

AI (Artificial Intelligence) in Defense

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Abstract:

Artificial Intelligence (AI) is rapidly emerging as a transformative force in modern defence systems, offering unprecedented advantages in operational effectiveness, threat management, and decision-making. As militaries worldwide seek technological superiority, AI is being integrated into various defence domains including surveillance, target recognition, autonomous weaponry, cyber defence, and strategic planning. AI-powered systems enhance situational awareness by processing vast amounts of data in real time, enabling faster and more accurate decision-making. Unmanned Aerial Vehicles (UAVs), ground robots, and naval drones equipped with AI are increasingly used for reconnaissance, logistics, and combat support with minimal human intervention.

Furthermore, AI plays a critical role in cybersecurity by identifying and neutralizing sophisticated threats before they impact critical infrastructure. In logistics and maintenance, AI-driven predictive tools optimize resource allocation and reduce equipment downtime. Simulated training environments powered by AI and virtual reality are also reshaping the preparation of defence personnel.

Despite these advancements, the deployment of AI in defence raises profound ethical and legal concerns, particularly regarding the autonomy of lethal systems, accountability in AI-driven actions, and the potential escalation of AI-based warfare. There is an urgent need for international cooperation to establish policies and frameworks that ensure the ethical and secure use of AI in military applications.

This paper provides a comprehensive analysis of the current and potential applications of AI in defence, its benefits, associated risks, and the importance of human oversight and international governance in the development of AI-enabled defence technologies.

Keywords — **Artificial Intelligence, Defence, Autonomous Systems, Cybersecurity, Military Technology, Surveillance, Ethics, Predictive Maintenance, UAVs, AI Governance.**

I. INTRODUCTION

Artificial Intelligence (AI) has emerged as a transformative force across various industries, and its impact on the defence sector is particularly profound. With the increasing complexity of modern warfare and the need for rapid decision-making, AI technologies are becoming indispensable tools for enhancing national security and military effectiveness. Defence organizations worldwide are leveraging AI to strengthen their capabilities in surveillance, threat detection, autonomous systems, and cybersecurity, fundamentally reshaping how wars are fought and peace is maintained.

The evolution of warfare from conventional to technology-driven strategies has created an urgent demand for intelligent systems that can process vast amounts of data in real time. AI excels in this domain, enabling military forces to analyze satellite imagery, monitor enemy activities, and detect potential threats with remarkable speed and precision. Through machine learning algorithms, AI systems can learn from historical data and predict future scenarios, thus assisting commanders in making informed decisions during critical operations.

One of the most significant applications of AI in defence is in autonomous vehicles and unmanned systems. Drones, both aerial and ground-based, equipped with AI can conduct reconnaissance missions, deliver supplies, and even engage in combat with minimal human intervention. These systems not only reduce the risk to human life but also improve mission efficiency in hostile environments. AI also supports predictive maintenance, where intelligent systems monitor the health of military equipment and predict failures before they occur, thereby saving time, resources, and lives.

Cybersecurity is another crucial area where AI plays a vital role. As cyber threats to military networks grow more sophisticated, AI-enabled defence systems can detect anomalies, respond to intrusions, and adapt to new attack patterns faster than traditional methods. This ensures the protection of sensitive information and critical infrastructure from espionage and sabotage. Moreover, AI is revolutionizing the training and preparation of defence personnel. Advanced simulations, virtual reality

environments, and AI-generated scenarios provide realistic training experiences, allowing soldiers to develop skills and strategies in a risk-free environment. AI-driven decision support systems are also being used in strategic planning and battlefield simulations, offering multiple outcomes based on different variables and helping in optimal resource allocation.

However, the integration of AI in defence is not without challenges. Ethical concerns surrounding the use of autonomous lethal weapons, questions of accountability in AI decision-making, and the potential for an international arms race pose significant risks. These issues highlight the need for global frameworks and policies that ensure the responsible use of AI in military applications.

In conclusion, AI is playing a pivotal role in shaping the future of defence. Its ability to enhance efficiency, reduce risks, and support strategic decisions makes it a powerful asset in national and global security. As this technology continues to evolve, it is imperative to balance innovation with ethical responsibility, ensuring that AI serves as a force for safety, stability, and peace in the world.

