



Digital Signal Processing

Introduction and Motivation

- What it means?
- History
- Scope
- Pros/Cons

What is a Signal ?

- A parameter that depends upon another independent parameter

Eg: Voltage is a parameter that evolves as a function of time $V(t)$: Here time is the independent parameter

- Usually a signal carries information that is useful to us
- **Common signals we come across** : Speech, Music (Audio Signals); Video signals; Pictures, Photographs (Image signals); Voltage, Current (Electrical Signals); Radio, Micro waves, Satellite, Radar signals (Communication signals)
- **Other signals** : Velocity, Force, (Mechanical Signals), Rates of reactions (Chemical Signals), Earth vibrations (Seismic Signals) etc
- The independent parameter : Usually time, can also be spatial coordinates, position, pressure, depth, temperature etc. Signal may be one-dimensional or multi-dimensional Eg: $V(t)$ one dimensional, $I(x,y)$ Image signal two dimensional

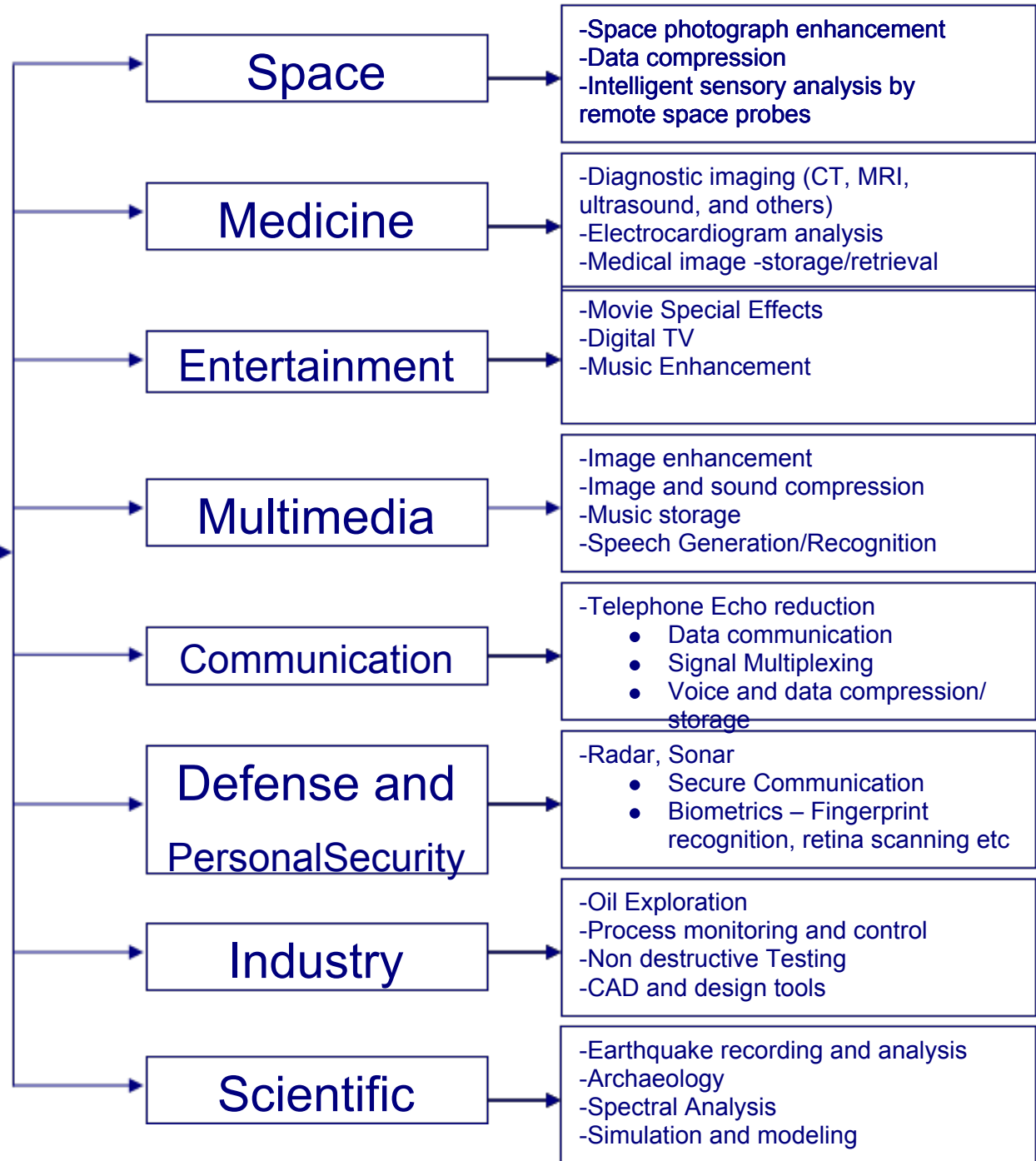
Signal Processing

- Signal processing is the manipulation, enhancement, extraction of information from signals. It involves mathematical techniques and algorithms
- Applications in a number of disciplines – Entertainment, Medicine, Communication, Space, Defense
- Two kinds – Analog Signal Processing and Digital Signal Processing
- Analog Signal Processing – Analog Signals i.e. independent parameter (time) is continuous
- Digital Signal Processing – Digital Signals i.e. time is discrete. Signal can be represented as a sequence of numbers/string of bits to be processed by a digital computer

Signal Processing History

- Digital Signal Processing has roots in 17th century numerical techniques (on integration, differentiation, interpolation)
- Till 1950's Signal processing mainly analog – not very sophisticated
- DSP not widespread because in analog – digital conversion of signals data is lost, and time required to do DSP too high to be practical
- In 1960's and 70's – Advent of Digital Computers – DSP in military applications
- 1965 – FFT – Fast Fourier Transform – Processing time significantly reduced
- 1980's -90's – PC revolution – Huge growth in DSP – Commercial applications
- 2000's – DSP a basic tool in a huge number of applications and science and engineering disciplines

DSP



Elements a Digital Signal Processing System



Analog to Digital Conversion:

- Sampling – Sample at $>$ twice the maximum frequency component to avoid aliasing
- Quantization
- Coding

Digital to Analog Conversion:

One of the techniques is interpolation

Digital Signal Processing vs Analog Signal Processing

Pros:

- In sophisticated signal processing applications, analog equipment required is very large and Digital circuits are more compact
- Digital Circuits less sensitive to changes/variations in component values/environment
- High Flexibility – can use the same DSP to perform different operations – Programmable DSPs, not possible in analog signal processing
- Adaptive Signal Processing : Can allow the processor characteristics to vary during operation according to requirements
- Reliable storage of data: Storage media like magnetic tapes, disks and optical disks store data without any loss over long periods of time
- Simulation of DSP is possible on computers

Digital Signal Processing vs Analog Signal Processing

Cons:

- Needs pre- and post –processing i.e. as most signals are analog we need Analog-to-Digital and Digital-to-Analog converters –hence not regularly used in real – time signal processing
- Frequency limitations – in A2D sampling frequency must be atleast twice highest frequency content of the signal, therefore sometimes we might require very high sampling frequencies