Lecture - 1

Introduction to DSP

Introduction

The world of science and engineering is filled with signals such as images from remote space probes, voltages generated by the heart and brain and countless other applications.

What is DSP ?

Digital signal processing is used in a wide variety of applications. DSP stands as-

Digital : Operating by the use of discrete signals to represent data in the form of numbers.

Signal : A variable parameter by which information is conveyed through an electronics circuit.

Processing : To perform operations on data according to programmed instructions. This leads to a simple definition of DSP.

Definition of DSP : DSP is defined as changing or analysing information which is measured as discrete sequences of numbers.

System :

* System is associated with signals.
* System is nothing but physical device that performs an operation on a signal.

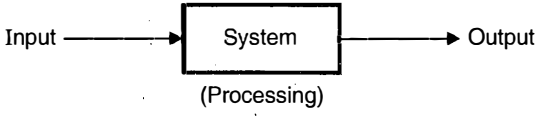

Fig. S-1 : Signal processing

As shown in Fig. S-1, when we apply an input signal to the system, the system will process the signal and we get the expected response. This phenomenon is called as signal processing.

Basic Elements of DSP and its Requirements :

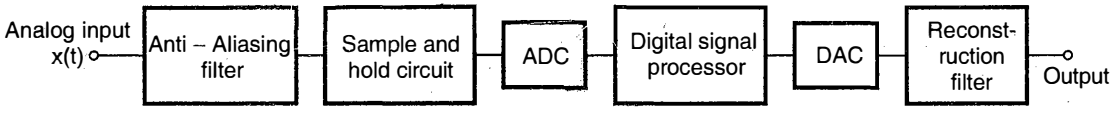

Fig. S-2

1. Input signal :

It is the signal generated from some transducer or from some communication system. It may be. biomedical signal like ECG or EEG. Generally input signal is analog in nature. **It** is denoted by x(t).

2. Anti-aliasing filter :

Anti aliasing filter is basically a low pass filter. **It** is used for the following purposes.

(a) It removes the high frequency noise contain in input signal.

(b) As the name indicates; it avoids aliasing effect. That means it is used to band limit the signal.

3. Sample and hold circuit :

As the name indicates; this block takes the samples of input signal. It keeps the voltage level of input signal relatively constant which is the requirement of ADC.

Some times amplifiers are used to bring the voltage level of input signal upto the required voltage level of ADC.

4. Analog to digital converter (ADC) :

As the name indicates; this block is used to convert analog signal into digital form. This is required because digital signal processor accepts the signal which is digital in nature.

5. Digital signal processor :

It processes input signal digitally. In a simple languages processing of input signal making modifying the signal as per requirement. For this purpose DSP processors like ADSP 2100 or TMS 320 can be used.

6. Digital to analog converter (DAC) :

The output of digital signal processor is digital in nature. But the required final output is analog in nature. So to convert digital signal into analog signal DAC is used.

7. Reconstruction filter :

Output signal of DAC is analog, that means it is a continuous signal.- But it may contain high frequency components. Such high frequency components are unwanted. To remove these components; reconstruction flter is used.

Advantages of Digital over Analog Signal Processing :

1. Versatility :

Digital systems can be reprogrammed for other applications (where programmable DSP chips are used) .. Moreover, digital systems can be ported to different hardware.

2. **Repeatability :**

Digital systems can be easily duplicated. These systems do not depend upon component tolerances and temperature.

3. **Simplicity :**

It is easy to built any digital system as compared to an analog one.

4. **Accuracy :**

To design analog system; analog components like resistors, capacitors and inductors are used. The tolerance of these components reduce accuracy of analog system: while in case of DSP ; much better accuracy is obtained.

5. **Remote processing :**

Analog signals are difficult to store because of problems like noise and distortion. While digital signal can be easily stored on storage media like magnetic tapes, disks etc. Thus compared to analog signals; digital signals can be easily transposed. So remote processing of digital signal can be done easily.

6. **Implementation of algorithms :**

The mathematical processing algorithms can be easily implemented in case of digital signal processing. But such algorithms are difficult to implement in case of analog signals.

7. Easy **upgradations :**

Because of the use of software; digital signal processing systems can be easily upgraded compared to analog system.

8. **Compatibility :**

In case of digital systems; generally all applications needs standard hardware. Thus operation of dsp system is mainly dependent on software. Hence universal compatibility is possible compared to analog systems.

9. **Cheaper:**

In many applications the digital systems are comparatively cheaper than analog systems.

Limitations of Digital Signal Processing :

The digital signal processing S)'stems have many advantages. Even though there are certain disadvantages as follows

1. **System complexity :**

The digital signal processing system, makes use of converters like ADC and DAC. This increases the system compJexity compared to analog systems. Similarly in many applications; the time required for this conversion is more.

2. **Bandwidth limitation :**

In case of DSP system; if input signal is having wide bandwidth then it demands for high speed ADC. This is because, to avoid alising effect, the sampling rate should be atleast twice the bandwidth. Thus such signals require fast digital signal processors. But always there is a practical limitation in the speed of processors and ADC.

3. **Power consumption :**

A typical digital signal processing chip contains more than 4 lakh transistors. Thus power dissipation is more in dsp systems compared to analog systems.

4. For small applications digital signal processing systems are expensive compared to analog systems.

DSP Applications

(1) DSP for Voice and Speech:

Speech recognition, voice mail, speech vocoding, speaker verification. speech enhancement, speech synthesis, text to speech etc.

(2) DSP for Telecommunications :

FAX, cellular phone, speaker phones, digital speech interpolation, video conferencing, spread spectrum communications, packet switching, echo cancellation, digital EPABXs, ADPCM transcoders, channel multiplexing. Modems adaptive equalizers, data encryption and line repcatcrs etc.

(3) DSP for Consumer Applications :

Digital audio/video/Television/Music systems. music synthesizer, Toys etc .

(4) DSP for Graphics and Imaging :

3-D and 2-D visualization, animation, pattern recognition, image transmission and compression, image enhancement, robot vision, satellite imaging for multipurpose· applications. etc.

(S) DSP ror Military/Defence : Radar processing. Sonar processing, Navigation. missile guidance. RF modems, secure communications.

(6) **DSP ror Biomedical Engmeeriog :**

X-ray storage and enhancement, ultrasound equipment, CT scanning equipments, ECO analysis, EEG brain mappers. hearing aids, patient monitoring systems, diagnostic tools etc.

(7) DSP' for Industrial Applications :

Robotics, CNC,security access and power line monitors etc.

(8) DSP for Instrumentation :

Spectrum analysis, function generaiion. transient analysis, digital filtering, phase Locked Loops, seismic processing, pattern matching etc.

(9) DSP for Control Applications :

Servo controJ, robot control. laser-printer control. disk control, engine control and motor control etc.

(10) DSP for Automotive Appllcalions :

Vibration analysis, voice commands, digital radio, engine control, navigation, antiskid brakes, cellular phones, noise cancellation, adaptive ride control etc,