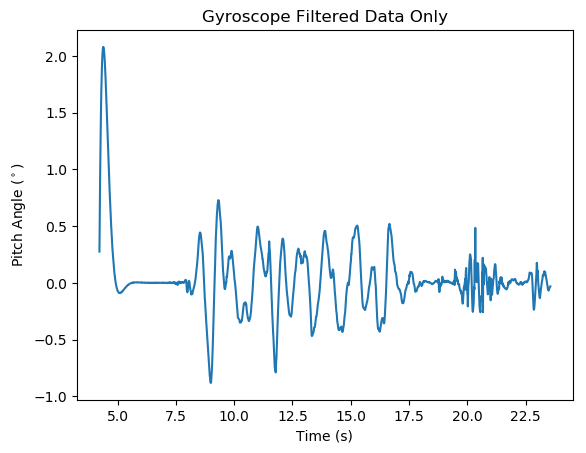
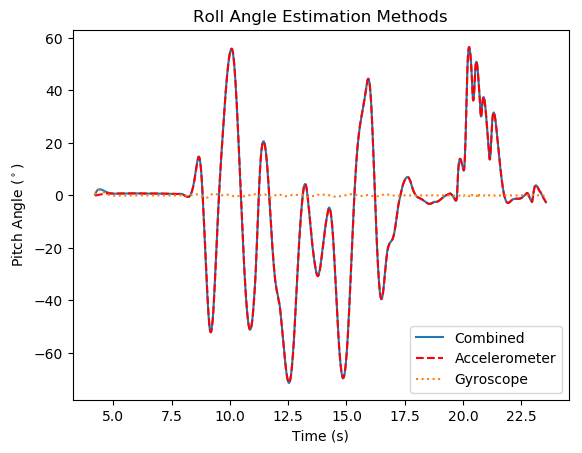
Problem 1:

As expected, the accelerometer produced a noisy dataset but roughly followed the motions of the quadcopter. A second order low-pass Butterworth filter smoothed out the graph but caused a slight delay in the data output response. The sampling frequency was 100 Hz and the cutoff frequency was 1Hz for the filter output.

The gyroscope raw data drift quickly dominated the output signal so that any variations from this device were drowned out by the scale between the two signals. Plotting the filtered data only shows modest spikes when the quad experienced motion. The direction of the graph approximates the actual movement during the trials but the gyroscope signal generally did not add more than 1 degree to the pitch angle measurement for the combination filter.

Problem 2:

In the complementary filter, we simply added the output from the two instruments after filtering. The graph shows how the complimentary filter basically followed the accelerometer output while the gyroscope only contributed to the overall output when the quad was in fast motion. This can be seen by the small deviations in the gyroscope data where the accelerometer was generating a steep change in pitch angle. These results effectively mimic the actual motion of the quad during the trial.

Problem 3:

Linear servo motor actuators are used for cruise control in cars as a part of a larger feedback system involving the accelerator.

Servos work using pulse width modulating (PWM) signals. This is the method that most electronics use to dim and brighten LED lights. A PWM signal is an electrical pulse consisting of a square waveform where the signal voltage is changed from 0V to Vs (usually 3.3v or 5v) during a known and pre-set period of oscillation. Information is sent through this waveform by changing the time that the signal is at Vs relative to the time that the signal is at 0V. For our purposes, these signals are usually then converted into a percentage of the whole signal between 0 and 1, where a PWM output of 1 means that the signal is at Vs for 100% of the time. A PWM output of 0.2 means that the signal wire is at Vs for 20% of a period, and then the signal drops down to 0V for the remaining 80% during the pulse cycle.

Servos have been pre-calibrated to accept these signals and relate a PWM input to an output arm position. This can involve a feedback system where the actual arm position is the output. The output can be converted to a voltage and sent to the microcontroller by using a rotary potentiometer attached to the output arm. This voltage is fed back into the microcontroller that finds the error between the signals and sends the error to the motor controller to complete the feedback loop.

<http://www.moticont.com/blog/servo-motor-actuators.htm>

<https://www.servocity.com/how-does-a-servo-work>

The HITEC-805BB (Giant Scale) can produce 343 oz-in of torque and should travel from 0-90 degrees in 0.21 seconds or less. It runs on 4.8V to 6v so we would probably need some kind of logic level converter if we want to control it using a 3.3v signal. Also, we are assuming that we have substantial power for everything since the servo consumes around 800mA.

<https://www.sparkfun.com/products/11881>

Opto-isolator breakout boards are cheap and convenient.

Digi-key Part: 1568-1279-ND

https://www.digikey.com/product-detail/en/sparkfun-electronics/BOB-09118/