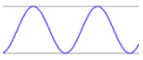
CPE 325: Embedded Systems Laboratory
Laboratory Assignment #10

Assignment [150 pts]

1. **[50 pts]** Write a C program to interface the 3-dimensional accelerometer, ADXL335. Your program should sample x, y and z axes 5 times per second. Calculate the accelerations in terms of 'g' (Gravity of Earth) and send the samples to your workstation. Samples should be sent such that they are displayed in the UAH serial app as three separate lines. Please revisit the previous Lab 8 assignment to see how to use the UAH serial app.

2. **[50 pts]** Modify part one such that it can be used as a bubble level. Assume that the straight position of the accelerometer is when the z-axis points upwards. Calculate angular deviation from this position along x-axis in degrees and send this value to the UAH serial app together with the other three values (you can temporarily hide the other curves in the UAH serial app for a clearer view). In addition to that, turn LED1 on and LED2 off if the deviation is positive and is greater than 15 deg. Turn LED2 on and LED1 off if deviation is negative and is less than -15 deg. Turn both LEDs off if the deviation is within -15 to 15 deg interval.

3. **[50 pts]** Write a C program that outputs different waveforms using DAC. It should have the following modes:

Switch held	Waveform displayed
None	$2\,[sin(x)\,+\,1]$: 
SW1	Triangle wave: 
SW2	Half the frequency of the current waveform

The waveforms will be viewed by connecting an oscilloscope to the output of DAC on MSP430. Modify the MATLAB script from the tutorial to generate a **512**-element lookup table (LUT) for the sine waveform; this waveform should be twice the amplitude of the triangle wave. The LUT will be included as a header file that is utilized by your main C program. The initial frequency of both signals should be **30 Hz**.

Generate the triangle wave in the microcontroller on the fly. That is, **do not use an array to store it in memory**. Make sure neither signal gets cut off. Amplitude is your choice, as long as the amplitude of the sine wave is double the triangle wave.

Bonus [15 pts]

Read the following article about a method of quick magnitude estimation: https://dspguru.com/dsp/tricks/magnitude-estimator/. Modify your part 1 program to find the overall magnitude of acceleration ($A = \text{sqrt}(x^2 + y^2 + z^2)$) using this method; you will need to think about how you can apply the method to the 3D case. Show in your demonstration that the calculated value is a good approximation of the actual magnitude of acceleration (you do not need to send the new metric to the UAH serial app).

Theory

1. Accelerometers
2. ADC and DAC

Deliverables

1. PDF report including:
    a. Formulas for accelerometer ADC and angular deviation
    b. Script you used to generate the look-up table
    c. Source code for parts 1-3