Assessing Artificial Intelligence's Military Application in Urban War: A Study of the Israel Defense Forces Operations Since 2021

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Abstract of Thesis

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This thesis examines the integration of AI in urban military operations, with a specific focus on the Israel Defense Forces' application of AI technologies in urban warfare. The study first defines urban settings to lay the groundwork for detecting peculiarities of urban settings in warfare, discusses theoretical perspectives on AI's potential to revolutionize warfare, and then moves into the actual employment of AI in urban combat by examining Israel Defense Forces operations since 2021. By analyzing how AI has been applied in the context of the urban operations, it seeks to understand AI's role in urban combat and its potential to shape future urban warfare dynamics.

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Chapter 1: Introduction

The last decade has seen significant development in the field of military innovation, with autonomy and Artificial Intelligence (AI) taking center stage in the wake of rapid technological advancements. This technological leap has made autonomy and AI a focal point in the military strategy and operations literature, with a growing interest in their potential to improve military capabilities. Urban warfare, on the other hand, emerged as a critical area of focus in the broader spectrum of modern military operations, especially in the 21st century. Although urban warfare may no longer be as fashionable a topic as it was in the early 21st century, it still preserves a certain degree of relevance. The rapid pace of global urbanization, particularly in the underdeveloped and developing world, means that the potential for urban conflicts is still a pertinent issue with a potential. This dual evolution sets a curious stage for exploring what the intersection of AI and urban warfare might bring. AI is expected to be a game-changer in various fields, especially in the global economy. There is a widespread expectation that with its vast potential, AI could modify or maybe revolutionize every aspect of life, including military operations. In this context, potential influences of AI might have significant implications for urban warfare, where it can help navigate the complex challenges of conducting military operations in urban areas. This topic is of particular interest to experts in the field, given the intriguing possibilities that AI offers. With these realities in mind, this research examines the relationship between AI and urban military operations. By delving into the peculiar features of urban combat, juxtaposed with the rapid advancements in AI technology, it seeks to serve as an introductory exploration of the limits of the transformative potential of AI in urban warfare contexts. It aspires to offer an overview of current capabilities, forecast future developments, and explore military AI's strategic and operational implications in urban settings.

It is important to examine the practical applications and benefits offered by AI beyond the assumptions generated by its hype. In parallel with this, this thesis examines AI applications in the most recent urban combat by raising the following research question: "How effectively has the Israel Defense Forces (IDF) used AI applications in contemporary urban combat?" The investigation will try to address the gap between the suppositional opinions of AI's military prowess and its practical utility on the urban battlefield. The existing broad literature on the potential of military AI presents contrasting views, ranging from portraying AI as a revolutionary force reproducing the nature and character of war to merely extending current capabilities. Therefore, empirical analysis of military combat is necessary to identify the actual cases in which novel AI mechanisms have been utilized. By focusing on specific military operations/campaigns conducted by a state actor, particularly those with advanced technology militaries like the IDF, this research endeavors to sift through the hype surrounding military AI applications. An empirical examination of the IDF's use of AI in urban operations will provide a grounded assessment of AI's actual impact versus its projected potential, thereby contributing a perspective on its prospect for urban warfare dynamics.

The choice to center the IDF's use of AI as the primary focus of this research is motivated by several pivotal aspects that align closely with the research objectives, particularly concerning the utilization of AI in urban warfare contexts. Firstly, the IDF has a track record of being at the forefront of adopting and implementing novel military technologies such as Unmanned Aerial Vehicles (UAVs), advanced electronic warfare systems (EWS), and automated missile defenses. This underscores their pioneering role in the domain of military technology. As discussed in the forthcoming chapters, Israel's ambitious AI agenda further highlights its actualized commitment to integrating novel technologies into its defense strategies. Secondly, the IDF distinguishes itself as one of the first military forces to operationalize AI technologies in widespread actual combat scenarios, supplying a larger source for the examination of these tools that provide a richer basis for analysis. Thirdly, and most importantly, the IDF's application of AI technologies predominantly occurs within urban combat environments, aligning precisely with the focus of this research. This distinguishes the IDF's campaigns from the use of AI-backed systems in other recent wars, such as those in Nagorno-Karabakh, Libya, and, more recently, Ukraine, where engagements often occurred in more open and less densely populated areas. The IDF's employment of AI in urban warfare presents a compelling case study that envelops the complicated facets and operational considerations unique to urban environments.

