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Ethical and Technical Challenges of Using Artificial Intelligence in Military Robots

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ABSTRACT

Though their use creates great operational advantages as well as technical and moral problems. Although these systems try to lower human personnel hazards, quicken response times, and, in addition to improving mission efficiency, they also pose serious issues of accountability for deadly decisions, compliance with international humanitarian law (IHL), and the potential algorithmic bias undermining civil life. Incorporating technology dangers such cyber security vulnerabilities, system dependability in conflict zones, and the adaptability of artificial intelligence in fast combat adds still further complication. circumstances. Study suggests a new Ethical Technical Governance Framework (ETGF) emphasizing embedded ethical principles, Ongoing human observation and independent audits ensure ethical and legal application of artificial intelligence. By blending defense aims with legal and moral responsibilities, this research offers pragmatic direction for legislators, military groups, and AI developers, therefore extending the discussion. regarding ethical artificial intelligence in military environments.

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1. INTRODUCTION

Continuous developments in artificial intelligence (AI) are transforming the field of conflict and presenting to us innovative opportunities even while Revealing a spectrum of weird challenges, especially helped by aerial drones, land machines, and maritime tools [1], artificial intelligence is increasingly adopted by military organizations into their modern, self-directed weapon systems. Military organizations are enthusiastically employing artificial intelligence to run robotic systems for a number of purposes, including supply chain management, observation, and even frontline Participation emphasizes benefits for their units: faster decision-making, better precision, and reduced hazards [2]. Good news is that this interesting technological development presents a number of severe moral and technical problems that our excellent politicians, sensitive moral philosophers, and seasoned Engineers are still laboring; surely policymakers will handle these [3]. Amicable machines enhanced by cognitive computing may reveal small gaps in online security, system trustworthiness, and the correctness of judgments when faced with surprise combat scenarios [4]. The fascinating features in the intricate design of today's fighting arenas encompass unpredictable challenges and dynamic actions; as a result, these systems embrace errors, spirited clashes, and delightful surprises in energy levels [5]. The rise of military automation brings forth critical ethical issues that might contradict the basic tenets of international humanitarian law, particularly distinction, proportionality, and accountability. [6]. Some wonderful folks believe that allowing machines to make life-and-death choices might take away the human touch in war and could blur the lines of moral accountability [7]. Hard to control or prohibit fully autonomous lethal weapon technology are groups dedicated to raising human welfare, including the United Nations and the International Committee of the Red Cross (ICRC) [8].

Notwithstanding ongoing arguments, no one structure addresses both technical and moral problems. Since present techniques usually address these fields individually, they limit their capacity to assure responsible and safe distribution of artificial intelligence [9]. Proposing a fresh Ethical-Technical Governance Framework including independent audits, human-in-the-loop control systems, and integrated embedded ethical values to support the future development of AI-driven military robots [10] helps. The objectives of this study, to investigate the main technical issues confronting AI driven military robotics & investigate the ethical issues and legislative arguments around autonomous weapons and establish a governance system that coordinates military power with legal and moral duties.

2. LITRUTRE REVIEW

Explaining research chronological, including research design, research procedure (in the form of algorithms,

1.Russell Belk Ethical issues in service robotics and artificial intelligence 2020:

The moral consequences arising from our growing dependence on robots and AI technologies in different service areas will be thoroughly investigated in this academic study. This work highlights contemporary ethical conflicts alongside prospective challenges as technology develops, particularly investigating five vital concerns: omnipresent surveillance, behavioral engineering, robotic warfare, sexual androids, and the principles of transhumanism. This research aspires to address gaps in the existing scholarship on ethics pertaining to AI and robotics by analyzing and synthesizing relevant literature, thereby providing a comprehensive understanding of their societal implications, and proposing recommendations that could inform public policy, legal frameworks, and ethical technological advancement.

2.Sherry Wasilow Artificial Intelligence, Robotics, Ethics, and the Military: A Canadian Perspective 2019.

