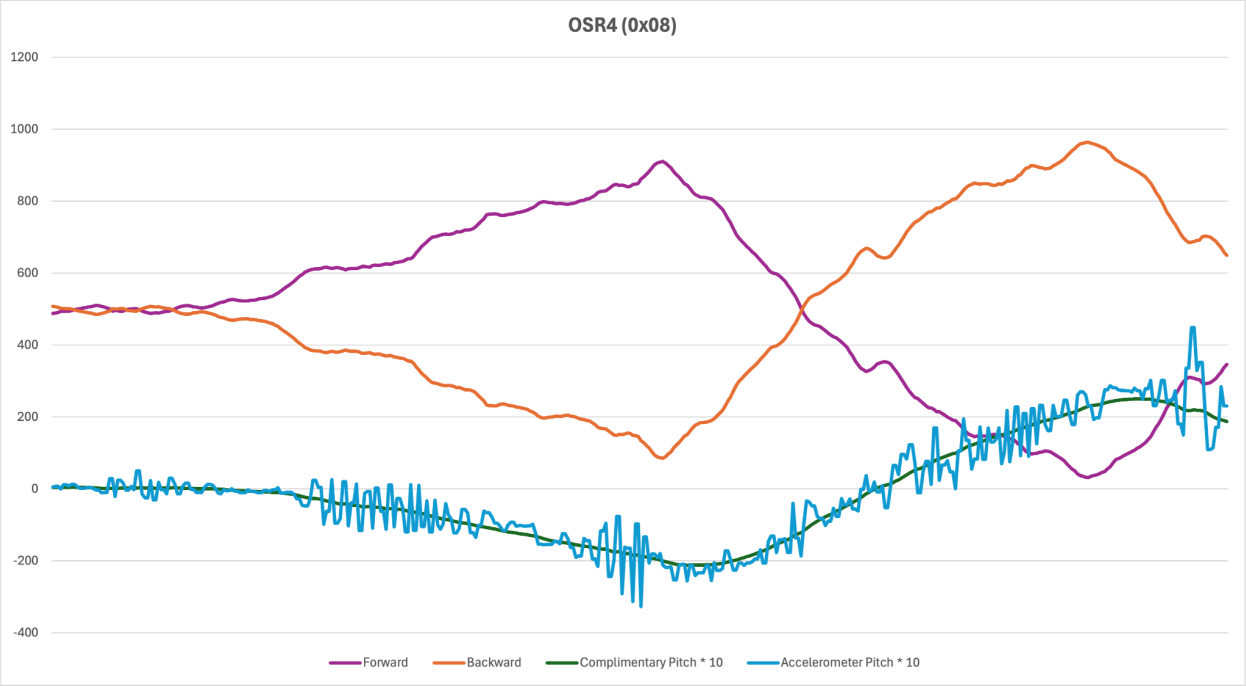
Front (blue) and back (red) motor power respond directly to Z-gyro rate (green): positive z gyro velocity drives front motor down / back motor up and vice-versa confirming zero proportional action and correct damping reaction.

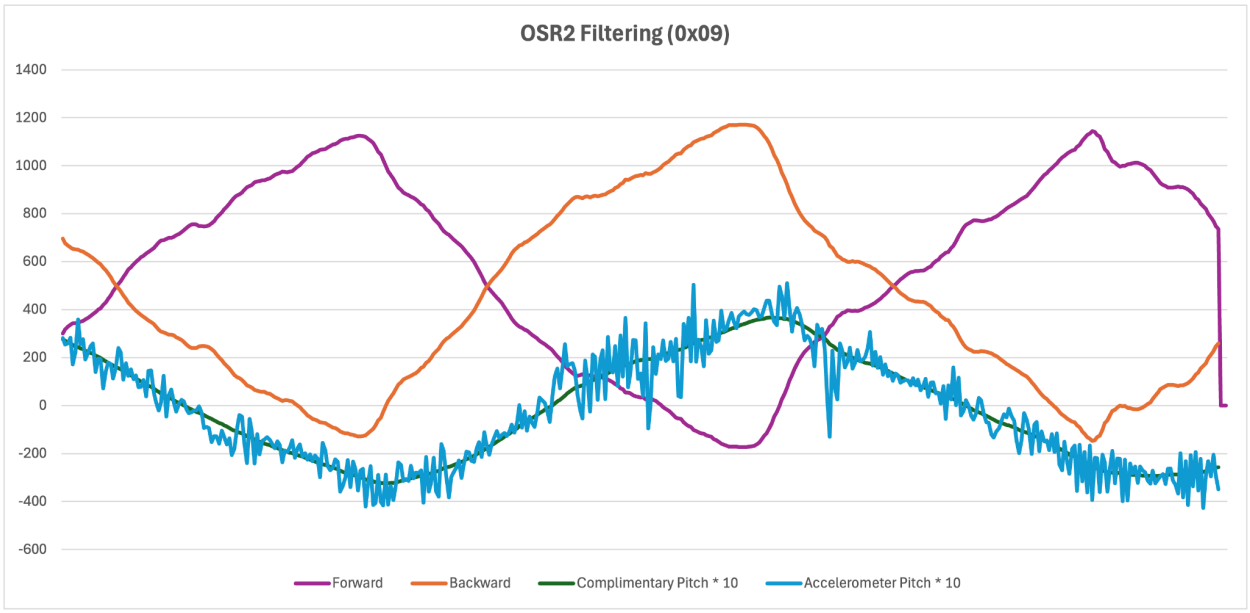
Milestone 4 (PD Control)

