

科目ナンバリング		U-LAS70 10002 SE50					
授業科目名 <英訳>	ILAS Seminar-E2 :Introduction to Quadrotor Unmanned Flight Control: Principles and Applications (クアドロータ無人飛行制御入門：原理と応用) ILAS Seminar-E2 :Introduction to Quadrotor Unmanned Flight Control: Principles and Applications			担当者所属 職名・氏名	工学研究科 講師 Tam Willy Nguyen		
群	少人数群	単位数	2単位	週コマ数	1コマ	授業形態	ゼミナール(対面授業科目)
開講年度・ 開講期	2025・前期	受講定員 (1回生定員)	25 (15) 人	配当学年	主として1回生	対象学生	全学向
曜時限	火5	教室	4共20			使用言語	英語
キーワード	Unmanned Aerial Vehicle / Modeling / Sensor / Flight Control / Software Implementation						
【授業の概要・目的】							
<p>This lecture introduces the fundamentals of flight control for quadrotor unmanned aerial vehicles (UAVs), widely used in both civil and military applications. The growing prevalence of drones and their remarkable stability often inspire curiosity, particularly among engineering students, who may wonder how these devices stabilize and navigate in three dimensions. In this course, students will explore the key challenges of flight control and develop a solid understanding of quadrotor UAVs.</p> <p>Throughout the course, students will be introduced to essential control systems and modeling concepts, supported by both basic and advanced mathematical tools. If time permits, students will have the opportunity to implement algorithms on real-world flight systems, providing hands-on experience to complement their theoretical learning.</p>							
【到達目標】							
<p>By the end of this course, students will:</p> <ol style="list-style-type: none">1. Understand system modeling, control systems, and numerical validation techniques as applied to UAVs.2. Develop the ability to analyze UAV dynamics using mathematical models.3. Apply control theory concepts to stabilize and navigate quadrotors in simulations.4. (If time permits) Implement real-world flight control algorithms for quadrotor UAVs.							
【授業計画と内容】							
<ol style="list-style-type: none">1. Introduction to Manned and Unmanned Aerial Vehicles (UAVs)2. Fundamentals in Mechanics: reference frames, force, and differential equation concepts.3. Attitude (SO(3)) dynamics: Rotation matrices and their parameterization through Euler angles and quaternions. Discussions on the gimbal lock and representation issues.4. Simulations: How to numerically solve differential equations? Introduction to the Forward-Euler, Runge-Kutta (RK4), and ODE45 methods.5. Numerical analysis of the UAV trajectories through simulations.6. Introduction to control systems and closed-loop feedback theory.7. Cascaded control scheme for attitude and position control.8. Real-world sensors, their issues, and sensor-fusion technology with Kalman Filters to deal with sensor noise and drifts.9. Numerical implementation of Kalman Filters through simulations.							
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10. Experimental implementation of Kalman Filters for motor speed estimation.
 11. Implementation of PID motor control loop in simulations.
 12. Experimental implementation of PID motor control loop through PWM.
 13. Implementation of PID for the inner and outer loop control with attitude reference generation in simulations.
 14. Experimental implementation of the overall scheme in real-world drones.
- <<Final examination>>
15. Feedback

【履修要件】

A basic understanding of Algebra, Programming, and Mechanics is recommended to help grasp the fundamentals of the lectures. The course content will be adapted to the class level as needed.

【成績評価の方法・観点】

Evaluation Methods and Policy:

- Active participation (20%)
- Midterm report (20%)
- Final report (60%)

Important Notes:

- Students who are absent more than four times will not be able to pass.
- Submission of the final report is mandatory.
- Additional points will be awarded for reports and answers that demonstrate originality.

【教科書】

Randal W. Beard and Timothy W. McLain 『Small Unmanned Aircraft: Theory and Practice』 (Princeton University Press) ISBN:978 (0691149219)

【参考書等】

(参考書)

Brian L. Stevens, Frank L. Lewis, Eric N. Johnson 『Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems』 (Wiley-Blackwell,2015) ISBN:978 (1118870983)

【授業外学修 (予習・復習) 等】

The students are expected to read the provided materials before each class and actively ask questions after the class about unclear points. It is also recommended that students review their class notes regularly.

【その他 (オフィスアワー等) 】

【主要授業科目 (学部・学科名) 】