CPE381
Fundamentals of Signals and Systems for Computer Engineers

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CPE381

- **Instructor**
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- **Office hours**
  - Tuesday 9 – 11 AM, Thursday 4 – 5 in TH N355 and by appointment.
- **Description** Introduction to the fundamental concepts in continuous and discrete signals and systems, and methods of signal and system analysis. Topics covered: Fourier series, Fourier and Laplace transforms, system representation by transfer functions and impulse response functions, convolution integrals, discrete time signals and system, sampling techniques, Z and discrete Fourier transforms. No credit for EE or OPE students.

Topics Covered

- Introduction (2 lectures). Continuous-time and discrete-time signals. Examples of signal processing applications.
- Continuous time Signals (1 lecture). Classification of time-dependent signals. Representation using basic signals.
- Continuous time Systems (3 lectures). System concept. LTI continuous-time systems. Linearity. Time invariance. Convolution integral. Causality. BIBO stability
- The Laplace Transform (3 lectures). Two-sided Laplace. One-sided Laplace. Analysis of LTI systems.
- Frequency Analysis: The Fourier Series (2 lectures). Eigenfunctions. Complex exponential Fourier series. Fourier series from Laplace. Time and frequency shifting. Response of LTI Systems to periodic signals.

Topics Covered

- The Fourier Transform (2 lectures). Fourier Transform from Laplace Transform. Inverse proportionality of time and frequency. Spectral representation. Convolution and Filtering. Examples.
- Sampling Theory (2 lectures). Uniform sampling. Nyquist-Shannon sampling theorem.
- Discrete-time signals and systems (2 lectures). Basic discrete-time signals. Recursive and non-recursive discrete-time systems. Convolution sum.
- Real-time System Implementation (3 lectures). Programming and implementation of signal processing algorithms. Real-time performance analysis and optimization.
- The Z-transform (2 lectures). Two-sided Z-transform. One-side Z-transform. Inverse Z-transform with MATLAB.
- Fourier analysis of discrete-time signals and systems (3 lectures). Discrete-time Fourier transform. Discrete Fourier transform.
- Applications (1 lecture).

Textbook

- Luis Chaparro, Signals and Systems using MATLAB, Elsevier, 2014.

Important Dates

- Midterm Exam
  - Monday, March 2, 2015, 2:20 - 3:40 PM
- Programming Project due
  - Phase I: Monday, March 9, 2015
  - Final: Monday, April 27, 2015
- Last day of Class
  - Wednesday, April 22, 2015
- Final Exam
  - Friday, April 27, 3 – 5:30 PM

Grading

- Academic misconduct of any type will not be tolerated.
  - Students are expected to conform to the UAH policies concerning academic misconduct as outlined in Section 8.32 of the current UAH Student Handbook.
- Attendance: up to 3 unexcused absences.
- Grades:
  - A (91-100), B (81-90), C (71-80), D (61-70), F (<60).
- Grading
  - Homework 20%
  - Programming Project 20%
  - Midterm Exam 25%, Final Exam35%
- Softcopies of all assignments must be submitted through Angel with hard copy due at the beginning of classes.
  - No late assignments accepted.

What do you have to know?

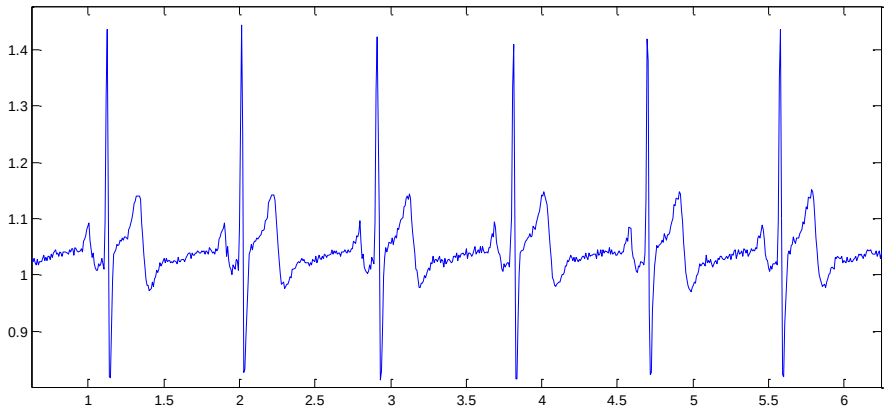
- Understand principles and system organization
- Design and implement real-time signal processing systems/algorithms
- Textbook coverage (2 semesters)
- Examples
  - Cruise control
  - Wearable health sensor
    - Cardiac monitoring example
    - Brain monitoring example

