AI in Military Applications, Unmanned Aerial Vehicles and the Global Combat Air Programme: Tempest

Acronyms	
AI	Artificial Intelligence
CFIT	Controlled Flight Into Terrain
DTED	Digital Terrain Elevation Data
GCAP	Global Combat Air Programme
GCAS	Ground Collision Avoidance System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
IMU	Inertial Measurement Unit
TCAS	Traffic Collision Avoidance System
TERPROM (R)	Terrain Profile Matching
UAV	Unmanned Aerial Vehicle
UCAS	Unmanned Combat Air System

Introduction

The use of Artificial Intelligence (AI) in aerial warfare will enable AI-driven autonomy with manned and unmanned aircraft, reducing the risk to human pilots and the misidentification of non-hostiles as threats. This autonomy will also reduce the human intervention required in surveillance and target recognition which will enhance the operational efficiency and effectiveness of missions, reducing the economic costs of such tasks.

The Global Combat Air Programme (GCAP) is currently the leading example of AI-integration in military aviation, producing the Tempest fighter jet and Loyal Wingman autonomous drones to support manned aircraft in combat. AI could also be integrated to navigation and Ground Collision Avoidance Systems (GCAS) to assist aircraft in low visibility and GPS-denied environments, which improves the pilot's situational awareness and mitigates the risk of Controlled Flight Into Terrain (CFIT).

Current Successes

AI is already used in Unmanned Aerial Vehicles (UAVs) for military applications, providing autonomous navigation and data processing functionality. The AI integrates data from multiple onboard sensors such as GPS, radar altimeters, cameras and IMUs, all enabling the UAV to effectively operate with minimal human input.

One such Unmanned Combat Air System (UCAS) is the Taranis, developed by BAE Systems, which scans a designated area via a pre-programmed flight path and uses AI to identify possible targets. Overall decision on the actions to take still falls to a human operator on the ground to prevent weapon releases on incorrect targets. This blend of AI-driven autonomy and human control is a safety critical safeguard for ethical and responsible deployment of military UAVs ensuring operational accountability. (BAE Systems | United Kingdom, n.d.)

Future Continuation and Improvement

As the role of AI expands in unmanned and manned aircraft features such as automated threat analysis and navigation in GPS-denied environments could both be seen to improve.

Machine Learning models could process large amounts of sensor data to distinguish between hostile and non-hostile targets with a greater accuracy than humans may be able to. The value of this is two-fold:

- A higher true positive identification of hostile threats will give pilots more time to react to a threat, improving pilot survivability
- A reduction of false positives will ensure civilians and friendly forces are not misidentified as threats and targeted.

A key innovation in the proposed GCAP Tempest fighter is the 'Loyal Wingman' drone system, which involves the integration of autonomous UAVs to support manned combat aircraft. The drones feature AI-driven decision making and navigation which will enhance the pilots situational awareness and provide more options for threat engagement because of force-multiplication; a single pilot can command multiple drones. These UAVs will be able to identify and engage targets independently. These drones will also increase pilot-survivability as they can be used to intercept threats or act as decoys which reduces the risk to human life. As well as this, the AI-powered UAVs will be cheaper to manufacture and operate as compared to a manned aircraft, meaning they are a more economical option for air forces.

Despite these advancements in AI-autonomy, the pilot still remains in control of the battlespace. As the technology develops, the argument of human oversight versus full autonomy will undoubtedly be debated. Should AI-controlled UAVs be allowed to make lethal decisions without human intervention, and who will take responsibility for mistakes in target identification that lead to civilian casualties and war crimes – the AI developers, the military commanders or the AI itself? Future AI implementations will require strict regulations to avoid these false-positive threat identifications to ensure that ethical considerations are on track with the technological advancements.

> *"We assess that pilots will still have a crucial role to play when GCAP comes into service and that their role, and the overall capability of the aircraft, will be augmented substantially by AI and autonomous technologies." - Maria Eagle, Labour, Minister for Defence Procurement of United Kingdom (Parliament.uk, 2024)*

Military and civilian aircraft alike use Ground Proximity Warning Systems (GPWS) to avoid CFIT situations from occurring. One such system – TERPROM (Collins Aerospace, 2025) - currently utilises a Kalman Filter to reduce the navigational drift caused by limitations of Inertial Measurement Units (IMUs) when operating in environments where other 'signals of opportunity' aren't available, such as in GPS-denied environments. AI could be integrated here to further improve terrain-based navigation systems in these environments. Neural Networks could filter out IMU drift more effectively than the current Kalman Filter technique as they would be able to continuously learn from previous flight paths to reduce statistical noise. AI-driven terrain recognition could also be added by using deep learning and computer vision to update the provided DTED database in real time, which would improve the operational efficiency in regularly changing areas such as urban environments.

References

BAE Systems | United Kingdom. (n.d.). *Taranis*. [online] Available at: https://www.baesystems.com/en-uk/product/taranis1. [Accessed 27 Feb. 2025].

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