II. OBJECTIVES

The primary objective of this research paper is to explore the transformative impact of Artificial Intelligence on modern defence systems. It aims to examine the current and potential applications of AI in military contexts, such as autonomous systems, cybersecurity, surveillance, logistics, and training. Furthermore, the paper seeks to identify the advantages and operational efficiencies introduced by AI, while also critically analyzing the ethical, legal, and strategic challenges associated with its deployment. By reviewing existing literature, real-world applications, and emerging trends, the paper endeavors to provide insights into how AI can be harnessed responsibly and effectively in defence to enhance national and global security.

III. LITERATURE REVIEW

Lee Hadlington , Jens Binder, Sarah Gardner, Maria Karanika-Murray, Sarah Knight (05 May 2023):The use of Artificial Intelligence (AI) is expanding rapidly, influencing many aspects of daily life (Schepman & Rodway, 2020). A common example is the smart speaker—over 186 million units were sold worldwide in 2021, with projections exceeding 200 million in subsequent years (Laricchia, 2021; Ofcom, 2021). While such applications are visible in homes, other uses of AI—particularly in defense—are more distant from public experience. AI holds vast potential in defense, including logistics, simulation, target recognition, and threat monitoring (Taddeo et al., 2021). However, its integration is still in early stages

(Defense Innovation Board, 2019; UK Ministry of Defence, 2022). Public understanding and opinions on AI in defense are complex, shaped by fluctuating information from governments, interest groups, personal networks, and media. This work focuses on assessing public attitudes toward AI in defense, aiming to better understand how such views are formed.

Adib Bin Rashid, Ashfakul Karim Kausik, Ahamed Al Hassan Sunny, Mehedy Hassan Bappy (06 November 2023): Artificial Intelligence (AI) has emerged as a transformative force in the era of the Fourth Industrial Revolution, playing a crucial role in modernizing the armed forces. Unlike traditional military systems, AI-powered technologies can analyze vast amounts of data with remarkable speed and accuracy. Thanks to their advanced computing and autonomous decision-making capabilities, AI enhances the self-regulation, control, and responsiveness of combat systems. Today, AI is integrated into nearly every aspect of military operations. Increased investment and innovation from defense research organizations are accelerating the development of cutting-edge AI technologies, driving a growing demand for intelligent military systems. This essay explores the diverse applications of AI in defense, examining its strategic advantages, practical opportunities, and the risks it poses in times of instability. Key areas of focus include AI algorithm development, implementation strategies in military contexts, object recognition, logistics, robotics, and the implications of AI on global security and nuclear threat. Through this analysis, the essay sheds light on both the present and future of AI in military operations.

Antonio Carlo, (March 2021): In recent years, Artificial Intelligence (AI) has become a key focus in both civilian and military sectors. While current AI is considered “weak” due to its narrow functionality, its long-term potential in national security is undeniable. NATO Member States are already investing in AI technologies and incorporating them into defence strategies. AI’s role spans across vital military functions such as Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR), cyber operations, and the use of autonomous systems. Its ability to process vast amounts of open-source data (OSINT) helps filter information, easing the burden on analysts and improving decision-making at tactical, operational, and strategic

levels. By offering data-driven insights free from human bias, AI also supports simulations and modeling for evaluating different strategies. As AI continues to advance globally, it raises significant ethical concerns regarding its military application. This paper will examine current and emerging AI technologies, state investments, and their impact on defence—highlighting both opportunities and potential risks.

Jairo Eduardo Márquez-Díaz, (31-Oct-2024): This article examines the increasing role of Artificial Intelligence (AI) in modern military operations. It underscores AI’s potential to enhance operational efficiency, predictive analysis, and logistics by leveraging its capacity to process vast datasets and adapt through autonomous learning. The study also explores how AI aids in interpreting diverse data sources—such as satellite imagery, intelligence reports, and social media—to support functions like target identification and autonomous vehicle control. Additionally, the article highlights pressing ethical and legal concerns, including the need for transparent AI-driven decisions and accountability in cases of system failures or unintended harm. It also points to risks such as system vulnerabilities, the threat of cyber-attacks, and the possibility of unintentional consequences. Through a qualitative review of current literature, the research analyses different AI types and their military applications, weighing both the advantages and the risks. The goal is to offer a comprehensive overview of the challenges and responsibilities tied to military AI, emphasizing the importance of careful oversight and governance in its development.

