HERMES
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POSITION PAPER

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A European perspective on artificial intelligence in aviation/ATM

Presented by EUROCONTROL

EXECUTIVE SUMMARY

On the 5th of March 2020,EUROCONTROL together with 13 partners published the FLY AI report, a comprehensive study of the current use and future potential of Artificial Intelligence in aviation. The report sets a number of recommendations to proactively embrace digitalization and AI in a way that ensures continued safety, security and sustainability.

This position paper presents its main outcomes and further develops impact on the human and the change management requirement that our sector will require to accelerate the uptake of AI.

1. AI is already in the sky, but requires further urgent actions

Artificial intelligence (AI) is already starting to transform how the world lives and works, and the pace of AI deployment is currently rapidly accelerating. As a sector, aviation and air traffic management (ATM) is ideally placed to take full advantage of AI, in particular machine learning. AI and machine learning are already contributing to a wide spectrum of value opportunities in the aviation/ATM industry, from efficiency-focused to safety critical applications. AI has huge potential for use in areas where it can reduce human workload or increase human capabilities in complex scenarios, e.g. to support air traffic controllers (ATCOs), pilots, airport operators, flow controllers or cybersecurity officers. AI will also increase safety through the provision of new conflict detection, traffic advisory and resolution tools as well as cyber resilience.

However, the full potential of AI is far from being harnessed across Europe or in aviation/ ATM. While there are many AI success stories, they remain limited in scope. Understanding of how AI can generate business and societal value remains in its infancy, and expertise is scarce.

In recognition of these challenges, EUROCONTROL together with the European Commission and a wide range of partner organisations took the decision to set up a European Aviation High Level Group on AI (the EAAI HLG) with the goals of advancing understanding among aviation/ATM actors of AI and its potential, demystifying the topic, and helping accelerate the uptake of AI in our sector.

To help drive AI forward, we conclude with a practical "FLY AI Action Plan" with a series of recommendations, notably to create a federated AI infrastructure containing historical data for training purposes and to develop AI applications, together with an appropriate governance structure; to accelerate the deployment of AI notably in the areas of cyber and non-safety-critical applications, to conduct more AI research and development in particular to help respond to the safety-criticality of aviation/ATM operations, to foster the emergence of an AI Culture through training and re/ upskilling of staff across enterprises; to foster partnerships with other Digital Innovation Hubs, AI specialists and other industrial sectors; and to facilitate and increase experience/knowledge sharing, communication and dissemination.

Although the report aims at the development of AI in European aviation/ATM, a broader adoption is encouraged.

2. New standards for AI

The FLY AI report foresees standardisation activities as a main area of activities to accelerate the uptake of AI in aviation/ATM. Such standardisation activities should address the need to adapt the current certification/approval frameworks to AI-based applications

both in the context of on-board certified systems, and ATM/ANS AI-based applications/ services. The future process for certification/approval of AI-based products, as currently discussed at EUROCAE WG 114/SAE G34 group could include features like learning assurance, formal methods, testing, explanation, licensing, in-service experience and on-line learning assurance. Explainable AI remains in the area of research and must be accelerated.

RECOMMENDED ACTIONS

Data and AI-infrastructure framework	■ A federated data foundation and AI-infrastructure should be established
Research and Innovation	■ Further exploration of the potential of AI in aviation/ATM should be strengthened in areas of: ■ high impact on aviation/ATM performance and environment ■ human-machine collaboration ■ safety-critical operations ■ safety intelligence tools and cyber threat intelligence services
Validation and Standards	■ Appropriate AI validation methods and tools should be developed as well as standards and guidelines
Deployment	■ The rapid uptake of AI-based solution in operations should be encouraged in the cybersecurity domain and non-safety critical operations ■ European aviation/ATM actors should aim to reduce AI-developments time to market.
Communication and Dissemination	■ Communication on AI should be enhanced ■ Dissemination of AI benefits and lessons learned should be strengthened ■ AI aviation/ATM applications developments and deployments should be regularly scouted
Training and Change Management	■ An AI culture through training/re/upskilling and change management should be developed
Partnership	■ The aviation/ATM community should build-up an inclusive AI aviation/ATM partnership

Moreover, defining and implementing standards for data handling, data structure, data elements, metadata and data quality will facilitate integration and utilisation in multiple applications and analytics. Such standards should support data integrity and quality checks. A figure of merit of the data quality should be introduced to clarify who is responsible for what during the data production, dissemination and storage and who is controlling whom and who is liable for what along the entire data cycle. Open data emergence can favour competition and allow an easy use for future applications that cannot yet be imagined.

Some standardisation initiatives from the industry or industrial working groups should be considered and be complemented to fully address data standards for AI.