Resources

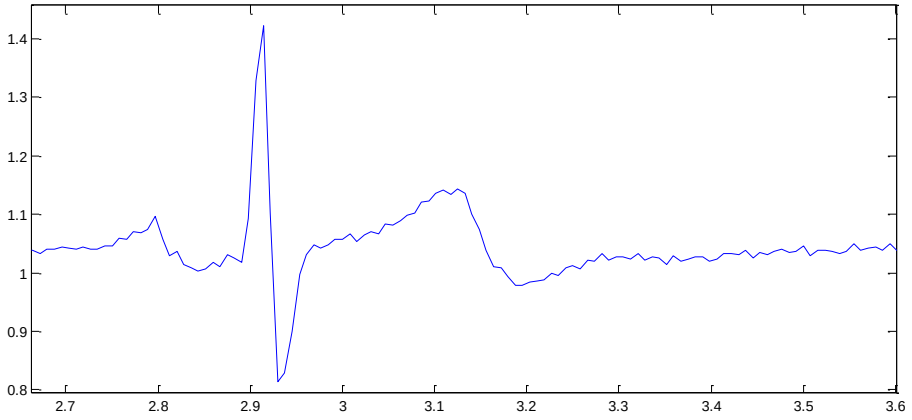
- Canvas course page/Resources
- Textbook website
- Examples (textbook/website/Canvas)
- Matlab/Help
  - Mathworks web site

