MULTI-SENSOR DATA FUSION

1	Course Title:	MULTI-SENSOR DATA FUSION	
2	Course Code:	BM5140	
3	Type of Course:	Optional	
4	Level of Course:	Second Cycle	
5	Year of Study:	1	
6	Semester:	2	
7	ECTS Credits Allocated:	6.00	
8	Theoretical (hour/week):	3.00	
9	Practice (hour/week):	0.00	
10	Laboratory (hour/week):	0	
11	Prerequisites:	Undergraduate Level Probability and Statistics Knowledge	
12	Language:	Turkish	
13	Mode of Delivery:	Face to face	
14	Course Coordinator:	Prof. Dr. KEMAL FİDANBOYLU	
15	Course Lecturers:	-	
16	Contact information of the Course Coordinator:	e-posta: kfidan@uludag.edu.tr Uludağ Üniversitesi, Bilgisayar Mühendisliği Bölümü Görükle Kampüsü, 16059 Nilüfer, Bursa	
17	Website:		
18	Objective of the Course:	To provide the students with knowledge about basic principles and applications of multi-sensor data fusion.	
19	Contribution of the Course to Professional Development:	Engineering Science: 85%; Engineering Design: 15%	
20	Learning Outcomes:		
		1	Define multi-sensor data fusion strategies
		2	Classify different types of sensors
		3	Describe the architectures of fusion networks
		4	Explain several sensor representational formats such as spatial alignment, temporal alignment, semantic alignment and radiometric normalization
		5	Examine Bayesian inference methods
		6	Investigate different concepts of parameter estimation
		7	Explain the principles of robust parameter estimation
		8	Examine different sequential Bayesian interfaces such as recursive filters, Kalman filters, particle filters and multi-sensor multi-temporal data fusion
		9	Discuss different approaches for pattern recognition
		10	Explain the fundamentals of ensemble learning and sensor management
21	Course Content:		

Course Content:

Week	Theoretical	Practice
1	Introduction: Multi-sensor data fusion strategies; Formal framework; Catastrophic fusion; Organization.	

2	Sensors: Smart sensors; Logical sensors; Interface file systems; Sensor observation; Sensor characteristics; Sensor model.	
3	Architecture: Fusion mode; Simple Fusion networks; Network topologies.	
4	Common Representation Format: Spatial temporal transformation; Geographical information system; Common representational format; Subspace methods; Multiple training sets.	
5	Spatial Alignment: Image registration; Mutual information; Optical flow; Feature based image registration; Resample/Interpolation; Pairwise transformation; Uncertainity estimation; Image fusion; Mosaic images.	
6	Temporal Alignment: Dynamic time warping; Dynamic programming; One sided dynamic time warping algorithm; Multiple time series.	
7	Semantic Alignment: Assignment matrix; Clustering algorithm; Clustering ensembles.	
8	Radiometric Normalization: Scales of measurement; Degree of similarity scales; Radiometric normalization functions; Binarization; Parametric normalization functions; Fuzzy normalization functions; Ranking; Conversion to probabilities.	
9	Bayesian Inference: Bayesian analysis; Probability model; A posteriori distribution; Maximum likelihood; Least squares; Linear Guassian model; Generalized Millman	
11	Robust Statistics; Outliers; Robust parameter estimation; Classical robust estimators; subspace in computer vision.	
13	Bayesian Decision Theory; Pattern recognition; Naive Bayes' classifer; Variants;	
14	Ensemble Learning: Bayesian framework; Diversity measures; Classifier types; Combination strategies; Simple combiners; Meta-learners; Boosting. Sensor Management: Hierarchical Classification; Sensor management techiques.	

Activites	Number	Duration (hour)	Total Work Load (hour)
Theoretical	14	3.00	42.00
Practicals/Labs	0	0.00	0.00
Self-study and preperation	14	5.00	70.00
Homeworks	1	33.00	33.00
Projects	0	0.00	0.00
Field Studies	0	0.00	0.00
Midterm Exams	1	15.00	15.00
Others	0	0.00	0.00
Final Exams	1	20.00	20.00
Total Work Load			180.00
Total work load/ 30 hr			6.00
ECTS Credit of the Course			6.00

22	Textbooks, References and/or Other Materials:	H.B. Mitchel, Data Fusion: Concepts and Ideas, 2nd Ed., Springer-Verlag 2012.
23	Assesment	

TERM LEARNING ACTIVITIES	NUMBER	WEIGHT
Midterm Exam	1	20.00
Quiz	0	0.00
Home work-project	1	20.00

Final Exam	1	60.00
Total	3	100.00
Contribution of Term (Year) Learning Activities to Success Grade		40.00
Contribution of Final Exam to Success Grade		60.00
Total		100.00
Measurement and Evaluation Techniques Used in the Course		Classical problem-solving ability will be measured in midterm and final exams. The project will include research, simulation, report writing and presentation on a subject related to the course content.

24 ECTS / WORK LOAD TABLE

25 CONTRIBUTION OF LEARNING OUTCOMES TO PROGRAMME QUALIFICATIONS

	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	PQ8	PQ9	PQ10	PQ11	PQ12	PQ13	PQ14	PQ15	PQ16
ÖK1	5	3	3	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK2	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK3	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK4	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK5	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK6	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK7	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK8	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK9	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0
ÖK10	5	4	4	2	2	2	0	0	0	0	0	0	0	0	0	0

LO: Learning Objectives PQ: Program Qualifications

Contribution Level:	**1 very low**	**2 low**	**3 Medium**	**4 High**	**5 Very High**