For these purposes, Chapter 1 examines urban warfare's evolution, the principal characteristics of urban environments, and their profound impact on military operations. It recognizes the unique peculiarities of urban settings, such as dense infrastructures, civilian presence, and complex terrain, which present significant challenges. In sum, it sets the stage for understanding some of the major challenges of successfully conducting urban warfare in contemporary world politics. Chapter 2 shifts from the theoretical underpinnings of urban warfare to the practical implications of AI and autonomy in military operations. It analyzes the ongoing debate regarding AI's revolutionary potential in warfare by roughly categorizing perspectives into conservative and revolutionary camps. It ends with an evaluation of the applications of AI in military operations, such as autonomous surveillance, target recognition, and decision-support systems that could revolutionize urban combat dynamics. Chapter 3 examines the practical application of Artificial Intelligence (AI) by the IDF in Gaza Operations during 2021 and since 2023 with the aim of synthesizing urban warfare and AI discussions. It starts with explaining how the IDF is recognized for its technological prowess, innovative warfare strategies, and AI-related capabilities. It continues with leveraged AI-backed target generation systems used in urban settings. Following the third chapter, the findings from cases and broader theoretical debate at the end of this research aim to discuss strategic benefits and operational challenges and serve as conclusion.

Chapter 2: The Changing Face of Urban Warfare: Complexity, Evolution, and Modern Challenges

Urban warfare is a challenging discipline in military operations that has evolved significantly over the centuries. The fighting landscape in urban environments has continuously adjusted to new challenges and opportunities, reflecting and going hand in hand with social, technological, and geopolitical transformations. In this sense, the evolution of urban combat strategies has always been influenced by broader shifts in demographic trends, technological advancements, and military doctrines. The transition, which will be discussed from traditional siege-based methods to modern, multifaceted urban combat strategies, highlights the interplay between the changing character of global conflicts and the strategic responses to these changes. As the global population increasingly urbanizes and the nature of adversaries shifts from state to non-state actors, the principles and tactics of urban warfare continue to evolve, presenting new strategic considerations for military forces worldwide.

One of the main reasons that any scholarly effort on military operations or military technology trends should consider the significance of urban warfare is the demographic shift towards urbanization. The world's population has grown significantly, with an observable trend of people moving to cities.[1] In 1960, cities were home to only 34% of the global population of 3.5 billion; in 2022, this percentage rose to 57% of 8 billion people. Experts like Russell Glenn and Ralph Peters had already predicted in 1996 that the growing

[1] Mohsen M. Aboulnaga, Mona F. Badran, and Mai M. Barakat, *Resilience of Informal Areas in Megacities - Magnitude, Challenges, and Policies: Strategic Environmental Assessment and Upgrading Guidelines to Attain Sustainable Development Goals* (Cham: Springer, 2022), 5.

trend of urbanization would lead to a higher incidence of conflicts in urban areas.[2] This prediction has been widely accepted, with a consensus that the complexities introduced by urbanization can potentially increase the frequency of conflicts in urban settings.[3] Therefore, it is imperative to understand the technical details of urban warfare to tackle the challenges posed by this phenomenon.

According to the United Nations' medium fertility scenario, the global population is estimated to increase significantly by the year 2050, reaching approximately 9.8 billion. This projection signifies a noteworthy change in population distribution, with urban populations anticipated to rise to around 6.7 billion while the rural population is expected to be around 3.1 billion.[4] An additional important demographic trend is that pre-industrial societies that have not completed institutional evolution in governance and security mechanisms will rapidly urbanize before the second half of the 21st century.[5] This demographic shift highlights a significant trend: urban areas are expected to have more than twice as many inhabitants as rural areas, indicating a substantial change in the global population dynamic.

When warfare is conducted in urbanized settings, it does not only imly a change of the locations of conflicts but also the character. Urban areas, particularly those with expanding

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[2] Russell W. Glenn, *Combat in Hell: A Consideration of Constrained Urban Warfare* (Santa Monica, CA: RAND, 1996), 2.; B. Guy Peters, *The Future of Governing: Four Emerging Models* (Lawrence: Univeristy Press of Kansas, 1996), 43.