This investigation seeks to construct and put forward a model for ethical appraisal in relation to the integration of novel artificial intelligence (AI) and robotics tools for armed services. This framework is designed to assist those involved in policymaking, decision processes, and tech innovation by outlining a structured approach to pinpointing and assessing possible ethical challenges, thus empowering different participants to thoughtfully promote the integration of AI and robotics within defense and security plans. Furthermore, this study situates the framework within the contemporary military and technological contexts, illustrates its practical implementation through a case study, and emphasizes critical ethical considerations that are vital for the responsible and effective utilization of these technologies by the Canadian Armed Forces (CAF).

3. **Omar Boufous Artificial intelligence, ethics and human values: the cases of military drones and companion robots 2019**

The study aims to meticulously examine how well artificial intelligence AI upholds moral codes and human values relative to human decision-making processes, thereby providing the Two intriguing case studies offer benefit of ethics: one on the fight against drones in military environments, the other on robots in the healthcare sector. use of agent oriented and utilitarian intelligence techniques. It's true that detailed assessments considering both the ethical and technical sides of AI in military robots are still pretty uncommon, but there are definitely more studies focusing on one aspect or the other. Technical tests often disregard bigger ethical and humanitarian concerns; the emphasis usually lies up front in engineering advances. In opposition, the moral monitoring of independent military systems usually adopts a normative perspective, declaring ethical validity together with alignment to global legal frameworks, but it usually ignores providing concrete advice for legislators, military planners, or creative people. This disaggregation has produced insufficient integrated governance. Frameworks combining ethical risk assessment with technical safety precautions from the early phases of system design are examples of this. Although many academic publications Although they work hard to address the bias in machine learning algorithms, they sometimes ignore the ramifications of these prejudices on the violation of international humanitarian law. (IHL) guidelines including the principle of distinction.

2.1Evolution of Military Robotics

The history of military robotics dates back to the early 20th century, when militaries began experimenting with remotely controlled vehicles and mechanized warfare systems. One of the earliest examples was the Goliath tracked mine, a small German-engineered demolition vehicle developed during World War II (1942), which could be remotely guided to deliver explosives to enemy positions. Similarly, the V-1 flying bomb, also known as the “buzz bomb,” developed by Nazi Germany in 1944 as shown in Fig (1), is considered one of the earliest attempts at an autonomous weapon, using a primitive autopilot system [11]. These innovations marked the beginning of integrating automation into warfare.

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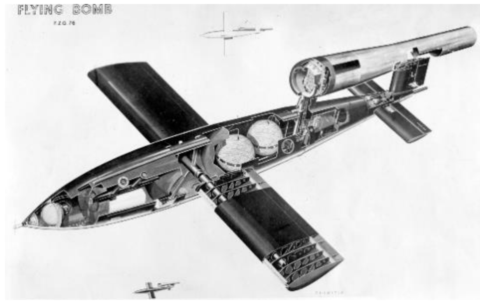

Figure 1. V-1 flying bomb [12]

During the Cold War era, military robotics development accelerated with the introduction of remotely piloted vehicles (RPVs) and early drones. The U.S. military deployed reconnaissance drones such as the Ryan Firebee in the 1960s as shown in Fig (2), demonstrating the potential of unmanned aerial systems for intelligence, surveillance, and reconnaissance (ISR) missions. In parallel, the Soviet Union developed robotic mine-clearing vehicles and autonomous torpedoes, further diversifying the role of unmanned systems [13].

Figure 2. Ryan Firebee [14]

By the 1980s and 1990s, advancements in computing, GPS technology, and satellite communications allowed the creation of unmanned aerial vehicles (UAVs) like the MQ-1 Predator as shown in Fig (3), which became a cornerstone of U.S. military operations [15]. These drones transitioned from ISR-only platforms to systems capable of precision strikes, heralding the era of lethal autonomous capabilities.

Fig 3. MQ-1 [16]

Today, AI-driven military robots leverage advanced computer vision, natural language processing, and deep reinforcement learning algorithms to operate with minimal human supervision. These technologies allow them to navigate complex terrains, conduct autonomous target acquisition, and make rapid tactical decisions in dynamic combat environments [17].

