DIGITAL SIGNAL ANALYSIS AND APPLICATIONS

OUTLINE

- My Background
- Course Information
- Applications
- Definition & Examples
  - Signals & Systems

MY BACKGROUND

- Assistant Professor @ IIITS: Signal processing and Pattern Recognition
- Associate Professor @ VRSEC: Signal processing and Pattern Recognition
- Post PhD Research @ UMES: Application of Bayesian learning & advanced signal processing for cognitive radar
- Post PhD Research @ MSU: Buried Target Detection and Identification, Building extraction
- PhD @ Mississippi State University : Spatio temporal data analysis.
- Masters @ Chalmers University, Sweden: RAMAS program
- B.Tech from (KLCE) Nagarjuna University. (ECE)

MY BACKGROUND

- My interests include: Statistical signal processing, machine learning, digital image processing, and signals analysis for robotics
- DSA is common to all these areas
- Contact info: anish.turlapaty@iiits.in
- More info on my work: https://sites.google.com/site/turlapatyanish/
- Youtube channel: https://www.youtube.com/user/anishchandT

CONTENTS: DIGITAL SIGNALS - ANALYSIS & APPLICATIONS

- **A. Theory**:
- *Module 1: Digital Signals and Systems Fundamentals* -- Introduction, Course Overview, Signal Representation and Types Signal Conversion, Signal Classification and Representation, Natural and Synthetic signals, Types, Representation, Impulse, Unit sample, Unit step and Ramp signals, Digital Signal Scaling and Shifting- Signal and Noise, Noise Types and Sources. (3w)
- *Module 2: System Classification and Response* -- Properties of Signal and System, LTI System, Principle of Superposition- System Classification and System Response, Linear Convolution. (3w)
- *Module 3: Digital Signal Analysis and Transformation* -- Fourier Series and Fourier Transform FT Properties, Coefficients and Representations- Analysis and Synthesis, Sine-Cosine Representation, Sampling, Intro to Sampling Theorem, reconstruction and Quantization. (3w)

CONTENTS: DIGITAL SIGNALS - ANALYSIS & APPLICATIONS

- *Module 4: Discrete Transforms* -- DFT, DTFT Properties, Correlation, Parseval's Theorem- FFT Z-Transform- System Function, Transfer Function. (3w)
- **B. Practice Topics**
- 1. Algorithms derived from the 4 modules (9w)
- 2. Applications (3m)
  - Communication: Signal propagation, Amplitude Modulation- Frequency Modulation
  - Image Processing- Image segmentation: edge detection and global thresholding
  - Bio-signals: EMG and EEG signals

