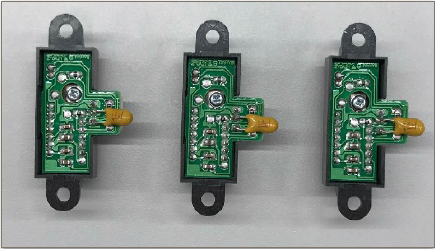
SC2107 Lab4 Assignment Sheet (to be submitted to NTULearn before next lab)

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1. Section 6.1. What is the issue when an obstacle is placed too close to the IR sensor? What can you do to prevent such ambiguity?
   1. The reading of the IR sensor at close distances is inaccurate.

As the output voltage of the IR sensor is non-monotonic, each output voltage would correspond to two distance values.

To prevent this, we limit the use case of the IR sensor to distances above 5cm and ignore distances below this threshold. This will result in the graph of the output voltages being monotonic.

1. Section 6.1. What is the purpose of the 10uF decoupling capacitor?  
   
   1. It is used on the power supply of the IR sensor to reduce noise. If the supply voltage spikes, the capacitor absorbs the excess power by charging up and if the supply voltage dips, the capacitor discharges stored power to offset the change in voltage.
2. Section 6.2. Which port pins is ADC Ch12, 16 and 17 inputs mapped to? Which PxSELx and what settings are required to configure the pins to ADC function?
   1. ADC Ch12 (center sensor) map to Port 4 Pin 1

ADC Ch16 (left sensor) map to Port 9 Pin 1

ADC Ch17 (right sensor) map to Port 9 Pin 0

P4->SEL1 |= 0x02;

P4->SEL0 |= 0x02;

P9->SEL1 |= 0x03;

P9->SEL0 |= 0x03;

1. Section 6.2. With respect to the ADC on MSP432, what are the two stages involved in every Analog to Digital Conversion of an Analog signal?’
   1. Stage 1: Sample-and-Hold. The ADC first samples the input signal voltage  
      Stage 2: Conversion. The detected voltage level is then passed into the SAR ADC for digitization.
2. Section 6.3. What does the function LPF\_Calc() does? What are the initial values of the buffer associated with LPF\_Calc()? Why do we need this function?
   1. The function uses a fixed-size array to keep track of previous ADC readings.

When the function is called, it adds the newest ADC reading to the array, subtracts the oldest ADC reading and returns the mean of the ADC readings in the array.

The initial values of the buffer are the raw ADC readings of each channel.

LPFSum = Size\*initial;

This function implements a moving average low pass filter. By taking the mean of the most recent ADC readings, this filter smooths out sudden changes in ADC readings which reduces high frequency noise.

1. Section 6.3. Describe the algorithm you used to estimate the actual distance based on the IR Sensor value.
   1. 1. Take the IR sensor readings when obstacle is placed at fixed interval distances.  
      2. Plot the graph of ADC output against distance.  
      3. Fit a curve using hyperbolic equation X = A / (n + B).   
      4. Use piecewise function to offset inaccuracies at certain range of distances.
2. Section 7.2. Which timer capture input (Timer and Channel number) does P10.4 and P10.5 correspond to?
   1. P10.4 correspond to Timer A3 Channel 0  
      P10.5 correspond to Timer A3 Channel 1
3. Section 7.2. Which edge (falling, rising, both) is the timer input capture configured to trigger on? What happens when a capture event occurs?
   1. Rising edge.

When a capture event occurs, the current value of the timer is stored into the respective CCR registers. (CCR0 and CCR1)  
The CCR value can be saved in a variable to calculate the period and frequency.

1. Section 7.2. Why is the calculated value of pulse duration, derived from the timer capture values, not a constant value but seemed to keep changing?
   1. Tachometer used in the RSLK is based on Hall Effect Sensor. The encoder outputs square pulses which the frequency is proportional to the speed at which the motor is rotating.

The changing calculated value of pulse duration could arise from sources such as power supply voltage fluctuations, external electromagnetic interferences or external interferences to the RSLK wheels which affects the motor rotational speed.