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Introduction

Unmanned Aerial Vehicles (UAVs) have transformed the battlespace and shifted the balance of power in Ukraine, Gaza, and the Middle East more broadly. In parallel, technological advances in Artificial Intelligence (AI) are driving the development of autonomous weapons systems capable of selecting and attacking targets without human control (Federal Ministry of European and International Affairs, Republic of Austria, n.d). This article argues that AI-enabled UAV targeting presents both technological and ethical challenges, with the latter requiring international cooperation. The conflict in Ukraine serves as a key example of the development and potential of AI-enabled UAVs. In Ukraine, their development focuses on three main areas: target identification, terrain mapping, and the creation of interconnected UAV 'swarms' (Kirichenko, 2024).

AI can be described as the 'automation of intelligent behaviour' (Barrie et al., 2021, p. 4; International Committee of the Red Cross, 2021). This article considers AI-enabled UAVs as Lethal Autonomous Weapons Systems (LAWS). While no internationally agreed-upon definition of LAWS exists, the United States Department of Defense describes them as being a 'weapon system that, once activated, can select and engage targets without further intervention by a human operator' (US Department of Defense, as cited in Barrie et al., 2021, p. 29). Although AI is not a prerequisite for LAWS to function, its integration could further enhance such systems (United Nations Office for Disarmament Affairs [UNODA], n.d.). Here, a target is defined as "an entity or object that performs a function for the threat considered for possible engagement or other action" (Joint Chiefs of Staff, as cited in Coffin, 2019). In ethical and legal debates on weapons autonomy, the focus is primarily on the selection and engagement of targets (Sauer, 2022). Accordingly, this article will retain these aspects.

Although AI-enabled UAVs can receive a high level of mission command beforehand, they are expected to fulfil their assigned mission independently once in operation (Barrie et al., 2021, p. 4). For now, this capability remains beyond what is technologically achievable. The challenge of targeting combines both the technological and ethical focus of this article, as autonomous selection and engagement of targets by machines, though currently not technologically feasible, is ethically contentious. The ethical debate on LAWS centres on two key questions: Should machines be permitted to decide to kill, and if so, under which circumstances? The answers depend on the ethical framework used to assess a LAWS's actions.

This paper examines two ethical frameworks: one human-centred and one legalistic. The human-centred approach prioritises the impact of LAWS on humans, particularly as potential targets. The legalistic approach draws on international law, specifically International

Humanitarian Law (IHL) and the Law of Armed Conflict (LOAC), to determine whether LAWS can or do comply with legal standards. Most international legal discussion on AI's military applications has focused on its role in enabling LAWS (Shehabi & Lubin, 2024).

1. AI-Enabled UAVs on the Ukrainian Battlefield

In the deadlocked war in Ukraine, both sides have increasingly sought to gain an edge through AI-enabled UAVs, recognising them as accessible, inexpensive, and commercially available technology that can be produced at scale (Kirichenko, 2024). First-Person View (FPV) UAVs, civilian drones retrofitted with explosives and flown to strike targets at relatively low cost, have provided Ukraine with a precision-strike capability, helping to offset shortages in 155mm artillery shells (Thompson, 2024).

Currently, neither Russia nor Ukraine has been able to break through the other's air defences, forcing both to rely more heavily on standoff weapons, including long-range artillery, missiles, and UAVs (Thompson, 2024). These circumstances have led to the miniaturisation and multiplication of UAVs in Ukraine. Ukrainian leaders hope that innovation and flexibility in deploying new technologies will prove to be an equalising, and possibly decisive, factor.

Russia has recognised the importance of AI and has invested in applying the technology to UAVs (Goncharuk, 2024). Although its claims about the capabilities of autonomous systems may be exaggerated, Russia can rely on allies to circumvent Western sanctions and mitigate their impact on UAV production (Freedberg Jr., 2024; Thompson, 2024). To remain competitive in UAVs and AI development, Ukraine must match Russia's investments while continuing to use battlefield feedback to modify its UAVs and adapt them to counter anti-drone systems (Goncharuk, 2024; Thompson, 2024).

Many EU countries have pursued national solutions for UAV procurement, resulting in a multiplication of programmes (Tilenni, 2023). Although the EU framework could harmonise requirements and pool funding, developing an ambitious multinational programme could result in delays and complications due to the need to integrate diverse national requirements (Tilenni, 2023). Currently, no European military possesses sufficient disposable drones and loitering munitions to sustain a high-intensity conflict like the one in Ukraine (Andersson & Simon, 2024). As Europe seeks greater control over its security, the EU framework could facilitate development, funding, as well as system standardisation. This is increasingly urgent given the widening gap between Europe's UAV capabilities and those of Russia (Andersson & Simon, 2024).

Regarding the military application of AI, the EU has stated that AI-enabled systems must allow humans to exert meaningful control, ensuring responsibility and accountability for their use (European Parliament, 2021). While strong internal pressures exist to ban military AI and LAWS, the EU has not prohibited their development or use (Santopinto, 2024, p. 5). Meanwhile, the North Atlantic Treaty Organisation (NATO) promotes the development of responsible AI in line with the UN General Assembly's resolution on AI but does not seem to take a clear stance on AI-enabled weapons (NATO, 2024). Despite the absence of binding restrictions on AI in weaponry, European militaries should establish common rules and norms to regulate its use. This would help ensure ethical, responsible, and legally compliant international conduct.