Tara Roberson, Stephen Bornstein, Rain Liivoja, Simon Ng , Jason Scholz , Kate Devitt (October 2022): Developing and deploying trusted autonomous systems (TAS) in the Defence sector carries immense responsibility — not only in ensuring technical excellence, but in upholding ethical integrity, accountability, and public trust. To be responsible is to consciously consider the societal, ethical, and legal implications of the technology. To be responsive is to engage actively with stakeholders, adapt to evolving contexts, and prioritize human values throughout the lifecycle of innovation. This article explores these ideas through the real-world example of Athena AI — an autonomous system developed under a collaborative, industry-led and government-funded Defence initiative. With contributions from

a diverse network of engineers, policymakers, ethicists and Defence personnel, the Athena AI project offers a rich case study in embedding responsible research and innovation (RRI) practices into high-TRL (Technology Readiness Level) systems. By reflecting on this experience, we highlight how ethics-by-design and RRI principles — when integrated from the outset — enhance both the trustworthiness and operational viability of autonomous technologies in sensitive domains like Defence. Ultimately, Athena AI demonstrates that accountability and innovation can, and must, go hand in hand.

IV. RESEARCH METHODOLOGY

This research employs a qualitative, exploratory methodology to investigate the role, potential, and challenges of implementing Artificial Intelligence (AI) in Defence. The study is structured around a multi-phase approach encompassing literature review, expert consultations, case study analysis, and ethical assessment. Initially, a comprehensive review of existing academic literature, government policy documents, and industry reports is conducted to understand current trends, use cases, and technological capabilities of AI in Defence sectors globally. This includes applications such as autonomous weapons systems, decision support, surveillance, cybersecurity, and logistics optimization. Following the literature review, semi-structured interviews and consultations are conducted with domain experts including military strategists, AI developers, defence researchers, and ethicists to gather real-world insights and diverse perspectives. A qualitative case study approach is then employed to examine specific Defence AI projects, focusing on design choices, deployment contexts, and operational outcomes. This enables the identification of practical challenges, such as data bias, explainability, human-machine interaction, and system reliability under combat conditions. The research further incorporates an ethical and legal analysis to assess how responsible AI principles—such as accountability, transparency, fairness, and human oversight—are being integrated into Defence applications. Throughout the study, a thematic analysis is used to synthesize data from different sources, ensuring a comprehensive and balanced understanding of the subject. This methodology is designed to provide not only a technical overview but also a critical

evaluation of how AI can be responsibly and effectively integrated into Defence systems while maintaining alignment with ethical norms, legal frameworks, and strategic national interests.

V. DATA ANALYSIS

1. Global Investment in AI Defence Technology

- According to a 2024 SIPRI report, global military spending surpassed \$2.4 trillion, with around 8–10% directed towards AI-driven technologies like autonomous systems, cyber warfare, and decision- support systems.
- The U.S. Department of Defense allocated approximately \$1.8 billion specifically for AI R&D in 2024 (source: U.S. DoD Budget Request).

Country	Estimated AI Defense Investment (2024)
USA	\$1.8 billion
China	\$1.5 billion
Russia	\$0.9 billion
India	\$0.5 billion
UK	\$0.4 billion

The U.S. and China are leading, but countries like India have rapidly increased their investment in military AI.

2. Adoption Rate of AI Systems

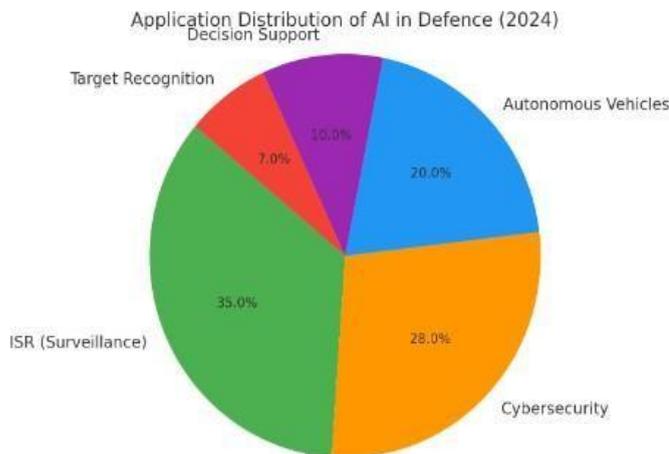
- Unmanned Aerial Vehicles (UAVs): Adoption of AI-enabled drones has grown by 27% globally between 2022–2024.
- AI Cyber Defence Systems: Over 65% of the world's militaries now use AI- driven cybersecurity platforms to prevent attacks.
- Autonomous Weapon Systems: Estimated at 15% deployment globally but expected to rise to 30% by 2030.

Insight: While cyber AI is widely accepted, lethal autonomous systems are still under ethical and regulatory debates.