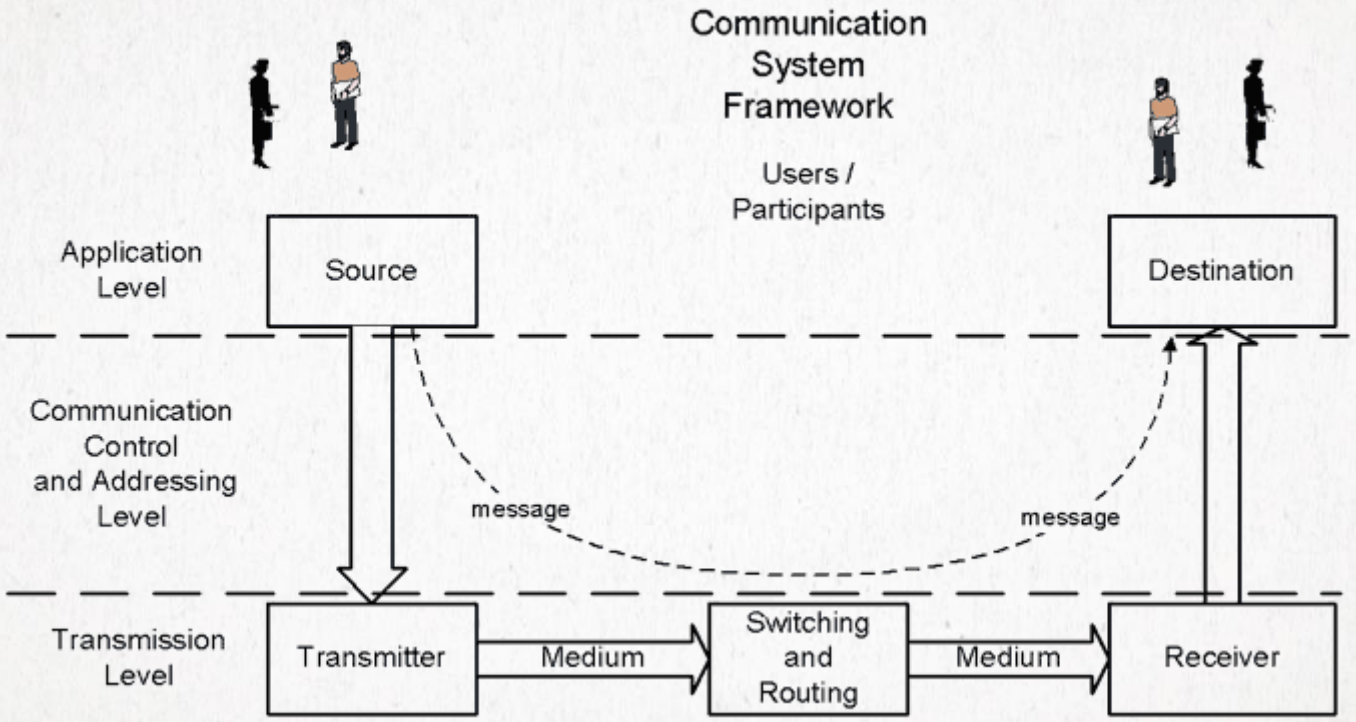
BOOKS

- ***Texts**:*
  - Signals & Systems by Oppenheim, Wilsky and Nawab
  - Digital Signal Processing, Proakis
- *References:*
  - Communication Systems (S. Haykin)
  - DIP using matlab (Gonzalez)
  - Signals and Systems using Matlab (L Chaparro)
  - DSP using matlab (V. Ingle and J. Proakis)
  - Introduction to electromyography (E. Criswell)
  - EEG Signal Processing, (S. Sanei and J. Chambers)
  - Essential Matlab for Engineers and Scientists (B. Hahn, D. Valentine)

APPLICATIONS

WHY DSAA?

COMM. SYSTEM

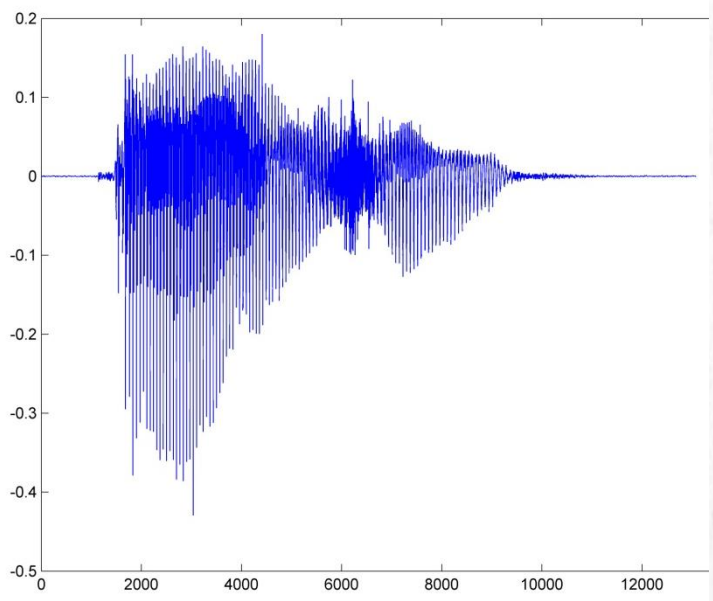

Communication
System
Framework
Users /
Participants
Application
Level
Source
Destination
Communication
Control
and Addressing
Level
message
message
Transmission
Level
Transmitter
Medium
Switching
and
Routing
Medium
Receiver

RADAR

ASTRONOMY

SPEECH SIGNAL

- Independent variable : Time
- Function of variable: Wave file – a function of time
- Information: Vibrations in the air (medium)



