EE2016 Microprocessor: Theory & Lab. Fall 2020

EE Dept, IITM

Mid-Semester Exam - Part 3 (Take Home)

Instructions: 3 days are given to you to solve the following problem and upload the report, after tarring all the files to moodle. Name the files after your roll no. For eg. ee18b032partC.tar.gz. An assignment link would be opened in moodle, over which you could submit.

1 Implementation Problem

1.1 Problem Definition

Implement the 5-tap (case A) and 32-tap (case B) version of bandpass FIR filter in AVR Atmega8 microcontroller. The bandpass range is defined as frequency range from 800 Hz to 3400 Hz. Corresponding to both the above cases, the filter coefficients $\{b_i\}$ are given in a separate file. [You are required to ONLY implement FIR filter and NOT its design]. The filter coefficients are given in the file

1.2 Demonstration

You need to demonstrate its working by feeding in the following input

1. DC signal
2. Sinusoidal signal within the passband 2.125 kHz
3. White noise variance

Show the i/p and o/p spectrum in both the versions of the FIR filter and for all the above three inputs. Draw the output frequency response and phase response. You need to use the Atmel AVR Studio emulation software for design, debugging and final demonstration.

1.3 Generation of Test Signals

Use MATLAB to generate (a) sinusoidal signal at 1800 Hz (b) white noise. Sample them. Overall consider 1000 samples. Put these in a file and read it, into the AVR microcontroller.

1.4 Constraints

It is strongly recommended to use the Application Note AVR223 (Ref[1]) uploaded in moodle, as a reference file. In the following, the Equations refer to those in the above application note.

1. Avoid overflow (Eq 9, Ref[1]) including sub-results
2. Adopt fixed point computation (Ref[4])
3. Comply to conservation criteria for avoiding overflow (Eq 7, Ref[1])
4. Accumulator resolution for both versions of the FIR filter
5. Use AVR hardware multiplier: Use instructions MUL, MULS, MULSU (Ref[3])

6. Implement the accumulator of right bit-length (given by equ 6 in [1]) using the 8-bit GPRs internal to Atmega8 microcontroller.

7. Use the circular register scheme (Page 4 of Ref[2])

1.5 References

1. AVR223: Digital Filters with AVR, Atmel Corporation, 2008

2. AN852: Implementing FIR and IIR Digital Filters Using PIC18 Microcontrollers, Microchip Technology Inc, 2002

3. AVR201: Using the AVR hardware multiplier, Atmel Corporation, 2000.

4. AVR32765: AVR32 DSPLib Reference Manual, Atmel Corporation, 2009