Module 21

Quiz: Sensor Integration

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Q1 I2C initialization

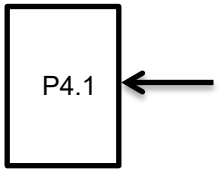
Assume the M clock is 12 MHz. Write C code that sets the I2C bit rate to 100 kHz. You need not include the entire initialization, just the part that sets the I2C clock.

Q2 I2C encoding

The Pololu OPT3101 module includes a 10k pullup on both SCL and SDA. What is the purpose of these resistors? What would be the advantage to changing the value to 2k? What would be the disadvantage?

Q3 GPIO interrupts

Assume an I2C sensor has a hardware interrupt that signifies an important event (sample complete, temperature overflow, collision etc.). This event is signified by a 0 to 1 edge on P4.1. Set the priority to 2.



Write C code to initialize P4.1 to generate an interrupt on the rising edge. Assume interrupts are enabled in the mail program after all modules are initialized. Write C code for the interrupt service routine to handle the interrupt. In the ISR, acknowledge the interrupt, call a User() function, and return from interrupt. You may assume no other software uses interrupts on Port 4.

Q4 Digital filter

Write a C function that implements this digital low pass filter. The 16-bit signed input to the function is the new data and the output from the function is the filter output (16-bit signed)

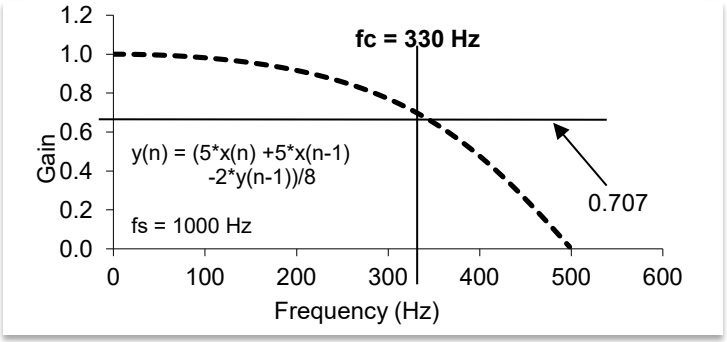
y(n) = (5*x(n) +5*x(n-1)-2*y(n-1))/8

where

x(n) is the current sample, `in`
x(n-1) is the previous sample
y(n) is the current filter output
y(n-1) is the previous filter output

If the data are sampled at f_s=1000 Hz, this filter is a low pass. The prototype is

```
int16_t Filter(int16_t in);
```



Q5 Nyquist Theorem

In 50 words or less, give a definition of the Nyquist Theorem. Explain what it means if the sampling rate is 1000 Hz.

Q6 Aliasing

In 50 words or less, give a definition of aliasing. What happens if the sampling rate is 1000 Hz and the input frequency is 600 Hz?

Q7 Central Limit Theorem

In 50 words or less, give a definition of the Central Limit Theorem. Explain how CLT applies to the robot and its sampling of the distance sensor.

Q8 Analog versus digital

The ADC converts an analog voltage (continuous in both amplitude and time) into digital values (discrete in both amplitude and time). The OPT3101 sends out IR light pulses at 100 MHz, and receives reflected IR light pulses also at 100 MHz. The OPT3101 calculates distance to the closest object by measuring the phase lag between transmitted and received light. The OPT3101 does return a digitized sample at a finite sampling rate.

a) In what way is the conversion of phase to digital value completely analogous to an ADC converting voltage to a digital value?

b) In what way is the conversion of phase to digital value similar to, but not completely analogous to an ADC converting voltage to a digital value?

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