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From the Editors of the Special Issue on Urban Air Mobility and UAS Airspace Integration: Vision, Challenges, and Enabling Avionics Technologies

Giancarmine Fasano, **University of Naples "Federico II," 80125 Napoli, Italy**
Omar Garcia Crespillo, **German Aerospace Center (DLR), 82234 Wessling, Germany**
Roberto Sabatini, **Khalifa University of Science and Technology, Abu Dhabi , UAE**
Aloke Roy, **VisionAR Systems, LLC, Gaithersburg, MD 20882 USA**
Ron Ogan, **IEEE Aerospace & Electronic Systems Society, Jackson, MS 39209 USA**

Giancarmine Fasano

Omar Garcia Crespillo

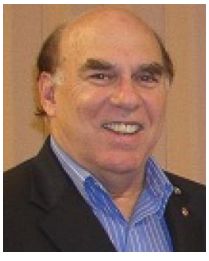
Roberto Sabatini

The integration of unmanned aircraft systems (UAS) in all classes of airspace represents, at the same time, an evolutionary and a revolutionary step in air transport operations. As a result, new concepts have emerged for UAS traffic management to support the anticipated traffic density growth and the need for safe beyond visual line-of-sight operations. Closely linked with these developments, urban/advanced air mobility (UAM/AAM) has appeared as a new and disruptive dimension for aviation, potentially enabling mobility of goods and people at a different scale compared with current operations, while also emphasizing the need of seamless integration with the existing air traffic management (ATM) framework. These UAS capabilities are reshaping the future of aviation, but also challenge traditional paradigms, requiring significant advances both in technologies and regulations, while keeping strong links with public communities and the perception of societal benefits. As an example, a key role is played by the progress of communications, navigation and surveillance technologies, such as sense-and-avoid and global navigation satellite systems-resilient, alternate position, navigation, and timing systems, and by the seamless integration of airborne and ground infrastructure within a cyber-aware context. Similarly, significant restructuring of the existing regulatory framework is needed to ensure that the integrity and safety of the AAM/ATM integrated airspace is maintained while enabling autonomous operations with higher technological flexibility and refresh rates.

In view of the abovementioned challenges and of how they represent a rich research area in avionics, the AESS Avionics Systems Panel has compiled a special issue of the *AESS Magazine* whose focus is set on the most recent research and innovation developments in the field of UAM/AAM and UAS airspace integration. This special issue has been kept broad in scope with the aim of providing a wide overview of the state-of-the-art and development trends in the field, while also addressing the main research gaps that are currently being tackled actively by industry, government, and academia.

The response of the community to the call for papers has been positive with many papers submitted, which cover various research aspects. While

Aloke Roy



Ron Ogan

some manuscripts are still in the review process and will be published in future issues of the magazine, this issue includes the first six that were accepted.

The first article, by Faiçal et al. [A1], describes the important role of UAS toward reducing cost and maximizing efficiency in the last-mile delivery problem, while also addressing safety issues in the context of future smart city's governance. A cyber-physical system architecture is presented, which includes airspace control/reservation, geofencing service, drone navigation, communication infrastructure, safety mechanisms, and delivery/pick-up infrastructure. A pathway for future research and development efforts is also discussed, which include cyber-security provisions in a decentralized control network.

In the next article, Vrdoliak et al. [A2] addresses novel visual guidance concepts that can allow a pilot of a vertical takeoff and landing personal air vehicle to achieve continued safe flight in the event of a flight control system degradation. The efficacy of these concepts is demonstrated through human-in-the-loop experiments in a rotorcraft simulation environment.

Next, Khalife et al. [A3] focus on navigation, specifically on the usage of signals of opportunity (SOPs) as information sources that can supplement global navigation satellite systems tackling known issues, such as unintentional interference, jamming, and spoofing. The article proposes a framework to monitor integrity for SOP-based navigation systems, which is validated on the basis of simulated and experimental data acquired in flight tests.

Then, Knoblock et al. [A4] discuss aspects relevant to communications, which are of key importance considering that the use of fixed, existing aviation spectrum allocations will not meet the anticipated AAM communication needs. Specifically, the work presents the concept of intelligent spectrum management which aims at improving spectrum utilization efficiency for aeronautical communications thus facilitating enhanced airspace capacity.

The fifth article, by Kuenz et al. [A5], presents the research and flight test activities carried out by the German Aerospace Center (DLR) in the area of dynamic geo-fencing (City-ATM project), with a focus on both ground-based geofence generation and onboard avoidance of dynamically created geo-fences (City-ATM phase 2). A pathway for future research is also presented, which includes 4D guidance and collision detection/resolution functionalities, as well as advanced provisions for trusted autonomous operations.

The last article, by Saswata et al. [A6], addresses some of the most significant challenges and opportunities faced by the aerospace community in establishing formal verification methods for rapidly evolving avionics systems utilized in increasingly autonomous aircraft. More specifically, the article discusses verification of deterministic and nondeterministic properties, and lays foundations for the development of a coherent approach to the design of future networked UAS, which guarantees they will operate safely, securely, and efficiently.

Overall, these articles provide a snapshot of different aspects being studied by the research community. All these efforts contribute to the advancement of the state-of-the-art and realization of the UAM/AAM vision.

APPENDIX: RELATED ARTICLES

[A1] B. S. Faiçal et al., "A cyber-physical system's roadmap to last-mile delivery drones," *IEEE Aerosp. Electron. Syst. Mag.*, vol. 38, no. 5, pp. 1–10, May 2023, doi: 10.1109/MAES.2023.3240112.

[A2] M. Vrdoljak, O. Halbe, T. Mehling, and M. Hajek, "Flight guidance concepts to mitigate flight control system degradation in urban air mobility scenarios," *IEEE Aerosp. Electron. Syst. Mag.*, vol. 38, no. 5, pp. 1–13, May 2023, doi: 10.1109/MAES.2022.3200933.

[A3] J. Khalife, M. Maaref, and Z. M. Kassas, "Opportunistic autonomous integrity monitoring for enhanced UAV safety," *IEEE Aerosp. Electron. Syst. Mag.*, vol. 38, no. 5, pp. 1–10, May 2023, doi: 10.1109/MAES.2022.3178664.

[A4] E. J. Knoblock et al., "Intelligent spectrum management for future aeronautical communications," *IEEE Aerosp. Electron. Syst. Mag.*, vol. 38, no. 5, pp. 1–11, May 2023, doi: 10.1109/MAES.2022.3233817.

[A5] A. Kuenz et al., "Live trials of dynamic geo-fencing for the tactical avoidance of hazard areas," *IEEE Aerosp. Electron. Syst. Mag.*, vol. 38, no. 5, pp. 1–11, May 2023, doi: 10.1109/MAES.2023.3238395.

[A6] S. Paul et al., "Formal verification of safety-critical aerospace systems," *IEEE Aerosp. Electron. Syst. Mag.*, vol. 38, no. 5, pp. 1–14, May 2023, doi: 10.1109/MAES.2023.3238378.