[3] Margarita Konaev, "The Future of Urban Warfare in the Age of Megacities," IFRI, March 2019, https://www.ifri.org/sites/default/files/atoms/files/konaev_urban_warfare_megacities_2019.pdf, 12.

[4] "68% of the World Population Projected to Live in Urban Areas by 2050, Says Un | UN Desa Department of Economic and Social Affairs," United Nations, May 16, 2018, https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.

[5] OECD/SWAC, *Africa's Urbanisation Dynamics 2020: Africapolis, Mapping a New Urban Geography*, West African Studies, Paris: OECD Publishing, 2020, https://doi.org/10.1787/b6bccb81-en.

informal/irregular settlements, provide strategic advantages to smaller, non-state militant groups, enabling them to counterbalance the more advanced weaponry of state forces. These groups use urban settings for stealth, concealment, ambush, and counterattacks. Moreover, operating in cities allows these groups to navigate the complexities of the laws of armed conflict and international humanitarian law, especially in engagements with nations that prioritize minimizing civilian casualties. This trend of urban insurgency is viewed as a significant military challenge in the early 21st century.

When examining urban warfare, it is essential to consider factors such as population size, spatial density, and the nature of the conflict. Typically, urban warfare is associated with large, densely populated, and culturally diverse cities with populations of 100,000 or more. However, there are complexities associated with characterizing smaller urban areas with populations of around 3,000. According to military doctrine, urban regions range from hamlets with fewer than 3,000 residents to cities with over 100,000 inhabitants. A settlement is considered urban if it has a population density of 400 individuals per square kilometer, indicating that urban warfare occurs in areas with a dense population of at least 7.5 square kilometers.[6] The severity of the conflict also plays a role in this definition. Thus, the intense urban battle is easily defined, like in Mosul, Aleppo, and Marawi, but the line is blurred when it comes to a lower conflict level. However, distinguishing urban hostilities from warfare can be more subtle at lesser degrees of conflict. When political motivations are present, and the death toll is significant, instances of urban violence, like gang clashes,

[6] This calculation derives from dividing the minimum population (3,000 residents) by the population density threshold (400 residents per square kilometer), generating 7.5 square kilometers as the minimal area. Such a parameter secures that military tactics, strategies, and doctrines account for the challenges and dynamics specific to urban settings, even at the smaller scale of urban settlements.

terrorist attacks, or counterinsurgency moves, may be reclassified as acts of warfare.[7] The significant death toll might change according to the evaluation criteria. Notably, major conflict research initiatives such as the Uppsala Conflict Data Program (UCDP) and the Peace Research Institute Oslo Conflict (PRIO) set 1,000 battle-related deaths as a threshold.[8] In this context, it is crucial to recognize that urban warfare encompasses a range of conflicts, not just high-intensity clashes. In this context the category might be broadened in a way to include guerrilla warfare within urban confines, civil unrest with prolonged confrontations, organized crime violence, and state-sponsored operations targeting non-state actors within metropolitan areas.

The Urban Environment

Many factors, including geography, history, economics, climate, construction materials, and cultural diversity, shape military operations in urban areas. These elements influence not only the size and density of urban populations but also the interconnectivity and interdependence of cities. As such, urban environments present a complex setting for military operations. To gain a comprehensive understanding of each unique urban environment, it is helpful to look through the lens of the "urban triad" concept outlined in

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[7] Anthony King, *Urban Warfare in the Twenty-First Century* (Cambridge, UK: Polity Press, 2021), 60-67.
[8] Both the UCDP and PRIO datasets distinguished between minor, intermediate, and war categories. An intermediate conflict was categorized through witnessing more than 25 but fewer than 1000 battle-related deaths in one calendar year in the given area/region/country. Similarly, Correlates of War project, which focuses on conflicts from 1900–1997 counted cases involving at least 1,000 combatant fatalities, and the Fearon and Laitin dataset, which examines civil wars between 1945–1999, also took 1,000 battle-related deaths as threshold. Therese Pettersson, "UCDP/PRIO Armed Conflict Dataset Codebook v 19.1" (2019], https://ucdp.uu.se/downloads/, 5.; M. R. Sarkees, "The Correlates of War Data on War: An Update to 1997," *Conflict Management and Peace Science* 18, no. 1 (2000): 123-144.; J. D. Fearon and D. D. Laitin, "Ethnicity, Insurgency, and Civil War," *American Political Science Review* 97, no. 1 (2001): 75-90.; Bethany Lacina and Nils Petter Gleditsch, "Monitoring Trends in Global Combat: A New Dataset of Battle Deaths," *European Journal of Population* 21 (2005): 145-166.