ECG example

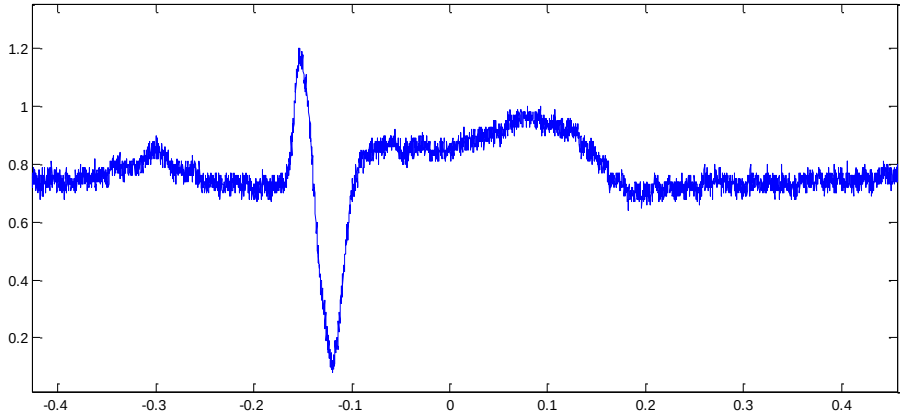
ECG



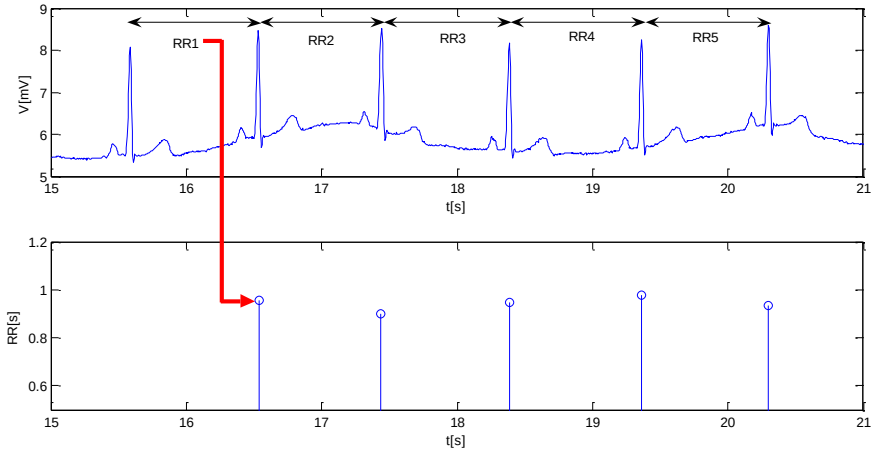
ECG – one heart beat



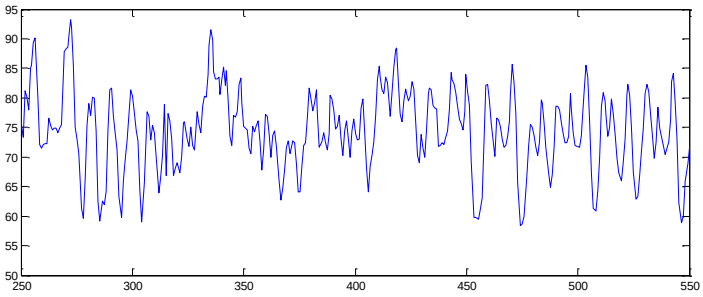
ECG with noise

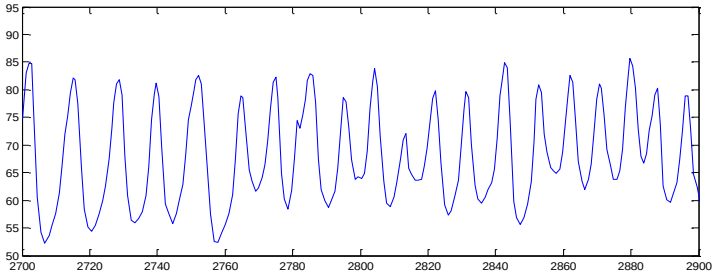


Heart Rate Variability



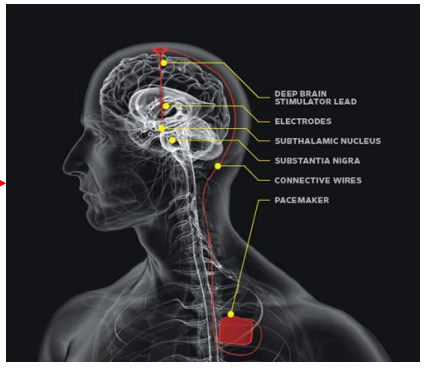
Heart Rate Variability





Sensor technology

- Disappearing technology



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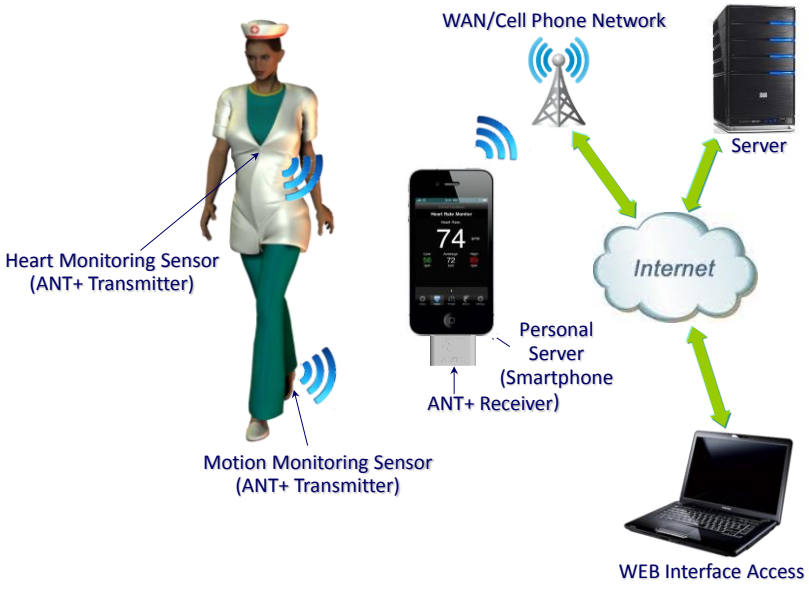
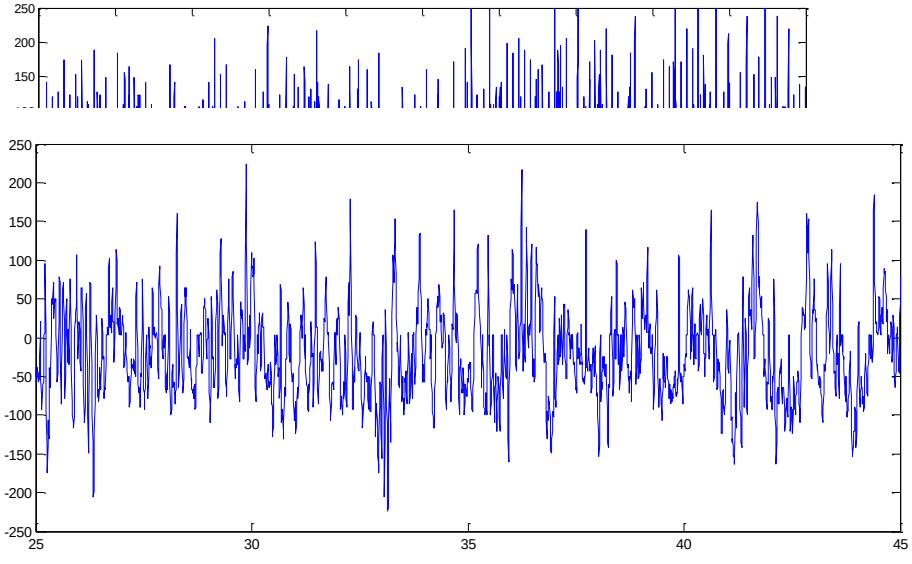
System Architecture



EEG Signal



BCI example

- Brain-computer interface
- EEG/EMG/fMRI
- Direct control of artificial limbs or external devices

Mind control