AGU Graduate School of Engineering and Science Electrical and Computer Engineering Program

COURSE RECORD

Code	**ECE 504**
Name	**Autonomous Mobile Robots**
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall-Spring
Type	Elective
Location	In class
Prerequisites	None
Special Conditions	
Coordinator(s)	Dr. Samet Güler
Webpage	
Content	The course will cover the theoretical and practical essentials of ground and aerial autonomous mobile robots. Topics include mobile robot motion modeling, kinematics and dynamics; navigation, perception, and execution algorithms for mobile robots; estimation frameworks such as Bayesian filtering methods (Kalman, EKF, particle, etc.) and their applications; localization; mapping; and path planning. The course will start with a quick review of linear algebra and probability. Special emphasis will be given to implementation of the algorithms on mobile robots in realistic simulation environments.
Objectives	The main goals of the course are: • Demonstrating work mechanisms of various ground and aerial autonomous mobile robots; • Providing fundamental background on mobile robot estimation, planning, and control algorithms; • Presenting applications on simulation environments for mobile robots such as Robot Operating System (ROS).
Learning Outcomes	Upon the completion of the course, the student will be able to: - (LO1) Analyze several path planning, control, and estimation techniques designed for autonomous mobile robots in unknown environments; - (LO2) Formulate a real-world problem for a mobile robot in terms of control, estimation, and navigation sub-tasks; - (LO3) Evaluate quantitatively the performance of estimation, control, and planning algorithm designs for mobile robots; - (LO4) Design and implement integrated navigation and perception algorithms on a set of mobile robots in realistic simulation environments such as Gazebo.
Requirements	Basic coding skills in Python/C++.
Reading List	- R. Siegwart, I. R. Nourbakhsh & D. Scaramuzza, "Introduction to autonomous mobile robots", MIT Press, Cambridge, MA, 2011. - S. Thrun, W. Burgard, & D. Fox, "Probabilistic Robotics", MIT Press, Cambridge, MA, 2005. - H. Choset, K.M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L.E. Kavraki, & S. Thrun, "Principles of robot motion: Theory, algorithms, and implementations", MIT Press, Cambridge, MA, 2005.
Ethical Rules and Course Policy	Students must adhere to AGU's ethical rules and policies.

LEARNING ACTIVITIES

Activities	**Number**	**Weight (%)**
Lectures	14	70%
Online materials	14	30%
	Total	100

ASSESSMENT

Evaluation Criteria	**Weight** (%)
Homework Assignments	30%
Group Project Assignments & Presentations	25%
Attendance/Participation	05%
Final Exam	40%
Total	100%

For a detailed description of grading policy and scale, please refer to the website https://goo.gl/HbPM2y section 28.

COURSE LOAD

Activity	**Duration** (hour)	**Quantity**	**Work Load** (hour)
In class activities	3	14	42
Group work	4	12	48
Research (web, library)	5	12	60
Required Readings	2	10	20
Assignments	5	5	25
		General Sum	**195**

ECTS: 7,5 (Work Load/25-30)

CONTRIBUTION TO PROGRAMME OUTCOMES*

	PO1	PO2	PO3	PO4	PO5	PO6
LO1	4	2	2	2	5	2
LO2	3	5	2	5	1	4
LO3	3	5	2	4	2	4
LO4	3	5	5	5	2	4

* Contribution Level: 0: None, 1: Very Low, 2: Low, 3: Medium, 4: High, 5: Very High

WEEKLY SCHEDULE

W	**Topic**	**Outcomes**
1	Introduction, Linear systems review	LO1, LO2
	Activity: In-class	
2	Probability review, coordinate transforms	LO1, LO2
	Activity: In-class	
3	Motion modeling	LO1, LO2
	Activity: In-class	
4	Introduction to ROS-Gazebo	LO1, LO2, LO4
	Activity: In-class, computer simulations	
5	Measurement models, sensors	LO1, LO2
	Activity: In-class	
6	Bayes filter, Kalman filter	LO1, LO2
	Activity: In-class	
7	Extended Kalman filter, Particle filter	LO1, LO2
	Activity: In-class	
8	Localization	LO1, LO2
	Activity: In-class	
9	Mapping, EKF SLAM	LO1, LO2
	Activity: In-class	
10	Control algorithms	LO1, LO2
	Activity: In-class	
11	Path planning	LO1, LO2
	Activity: In-class	

12	Path planning, Application examples Activity: In-class, computer simulations	LO1, LO2, LO3, LO4
13	Multi-robot systems, Review Activity: In-class, computer simulations	LO1, LO2, LO3, LO4
14	Project demonstrations Activity: Exam	LO3, LO4

Prepared by Dr. Samet Güler
Date 10.06.2020