

Use of MATLAB in Signals and Systems Course



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Signals and Systems I, Electrical and Electronics Engineering

Course description and learning objectives

2023-2024

Bachelor Students

Fall Term

Engineering Faculty

Physical

At the end of this course, the students;

- 1) Will be able to model linear systems.
- 2) Will be able to learn and to utilize signal types.
- 3) Will be able to learn and to utilize continuous-time and discrete-time Fourier series.
- 4) Will be able to learn and to utilize continuous-time and discrete-time Fourier transforms.
- 5) Will be able to gain problem solving skills for signals and systems problems.
- 6) Will be able to be able to utilize the related software for signals and systems.

Signals and Systems II, Electrical and Electronics Engineering

Course description and learning objectives

2023-2024

Bachelor Students

Spring Term

Engineering Faculty

Physical

At the end of this course, the students;

- 1) To gain problem solving skills for signals and systems problems.
- 2) To learn and utilize basic signal transformations.
- 3) To learn about the sampling theory and its applications.
- 4) To calculate a system transfer function and phase response.
- 5) To be able to know telecommunication applications.
- 6) To apply theoretical information with modern technical tools.

Write here your course name and course of study
Reason for adoption MATLAB and Simulink Tool

- Visualization
- Hands-On Learning
- Complex Calculations
- Code and Script Development
- Integration with Theory
- Standard Industry Tools
- Educational Resources

How MATLAB and Simulink were used in the course

- **Signal Visualization and Analysis:** Plotting, Spectral Analysis (plot, stem, fft, spectrogram)
- **Mathematical Operations:** Transformations, System Analysis (conv, xcorr, filter)
- **Algorithm Development**
- **Educational Toolboxes:** Signal Processing Toolbox, Control System Toolbox

How MATLAB and Simulink were used in the course

Example Applications in the Course

Filter Design: Students can design and analyze digital filters using functions like *designfilt* and *filter*. They can visualize frequency responses and time-domain behaviors.

System Response Analysis: Students can analyze system responses using functions like *step*, *impulse*, and *bode*.

Signal Processing Projects: Students can develop custom algorithms for tasks such as noise reduction, feature extraction, or modulation/demodulation.

Benefits / added value of using MATLAB and Simulink

- Enhanced Visualization and Intuition
- Practical Experience with Real-World Tools
- Simplified Complex Calculations
- Improved Understanding Through Simulation
- Facilitation of Hands-On Learning
- Integration of Theory and Practice
- Access to Extensive Resources
- Efficient Learning and Teaching
- Collaboration and Sharing

Results obtained and personal considerations

- Enhanced Comprehension
- Increased Student Engagement
- Practical Skill Development
- Enhanced Problem-Solving Abilities
- Efficient Learning and Teaching

Future plans

- Within the scope of the course, students will be required to complete on-ramp courses
- MATLAB class will be used for homework platform
- MATLAB application lessons will be requested from FIGES company in the courses

Use of MATLAB in Artificial Intelligence Application Research



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Use of MATLAB in Artificial Intelligence Application Research

Research Topics

- Machine learning-based weather prediction with radiosonde observations
- Image processing-based quality control system to determine the surface defect in wooden raw materials
- Classification of Turkish e-commerce product reviews
- Classification of human movements by using Kinect sensor
- Estimation of Concentration Values of Different Gases Based on Long Short-Term Memory by Using Electronic Nose
- Calibration transfer in temperature modulated gas sensor arrays

Machine learning-based weather prediction with radiosonde observations

Research Goals

- Collecting data from the radiosonde device
- Estimating the highest and lowest temperatures for the next day using data obtained from the Radiosonde Device
- Making estimations with minimal error

Image processing-based quality control system to determine the surface defect in wooden raw materials

Research Goals

- To classify defective and non-defective wooden raw materials
- To classify images obtained using a specialized camera system with maximum accuracy

Classification of Turkish e-commerce product reviews

Research Goals

- The comments under a product on online shopping sites were collected and a dataset was created
- The dataset has 6799 positive, 6978 negatives, and 1393 neutral comments, including 15170 comments.
- To provide a brief overview of machine learning methods for text classification.

Classification of human movements by using Kinect sensor

Research Goals

- With the help of learning-based algorithms, human posture can be defined in the images obtained by various imaging methods.
- This study used a dataset called CAD60 that included real-time human posture information and images obtained using a Microsoft Kinect sensor.
- To classify 13 human movements, a successful method is proposed.

Estimation of Concentration Values of Different Gases Based on Long Short-Term Memory by Using Electronic Nose

Research Goals

- This study has been carried out to increase the classification and regression successes of concentration values of four different gases (Ethylene, Ethanol, Carbon Monoxide, Methane) detected by four metal oxide gas sensors (TGS2611, TGS2612, TGS2610, TGS2602).
- To distinguish gases according to their concentrations with maximum accuracy.

Calibration transfer in temperature modulated gas sensor arrays

Research Goals

- We study the use of multivariate techniques to transfer the calibration model from a temperature modulated gas sensor array to another when a global change of temperature occurs.
- To do so, we built 12 identical master sensor arrays composed of three different types of commercial Figaro sensors and acquired a dataset of sensor responses to three pure substances (ethanol, acetone and butanone) dosed at 7 concentrations.
- Data correction is performed for an increasing number of transfer samples with 4 different calibration transfer techniques: Direct Standardization, Piece-wise Direct Standardization, Orthogonal Signal Correction and Generalized Least Squares Weighting.

Benefits / added value of using MATLAB and Simulink

In all of these studies, the MATLAB platform was employed for machine learning tasks. Both built-in functions and pre-existing applications within this platform were utilized. The most frequently used toolboxes included those for statistics, machine learning, deep learning, and computer vision. Additionally, classification and regression learner applications were also utilized. These tools facilitated the rapid application of machine learning algorithms to the collected signals or data. The effects of the algorithms were analyzed by easily adjusting the parameters. Furthermore, different algorithms were integrated in a hybrid manner, and custom scripts were developed.

Results obtained and personal considerations

- In all of these studies, the results exceeded the level of success reported in the existing literature.
- MATLAB platform was used to obtain these results.
- It was observed that MATLAB was quite sufficient in machine learning applications.

Future plans

- Ensuring the use of MATLAB and Python together in image processing applications
- Creating an effective model using whichever platform is superior in image processing

Thank you

Q&A – 5min

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