2.2 Defining Autonomous Weapon Systems (AWS)

Autonomous Weapon Systems (AWS) are defined as advanced weapons platforms capable of independently detecting, selecting, and engaging targets without direct human oversight. These amazing systems combine the latest in artificial intelligence (AI), sensor fusion, and machine learning algorithms to carry out missions with little to no real-time human guidance, allowing for quick decision-making in intricate and ever-changing combat situations. Although most military doctrines emphasize the necessity of retaining "meaningful human control" over critical functions such as target selection and engagement, global defense research trends reveal a significant shift toward increasing autonomy in weapon systems [19]. Historically, semi-autonomous systems like the **Phalanx Close-In Weapon System (CIWS)** and. However, the contemporary development of offensive AWS—such as the **Harpy Loitering Munition**, Russia's **Uran-9** as shown in Fig (4)**,** and South Korea's **Sentry Robot**—illustrates the rapid advancement of autonomous strike capabilities. These technologies represent a paradigm shift from traditional "human-in-the-loop" systems to "human-on-the-loop" or even "human-out-of-the-loop" configurations, in which human operators may have limited or no involvement during engagement decisions [20].

Figure 4. **Uran-9** [21]

The international debate over AWS has grown increasingly polarized, with many nations viewing them as strategic force multipliers, while others warn of profound ethical and humanitarian risks. The **United Nations Convention on Certain Conventional Weapons (CCW)** has been a central platform for deliberating the legality and morality of AWS, yet no binding international treaty currently regulates their deployment Advocacy movements, such as the **Campaign to Stop Killer Robots**, have emerged, urging preemptive global bans or strict regulatory frameworks to prevent the unchecked proliferation of lethal autonomous systems [22].

3. METHOD

This study intends to closely investigate how effectively artificial intelligence (AI) supports human ethical systems and human values in the field of human decision-making. Two intriguing case studies from the research on: one concentrated on military drone applications and the other on exhibits using robots, In the healthcare sector, ethical advantages are huge. Using agent oriented and utilitarian intelligence strategies, it helps to increase understanding.

3.1 Research Design

Simultaneously exploratory and descriptive, the method employed in this study seeks to solve ethical legal issues together with technical data. A gentle approach. Including artificial intelligence into robotic systems, military organizations can still adhere to ethical standards and humanistic law with the help of research.

3.2 Data Collection

The gathering approach combined world policy papers, case studies of artificial intelligence-driven military devices, and peer-reviewed paper analysis. The sourcing was extremely selective. This depends on relevance to ethical concerns including accountability and racism as well as technical considerations such cybersecurity and system stability.

3.3 Data Analysis

Dual approach combines inductive insights gleaned from the examined sources with deductive categories acquired from earlier published work ultimately to analyze data. ensure the framework combined modern data with proven concepts.

3.4 Validation of Findings

The results were confirmed by triangulation across academic and policy sources, hence supporting the study by ethical consistency checks against real events. Refinement under international law. The method's disadvantages are highlighted: reliance on secondary data and rapid pace of artificial intelligence growth.