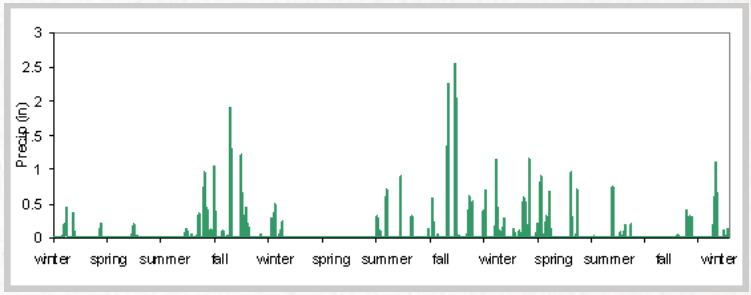
plot of a vowel sound

http://stat.bell-labs.com/dxsun/speech/index.html

GEOPHYSICAL SIGNAL

Image of Precipitation

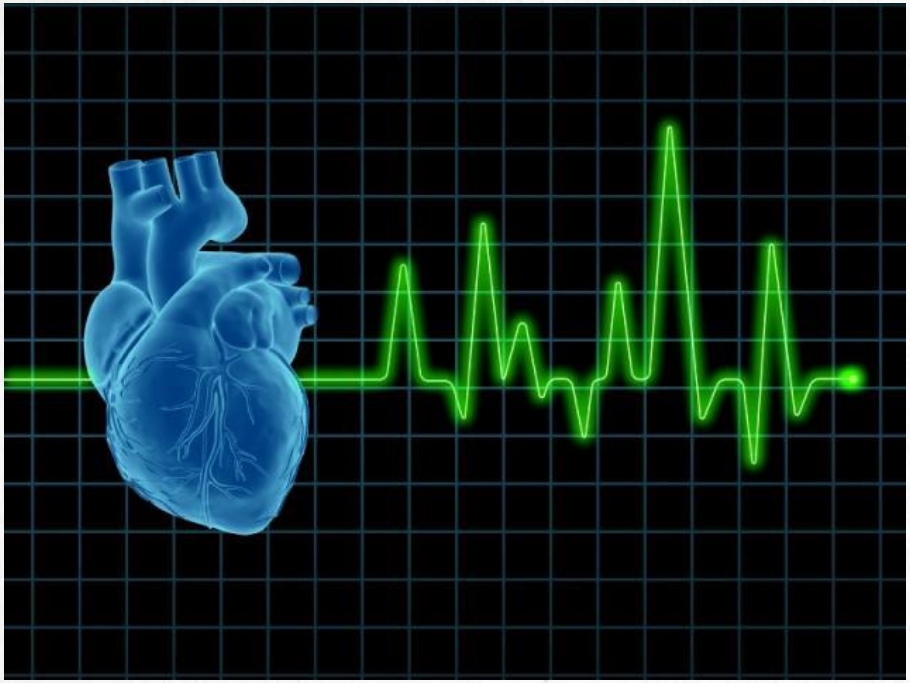
Precipitation Signal



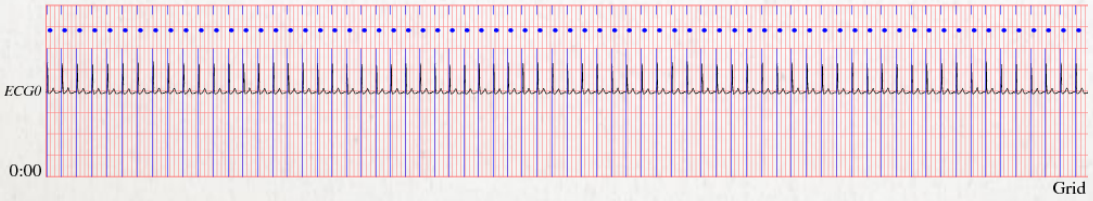
http://www.nws.noaa.gov/om/csd/pds/PCU2/statistics/Stats/part1/CTS_TimeVar.htm

BIOSIGNAL

- Electrocardiogram



Heartbeats:
ECG signals that represent an electric signal that travels through the heart



