APPLICATIONS OF DSP

DSP is Everywhere

- **Sound applications**
  - Compression, <u>enhancement</u>, special effects, synthesis, recognition, echo cancellation,...
  - Cell Phones, MP3 Players, Movies, Dictation, Text-to-speech,...

- **Communication**
  - Modulation, coding, detection, equalization, echo cancellation,...
  - Cell Phones, dial-up modem, DSL modem, Satellite Receiver,...

- **Automotive**
  - ABS, GPS, Active Noise Cancellation, Cruise Control, Parking,...

- **Medical**

  Magnetic Resonance, Tomography, Electrocardiogram,…

- **Military**

  Radar, Sonar, Space photographs, remote sensing,…

- **Image and Video Applications**

  DVD, JPEG, Movie special effects, video conferencing,…

- **Mechanical**

  Motor control, process control, oil and mineral prospecting,…

Signal Processing

- Humans are the most advanced signal processors
  - speech and pattern recognition, speech synthesis,...
- We encounter many types of signals in various applications
  - Electrical signals: voltage, current, magnetic and electric fields,...
  - Mechanical signals: velocity, force, displacement,...
  - Acoustic signals: sound, vibration,...
  - Other signals: pressure, temperature,...

Signal Processing (contd…)

- Most real-world signals are analog they are continuous in time and amplitude Convert to voltage or currents using sensors and transducers

- Analog circuits process these signals using Resistors, Capacitors, Inductors, Amplifiers,…

- Analog signal processing examples Audio processing in FM radios Video processing in traditional TV sets

Limitations of Analog Signal Processing

- Accuracy limitations due to
  - Component tolerances
  - Undesired nonlinearities

- Limited repeatability due to
  - Tolerances
  - Changes in environmental conditions
    - Temperature
    - Vibration

Limitations (contd..)

- Sensitivity to electrical noise
- Limited dynamic range for voltage and currents
- Inflexibility to changes
- Difficulty of implementing certain operations
    - Nonlinear operations
    - Time-varying operations
- Difficulty of storing information

Digital Signal Processing

- Represent signals by a sequence of numbers
  - Sampling or analog-to-digital conversions

- Perform processing on these numbers with a digital processor
  - Digital signal processing

- Reconstruct analog signal from processed numbers
  - Reconstruction or digital-to-analog conversion

analog signal → **A/D** → digital signal → **DSP** → digital signal → **D/A** → analog signal
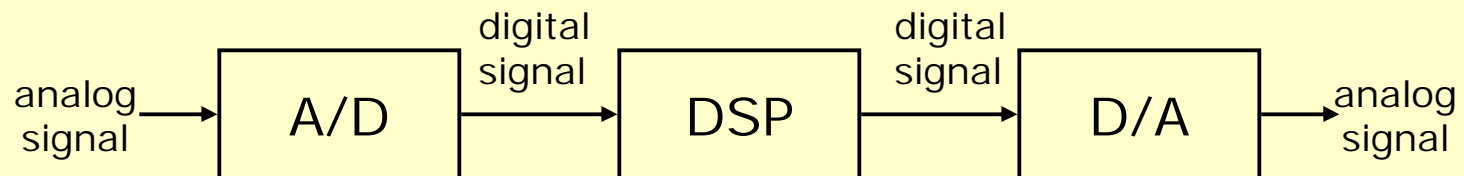
- Analog input – analog output
  - Digital recording of music

- Analog input – digital output
  - Touch tone phone dialing

- Digital input – analog output
  - Text to speech

- Digital input – digital output
  - Compression of a file on computer

Pros and Cons of Digital Signal Processing

- **Pros**
  - **Accuracy can be controlled by choosing word length**
  - **Repeatable**
  - **Sensitivity to electrical noise is minimal**
  - **Dynamic range can be controlled using floating point numbers**
  - **Flexibility can be achieved with software implementations**
  - **Non-linear and time-varying operations are easier to implement**
  - **Digital storage is cheap**
  - **Digital information can be encrypted for security**
  - **Price/performance and reduced time-to-market**
- **Cons**
  - **Sampling causes loss of information**
  - **A/D and D/A requires mixed-signal hardware**
  - **Limited speed of processors**
  - **Quantization and round-off errors**