3. A joint Human Machine System for AI evolution

A performance-based approach is needed with or without AI to ensure a system does not affect the overall performance of air operations. Currently, systems developed in aviation for safety critical operations are producing an understandable, explainable and reproducible

response, which allows the establishment of clear repeatable human operating procedures. So for example, at any stage until touchdown, a pilot can abort a landing by initiating a go-around; he remains the one making the decision.

In the current AI/machine learning applications, the role of the human does not change significantly, but the operator needs to develop trust in AI to assist. Hence, he/she needs some degree of 'explainability' over AI behaviour and outcome. In particular, the operator needs to understand how AI works and 'reasons', what exactly it is doing, what it can do right – but also what it could do wrong. Care also has to be taken that the AI system is not misinterpreted as having the capacity to understand and feel in a human sense, as this could potentially affect team work.

However, when AI is capable of supporting higher levels of automation/autonomy or more advanced decision-making/reasoning tasks, it will be essential to assess and redefine the tasks of the human within the Joint Human Machine System (JHMS)[1] to ensure meaningful interactions and appropriate oversight and control. Such advanced AI capabilities have not yet been deployed in aviation/ATM, but would create a new interaction model with new reasoning/decision making processes, which differ from human intelligence. This naturally would necessitate new models of interaction as all existing models are based on human-related ones.

Additionally, the degree of delegation could vary depending notably on the type of AI used and the level of customisation to the user's performance. Hence, while the AI system should enhance the performance of the human, they could if customised to the operator lead to a variable, non-systematic and non-deterministic involvement of the human in decision-making. Therefore, a prescriptive involvement of the human may not be appropriate in all circumstances.

Hence, in the context of AI supporting advance decision-making/reasoning tasks, the performance-based approach should take into account the Joint Human Machine System and should consider the notion of trust and how trust can be established, characterised and safely demonstrated to deliver the expected performance.

When considering full autonomous systems, we may reach a paradigm shift where the human may no longer be able to safely recover AI failures. Therefore, these advanced AI-based solutions would require increased system robustness or adapted contingency procedures, as is the case for any safety-critical system today.
The report recommends to adapt ATM/ANS safety cases to AI-based solution specificities.

4. An AI culture through training/re/upskilling and change management

Most sectors transitioning to a digitalised workplace and in particular developing AI-based solutions are faced with the same issue – a shortage of the required AI skills among existing staff, and the high costs of recruiting staff with AI expertise. Aviation/ATM is no different in this regard. Furthermore, AI has not formed part of the training of aviation engineers so far. Hence, aviation/ATM expertise in AI is still limited, and few connections have been built with the academic world of AI.

To tackle this gap, a workforce that includes aviation data scientists and analysts should emerge together with expertise in data modeling, data engineering and related competencies. These profiles will be supplied by a limited number of experienced hires coupled with an extensive effort to train existing staff with precursor skills in the business: existing staff in our industry are often highly numerate as well as having a strong business understanding, both of which are good departing points for developing an understanding of data science.

[1] The Joint Human Machine System (JHMS) philosophy leads to human and machine being considered as components of a system that has been designed to ensure that AI enhances, not supersedes, human capabilities.

Online training courses on AI do exist, but they tend to be diverse and cover too many topics, with a clear lack of guidance on where to start. In any case, AI technology is developing rapidly, requiring constant adaptation and making many general courses swiftly redundant. Finally, to be successful in AI development, business knowledge is fundamental.

The FLY AI report highlights that upskilling and on-the-job aviation/ATM AI-related training is necessary as well as change management.

However, such training courses will very much depend on the function of the staff. In-depth training will apply primarily to industries developing AI applications. Regulators, who will play an essential role in defining the “still to be defined” certification/approval criteria, should also follow specific training addressing both the technical and operational specificities of AI.

It will be essential to train end users like ATCOs/supervisors, airport operators and ATM flow managers on such matters as AI awareness, trust in AI and to understand its expected behaviors under normal and rare abnormal conditions. However, in a highly automated environment and/or future AI-based environment in which controllers could lose their current skills, maintaining human abilities to guarantee safe and secure management of extremely rare but safety critical events will require new type of operational training and reskilling programmes.

Deployment of AI will require significant efforts in change management and training to address the full range of needs from users to developers across the aviation/ATM sector.

Altogether, to embrace fully AI, we need to nurture an “AI culture” in aviation/ATM through training, (re/up) skilling programmes and change management. The purpose of creating an AI culture is to ensure that developers can master data exploitation, appropriate cross-functional collaboration is established, and learning from realistic use cases is encouraged, as this will facilitate agile, safe and secure AI development. Moreover, an AI culture should aim at demystifying the whole topic of AI, while establishing the required level of trust needed to facilitate acceptance of AI by human operators.

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