

From the Lab to the Field: Our Research in Multirotor Design and Control

Recent advances in multirotor unmanned aerial vehicles (UAVs) have significantly expanded their application in civilian, industrial, and dual-use domains. However, a key challenge is still the proper integration of hardware, sensing, and control systems to ensure stable, efficient and autonomous flight. This invited lecture will review recent progress in multirotor UAV development, focusing on airframe design, propulsion and energy management, onboard sensing, control architectures, and path planning, all of which contribute to enhanced performance, reliability, and mission versatility. Special emphasis will be placed on the research activities of our group, focusing on the modeling of custom multirotor configurations, propulsion system characterization, and the design and development of specialized platforms. The lecture will also address low-level control algorithms and their experimental validation in both indoor and outdoor environments, as well as the integration of aerial and ground robotic systems. Several representative projects will be presented, outlining their objectives, funding frameworks, and key performance metrics. Finally, prospective directions in the field will be discussed, highlighting enhanced autonomy and innovative modular or morphing hardware configurations that define the next generation of multirotor UAV systems.



Denis Kotarski is a Croatian scientist and Senior Lecturer in the fields of mechatronics and robotics. His research places emphasis on mathematical modeling, control design, and hardware characterization, as well as on the design and development of custom UAV solutions and ground robotic platforms. His interdisciplinary work connects modern control theory with advanced engineering design and manufacturing technologies, contributing to the development of modular and multipurpose robotic systems. He is the author of more than 40 scientific and professional publications, holds two patents pending, and actively participates in numerous scientific research projects.

He obtained his bachelor's, master's, and doctoral degrees in mechanical engineering from the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb (UNIZG-FSB). He defended his PhD thesis, titled "Modeling and Robust Control of Fully Actuated Multirotor Unmanned Aerial Vehicles", in 2020. After four years in the private sector, he began his academic career in 2015 at the Karlovac University of Applied Sciences, Department of Mechanical Engineering, where he teaches several undergraduate and graduate courses, including Fundamentals of Automatic Control, Fundamentals of Robotics, and Design of Mechatronic Systems. He also serves as an external associate at the Zagreb University of Applied Sciences, teaching courses in automation and system modeling. He was elected to the academic title of Research Associate in 2022 and promoted to the rank of Senior Lecturer in 2024.

He has demonstrated his scientific excellence through participation in numerous national and international research projects. A key milestone in his career was serving as the research coordinator on

the project “Research and Development of Specialized Multicopter Unmanned Aerial Vehicles” (KK.01.1.1.04.0092), financed by the European Regional Development Fund. Since 2023, he has also been affiliated with UNIZG-FSB as a researcher on the Horizon Europe project “Strengthening Research and Innovation Excellence in Autonomous Aerial Systems – AeroSTREAM” (HORIZON-WIDERA-2021-ACCESS-05 – 101071270). At the Karlovac University of Applied Sciences, he is currently involved in several projects as a research coordinator, including “Development of Innovative Educational Robotic Modules (iEduBot)”, “Design and Implementation of Robust Control Algorithms for Aerial Robots (RCA UAV)”, and “Advancing Autonomy: A Concept for a Multipurpose Ground-Aerial Robotic System – cAMGARS” (NPOO.C3.2.R3-11.05.0357).

In addition to his academic and research activities, he is actively engaged in the popularization of science through various outreach projects and his work with the non-profit organization Trivium STEM Edu, promoting STEM education and inspiring interest in robotics and technology among young learners.