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The Commitment

Audio_Interface	Description: This module will interface with the onboard microphone and output an 8-bit audio signal at 9.375khz Test: Record and playback of 10 seconds similar to lab 5 to verify the sound fidelity.
FFT	Description: It will take a 4096pt FFT and output its magnitude Test: Take preloaded signals and in simulation verify that the output is what we would expect.
Histogram	Description: Display a histogram of the FFT. Test: Input the same 4096pt into the FFT with a known FFT and verify that the display is as expected.
Reference_Generator	Description: FSM that generates a valid reference signal to control module based on input signal. Test: Run in simulation with inputs with known outputs and show FSM functionality in different cases
PSD Controller	Description: FSM based PSD controller, includes submodules for signed arithmetic required for control signal generation. Test: Test ability to accurately follow a varying reference signal when interfaced with hardware.
PWM Generator	Description: takes the control signal generated by the PSD controller and uses it to output a PWM signal at an appropriate duty cycle. Test: Give the module a set reference signal and track outputs using an oscilloscope.
A2D	Description: loops through four channels on the MCP3008 to continually update registers corresponding to the ball's height and the PSD gain tuning values.

The Goal

Audio_Interface	Description: This module will interface with the onboard microphone and output a 16-bit audio signal at 48khz Test: Record and playback of 10 seconds similar to lab 5 to verify the sound fidelity.
FFT	Description: It will apply a low pass filter to the signal then perform a 4096pt fft and output its magnitude Test: Take preloaded signals and in simulation verify that the output is what we would expect.
MaxSearch	Description: Outputs the max frequency given the FFT magnitude. Test: Simulate using externally generated noisy data with a known max.
Histogram	Description: Display histogram of FFT with variable scaling. Test: Input the same 4096pt into the FFT with a known FFT and verify that the display is as expected.
Freq_disp	Description: Displays the frequency of the max frequency in the output of the FFT and the respective reference signal in cm. Test: Set the input max frequency to a known value and verify that the display is as expected.
Pole Place Controller	Description: A separate control module that uses eigenvalue placement to determine control gains. Should be able to switch between controllers at will. Test: After interfacing with hardware, test controllers ability to follow a varying reference signal.
LQR Controller	Description: A separate control module that takes in the same inputs as the PSD controller and outputs a similar control signal, but uses the LQR algorithm to generate optimal gains. Test: After interfacing with hardware, test controllers ability to follow a varying reference signal.

Strech Goals

Spectrogram	Description: Displays a real time spectrogram. System will be able to switch between this and the histogram.
System_Display	Description: Display the idealized state of the levitator given the current reference signal.
Dual_max	Description: Split the FFT output into two regions and find the max in each. Test: Input data with 2 known frequencies and alter Freq_disp to display both. Then verify that they are both correct
Two Tower Controller	Description: Uses LQR control to balance a ball on a beam connecting two fan operated towers. Test: See if the ball stays in the center of the balance beam.
Kalman Filter	Description: Assumes sensor noise is Gaussian with an expected value of 0 to filter out noise and receive more accurate measurements. Test: Print out sensor outputs with and without the sensor to determine if filter has a smoothing effect.