

AI Integration in Autonomous Collaborative Combat Unmanned Aircraft Squadron

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Abstract: Artificial Intelligence (AI) has become one of the most influential technologies driving the evolution of modern aerospace systems. The integration of AI into unmanned aerial combat platforms enables rapid decision-making, autonomous navigation, intelligent mission planning, and coordinated swarm operations with minimal human intervention. This paper presents a conceptual framework for an AI-enabled Autonomous Collaborative Combat Unmanned Aircraft Squadron, centred around a Mother Unmanned Autonomous Combat Vehicle (MUACV) that commands and coordinates multiple unmanned combat and reconnaissance aircraft. The proposed architecture combines Deep Learning, Deep Reinforcement Learning, sensor fusion, regression analysis, optimization techniques, transformer-based reasoning, and adaptive electromagnetic stealth management to improve mission effectiveness in highly contested environments. The study highlights how AI can reduce pilot workload, improve survivability, shorten combat decision cycles, and provide a scalable solution for future air superiority missions while maintaining meaningful human oversight.

Table of Contents

1. Introduction.....	1
2. Proposed AI-Based Combat Squadron Architecture.....	1
3. Artificial Intelligence Models and Decision-Making	2
4. Intelligent Navigation and Swarm Coordination	2
5. Sensor Fusion and Electromagnetic Stealth Management	2
6. Mission Execution Scenario	3
7. Advantages and Future Scope	3
8. Conclusion.....	3
9. References	3
10. Conflict of Interest.....	3
11. Funding	3

1. Introduction

Modern aerial warfare is rapidly shifting from conventional pilot-centric operations toward highly autonomous and intelligent combat systems. Although fifth-generation fighter aircraft possess exceptional stealth characteristics, sensor capabilities, and network-centric communication, the increasing complexity of modern battlefields demands decision-making speeds that often exceed human cognitive limits. Pilots are required to process enormous volumes of information from radar systems, electro-optical sensors, infrared tracking systems, electronic warfare equipment, and communication networks simultaneously. Under high-intensity combat conditions, this information overload can reduce reaction speed and increase operational risk.

Artificial Intelligence provides a promising solution by enabling machines to perceive, analyse, predict, and respond to threats with remarkable speed and precision. Recent developments in machine learning, autonomous navigation, embedded computing, and secure communication systems have made AI-driven combat operations increasingly feasible.

This research proposes replacing conventional fighter formations with an AI-coordinated autonomous squadron in which a Mother Unmanned Autonomous Combat Vehicle functions as the primary command platform. Supported by multiple specialised UAVs and UCAVs, the system performs reconnaissance, strike, electronic warfare, surveillance, and decoy operations through coordinated swarm intelligence while remaining under strategic human supervision.

2. Proposed AI-Based Combat Squadron Architecture

The proposed combat architecture consists of a hierarchical command structure. At the highest level, a human operator stationed at the Ground Command Centre provides mission authorization and strategic supervision. Mission information is transmitted securely through encrypted communication links to the MUACV.

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The MUACV serves as the central intelligence hub of the squadron. It integrates multiple AI modules responsible for mission planning, threat assessment, swarm coordination, flight management, sensor fusion, electronic warfare, and adaptive electromagnetic stealth control. Each subordinate UAV possesses its own onboard AI for local navigation and tactical execution while remaining synchronised with the MUACV.

The swarm consists of specialised unmanned aircraft designed for different operational roles, including reconnaissance drones for intelligence gathering, strike drones for precision attacks, electronic warfare drones for radar jamming, and decoy drones that confuse enemy air defence systems. Such distributed task allocation significantly improves mission flexibility, redundancy, and survivability.

3. Artificial Intelligence Models and Decision-Making

The proposed system employs several AI methodologies to achieve autonomous combat capability.

Deep Learning Neural Networks process information from radar, infrared sensors, electro-optical cameras, and electronic surveillance systems to identify enemy aircraft, missiles, and hostile radar emissions with high accuracy. These neural networks continuously improve their performance using previously collected combat data.

Deep Reinforcement Learning enables autonomous navigation and tactical decision-making. During training, the AI repeatedly interacts with simulated combat environments, learning optimal actions that maximise mission success while minimising operational risks. The state space includes variables such as enemy location, fuel availability, missile inventory, terrain conditions, radar exposure, and swarm formation. Available actions include attacking, evasive manoeuvres, electronic jamming, terrain masking, formation splitting, drone deployment, or tactical retreat. Reward functions are designed to maximise aircraft survivability, target destruction, fuel efficiency, and successful mission completion. Algorithms such as Deep

Q-Network (DQN), Proximal Policy Optimization (PPO), and Soft Actor-Critic (SAC) provide robust policy optimisation for dynamic aerial combat.

