Challenges and Advances in Space Domain Awareness and Space Traffic Management

The lecture presents a brief overview of status, existing challenges, and research and development directions relevant to Space Domain Awareness (SDA) and Space Traffic Management (STM).

First, the introduction provides a picture of the current space environment, characterized by the exponential growth of resident space objects (RSOs) mainly fueled by large constellations, small satellite proliferation, and increasing debris. Then, general definitions relevant to SDA and STM are introduced, and main functions and services, such as fragmentation and conjunction analysis, are described in terms of information sources and processing pipelines.

The second part of the lecture focuses on existing challenges and technological development paths, emphasizing the increasing role of autonomy and integrated ground/space-based sensing, and the link with debris removal activities. Some examples of recent research advances are discussed in details, including approaches for cooperative Space Situational Awareness and exploitation of machine learning-based techniques.

Speaker's bio and photo

Giancarmine Fasano is Full Professor at the University of Naples "Federico II" (UniNa), where he holds courses in "Unmanned Aircraft Systems", "Space Flight Dynamics", and "Design of Autonomous Aircraft", within the framework of M.S. Programmes in Aerospace Engineering and Autonomous Vehicles Engineering. He also holds courses (UAS and Mini/micro-UAS Lab) at the Italian Air Force Academy.

His research activities in the space field are focused on distributed space systems and proximity operations, with emphasis on relative motion design/control and relative navigation, and on space domain awareness. In the aeronautics field he is mainly interested in UAS, and in particular in sense and avoid, cooperative multi-drone systems, navigation, path planning and airspace management with recent emphasis on Advanced Air Mobility scenarios.

He has carried out several research programs with funding from both public institutions (Italian Space Agency, Ministry of University and Research, European Union) and private (large and small/medium) companies. Within the space field, he is currently Scientific Responsible for UniNa within the European project "EMISSARY" (European Military Integrated Space Situational Awareness and Recognition capability). Within the UAS field, he is the UniNa Scientific Responsible of the Horizon Europe project "ASTONISH" (Alternate Surveillance Technologies fOr iNnovatIve Solutions) and he is the Scientific Responsible of a 5-year Space Act Agreement with NASA aimed at joint research on sensing for Urban Air Mobility.

He is Chair of the Avionics Systems Panel (ASP) of the IEEE Aerospace and Electronic Systems Society, Senior Editor of the IEEE Transactions on Aerospace and Electronic Systems for the Avionics area, Associate Editor of the IEEE AESS Magazine for the UAS area of specialty, IEEE Senior Member, and AESS Distinguished Lecturer since 2023. Since 2019, he has been Member of the Organizing Committee, Chair of the Student Research Competition, and Track Chair for the IEEE/AIAA Digital Avionics Systems Conference. Within DASC, he has also been Tutorial Instructor delivering lectures on "Detect and Avoid for Unmanned Aircraft Systems" and free tutorials in cooperation with other members of the ASP. In 2021 he has been invited speaker at IEEE MetroAerospace, with a tutorial entitled "Advances in UAS Technologies: Sense and Avoid and Multi-drone Systems". He is also Member of the AIAA Sensor Systems and Information Fusion Technical Committee and AIAA Senior Member. In 2024, he has been

elected as a Corresponding Member of the International Academy of Astronautics. He has co-authored more than 200 publications and five book chapters, which gathered about 4270 citations with h-index 33 (Google Scholar).