



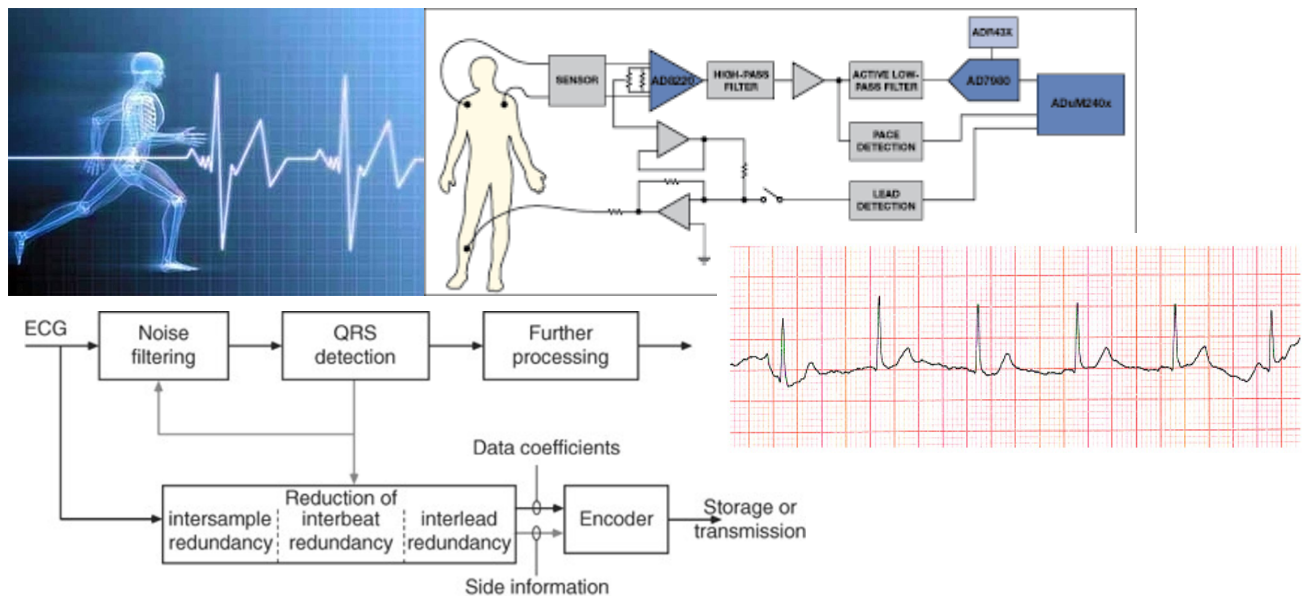
Biomedical Signal Processing

Instructor: Fatemeh Hadaeghi

Fall 2017

The aim and the scope

- The origin and characteristics of biomedical signals
- Difficulties in the measurement and processing procedures
- Basic processing algorithms with particular emphasis on frequency domain analysis



Contents

Chapter 1: Introduction

1-1 General measurements and diagnostic systems

1-2 Classification of signals

1-3 Fundamentals of signal processing

1-4 Biomedical signal acquisition and processing

Chapter 2: The origin of bioelectric signals

2-1 The nerve cell

2-2 The muscle

2-3 Volume conductors

2-4 Bioelectric signals

Chapter 3: Digital signal processing

3-1 Discrete- time signals

3-2 Discrete-time systems

3-3 Linear time invariant systems

3-4 Properties of Linear time invariant systems

3-5 Linear constant- coefficient differential equations

3-6 Frequency- domain representation of discrete time signals and systems

3-7 Representation of sequences by Fourier transforms

3-8 Symmetry properties of the Fourier transforms

3-9 Fourier transforms Theorems

Chapter 4: z- transform

4-1 z- transform

4-2 Region of convergence for the z- transform

4-3 z- transform properties

Chapter 5: Random processes

5-1 Elements of probability theory

5-2 Random signal characterization

5-3 Correlation analysis

5-4 The Gaussian process

Chapter 6: Sampling of continuous-time signals

6-1 uniform sampling

6-2 non-uniform sampling

Chapter 7: Finite time averaging

7-1 Finite time estimation of the Mean Value

7-2 Estimation of the Variance and Correlation

Chapter 8: Frequency domain analysis

8-1 Discrete and fast Fourier transforms (DFT, FFT)

8-2 Spectral analysis

8-3 Linear filtering

8-4 Cepstral analysis

Chapter 9: Time series analysis- Linear prediction

9-1 Autoregressive (AR) models

9-2 Moving Average (MA) models

9-3 Mixed Autoregressive Moving average (ARMA) models

9-4 Non-stationary processes, Autoregressive Integrated Moving Average (ARIMA) models

Chapter 10: Spectral estimation

10-1 Methods based on the Fourier transform

10-2 Maximum Entropy Method (MEM) and AR method

10-3 Autoregressive Moving average (ARMA) methods

References

- Alan, V. Oppenheim, W. Schafer Ronald, and R. B. John. *Discrete-time signal processing*. New Jersey, Printice Hall Inc (1989).
- Cohen, Arnon. *Biomedical Signal Processing: Time and frequency domains analysis*, Volume I. CRC-Press, 1986.
- Proakis, John G., and Dimitris G. Manolakis. *Digital signal processing: principles, algorithms, and applications*. (1996).
- Cohen, Arnon. *Biomedical Signal Processing: Compression and automatic recognition*, Volume II. CRC-Press, 1986.
- Rangayyan, Rangaraj M. *Biomedical signal analysis*. Vol. 33. John Wiley & Sons, 2015.
- Sörnmo, Leif, and Pablo Laguna. *Bioelectrical signal processing in cardiac and neurological applications*. Vol. 8. Academic Press, 2005.
- Van Drongelen, Wim. *Signal processing for neuroscientists: an introduction to the analysis of physiological signals*. Academic press, 2006.
- Najarian, Kayvan, and Robert Splinter. *Biomedical signal and image processing*. CRC press, 2005.
- Cerutti, Sergio, and Carlo Marchesi, eds. *Advanced methods of biomedical signal processing*. Vol. 27. John Wiley & Sons, 2011.
- Akay, Metin. *Biomedical signal processing*. Academic Press, 2012.
- Devasahayam, Suresh R. *Signals and systems in biomedical engineering: signal processing and physiological systems modeling*. Springer Science & Business Media, 2012.
- Sanei, Saeid, and Jonathon A. Chambers. *EEG signal processing*. John Wiley & Sons, 2013.
- Acharya, Rajendra, et al., eds. *Advances in cardiac signal processing*. Berlin: Springer, 2007.

Grading and Exams

The final course grade will be determined as follows:

- Class attendance (presence sheets) will count for 10% of the final grade
- Three mini-quizzes which each will account to 10% of the final grade
- Homework will count for 15% of the final grade
- One final exam will count for 45% of the final grade

✓ All quizzes and the final exam are open book.

How to access class materials and additional resources?

visit this link:

<http://minds.jacobs-university.de/teaching/BSPFall2017>

How to ask your questions?

Drop a line to:

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