ME 410 - Week 2 Summary

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Summary

This week's primary objectives were to implement a complementary filter for improved roll and pitch estimation, and to interface the system with a handheld controller for drone operation.

The complementary filter fuses accelerometer and gyroscope data to produce more reliable roll and pitch angle estimates. Accelerometer data provides long-term accuracy, while gyroscope data offers low noise and short-term precision. The filter uses a constant A ($0 < A < 1$) to balance the weighting of each sensor. We chose a small value, A=0.02, prioritizing gyroscope data for smoother output. This value can be adjusted to trade off between smoothness and drift—higher A increases responsiveness but also noise, while lower A reduces noise at the risk of drift. To demonstrate the filter's impact, we captured comparative plots of filtered vs. unfiltered data for both moving and rest conditions.

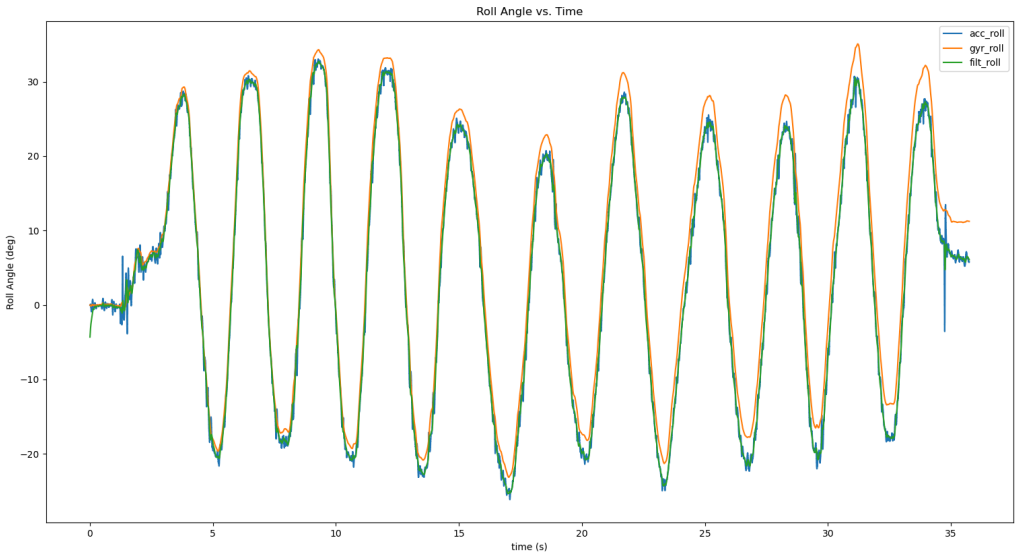

Figure 1: Roll Angle Testing

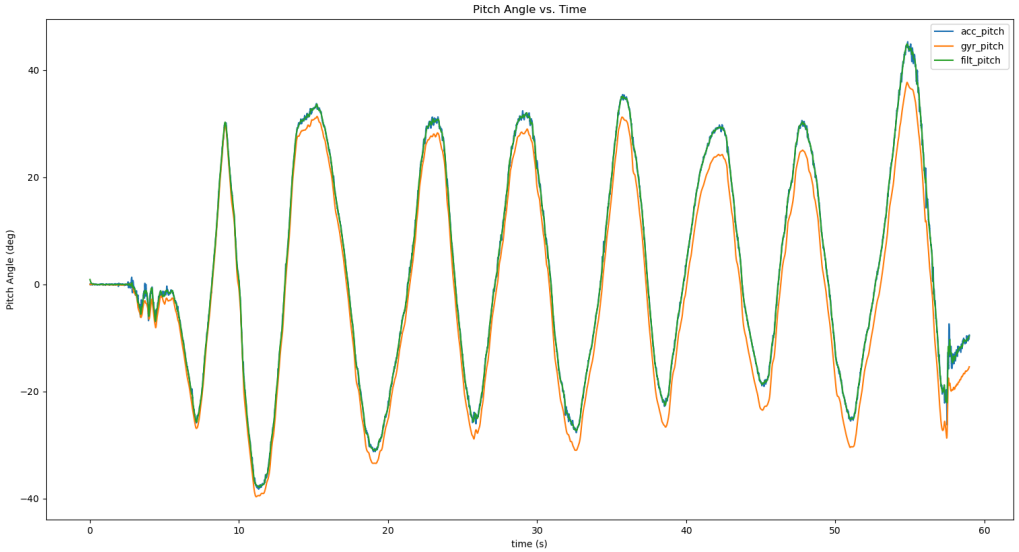

Figure 2: Pitch Angle Testing

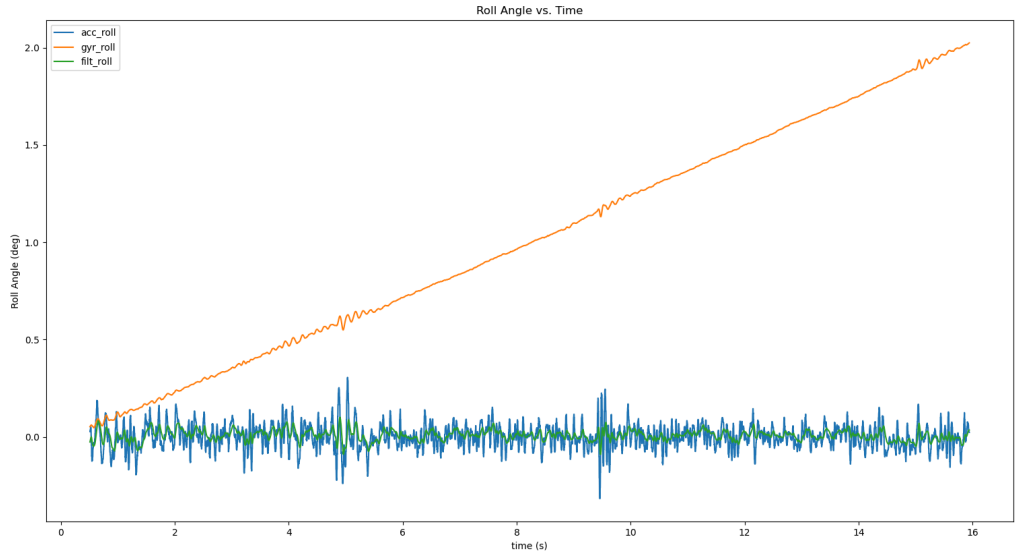

Figure 3: Roll Angle Testing While at Rest

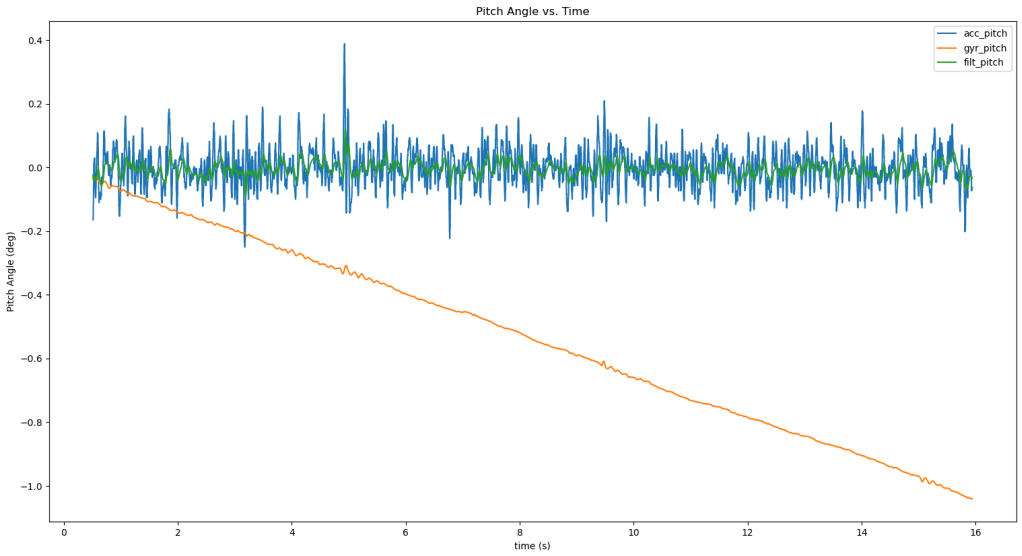

Figure 4: Pitch Angle Testing While at Rest

To interface with the handheld controller connected to our laptop, we used provided scripts—one running on the laptop and the other on the Pi via a separate SSH session. We added safety features to the program by modifying the main while loop to monitor a run_program boolean variable, updating joystick data from shared memory, and introducing a trap function to handle Ctrl+C interruptions.

