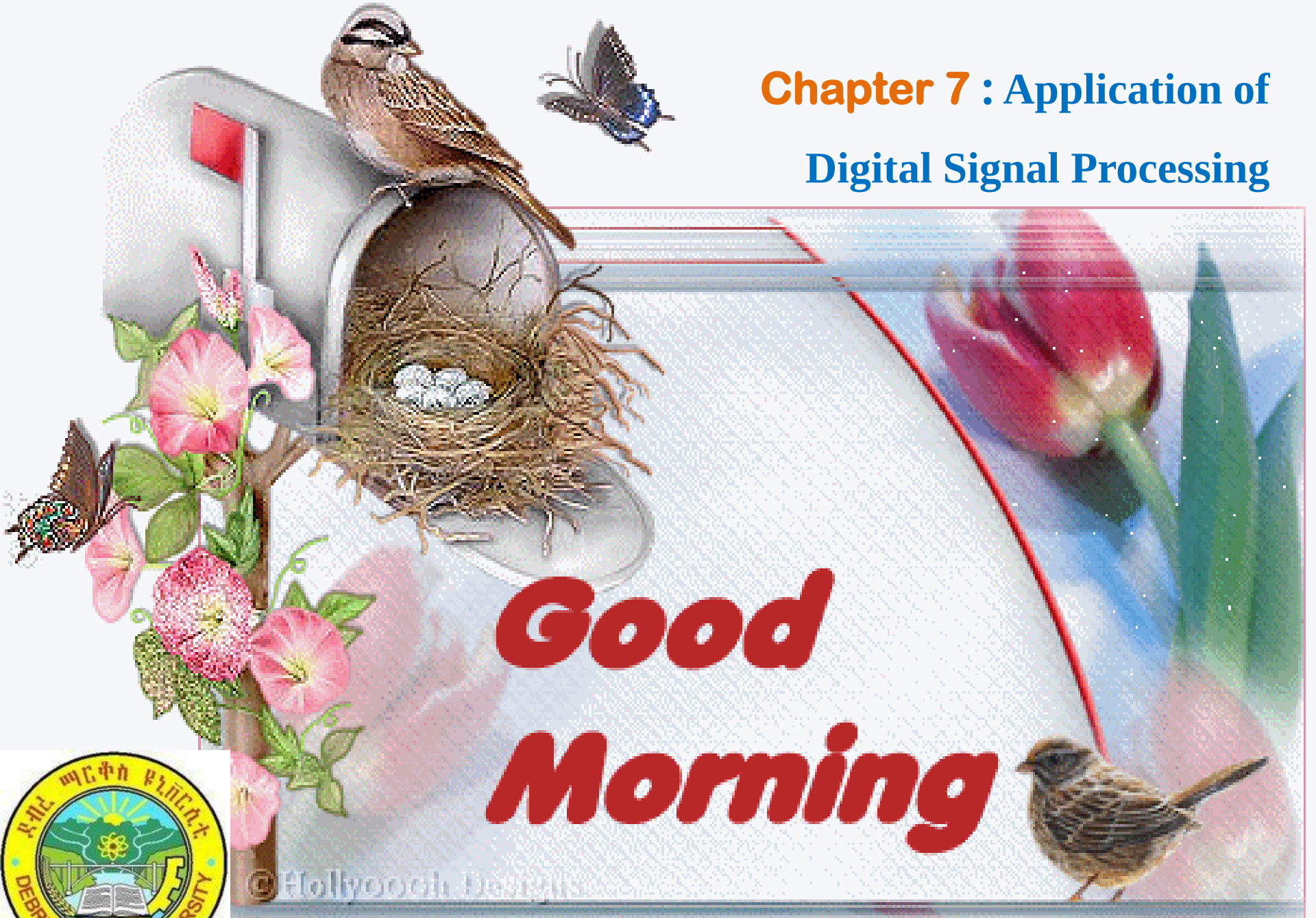
Chapter 7 : Application of Digital Signal Processing



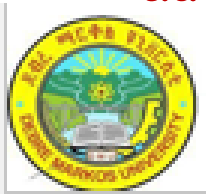
Outline

- Application of Digital Signal Processing
- Image Processing
- Speech Processing
- Implementation

Application of Digital Signal Processing

- **Digital signal processors** are used for a wide range of applications, from communications and controls to speech and image processing.
- They are found in cellular phones, fax/modems, disk drives, radio, and so on.
- These processors have become the product of choice for a number of consumer applications, since they have become very cost-effective.
- They can handle different tasks, since they can be reprogrammed readily for a different application.
- DSP techniques have been very successful because of the development of low-cost software and hardware support.
- For example, modems and speech recognition can be less expensive using DSP techniques.