the U.S. Military's Joint Publication 3-06.[9] This framework breaks down the urban environment into three primary components: a complex man-made physical terrain superimposed on the natural landscape, characterized by varied structures and spatial arrangements; a dense population that engages with both the man-made and natural environments, marked by significant sociocultural diversity; and an essential infrastructure that supports the area's human services, cultural, and political structures, extending its influence regionally or even globally. The urban triad model provides a foundational perspective, revealing the all-around interaction between physical terrain, population, and infrastructure and emphasizing the distinct challenges and considerations for military operations within such dynamic and dense environments.[10]

Urban areas encompass a complex "system of systems" that present distinct challenges in terms of operations, as outlined by the urban triad concept. To make sound military decisions and prepare intelligence for urban scenarios within this framework, it is imperative to comprehend the operational variables, such as political, military, economic, social, information, infrastructure, physical terrain, and time (PMESII-PT). These variables are crucial to mission analysis during military decision-making and planning, ultimately shaping the Common Operational Picture (COP). Additionally, mission variables and civil considerations are key factors in urban operations, highlighting the significance of adapting

[9] Joint Chiefs of Staff, *Joint Publication JP 3-06: Joint Urban Operations* (20 November 2013), 2, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_06.pdf

[10] A similar conceptualization can be seen in the NATO "urban quad" model that divide the urban environment into physical, demographic, infrastructural, and informational components. David Kilcullen and Gordon Pendleton, "Future Urban Conflict, Technology, and the Protection of Civilians: Real-World Challenges for NATO and Coalition Missions" (Stimson Center, June 2021), https://www.stimson.org/2021/future-urban-conflict-technology-and-the-protection-of-civilians/, 6.

to the ever-changing urban landscape and its cyclical transformations influenced by diverse factors, including civil or military actions[11]

Terrain

According to U.S. Military's 'Commander and Staff Organization and Operations Doctrine,' military leaders comprehensively analyze the terrain based on the five critical aspects using OAKOC: Observation and Fields of Fire, Avenues of Approach, Key Terrain, Obstacles, and Cover/Concealment. This method helps identify potential advantages and disadvantages of the terrain and assists in developing effective strategies to achieve the mission objectives.[12] Similarly, the challenges of urban terrain within the framework of the urban triad underscore the unique obstacles encountered in urban operations. Nearly 60% of buildings worldwide are constructed with materials that resist penetration, such as concrete or brick, making breaching techniques more complex and diminishing the impact of weapons.[13] Urban combat has the potential to transform the built environment, resulting in power outages, flooding, and fires that can impact both civilian safety and force mobility. Additionally, operations must factor in the potential presence of hazardous industrial materials, adding further complications. Urban operations require a multi-dimensional approach encompassing surface, subsurface, maritime spaces, cyberspace, space operations, and information domains. This complexity necessitates increased combat

[11] Headquarters Department of the Army, *Army Techniques Publication No. 3-06 / Marine Corps Tactical Publication No. 12-10B* (21 July 2022), 2, https://armypubs.army.mil/epubs/DR_pubs/DR_a/ARN35826-ATP_3-06-000-WEB-1.pdf.

[12] Headquarters, Department of the Army, *FM 6-0, Commander and Staff Organization and Operations* (May 2014), A-3 - A-4.

[13] *Army Techniques Publication No. 3-06,* 4.

capacity and enhanced capabilities across military echelons to navigate the complicatedness of urban warfare effectively.

Urban military operations are becoming more complex with the expansion of the operational theater into a tripartite domain of surface, supersurface, and subsurface realms. Each domain poses unique tactical challenges and demands specialized knowledge for effective utilization. The natural and man-made components of urbanization are seamlessly integrated into the surface domain, which encompasses both land and water. The supersurface strata, comprising the heights and internal stratifications of man-made structures, offer both advantages and vulnerabilities. Airspace over urban environments, intersecting with the supersurface strata, adds another layer of complexity. Drones, aircraft navigation, and air-to-ground battle coordination are considerable elements for executing and monitoring operations. The subsurface realm, a complex network of utility conduits and underground passageways, requires a shrewd understanding for effective maneuvering and concealment. These challenges are further compounded by possible toxic industrial materials, necessitating an elevated echelon of combat readiness and strategic acuity.

