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MULTIMODAL SENSOR FUSION AND NAVIGATION

1. SYLLABUS INFORMATION

1.1. Course title
Multimodal Sensor Fusion and Navigation

1.2. University
Pázmány Péter Catholic University

1.3. Semester
1st year, 1st semester

2. COURSE DETAILS

2.1. Course nature
Compulsory

2.2. ECTS Credit allotment
5

2.3. Recommendations

2.4. Faculty data
Dr. András Horváth

3. COMPETENCES AND LEARNING OUTCOMES

3.1. Course objectives
The main goal of the course is to give an overview about real time algorithms and architectures used in multi-sensor data fusion and navigation. The focus of the course is multi-parallel processing and target tracking.

The course introduces estimation theory, the necessary definitions in static, dynamics linear and non-linear cases for both discrete and continuous systems. It reveals and explains such generally used algorithms like the Kalman- and the Bootstrap-filter, as well as the limitations and applications of these algorithms in practical problems.

The course gives comprehensive knowledge about system level computations in both top-down and bottom up design of adaptive algorithmic solutions. Examines the topographic and non-topographic partitioning of data-flows regarding the modern multi-parallel architectures.

3.2. Course contents
Data-fusion in the human nervous system
Definition and basics of estimation theory, MLE, MSE estimators

Estimation in static systems, Estimation of Gaussian random vectors, least squares estimation, polynomial fitting etc.
Filtering, Prediction, Smoothing, State estimation in discrete state spaces (Viterbi, Forward-Backward, Baum)
State estimation methods in linear dynamic systems (Kalman Filter, kinematic models)
State estimation methods in non-linear dynamic (but linearizable) systems (Extended Kalman filter, Unscented Kalman Filter)
State estimation methods in non-linear dynamic systems I.: Particle Filter
State estimation methods in non-linear dynamic systems II: Sampling, Resampling, Bootstrap Filter
Data association and data matching / SNF, NNF, PDA, JPDA, JVC, MHT methods and algorithms
Image fusion: Topographic and non-topographic (rigid Non-rigid, registration)
Adaptive tracking of maneuvering targets / IMM model and applications, IMM-JVC and IMM- JPDA models

3.3. Course bibliography

[1] Bar-Shalom, Yaakov, Li, X. Rong, Kirubarajan, Thiagalingam: Estimation with Applications to Tracking and Navigation, Wiley, 2002
[2] Ramon van Händel: Hidden Markov Models, Lecture Notes, 2008

4. TEACHING-AND-LEARNING METHODOLOGIES AND STUDENT WORKLOAD

4.1. Contact hours

	Hours
Classroom instruction (minimum 33%)	48
Independent study time	48

4.2. List of training activities

Activity	Hours
Lectures	24
Practice	12
Computer lab	12
Assessment activities	4

5. EVALUATION PROCEDURES AND WEIGHT OF COMPONENTS IN THE FINAL GRADE

5.1. Regular assessment

5.2. List of evaluation activities

Evaluatory activity	%
Final exam	50
Programming assignments/classroom activities	50