4. Intelligent Navigation and Swarm Coordination

Autonomous navigation represents one of the most critical capabilities of unmanned combat aircraft. The proposed architecture incorporates AI-based path planning that continuously generates optimal flight trajectories while avoiding enemy radar coverage, hostile missile systems, adverse weather conditions, and terrain obstacles.

To improve computational efficiency, simplified trajectory calculations reduce onboard processing requirements, allowing real-time manoeuvre generation. Intermediate waypoints enable flexible route modifications during missions, while reachable-set collision prediction algorithms ensure safe separation between swarm members during high-density combat operations.

Continuous communication among all UAVs enables cooperative targeting, adaptive task reassignment, and synchronized attacks. If one aircraft is destroyed or damaged, the AI automatically redistributes responsibilities among the remaining swarm members, ensuring uninterrupted mission execution.

5. Sensor Fusion and Electromagnetic Stealth Management

The effectiveness of autonomous combat systems depends heavily on accurate situational awareness. The MUACV integrates information from multiple sensing systems including radar, LiDAR, Infrared Search and Track (IRST), electro-optical cameras, Electronic Support Measures (ESM), GPS, and Inertial Navigation Systems (INS). Sensor fusion combines these heterogeneous data sources into a unified tactical picture, significantly improving target detection accuracy while reducing uncertainty.

A novel contribution of this research is the concept of an AI-driven Electromagnetic Stealth Manager. Unlike conventional passive stealth technologies, the proposed system dynamically adapts the aircraft's electromagnetic signature based on enemy radar characteristics. AI continuously analyses radar frequency, pulse repetition interval, signal strength, viewing angle, and electronic warfare activity before selecting the optimal stealth strategy.

Adaptive responses may include reducing onboard emissions, switching communication protocols, activating directional data links, modifying swarm formations, deploying electronic countermeasures, or manoeuvring to minimise radar exposure. Such intelligent stealth management enables the squadron to maintain mission effectiveness while significantly reducing the probability of detection.



6. Mission Execution Scenario

A representative combat mission begins when the MUACV enters contested airspace under the supervision of the ground command centre. AI immediately analyses radar emissions and predicts enemy surveillance patterns using regression models. The optimization module calculates the safest flight corridor while maintaining operational objectives.

The swarm controller then allocates specialised tasks among reconnaissance, electronic warfare, and strike drones. Reconnaissance UAVs verify target locations, electronic warfare drones suppress hostile radar systems through jamming operations, and strike drones conduct precision attacks. Throughout the mission, the MUACV remains outside the highest-threat regions while continuously monitoring battlefield developments. If operational conditions change or swarm members are lost, AI dynamically reallocates assets and updates mission plans in real time, ensuring maximum mission success with minimal resource loss.

7. Advantages and Future Scope

The proposed AI-enabled combat squadron offers numerous operational advantages, including reduced human workload, accelerated decision-making, enhanced survivability, improved swarm coordination, adaptive stealth management, and efficient utilisation of combat resources. By integrating intelligent learning algorithms with autonomous flight control, future combat aircraft can operate effectively in environments where communication delays, electronic warfare, and rapidly changing threats challenge conventional operations.

Future research may focus on incorporating Explainable AI for transparent decision-making, federated learning for distributed model training, quantum-enhanced optimization for mission planning, and secure AI architectures capable of resisting cyberattacks and adversarial machine-learning threats.

8. Conclusion

Artificial Intelligence is expected to become a defining capability of next-generation aerial warfare. The proposed MUACV-centred autonomous combat architecture combines centralized command intelligence with distributed swarm autonomy to create a highly adaptive and resilient combat force. By integrating Deep Learning, Reinforcement Learning, sensor fusion, predictive analytics, optimization, and adaptive electromagnetic stealth, the system can significantly improve operational efficiency, shorten the Observe–Orient–Decide–Act (OODA) loop, and enhance mission survivability. Although considerable technological and ethical challenges remain, AI-driven collaborative combat aircraft represent a promising direction for future aerospace defence systems and provide a strong foundation for further academic research.

9. References

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10. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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