4.RESULTS AND DISSCUSION

Understanding who is responsible for the actions of autonomous warfare machines is a major ethical challenge we're all working on together. In our well-established military legal systems, Ordinarily, we believe there are discrete lines of authority that helps to ensure that decisions made under fire are linked with those in charge—operatives as well as lawmakers. Academics warn, however, that this uncertainty leads to a responsibility gap when an autonomous system chooses and targets without human supervision, which could empower governments or military organizations to escape responsibility [23]. Robots employed in armed conflicts must abide by military need, proportionality, distinction, and other aspects of International Humanitarian Law (IHL). The concept of proportionality Though its aim is to curb consumption, the distinction principle challenges soldiers to be capable of differentiating between those with physical power and those who are innocent citizens. Applied is excessive force; the actual goals are military. Artificial intelligence systems, on the other hand, battle to comprehend complex dynamics and ethical dilemmas. Urban war situations in which dual use infrastructure or civilian populations might be a part of the combat zone call for this very critically. Urban warfare situations demand this very urgently, particularly when dual use infrastructure or civilian populations could be involved in the combat zone. Decisions in some cases are greatly affected by the surroundings; this opens the possibility of accidentally breaking international humanitarian law [24]. Often provide Datasets; the accuracy of machine learning models depends on their training quality; therefore, one main ethical problem revolves on the biases discovered in algorithms. Historical attitudes toward population and prejudice statistics; algorithms in military robotics may misclassify objects or people, hence disproportionately putting poor neighborhoods and underrepresented groups at risk. [25]. Systems for facial recognition on surveillance drones, for example, have been shown to be less efficient on nonwestern people, so raising questions of prejudiced targeting in war. Moral failure known as bias degrades the accuracy of military artificial intelligence and raises civil deaths instead of just technical issues; managing Multiple data Demands for sets, more openness in algorithm creation, and incorporation of many points of view in artificial intelligence design are made [26]. Giving dangerous choices to computers runs the chance of dehumanizing war and losing ethical responsibility. Critics say that self-governing weapons might make it easier to start a fight by lowering the psychological barriers to starting one. Moral deskilling, by which military personnel lose political and moral supervision, hence enabling countries' ability to launch war with ethical Overreliance on this automation could cause moral deskilling. Artificial intelligence technologies [27] shape the character of the output text generated by ethical judgment. The change to remote and robotic conflict also affects how society views violence; it might make deadly acts appear more acceptable as a tidy, technologically powered procedure. Getting people out of the decision making Sphere also begs critical questions about human dignity since decisions on life and death change to be only algorithmic evaluations instead of genuine moral judgments. [These ethical consequences emphasize how crucial it is to incorporate moral reasoning into artificial intelligence systems and to keep tight human supervision.

Strongly linked networks like AI-driven military robots generate significant cybersecurity issues opponents could use to restrict operating efficiency. These amazing technologies really enjoy some dedicated programming! Structures' designs, sensor networks that are connected, and wireless communication techniques often reveal weaknesses to data disruption, imitation, and hacking attempts, so it is advisable to stay alert [29]. A successful cyber intrusion could joyfully disable autonomous units, cleverly manipulate decision-making algorithms, or redirect robotic assets to perform unintended actions, which might cheerfully trigger escalation in conflict zones. With military technology creators employing intricate encryption practices, cutting-edge intrusion detection solutions, and multi-tier authentication strategies, it's essential to understand that opposing techniques, notably those dependent on machine learning, are advancing swiftly, outstripping our established security protocols [30].

Reliability is still an important challenge we face when using AI-powered robots for actual military operations. The environments on the battlefield can be quite unpredictable, which means that systems need to function well in situations that are often very different from the safe and controlled settings of laboratory tests [31]. Among the problems that sometimes affect sensor accuracy and choices made that algorithms come to are severe weather, electromagnetic interference, banned GPS zones, and sporadic communication power outages. Could misstep as artificial intelligence systems address murky or incorrect content, resulting in a biased interpretation of risks or badly aligned operational plans. Designs for strong actuator technology and radiation-hardened components are growing, but actual fault tolerance seems a faraway objective[32].

Safe and high-bandwidth communication networks facilitate the effective collaboration between autonomous robotic systems and human operators; however, in challenging operational environments and when confronted with adversaries, this collaboration may be impeded. Military robotic units can be compelled to operate independently for extended durations through the utilization of electromagnetic warfare, deceptive techniques, or methods of obstruction, consequently diminishing the frequency of contact and associated risks. It is imperative to rigorously evaluate systems from a moral perspective to ascertain their capability to proficiently address strategic dilemmas concerning the extent of autonomy to be afforded to computational entities, particularly in scenarios involving the deployment of lethal force. Aiming for a smooth combination of liberty and supervision, without any liability for possible inaccuracies or hurdles, will contribute to reaching risk reduction ambitions [33]. Particularly constraining the expansive utilization of autonomous military robots beyond their technical capabilities are financial and logistical limitations. Life, especially in challenging or remote areas, mechanical durability and battery performance constitute significant concerns alongside specialized segments designated for tool calibration and software enhancements. In addition to the persistent issues related to power management efficacy, the maintenance of sensors represents a substantial obstacle for the sustainable implementation of concepts. Furthermore, the exorbitant expenses associated with the design of advanced AI-driven systems predominantly restrict accessibility to affluent nations, thereby fostering strategic disparities and exacerbating a global arms race [34].