A key addition was the safety_check() function, which terminates the program within 0.35 seconds if any unsafe condition is detected. These conditions include: gyro rate > 300°/s, roll/pitch angle > ±45°, joystick "B" button press, joystick timeout, or Ctrl+C. Most conditions were simple to implement using straightforward if-statements. The joystick timeout required extra logic involving timing and sequence number checks. In all cases, an appropriate message is printed to the terminal to indicate the reason for termination.

Assessment - What Went Well

This week, I feel like everything other than collecting data from the plots went well. Ben and I implemented the filter very quickly in our main code and did not experience many issues integrating the handheld controller. I feel like our process for editing code was much better this

week as we would edit the code on our laptops and copy the new file over the Pi via the scp command in linux.

Assessment - What Did Not Go Well

I feel like our main issues this week were related to the plotting milestone. Collecting data, sending it over to our laptops, formatting, and plotting it took up a decent bit of time, but once we got that working, we noticed that our angle estimates based on the gyro data did not match our other plots. Due to this issue, we spent most of our class time debugging and had to finish up the rest of the milestones outside of class. It turned out that our bad plot was due to an error in our lines of code calculating angles based on the gyro data, so it was a simple fix, but it took us a little while to realize.

Assessment - Adjustments for Next Class

Overall, I think the main adjustment we need to make is just better debugging if we encounter errors, so we can use our in-class time more effectively.

Team Member Effort

Me - 52% (Handled data formatting and plotting, helped with editing main program, finished milestone 1 outside of class)

Ben - 48% (We worked on his laptop during in-class time, handled data collection, finished milestone 2 outside of class)