The challenges of urban warfare extend beyond physical landscapes, as was illustrated by the siege of Mosul in June 2014, encapsulating combat's evolution into a domain that transcends the physical to embrace the digital and informational spheres.[14] Army units have to navigate 'the multi-domain extended urban battlefield,' which includes digital battlegrounds for controlling access while defending against cyber threats.[15] The cyber

[14] King, *Urban Warfare in the Twenty-First Century*, 32.

[15] Richard L. Wolfel, Amy Richmond, and Jason Ridgeway, "Dense Urban Environments - the Crucible of Multi-Domain Operations," Army University Press, January 2021, https://www.armyupress.army.mil/Portals/7/military-review/Archives/English/JF-21/Wolfel-Dense-Urban-Environment-1.pdf.

dimension of this multi domain conception involves networks and information systems, which cyberattacks can target to disrupt critical infrastructure and spread misleading information. The cognitive domain on the other hand focuses on attitudes, beliefs, and morale, impacting military personnel and civilians.[16] Therefore, a proactive approach to identifying, prioritizing, and securing essential networks and data against potential intrusions is essential not solely for safeguarding physical infrastructure but also for fortifying the cognitive landscape against adversaries' attempts to erode resolve and manipulate. Meanwhile, the architecture of urban environments presents a unique set of challenges for aerial navigation and munition deployment due to the "urban canyon effect" induced by high-rise structures, unpredictable wind patterns, and turbulence. The information environment, comprised of global networks, social media, and technical infrastructures, has become a battlefield where information warfare strategies are pivotal. This illustrates the inseparable link between digital and physical terrain in urban combat.

Infrastructure

Urban infrastructures serve as crucial support systems for residents and their economic activities, bridging the gap between the physical terrain and urban societies. In urban operations, restoring or safeguarding critical infrastructure components, including their integrated networks and nodes, is pivotal for mission success and can significantly impact the outcome of broader operations. Both irregular forces and near-peer adversaries depend on local infrastructure such as water, electricity, and fuel for operational support, making controlling or disrupting these resources a strategic objective to impair enemy capabilities

[16] Peter Layton, "Countering China's Gray Zone Strategy," Small Wars Journal , October 10, 2021, https://smallwarsjournal.com/jrnl/art/countering-chinas-gray-zone-strategy.

and sustainment.[17] Urban warfare, in this sense, is a war of microenvironments that might require command decentralization, as underlined by Evans.[18] Micro-environments include streets, paths, and quads through a labyrinth of rooms, corridors, stairwells, rooftops, and subterranean infrastructure tunnel systems that is sometimes long enough to compete with the London metro network. Consequently, securing micro-environments, especially key logistical nodes, and communication mediums within and around urban areas, is essential for maintaining operational advantage, isolating threats, and preventing adversaries from mobilizing support among the urban populace.

The functionality of urban infrastructure can be understood by dividing it into six pivotal categories: economics and commerce, administration and human services, energy, culture, communications and information, and transportation and distribution.[19] Within these broad categories lie hundreds of interconnected systems, each playing a vital role in the urban ecosystem.[20] In stability operations, rivals may target these systems to undermine societal stability and achieve strategic objectives. Conversely, hybrid or conventional forces strive for positional superiority in large-scale combat scenarios within urban environments, potentially engaging across extensive fronts or focusing efforts to breach defenses. Such operations might also see adversaries employing a layered defense strategy across interconnected urban areas, aiming to delay, disrupt, deceive, or weaken opposing forces.

Population

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[17] Joint Chiefs of Staff, *Joint Publication JP 3-06: Joint Urban Operations,* II-7.

[18] Michael Evans, *City without Joy: Urban Military Operations into the 21st Century* (Canberra: Australia Department of Defence, 2007).

[19] Joint Chiefs of Staff, *Joint Publication JP 3-06: Joint Urban Operations*, III-8 - IV - 20.

[20] Ibid, II-8.

