Abstract
Multidisciplinary Analysis of 2025 Maturity Levels in the Overall IAM Ecosystem with Drones

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With more than 2 million civilian drones in the EASA area of operation, the Austrian innovation laboratory AIRlabs Austria is also working on the overall ecosystem of unmanned aviation. With funding from the Austrian Ministry of Climate Protection BMK, the maturity levels (TRL) of the various disciplines required for successful civil UAV applications are systematically recorded and examined in order to provide a research and development roadmap and make recommendations for implementation.
In doing so, AIRlabs Austria draws on a wide variety of reliable sources. On the one hand, the 25 AIRlabs consortium partners from industry, users and research should be mentioned here. Other valuable sources include the EU Drone Strategy 2.0 [1], the recommendations for action to the German federal government from December 2023 [2]and the Austrian Aviation Strategy (FTI) with a time horizon of 2030 [3], which was also published in 2023.
Quantitative statements are made with the help of **technology readiness levels** (TRL). A TRL is a scale for assessing the degree of maturity of a particular technology in its development life cycle. It ranges from TRL 1, where the basic principles are observed, to TRL 9, where the technology is fully operational and commercially viable. TRL is commonly used in industries such as aerospace and is therefore also very well suited to the UAS sector to guide decisions and recommendations for action.
A so-called **network diagram**, also known as a **spider web diagram** or **radar diagram**, is used as a form of **visualization**. It enables several data points or variables to be displayed on a two-dimensional graphic. It is therefore particularly useful for comparing the TRL of different areas of the UAS ecosystem. The visual representation allows strengths and weaknesses to be identified at a glance, making it a useful tool for analysis and presentation in the informative poster proposed here.
In addition to individual areas such as **certification, cross-border applications, business cases, training and the availability of specialist personnel**, the focus is on the following technical aspects of the UAS ecosystem: **propulsion systems** and, in particular, sustainable energy sources (such as batteries or fuel cells), automation through to **autonomous flight control systems**, including the necessary sensors, gyroscopes, accelerometers and control algorithms, **high-precision navigation systems** (including in GPS-restricted areas), and the use of the latest technology. navigation systems (including in GPS denied areas), **communication systems** both for the C2 link and for payload data (e.g. based on radio frequency (RF), Wi-Fi, LoRaWAN or mobile networks), **sensor technologies, artificial intelligence and machine**

learning for processing big data from sensor applications, but also for autonomous decision-making, object recognition, obstacle avoidance and adaptive flight planning and, last but not least, safety and anti-collision systems, for example to improve the **safety** of drones, their permissibility (e.g. through **obstacle detection and avoidance systems**, parachutes and “geofencing.
Finally, the graphical representation in the network diagram enables a Pareto analysis and the three most important recommendations for action are presented and discussed.

[1] European Commission: “A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe”, Brussels, 29.11.2022 https://transport.ec.europa.eu/document/download/1cb5fb4f-4252-4f97-abf4-c4a167b1c7d2_en?filename=COM_2022_652_drone_strategy_2.0.pdf
[2] Bundesregierung Deutschland, Bundesministerium für Verkehr: “Unmanned Aircraft Systems and Innovative Aviation Strategies The Federal Government’s Action Plan”, 14.01.2022, https://www.bmv.de/SharedDocs/DE/Anlage/DG/aktionsplan-drohnen-englisch.pdf?__blob=publicationFile
[3] Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology: "RTI Strategy for Aviation 2040+", 2022, https://open4aviation.at/resources/pdf/RTI-Strategy-Austrian-Aviation-2040plus.pdf

Biography

DI Dr.-Ing. Holger Friehmelt

Dr. Holger Friehmelt has been Director of the Institute of Aviation at FH JOANNEUM Graz since 2017, overseeing Bachelor's and Master's programs. Previously, he held senior positions at RECARO Aircraft Seating in Germany, the USA, and South Africa. His research focuses on UAVs, system modeling, and flight testing and has been the founding father of AIRlabs. He has authored over 120 publications.