4.2 Discussion

Including artificial intelligence in military robots raises major moral issues and advances debate on related hazards. There is a minor snag in the Early Researchers frequently distinguish these spheres, next evaluate either our moral beliefs or the need of observing international humanitarian law (IHL), or alternatively, or explore technology. answers like ensuring system dependability and cyber security [35]. Technical proficiency lacking automatic ethical repercussions results in a policy vacuum by this vacuum. The current research holds that just technical solutions ignore ethical and legal ones. The Integrated Ethical Technical Governance Framework of the Precise IETF seeks to ensure safe, legal, and dependable use of AI-driven military weapons. Contrary to usually preventing algorithmic integration, current laws emphasize cyber security resilience and flexible policymaking that changes with technical advancement [36]. It therefore has to be theoretical as designs of synthetic ethics have to be incorporated. This frame converts ethical obligations into practical engineering standards. Cleanable artificial XAI techniques' intelligence raises accountability; Decision-making clarity is one of three. Robust cybersecurity protections and backup control systems are required for areas of the Combating more and more complex cyberattacks: IETF. [37] All design, operational, and governance have to interact. Design brings together friendly specialists from a variety of fields, including engineering and other knowledgeable experts. Ethical and legal professionals ensure that ethical standards are upheld by exploring disciplines from the very beginning of work on international law, and they should assess events in an interdisciplinary manner. The operational layer underscores the critical need for analyzing risks, fostering resilient communication, and ensuring cybersecurity, along with the validation and testing processes in genuine circumstances. The Defense agency hopes to promote continuous openness and accountability. National and global surveillance systems help the agency grow [38]. This method is all about being proactive, moving beyond the current artificial intelligence governance systems in place. It’s great to shine a light on NATO's AI Strategy along with the U.S. Department of Agriculture's initiatives. They present broad ethical principles, but there’s a chance they might limit certain specific applications. The Ethical AI Guidelines from Defense don’t provide tools for technical enforcement; projects driven by activism often lend their support to the Campaign to Stop Killer Robots, rather than focusing on providing safe alternatives for use [39], combining ethics and technology from the early stages of development to their deployment on the battlefield, there are certain guidelines or limitations that respond to this need. It provides clear and friendly guidance on the lifespan of unarmed military systems; this approach presents a thoughtful plan for weaving in ethical and safety assessment processes before engaging in large-scale global collaboration, weapon development, and mission planning. As systems evolve, it also provides artificial intelligence with the means to evaluate and foresee the results influenced by machines [40].

5. Conclusion

The progression of elite AI functionalities has thoroughly reshaped military frameworks by facilitating swift decision-making, sharpening situational perception, and enhancing operational triumph in warfare. Nevertheless, these advantages engender substantial ethical and technical dilemmas that necessitate careful contemplation. The advent of revolutionary military drones and robotic innovations has generated multifaceted ethical, legal, and accountability obstacles in military operations, accentuating the crucial role of a prudent and conscientious strategy for the use of AI in warfare. The structures for ethical leadership, tech defenses, and international law frameworks (SETIL) are key to ensuring that artificial intelligence operates within moral boundaries. The growth of AI engineered for military use is significantly influenced by vital tenets including personal self-sufficiency, precision, and answerability. Effective mitigation of AI-associated risks necessitates unequivocal communication systems, with the principal defensive strategies encompassing independent evaluation systems, certification protocols, as well as international cooperation and enforceable agreements among policymakers, military entities, and artificial intelligence experts. Ultimately, it is essential that the incorporation of artificial intelligence in military robotics is underpinned by a robust commitment to social and moral responsibility, alongside technical innovation; this comprehensive approach assures that advancements in defense technology remain instruments of security and stability rather than unrestrained mechanisms of destruction.

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