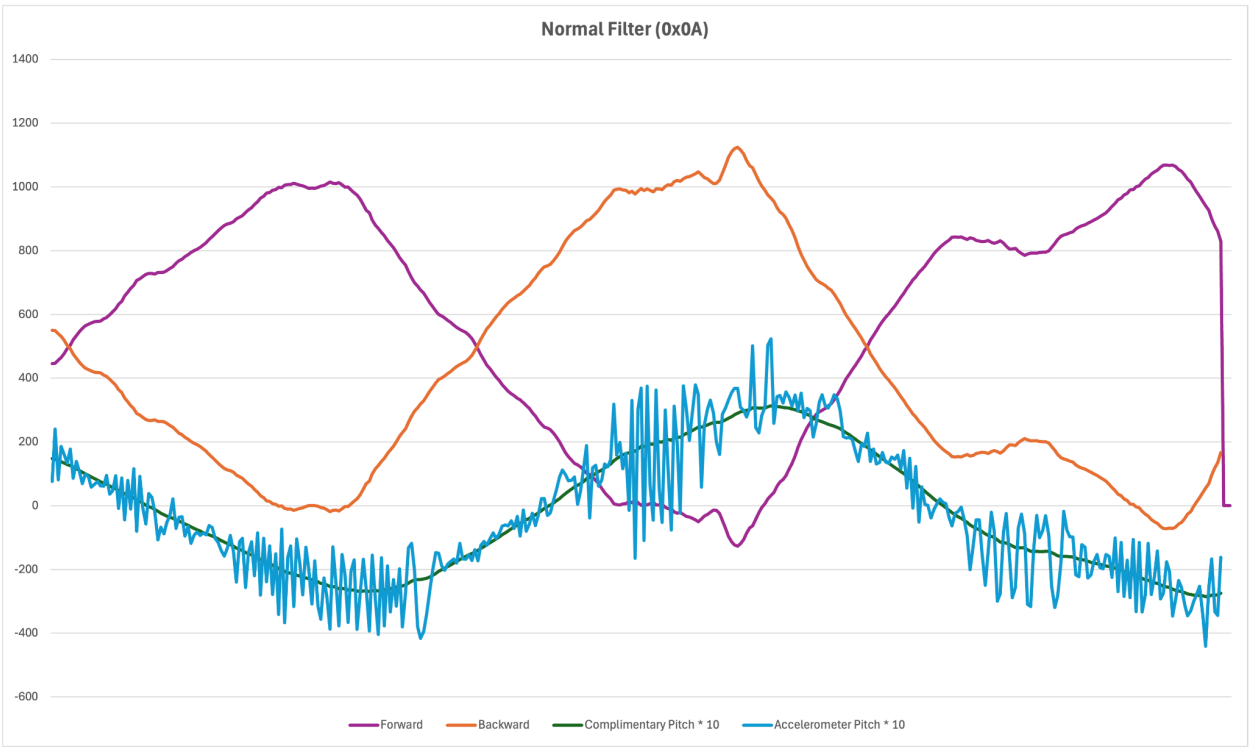


Reaches pitch setpoint with short rise time and minimal oscillations as shown in green trajectory.
P=16; D=3.0

Milestone 5


OSR4 (0x08)
1200
1000
800
600
400
200
0
-200
-400
Forward
Backward
Complimentary Pitch * 10
Accelerometer Pitch * 10





Increased noise for normal filter over OSR2 filtering and OSR4 filtering.