Microprocessor Architectures [ELEC-H-473]
dsPIC33: Exercise

2015–2016

Purpose

The goals of this exercise are:
- reuse what you learnt about the dsPIC33 during the 2 labs.
- implement a specific algorithm with keeping in mind the abilities of the dsPIC33
- predict and measure the performances of your implementation
- prepare yourself for the written exam.

Useful Documents

A set of useful documents can be found in the network share "Labo/ELEC-H-473/dsPIC33":
- Introduction to MPLAB
- MPLAB C30 C Compiler User's guide
- dsPIC30F/33F Programmer's Reference Manual
- dsPIC33FJXXXGPX06/X08/X10 Data Sheet
- dsPIC30F/33F CPU reference manual

1 Algorithm

1.1 Math

The goal of this exercise is to implement a Discrete Fourier Transform:

$$X(k) = \sum_{n=0}^{N-1} x_n \cdot e^{-2i\pi k \cdot n/N}, k \in \mathbb{N}$$

1.2 Constraints

- $N = 128$, samples (x_n) are stored in a circular buffer (meaning: the first element of the array is not necessary the first to be used in the computation)
- samples are 8bit signed integers
- $e^{-2i\pi \cdot m}$ stored as fixed point complex numbers (we assume $m = k \cdot n/N$ rounded to nearest integer)
- output samples are complex numbers, fixed point representation
- even if more efficient algorithms exists, this one must be used.
- all computations must be performed using fixed point arithmetic
- input: x_n, size=N
- output: X_k, size=N, complex

2 Implementation

Proposed computation:

$$\forall k \in [0 \dots N-1], Output[k] = \sum_{n=0}^{N-1} Input[n] \cdot En[k \cdot n/N]$$

Constants:

- $N = 128$
- En_R, En_I: Real and Imaginary parts of $e^{-2i\pi m}, m \in [0, 127]$, each stored in a 8bit signed integer using fixed point representation with $[-1, 1]$ range.

Variables:

- $first\_sample$: index of the first sample in the circular buffer (modified externally)
- n: index of the input sample
- k: index of the output sample
- $Input[N]$: the input array containing N samples to process, this circular buffer is modified externally, 8bit samples
- $Output_R[N]$, $Output_I[N]$: Real and imaginary components of the computed points of the Fourier Transform, 8bit+8$i$bit samples

Don't forget that En_R, En_I, $Output_R[N]$, $Output_I[N]$ are complex and thus products and sums should take that into account.

3 Assignment

Write a short report (3p maximum) answering the following questions:

Question 1. Split the computation into smaller operations and draw a graph of your computation flow, name the intermediate results.

Question 2. Explain the size and type of the different intermediate results.

Question 3. For each operation, justify that no overflow will occur and compute the accuracy.

Question 4. Assuming the circular buffer filling does not affect your computation, what is the maximum possible frequency for the input sampling? Use the figures you got from basic operations in the labs.

We do not expect you to simulate your code because we do not provide tests vectors.

Send your report and your code to the assistants.