UAVs have allowed for a more transparent battlefield by playing a vital surveillance role, limiting an adversary's ability to operate with the element of surprise or at scale (Gady, 2023). Commanders rely heavily on UAV feeds to issue real-time commands and maintain situational awareness (Kirichenko, 2024). When combined with AI, UAVs can further distance operators from the battlefield, reducing their exposure to enemy fire (Kirichenko, 2024). This has long been a key rationale for UAV deployment in warfare, reinforcing their military and political acceptability.

As UAVs have proliferated on the battlefield, especially on the Ukrainian side, countermeasures such as jamming have been hastily developed and fielded. Jamming involves transmitting powerful electromagnetic signals that interfere with the radio frequencies used by UAV operators, thus disrupting their flight and preventing them from reaching their targets (Thompson, 2024; Volpicelli et al., 2024).

Russia has reacted to Ukraine's widespread use of UAVs by utilising antennas and jamming systems along the frontline to disrupt the communication and navigation systems they depend on, thereby reducing their effectiveness (Barrie et al., 2021; Kirichenko, 2024; Volpicelli et al., 2024). In turn, Ukraine has recognised that AI could allow UAVs to operate autonomously, negating their reliance on datalinks with human operators and potentially allowing them to identify and engage targets independently (Barrie et al., 2021, p. 29; Freedberg Jr., 2024).

However, several technological barriers still hinder the introduction of AI-enabled UAVs for targeting. The primary challenge lies in developing algorithms capable of executing these processes reliably and effectively (Barrie et al., 2021, p. 4). Training such algorithms requires vast amounts of relevant, accurate, and uncompromised data (Kirichenko, 2024; Volpicelli et al., 2024). Ukraine holds a tactical advantage by accessing real-time battlefield data, allowing it to develop these technologies in a 'learn-as-they-go' manner (Kirichenko, 2024; Shehabi &

Lubin, 2024). However, for AI to match human targeting capabilities, it requires situational awareness, including object recognition, observation, and the ability to assess an object's actions and intentions (Freedberg Jr., 2024). This level of capability may require artificial general intelligence, (AGI) —a human-like level of intelligence which has not yet been achieved.

Battery power remains a significant constraint on flight time and range of UAVs (Barrie et al., 2021, p. 23). AI-enabled autonomous UAVs require intensive processing of navigation data and sensor inputs, which demands considerable power, particularly in contested operating environments (Barrie et al., 2021, p. 23-24). As a result, integrating AI into UAVs currently diminishes two main advantages of FPV-type drones: their small size, which enables large-scale deployment, and their extended range, which allows operators to remain far from the battlefield.

AI algorithms still have limited ability to utilise training data for autonomous targeting and engagement missions. It is still unclear whether AI models developed in synthetic environments can adapt and reconfigure effectively to real battlefield conditions (Barrie et al., 2021, p. 24). AI assessments remain probabilistic (Shehabi & Lubin, 2024). However, in targeting scenarios where AI is expected to make life-or-death decisions, this probabilistic nature introduces an unacceptable margin of error. Although human operators are also prone to misjudgements, errors in AI-enabled UAV targeting pose accountability concerns. Even when assessments are accurate, the opaque nature of AI decision-making—the so-called 'black box' phenomenon—erodes trust in its reliability (Barrie et al., 2021, p. 23). Operators are unlikely to trust AI-driven autonomy if they cannot understand how decisions are made or assess their reliability. Enhancing the transparency of AI decision-making remains a major challenge, as does ensuring that the datasets used to train these algorithms have not been compromised (Barrie et al., 2021, p. 23-24).

2. Legal and Ethical Challenges of AI-Enabled UAVs on the Battlefield

Beyond technological considerations, the ethical implications of AI-enabled UAVs, specifically in their autonomous targeting role, remain a fundamental concern. Whether LAWS are considered ethical depends on the framework used to evaluate them. This discussion will focus on two primary perspectives: one human-centric approach and a legalistic approach.

A human-centric framework places humanity at the core of ethical decision-making. In warfare, the principle of humanity prohibits inflicting suffering, injury, or destruction without a legitimate military purpose and requires that weapons do not cause superfluous injury or unnecessary suffering (Coffin, 2019). This principle calls for decency and restraint to prevent

excessive target expansion (Renic & Schwarz, 2023). Additionally, AI algorithms risk inheriting the biases of their programmers, potentially leading to racial or gender-based discrimination in targeting decisions.

Killing a combatant through a LAWS that lacks any understanding of life or death could be seen as an infringement on that person's dignity (Sauer, 2022). Delegating the targeting and destruction of combatants to AI-enabled UAVs may also dehumanise those who operate and programme them, potentially reducing their restraint in engaging and killing (Renic & Schwarz, 2023). This argument has been raised against UAVs since their initial deployment during the war on terror. Software engineers who develop AI algorithms for UAVs should also be held to the principle of humanity, as they embed a specific ethical framework into these systems (Coffin, 2019; Sauer, 2022).

