



Subject card

Subject name and code	Autonomous mobile vehicle, PG_00073161						
Field of study	Automation, Robotics and Control Systems						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2026/2027		
Education level	second-cycle studies		Subject group				
Mode of study	Part-time studies		Mode of delivery		at the university		
Year of study	1		Language of instruction		Polish		
Semester of study	1		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Control Engineering -> Faculty of Electrical and Control Engineering -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Krzysztof Armiński				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	10.0	0.0	0.0	0.0	10.0	20
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	20		10.0		45.0	75
Subject objectives	The course teaches students to design and implement the control system of an autonomous mobile vehicle, using an autonomous sailing yacht as the example. Students apply knowledge of control engineering, signal processing and programming gained earlier in their studies. In the project, they build a complete control system that guides a simulated yacht along a regatta course.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_U04] has the ability for self-directed learning in order to improve his/her professional qualifications, and is able to identify directions for further learning		Is able to independently acquire, supplement and apply knowledge from previous courses and the literature to solve the control problem of an autonomous mobile vehicle. Is able to justify the chosen approach and identify directions for its further development.		[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment		
	[K7_W08] has in-depth knowledge of program development and design of complex systems automation systems using PLC and SCADA, transmission and processing of signals occurring in a variety of physical objects		Knows methods for processing signals from the sensors of a mobile vehicle (IMU/MARG, GNSS, anemometer), including the Madgwick filter for orientation estimation. Knows the principles of implementing control algorithms in PLCs.		[SW1] Assessment of factual knowledge		
	[K7_W06] has an extended knowledge of the design of automation components and devices, control and decision support systems control and decision support systems and complex mechatronic systems		Knows the structure of the control system of an autonomous mobile vehicle and the operating principles of a sailing yacht. Knows methods for designing heading and sail-trim controllers and manoeuvre logic, and is able to select appropriate ones.		[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge		

Subject contents	Course content – lecture		
	- Autonomous mobile vehicles: overview and typical control system architecture (perception, navigation, guidance, control, supervision). Introduction to the project task: yacht model, regatta course and assessment criteria. - Sailing yacht operating principles: forces on the sail and keel, angle of attack, apparent wind, no-go zone, tacking and gybing. - Yacht control system design: rudder-based heading control, sail trim, path following (line following), beating to windward, manoeuvre logic as a state machine. Use of known methods (PID, cascade control, LQR, MPC). - Orientation estimation: IMU/MARG sensors, the Madgwick filter, comparison with the complementary filter and the Kalman filter. - Implementation of control algorithms in PLCs.		
	Course content – seminar		
	The classes take the form of a team project. Students receive a Python model of a yacht and a regatta course. Their task is to design and implement a control system that sails the yacht through the entire course.		
Prerequisites and co-requisites	Prerequisites: - Fundamentals of control engineering: state-space representation, stability, PID controllers and their tuning, cascade control, discrete-time controllers. - Python programming: functions and classes, NumPy, Matplotlib, running simulations and analysing their results. - Mathematics: linear algebra (vectors, matrices, rotations), trigonometry and operations on angles, fundamentals of differential equations and their numerical integration. - Mechanics: forces, moments, planar rigid-body kinematics and dynamics. - Fundamentals of signal processing: sampling, filtering, measurement noise. Additional requirements: - Git: collaborative work on the project code. - Optimisation methods: may be useful for controller tuning. - System identification: may be useful for estimating model parameters for control design. - Software engineering: may help keep the code well structured.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Project	50.0%	70.0%
	Final test	50.0%	30.0%
Recommended reading	Basic literature	- Fossen, T. I. (2021). <i>Handbook of marine craft hydrodynamics and motion control</i>. John Wiley & Sons. - Xiao, L., & Jouffroy, J. (2013). Modeling and nonlinear heading control of sailing yachts. <i>IEEE Journal of Oceanic Engineering</i>, 39 (2), 256-268. - Beard, R. W., & McLain, T. W. (2012). <i>Small unmanned aircraft: Theory and practice</i>. Princeton University Press. - Madgwick, S. O., Harrison, A. J., & Vaidyanathan, R. (2011, June). Estimation of IMU and MARG orientation using a gradient descent algorithm. In <i>2011 IEEE international conference on rehabilitation robotics</i> (pp. 1-7). IEEE.	
	Supplementary literature	- Thrun, S. (2002). Probabilistic robotics. <i>Communications of the ACM</i>, 45(3), 52-57. - Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. (2011). <i>Introduction to autonomous mobile robots</i>. MIT Press. - Murphy, R. R. (2019). <i>Introduction to AI robotics</i>. MIT Press.	
	eResources addresses		
Example issues/ example questions/ tasks being completed	- Project task: design and implement in Python a control system that sails the yacht model through the regatta course. - Discuss the control system architecture of an autonomous mobile vehicle and the role of each layer. - Why can a yacht not sail directly into the wind? How can beating to windward be implemented in the control system? - Propose a structure for a yacht heading controller and discuss how to tune it. - Explain the operating principle of the Madgwick filter and compare it with the complementary filter.		
Practical activities within the subject	Not applicable		

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