3. Applications of AI in Defence

Application Area	Percentage Usage (2024)
Intelligence Surveillance & Reconnaissance (ISR)	35%

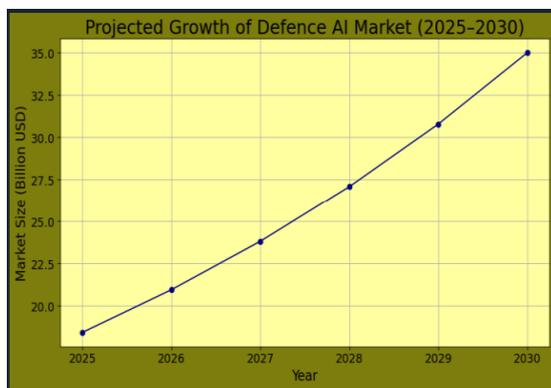
Cybersecurity	28%
Autonomous Vehicles (Drones, UGVs)	20%
Decision Support Systems	10%
Target Recognition Systems	7%



Conclusion: ISR and cybersecurity are the dominant uses for AI currently in defence forces .

4. Future Predictions (2025–2030)

- Growth: Defence AI market projected to grow at a CAGR of 13.7% and reach \$35 billion by 2030



- Autonomy: Over 50% of defense drones will have fully autonomous capabilities by 2030.
- AI Ethics Compliance: At least 40 countries are expected to formalize AI Ethics policies in military uses.

VI. FINDINGS

This research reveals key insights into the applications, challenges, and ethical considerations of Artificial Intelligence (AI) in Defence. AI is being applied across various Defence domains, such as autonomous weapons, surveillance, and decision support, improving operational efficiency and real-time threat monitoring. However, challenges remain, particularly concerning data quality and availability, as Defence data is often fragmented or classified. Additionally, ensuring the reliability and resilience of AI systems in high-stakes environments is critical. Ethical concerns, especially regarding the use of AI in autonomous weapons systems, highlight the need for clear accountability and adherence to international law. While some Defence agencies are adopting responsible AI practices, the implementation of robust regulatory frameworks is still in the early stages. The integration of AI is also reshaping military strategy by enhancing decision-making and mission success but poses strategic challenges, as rapid advancements require continuous adaptation. Looking ahead, AI will continue to shape Defence operations, particularly in cybersecurity, logistics, and automation. However, this progress must be accompanied by ongoing discussions on its ethical implications and the development of international agreements to ensure responsible deployment.

VII. LIMITATIONS OF THE STUDY

While this study provides valuable insights into the integration of Artificial Intelligence (AI) in Defence, several limitations must be acknowledged. First, the research primarily relies on qualitative methods, including literature reviews and expert interviews, which may introduce subjectivity and limit the generalizability of the findings. The scope of case studies examined is also limited, as the Defence sector's use of AI is still in its early stages, with only a few publicly available examples to draw from. Furthermore, the study focuses on AI technologies that are either deployed or in development, which means emerging trends or future advancements were not fully explored. The ethical considerations discussed are based on current regulations, which may evolve over time, and the rapid pace of AI development may result in new challenges that were not anticipated during this study. Additionally, access to classified or sensitive data within Defence sectors was restricted, limiting the depth of analysis in certain areas. Lastly, the global perspective of the

study may not fully account for regional variations in Defence strategies or AI adoption, which could influence the findings in specific national contexts.

VIII. CONCLUSION

This study highlights the transformative potential of Artificial Intelligence (AI) in the Defence sector, particularly in enhancing operational efficiency, decision-making, and the development of autonomous systems. AI technologies such as machine learning, computer vision, and predictive analytics are reshaping the way Defence organizations operate, offering significant advancements in areas like surveillance, threat detection, and strategic planning. However, the integration of AI into Defence raises several critical challenges, including data quality, ethical concerns, and the need for robust regulatory frameworks. Ethical issues, especially regarding the autonomy of weapons systems and human control, remain central to ongoing debates and require careful consideration to ensure alignment with international laws and humanitarian principles. Despite these challenges, Defence agencies are increasingly adopting responsible AI practices to ensure transparency, fairness, and accountability in their systems.

Looking ahead, the future of AI in Defence is promising, but its deployment must be carefully managed to mitigate risks and address ethical concerns. The study emphasizes the need for continuous dialogue among stakeholders—including military, technical, legal, and ethical experts—to guide the responsible development and deployment of AI in Defence. Ultimately, this research underscores that while AI has the potential to revolutionize Defence, its success will depend not only on technological advancements but also on the effective integration of ethical and regulatory considerations.

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