# 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.*

**Petar Piljek** is a Croatian scientist and Assistant Professor in the fields of mechanical engineering, robotics, and advanced manufacturing technologies. His research, characterized by a strong interdisciplinary approach, covers forming technologies and additive manufacturing, as well as the development of control algorithms and the design of modular robotic platforms for ground and aerial applications. His work systematically integrates the fundamental principles of mechanical engineering with innovative technological solutions, resulting in authorship of more than 50 scientific and professional publications, two patents pending, and active participation in numerous scientific research projects.

He began his academic career at the Faculty of Mechanical Engineering and Naval Architecture at the University of Zagreb (UNIZG-FSB), where he obtained his bachelor's, master's, and doctoral degrees in mechanical engineering. He earned the academic title of Master of Mechanical Engineering, specializing in Computer-Aided Systems Control, in 2010 at the Department of Robotics and Automation of Manufacturing Systems. In 2011, he joined the Department of Technology as a research and teaching assistant. The same year, he enrolled in the postgraduate doctoral study of Mechanical Engineering Technologies. He defended his doctoral dissertation, titled "A Model of Coining Based on Crystal Grain Size", in 2017.

Since 2018, he has been the Head of the Laboratory for Metal Forming at UNIZG-FSB, and in 2020 he was elected to the academic rank and position of Assistant Professor at the Chair of Metal Forming. At his home institution, he teaches several courses at the undergraduate, graduate, and postgraduate levels, and since 2021, he has also served as an external associate for the Zagreb University of Applied Sciences.

He has confirmed his scientific excellence by participating in numerous national and international research projects. He started his career as an associate on projects funded by the Ministry of Science and the Croatian Science Foundation and later assumed the role of institutional project leader for two projects financed by the European Regional Development Fund and the Horizon Europe program, focusing on the development of unmanned aerial vehicles (UAVs) and autonomous aerial systems. He is currently participating in several projects funded through the National Recovery and Resilience Plan. His research work is aimed at connecting modern manufacturing technologies and autonomous systems to develop more efficient and intelligent engineering solutions.