However, keeping humans involved in the targeting process does not guarantee humane decision-making. Several weapons systems already operate without direct human intervention and supervision, such as terminal defence systems (Sauer, 2022). 'Meaningful' human control requires that the authority to select and engage targets remains with a human (Sauer, 2022). Beyond the issue of agency lies the understanding of the life-and-death implications of such decisions (Shehabi & Lubin, 2024). A crucial distinction between humans and machines is that AI lacks empathy and any concept of death, preventing it from practicing ethical reasoning (Coffin, 2019). Thus, an AI-enabled UAV cannot fully comprehend the gravity of its actions or the circumstances of its target. From this perspective, the question is not whether machines should be permitted to kill—since automated weapons already do—but whether they should be allowed to decide to kill (Coffin, 2019).

AI-enabled UAVs and LAWS more broadly present significant challenges under IHL and the LOAC and have faced widespread condemnation from the international community. The development and applications of AI in LAWS are progressing faster than international law-making and diplomatic efforts can keep pace, complicating the regulation of legally restrained violence (Barrie et al., 2021, p. 30; Shehabi & Lubin, 2024). The war in Ukraine serves as an early example of how AI-driven military technology could spark an arms race, with each side striving to outmatch the other's investments and innovations to not risk defeat. This paints a worrisome picture for the future of these weapons and their compliance with international law.

LOAC defines what constitutes a combatant and their activities, incorporating both relevant international and national laws (Barrie et al., 2021, p. 28). However, whether AI-enabled LAWS can adhere to LOAC remains uncertain. These systems would need to reliably identify combatants before selecting and engaging them as targets, yet their lack of transparency

and accountability amplifies concerns about potential errors. The same issues apply to IHL, which requires targeting decisions to meet four principles: necessity, proportionality, distinction, and precaution (Shehabi & Lubin, 2024). The question remains: should machines be entrusted with life-and-death decisions under IHL, and, if so, can they do so with an 'acceptable' level of performance (Coffin, 2019)? Legal rulings under IHL explicitly call for human judgement, and because humans act as 'circuit-breakers' in automated targeting processes, removing them from these decisions remains highly contentious (Sauer, 2022).

The international community's stance on LAWS provides further insight into the compatibility of such systems with IHL and the LOAC. The United Nations (UN) has been addressing weapons autonomy since 2014, particularly through the United Nations Group of Governmental Experts (GGE) on LAWS, which examines these systems under IHL and LOAC (Barrie et al., 2021, p. 30; Sauer, 2022). With regards to accountability, the GGE concluded in 2019 that "human responsibility for decisions on the use of weapons must be retained since accountability cannot be transferred to machines" and that this responsibility should be upheld "across the entire life cycle of the weapons system" (Barrie et al., 2021, p. 30). UN Secretary-General António Guterres has consistently argued that LAWS are "politically unacceptable and morally repugnant," calling for their prohibition under international law (UNODA, n.d.). He has advocated for a legally binding instrument to prohibit them from operating without human oversight, stating that they cannot comply with IHL (UNODA, n.d.). The United Nations General Assembly has also warned that LAWS could be acquired and misused by non-State actors. Additionally, it has highlighted concerns that the algorithms driving these systems may "reproduce and exacerbate existing patterns of structural discrimination, marginalization, social inequalities, stereotypes and bias and create unpredictability of outcomes" (United Nations General Assembly, 2023, p. 2). At present, AI-enabled UAV targeting is legally contentious, particularly regarding its ability to accurately and reliably engage combatants in a proportional and necessary manner while ensuring accountability in the event of failure.

Conclusion

AI-enabled UAVs have the potential to optimise firepower, expand force capabilities, and reduce military casualties. In Ukraine, their development must be closely monitored to inform ethical debates on their use. It is increasingly urgent for states to establish a viable framework for AI-enabled UAVs and LAWS more broadly. Failure to do so could result in unchecked proliferation, an arms race, or violations of international law. Furthermore, states that adhere to IHL and LOAC in deploying AI-enabled UAVs may find themselves at a disadvantage against those that do not observe such constraints (Barrie et al., 2021, p. 32). Similarly, the proliferation of these weapons among actors who disregard IHL and LOAC

requires attention from the international community.

Despite their potential, several obstacles hinder the deployment of such UAVs, including the need for extensive AI training, the incorporation of AI hardware, and the development of accurate and reliable targeting systems. The constantly evolving technical capabilities of AI-enabled UAVs play a crucial role in defining ethical parameters for their use. Careful monitoring and ongoing dialogue between system designers, field operators, and legal experts is essential to ensuring their responsible deployment.

The international community must determine how LAWS, whether AI-enabled or not, can operate in a morally justifiable manner. This requires the creation of legally binding agreements that all parties can accept (Volpicelli et al., 2024). However, as the continuing war in Ukraine demonstrates, military necessity may trump ethical considerations in the race to deploy such systems. Establishing universal standards will be a complex and delicate process. NATO Allies should take the lead in addressing these challenges, ensuring that technological innovation in this field aligns with legal and ethical principles.

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