Chapter 8

Digital and Analog Interfacing Methods

Lesson 19

DSP Control

DSP

- Digital Signal Processing (DSP) operations process the continuous signals and data
- Many times, the operations in real-time

DSP Application Examples

- Digital filters,
- Motor control,
- Voice recognition and synthesis,
- waveform generation,
- Spectrum analysis and
- Pattern matching

DSP Requirements

- Need high arithmetic calculations performance .
- Need MAC unit in the processor. [*MAC means multiply and accumulate*. The coefficients are multiplied and accumulated in the sum for the desired number of terms in many expressions for the DSP operations like digital filtering.]

Laplace transform

- **Determines the continuous time frequency response in a filter**

Z transform

- **Performs the discrete time transform, which needs the discrete samples of the input at successive intervals**

80296SA high performance

- 12.5 MIPS (Million Instructions Per Second) DSP instructions and 16 MIPS general purpose instructions

80296SA

- MAC unit executes a MAC in 80 ns using 40-bit hardware accumulator.
- The 40-bit accumulator permits high precision in the arithmetic operations

80296SA MCU Features

- Pipelined architecture and RISC instructions
- 512 B register RAM (8051 only 32 B) and 2kB internal code/data RAM (8051 only 128B)

80296SA MCU Features Required

- Address space is 6MB. It permits bigger code store after high-level language compilation

A linear and time invariant digital filter

- Filter represents by a convolution equation for the output *y*(n), given an arbitrary input x(n), is as follows:

$$y(n) = x(n) \text{ CONV } h(n),$$

where h(n) is the impulse response function of the filter

Convolution

- The convolution in the time domain means the multiplication in the frequency domain.

Z-transform

- Simplifies the convolution into the multiplications
- Filter characteristic equation using the associated Z transforms gives the following equation.

$$Y(z) = X(z)H(z) \text{ or } H(z) = Y(z) / X(z)$$

Y(z) and X(z) polynomials

- Y(z) = Zeros of H(z) and the roots of the X(z) = Poles of H(z). The values of the zeros make the H(z) = 0 and the value of the poles make the H(z) = ∞ (infinity).

Common digital filters

- FIR (Finite Impulse Response) and
- IIR (Infinite Impulse Response) filters

FIT Filter Greater Stability

- FIR output normally depends only on past inputs (not on past outputs). It can be easily conditioned to give response, which is linear in phase.

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FIR Filter Stability greater than IIR

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IIR Filter Stability

- IIR filter on the other hand can be unstable and therefore give a phase shift from input to output.
- IIR output normally depends on the past outputs as well as past inputs, which affects the present output

IIR advantage

- IIR advantage is when the phase shift does not affect. Then the less number of poles need to be calculated.
- Les execution time is needed because there is smaller number of MAC operations in the IIR filter algorithm

Summary

We learnt

- DSP operations need fast arithmetic MAC operations
- Filter equations are needed in many operations

End of Lesson 19

DSP Control