- DSP processors are concerned primarily with real-time signal processing. Real time processing means that the processing must keep pace with some external event; whereas non-real-time processing has no such timing constraint.
- The external event to keep pace with is usually the analog input. While analog-based systems with discrete electronic components such as resistors can be more sensitive to temperature changes, DSP-based systems are less affected by environmental conditions such as temperature.
- DSP processors enjoy the advantages of microprocessors. They are easy to use, flexible, and economical.
- Various technologies have been used for real-time processing, from fiber optics for very high frequency to DSP processors very suitable for the audio-frequency range.



Digital signal processing (DSP) is the use of digital processing, such as by computers or more specialized digital signal processors, to perform a wide variety of signal processing operations.

- The signals processed in this manner are a sequence of numbers that represent samples of a continuous variable in a domain such as time, space, or frequency.
- Digital signal processing and analog signal processing are subfields of signal processing.

- **DSP applications** include audio and speech processing, sonar, radar and other sensor array processing, spectral density estimation, statistical signal processing, digital image processing, signal processing for telecommunications, control systems, biomedical engineering, seismology etc…

- DSP can involve linear or nonlinear operations.
- Nonlinear signal processing is closely related to nonlinear system identification and can be implemented in the time, frequency.
- The application of digital computation to signal processing allows for many advantages over analog processing in many applications, such as

✓ Error detection and Correction in transmission as well as data compression.

- DSP is applicable to both streaming data and static (stored) data.

- **The main applications of DSP** are audio signal processing, audio compression, digital image processing, video compression, speech processing, speech recognition, digital communications, digital synthesizers, radar, sonar, financial signal processing, seismology and biomedicine.
- **Specific examples** are speech compression and transmission in digital mobile phones, room correction of sound in hi-fi and sound reinforcement applications, weather forecasting, economic forecasting, seismic data processing, analysis and control of industrial processes, medical imaging such as clear air turbulence (CAT) scans and Magnetic resonance imaging (MRI), MP3 compression, computer graphics, image manipulation, hi-fi loudspeaker crossovers and equalization, and audio effects for use with electric guitar amplifiers.

- **Audio signal processing** or **audio processing** is the intentional alteration of audio signals often through an **audio effect** or effects unit.
- As audio signals may be electronically represented in either digital or analog format, signal processing may occur in either domain.

- Analog processors operate directly on the electrical signal, while digital processors operate mathematically on the digital representation of that signal.

- Processing methods and application areas include storage, level compression, data compression, transmission, enhancement (e.g., equalization, filtering, noise cancellation, echo or reverb removal or addition, etc.)

Audio broadcasting

- Traditionally the most important audio processing (in audio broadcasting) takes place just before the transmitter.
- Studio audio processing is limited in the modern era due to digital audio systems (mixers, routers) being pervasive in the studio.

- **Audio data compression**, not to be confused with dynamic range compression, has the potential to reduce the transmission bandwidth and storage requirements of audio data.
- Audio compression algorithms are implemented in software as audio codecs.

7.1 Image Processing

- In computer science, Digital image processing is the use of computer algorithms to perform image processing on digital images.
- As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing.

- It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing.
- Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.

