ECEC-T580: Computing and Controls, Fall 2018-19
Project I

Objective: Design and build a computer/hardware system using the Arduino Mega 2560 that implements the process demonstrated in class, briefly:

- Uniformly sample an analog signal, perform a filtering operation and then output the processed signal for visualization on an oscilloscope.
  - Illustrate some relationship between sampling rate, and quantization for a fixed amplitude signal
  - Measure the processing time that it takes to implement the filtering and to determine its statistics.
  - Show appropriate signals, and data types.

Model-based design approach

The Simulink model that was used in class is included in the project directory and can be modified to test your solution prior to building and testing (especially for tuning/designing filters etc.). Recall the model shows the major components of this process with appropriate offsets for both analog and digital signals. Look inside all the blocks. It is not a one-to-one exact model but is illustrative.

General constraints/guidelines

- Sample and quantize an analog signal such that $|x_a(t)| \leq 2.4$ v.
  - Offset the signal so that it is between 0 and 5 volts – set signal zero to "2.5 v"
  - Use the 10 bit internal 0-5v A/D converter
  - Sample the signal using an interrupt, either with an internal timer or external clocking signal
  - Which analog signal to use?
    - More difficult: sum of a 25 Hz and 50 Hz sine wave. Choose the amplitudes such that $|Acos(2\pi 50\mathrm{t}) + Bcos(2\pi 25\mathrm{t})| \leq 2.4$ v.
    - Use a signal generator with a triangular wave (25 Hz) and offset it so that zero is at 2.5 v.
    - Something else but not a square wave since you don't see quantization
- Filtering:
  - Constrain to FIR filters for ease of implementation
    - Use a notch filter implemented recursively to remove the 25 Hz component if you choose the two sine wave input option
    - Use a low pass filter (look up how to design) for the triangular wave so that the result looks like a sine wave (pick 25 Hx cut off and enough terms to get a reasonable result).
    - Anything else that demonstrates the concepts.

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- Output the filtered signal (idea is 8 bit output to show quantization)
    - Use the 8bit PWM and display on a scope, you may want to use a low pass filter. You can use the native PWM frequencies or change the frequency if desired.
    - Use a parallel input 8 bit D/A chip such as DAC080 which is available at the 2nd floor window
    - Implement a D/A via SPI or I2C interface
    - Need to display both input and putputs signal and get scope picture

- Remember to determine the computational statistics for the processing – this could be the total time from sampling to output. Mean, variance, min max etc.

What to turn in (per group max 3) :

- 2-3 page terse memo showing system diagram, key waveforms, and results
- Video of working system (upload)
- Note each group must have at least one CE and one EE member