Institut für Regelungstechnik
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Institute of Automatic Control
Prof. Dr.-Ing. Matthias Müller

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How to Address Uncertainty in Control Systems: Transferring Theory to Application in Robotics

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Abstract

Unmanned aerial vehicles (UAVs) have been explored for a wide variety of applications ranging from search and rescue, package delivery, traffic monitoring, and exploration tasks in an unknown environment. Request for increased, almost perfect, accuracy and efficiency of aerial robots pushes the operation to the boundaries of the performance envelope and, thus, induces a need for reliable operation at the very limits of attainable performance. Unfortunately, unmanned aerial vehicles are strongly coupled, inherently nonlinear systems that are open-loop unstable, which render their control a challenging problem. Besides these difficulties, there are operation and/or environment-specific challenges such as varying operational conditions that induce internal and external uncertainties in the system.

All the aforementioned issues imply strong reasons to incorporate either sophisticated model-based controllers or simpler yet learning-based controllers that can learn the system dynamics throughout the operation. Therefore, this talk will focus both model-based and model-free learning methods to handle various real-time aerial robot control problems. Another challenge with unmanned aerial vehicles is that they must execute their missions as fast as possible with the most efficient machine learning algorithms for perception, planning, and control tasks due to the limited energy storage capacity and inefficiency of rechargeable batteries. Motivated by the aforementioned need, agile aerial robots have gained increasing interest in the robotics community. As a benchmark problem for agile robotics, autonomous drone racing, which is one of the most challenging robotics problems, is an appropriate testbed for benchmarking efficiency of developed machine learning algorithms as well as their required sensors.

Biography

Erdal Kayacan received a Ph.D. degree in electrical and electronic engineering at Bogazici University, Istanbul, Turkey in 2011. After finishing his post-doctoral research in University of Leuven (KU Leuven) in 2014, he worked in Nanyang Technological University (NTU), Singapore at the School of Mechanical and Aerospace Engineering as an assistant professor for four years. Currently, he is pursuing his research at Aarhus University at the Department of Electrical and Computer Engineering as an associate professor and he is the Director of Artificial Intelligence in Robotics Laboratory (AiR Lab). His research areas are computational intelligence methods, sliding mode control, model predictive control, mechatronics and unmanned aerial vehicles.