Applications

Digital camera images

- Digital cameras generally include specialized digital image processing hardware either dedicated chips or added circuitry on other chips to convert the raw data from their image sensor into a color-corrected image in a standard image file format

Film

- Computer graphics
- Computer vision
- Holomorphic filtering
- Image analysis
- Multidimensional systems
- Standard test image
- Superresolution

7.2 Speech processing

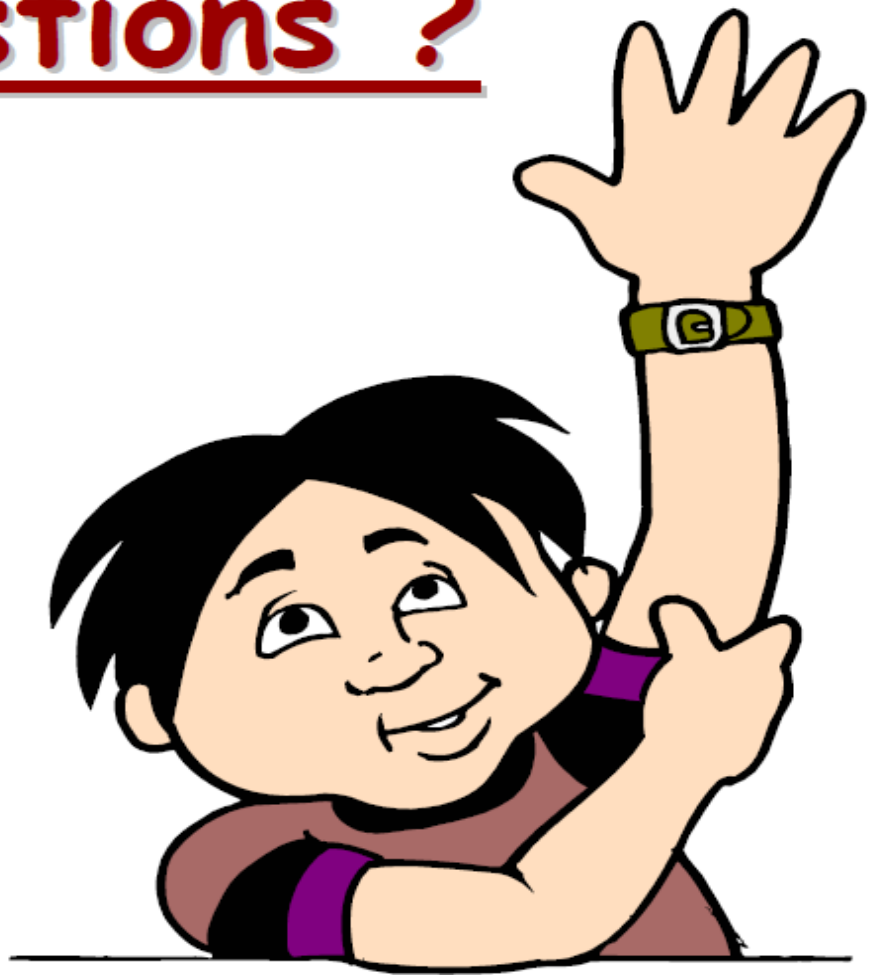
- Speech processing is the study of speech signals and the processing methods of these signals. The signals are usually processed in a digital representation, so speech processing can be regarded as a special case of digital signal processing, applied to speech signal.
- Aspects of speech processing includes the acquisition, manipulation, storage, transfer and output of speech signals.
- The input is called speech recognition and the output is called speech synthesis.
- Speech recognition is the inter-disciplinary sub-field of computational linguistics that develops methodologies and technologies that enables the recognition and translation of spoken language into text by computers. It is also known as "automatic speech recognition" (ASR), "computer speech.
- Speech recognition applications include voice user interfaces such as voice dialing (e.g. "Call home"), call routing.

7.3 Implementation

- DSP algorithms have long been run on general-purpose computers and digital signal processors.
- DSP algorithms are also implemented on purpose-built hardware such as application-specific integrated circuit (ASICs).
- Additional technologies for digital signal processing include more powerful general purpose microprocessors, field-programmable gate arrays (FPGAs), digital signal controllers (mostly for industrial applications such as motor control), and stream processors.
- Depending on the requirements of the application, digital signal processing tasks can be implemented on general purpose computers.

- Often when the processing requirement is not real-time, processing is economically done with an existing general-purpose computer and the signal data (either input or output) exists in data files.
- This is essentially no different from any other data processing, except DSP mathematical techniques (such as the FFT) are used, and
- The sampled data is usually assumed to be uniformly sampled in time or space.
- For example: processing digital photographs with software such as *Photoshop*.

Questions ?



Thanks !!!