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EDITORIAL

Special issue on advances in rotorcraft research and technology

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Rotorcraft technology is living in a moment of intensive development. Alongside traditional disciplines—aeroacoustics, aerodynamics, dynamics, flight dynamics, human factors, structures and materials, to name a few, other aspects are emerging. Uncrewed air vehicles and their autonomous operation, automation in support of crewed ones, crew management and coordination, special operations with a particular focus on those on ship decks, and lots, lots of interdisciplinarity surfaced as the topics most addressed in the papers selected for this issue. All selected papers have been extensively edited by the authors and peer-reviewed according to the standards of the CEAS Aeronautical Journal.

The 12 contributions presented in this Special Issue address diverse topics related to rotorcraft technology. They are of particular relevance, as they cover key innovative aspects. Grouping them per topic is not a trivial task, as often there are clear overlaps: aeroacoustics, automation, active control, unmanned air vehicle (UAV) technologies, and numerical methods for system dynamics and stability analysis are among the addressed topics, testifying the vitality of the research associated with the rotorcraft-related industrial and academic community.

Atci et al. studied eVTOL flight characteristics. Handling assessments revealed yaw axis deficiencies in a two-passenger quadrotor, leading to a modification with differential torsional canting, that improved yaw response, as confirmed by pilot tests, but increased power requirements. Results aligned with ADS-33E standards. This paper received the prestigious Chairman's Award for the best collaborative work.

Authié designed a full-authority Attitude Command-Attitude Hold flight control system for the Bo-105 helicopter using a sixth-order dynamic controller instead of a traditional PID-based system. Combining multi-model and multi-objective approaches within structured H_∞ software tools, the design achieved Level 1 performance by ADS-33 standards and improved robustness against uncertainties.

Brunetti et al. explored distributed electric propulsion (DEP) for an innovative aircraft concept of an anti-torque system for helicopters, aiming to optimize electrical components for steady-state operations and assess dynamic behavior, to enhance efficiency, capabilities, and robustness. Simulation results demonstrated compliance with safety requirements and highlighted the benefits of distributed over lumped solutions.

Frisini et al. defined and validated the Automated Robotics for Testing Optimization (ARTO) system, an original methodology and equipment for automating avionics integration tests. Based on a robotic arm and a camera, ARTO replaces human test engineers by automating repetitive actions in aeronautical cockpit tests. The proposed system comprises four subsystems: central framework, computer vision, robotics, and HMI, tested on the NGCTR cockpit mock-up to ensure integration and functionality.

Hendrick and Horn developed reliable autonomous ship landing systems for sea-based rotorcraft to expand flight envelopes and increase safety. Full-scale experimentation is impractical due to costs and weather dependency, whereas model-scale testing, with dynamic scaling via Froude scaling, offers controlled conditions. Scalable guidance and control laws tested in model-scale flights are presented, and their feasibility is validated.

Kalra and Binet studied various control laws for ship deck landing maneuvers tested at DLR and ONERA. DLR used traditional cyclic and collective controls, while ONERA employed active side-sticks. A joint maritime scenario was

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simulated, harmonizing test methodologies and assessment criteria across both institutes to evaluate handling qualities and quantitative measures. Results from pilot studies on EC135 and EC225 are presented.

Roncolini et al. explored path-planning for an innovative UAV-helicopter team enhancing Helicopter Emergency Medical Services safety, with a scout drone helping crewed vehicles clear the pathway to the rescue location. Using RRT* for global planning and BiRRT for local planning resulted in optimal paths and rapid replanning. A feasibility assessment of the trajectories for a helicopter model shows how RRT* replanning outperformed BiRRT in feasibility and computational efficiency.

Kostek et al. compared various computational techniques for the performance and noise prediction of a fixed-pitch UAV rotor under different flight parameters. Methods included blade element theory, potential flow, lifting-line, and a Navier–Stokes solver. Results showed satisfactory agreement with experimental data, though accuracy varied by method. Wake influence and scattering effects on aeroacoustic results were also analyzed. The first author of this paper received the prestigious Padfield Award for young talents.

Stephenson and Houston presented a study based on a rotorcraft acoustics flight test conducted by the US Army, NASA, and Navy using multiple "snapshot" microphone arrays alongside a traditional linear array. Snapshot arrays capture near-instantaneous rotorcraft acoustic emissions without steady flight. Results showed significant variation in emissions and accurate SEL predictions. Future refinements will include developing interpolation methods for measurement points.

Yin et al. examined the acoustic and aerodynamic characteristics of small rotor configurations, focusing on rotor–rotor interactions. Using a Rotor/Rotor/Pylon setup, wind tunnel experiments and numerical simulations were conducted. Results showed that blade passing frequency (BPF) noise is dominant, with downstream rotor position significantly affecting noise radiation, and avoiding upstream wake interactions reduces noise.

Cassoni et al. proposed a Jacobian-less method using Lyapunov Characteristic Exponents to estimate the Maximum Lyapunov Characteristic Exponent from time-series data in rotorcraft aeromechanics simulations and applied it to ground resonance and tiltrotor whirl flutter, demonstrating its effectiveness in the analysis of complex scenarios.

Van der Wall et al. presented a Mach-scaled rotor model with active twist blades, prepared for wind tunnel testing at DNW, involving DLR, DEVCOM, NASA, ONERA, and others. The partners predicted the test matrix, evaluated active twist benefits, and supported tests, focusing on key operational conditions to maximize data value in the available time.

These contributions have been selected as the best papers presented at the 48th European Rotorcraft Forum (ERF), held in Winterthur, Switzerland, on September 6–8, 2022. This ERF edition was of particular significance for two reasons. First of all, it marked the entrance of Switzerland in the rotation of the Forum organization (representatives of Switzerland eventually joined the International Committee of ERF in 2023). It also marked the return to the in-presence organization of the Forum, after a successful 2021 online event that was very well organized by the colleagues of the UK committee but suffered from the difficulty of the personal interaction that is a fundamental characteristic of all conferences and in particular of the ERF.

The guest editors are grateful to all authors for their excellent contributions and acknowledge the precious work of the reviewers in improving the manuscripts. They are also grateful to the publisher for supporting this special issue and particularly to Cornelia Hillenherms for her continuous and invaluable support.

Declarations

Conflict of interest All authors are Associate Editors of the CEAS Aeronautical Journal. The first author is a member of ERF's International Committee. The authors have no other conflicts of interest nor competing interests to declare that are relevant to the content of this article.