A real ECG signal from PHYSIOBANK

2 D SIGNAL

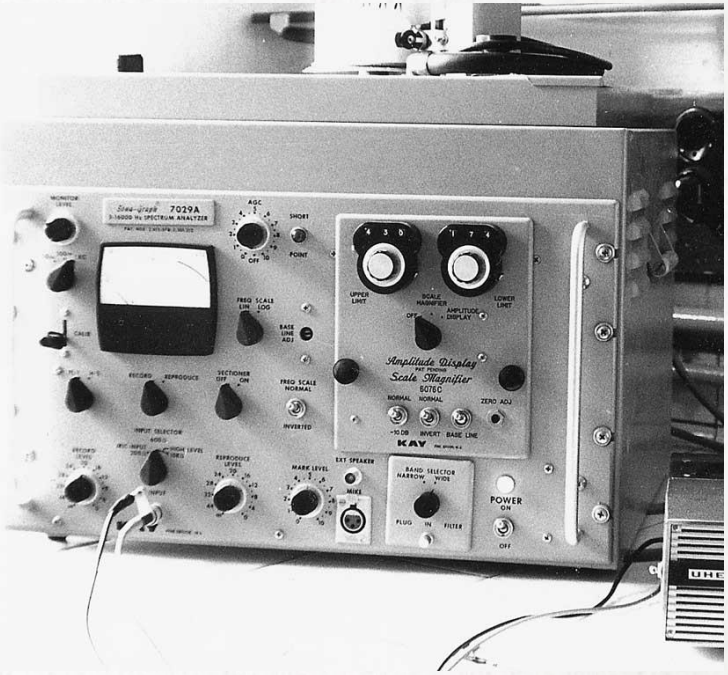
SIGNAL PROCESSING

- Analog signals
- Most of signals in the world are analog
- E.g signals such as speech is a function of time, EM energy function of space and time.
- Processing: Analog devices can process these signals.
- E.g. filters, frequency analyzers and multiplexers.

ANALOG FILTER

SPECTRUM ANALYZER

ITC INSTRUMENTS SA 1300B



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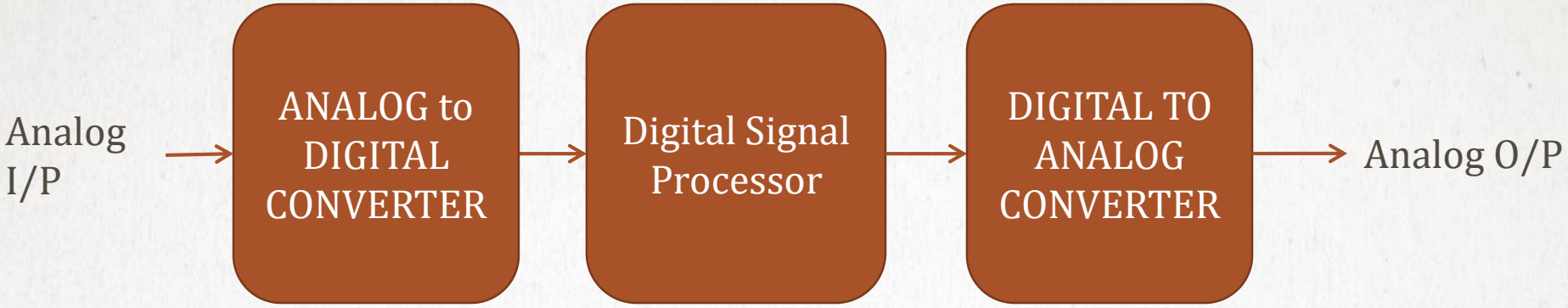
DIGITAL SIGNAL PROCESSING



- Large programmable digital computer
- Small programmable microprocessor, flexibility through change of software
- Hardwired digital processor: good for well defined operations and optimized for particular operations and faster.

MAJOR ADVANTAGES

RECONFIGURABILITY

- Reprogramming is easier mainly in software (through algorithms)
- Reprogramming requires system redesign

EASE OF STORAGE AND TRANSFER

- Digital data can be stored in tapes or disks and be easily copied.

ACCURACY CONSIDERATIONS

- Tolerance issues in analog systems.
- Digital systems have word lengths, fixed point vs. floating point arithmetic

LOWER COST

- Digital processors are cheaper either due to advances in hardware or easy programmability