



DE 340113:
Biomedical Signal Processing

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This course is about ...

- the origin and characteristics of biomedical signals
- difficulties in the measurement and processing procedures
- basic processing algorithms

The objectives of biomedical signal processing are ...

- to reduce the subjectivity of manual measurements
- to develop methods that extract features to better understand and interpret the information contained in a signal
- to reduce the noise and artifacts
- data compression of the digitized signals
- mathematical signal modeling and simulation to attain a better understanding of underlying biological processes

Major clinical applications of biomedical signal processing are ...

Diagnosis:

- the pathological conditions can be identified by processing the signals recorded from organs in combination with clinical symptoms.
- for this purpose, the algorithms work in an off-line fashion.
- the scope of this algorithms ranges from performing a simple noise filtering to form a more influential step of the clinical decision- making procedure.

Therapy:

- in therapeutic context, an algorithm is used to modify the behaviour of a particular physiological process (e.g. pacemaker or implantable heart defibrillator).
- for this purpose, on-line analysis is necessary and the algorithms should work in real- time.
- these algorithms are not power consuming and computationally expensive.

Monitoring:

- during the monitoring, the signal is processed in a sequential fashion and the past samples play a major role in decision making.
- this algorithms are mainly designed to detect the variations in cardiac or neurological functions in intensive care units.

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 and Database
- 2-5 Performance Evaluation

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

3-10 Z- Transform

3-11 Z- Transform Properties

Chapter 4: EEG- A Brief Introduction

4-1 The Nervous System

4-2 The Electroencephalogram- Electrical activity Measured on the Scalp

4-3 Recording Techniques

4-4 EEG Applications

Chapter 5: EEG Signal Processing

5-1 Modeling the EEG Signal

5-2 Artifacts in the EEG

5-3 Nonparametric Spectral Analysis

5-4 Model-Based Spectral Analysis

5-5 EEG Segmentation

Chapter 6: ECG- A Brief Introduction

- 6-1 Electrical Activity of the Heart
- 6-2 Generation and Recording of an ECG
- 6-3 Heart Rhythms
- 6-4 Heartbeat
- 6-5 Noise and Artifacts
- 6-4 Clinical Applications

Chapter 7: ECG Signal Processing

- 7-1 Baseline Wander
- 7-2 Powerline Interference
- 7-3 Muscle Noise Filtering
- 7-4 QRS Detection
- *7-5 Data Compression
- *7-6 Heart rate variability

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).
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- 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 20% of the final grade
- A take home final exam will count for 40% of the final grade

How to access class materials and additional resources?

visit this link:

<http://minds.jacobs-university.de/teaching/BSPSpring2018>

How to ask your questions?

Drop a line to:

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