The third element in the urban triad is population. Urban operations are inherently complex, requiring a grasp of urban environments' demographic structure, social systems, and human geography. Urban operations are inherently centered around people, with the urban population being crucial to the success of military campaigns. The actions and attitudes of city residents have the power to drastically affect the importance of an urban area, turning it from a bustling hub of activity to a quiet and uneventful space. The essence of humanity is distilled within the fabric of urban life, with urban centers often being a melting pot that amplifies the full range of human characteristics.[21] Military conflicts within these environments have traditionally varied from swift domination to prolonged sieges, with the behavior and morale of the civilian population frequently determining the direction and conclusion of these engagements.

When it comes to combining urban society and military operations, it's important to take a careful look at the demographics of the civilian population - where they're located, how many there are, and how they move around. This information is crucial for identifying potential risks that could arise if civilians get too close to important military operations, like blocking supply routes. Commanders use this intelligence to understand urban life rhythms better, which is key for planning and executing successful operations. Amid urban conflict, the way civilians view military forces can have a big impact on the strategy and plans for stabilizing the region after the conflict ends, which underscores the importance of carefully engaging with the urban population.

The Evolution of Urban Warfare

[21] Ibid., IV-33 - IV-35.

Throughout history, many factors spanning technological advancements, social and economic changes, and strategic developments have played a significant role in shaping the course of urban warfare. From ancient to early modern times, siege warfare was the predominant tactic employed in urban conflicts. This method involved blockading and besieging cities to force surrender.[22] However, the advent of gunpowder and artillery marked a turning point in urban warfare, as cities were compelled to adapt and fortify themselves against these new threats, leading to a shift in strategies and tactics. Throughout the 19th century, urban warfare evolved rapidly as cities became vital strategic and economic hubs. The rise of urbanization and industrialization transformed these areas into hybrid battlefields, where siegecraft and street-fighting tactics were combined.[23] The two World Wars, especially World War II, marked a significant turning point in the history of urban warfare. Military tactics and strategies shifted dramatically during these conflicts in a way to include urban settings. Rather than relying on traditional siege-based methods, direct combat took place within cities, fundamentally changing the nature and impact of urban war.

One of the most significant examples of the shift towards urban warfare can be observed in the Battle of Stalingrad during World War II. This battle was characterized by violent close-quarter combat and marked a crucial turning point of the war on the Eastern Front. The intense fighting within the city's boundaries resulted in unprecedented levels of destruction and civilian losses, underscoring the devastating consequences of urban

[22] Louise A. Tumchewics and Paul Latawski, "The Evolution of Urban Warfare," essay, in *Small Armies, Big Cities: Rethinking Urban Warfare* (Boulder: Lynne Rienner Publishers, 2022), 27–44, 27-28..
[23] Mikael Weissmann and Niklas Nilsson, *Advanced Land Warfare: Tactics and Operations* (Oxford, United Kingdom: Oxford University Press, 2023), 7-12.

warfare.[24] The battle also highlighted the strategic importance of urban areas in modern warfare, as control of the city was pivotal for both the Axis and Soviet forces. Other notable cases of urban warfare include the Battle of Aachen in 1944 and the Battle of Manila, in which over 100,000 civilians were killed and was among the deadliest urban battles of the Pacific War. The Korean and Vietnam Wars saw the battles of Seoul and Hue, respectively, demonstrating the effectiveness of combined arms teams in urban combat.[25] While capturing these cities was of great strategic importance, the high costs and complexities of urban warfare were brought to the fore once again, leading to significant collateral damage and civilian casualties. The extensive destruction of cities and the high number of civilian casualties brought new attention to the need for revised military tactics and strategies in urban environments, as well as the importance of considering the humanitarian implications of urban warfare.

In scholarly discourse on urban warfare, demographics and asymmetry have predominantly been linked to explaining urban insurgencies and civil conflicts. This focus aligns with the prevalence of urban battles within such conflicts in the last decades. However, this perspective has often been extended to interstate wars as well. For example, Alec Wahlman, in his examination of the history of the U.S. Army's urban battles, posits that demography and asymmetry are critical determinants in contemporary urban warfare,

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[24] Jayson Geroux and John Spencer, "Urban Warfare Project Case Study #1: Battle of Stalingrad," Modern War Institute, January 27, 2022, https://mwi.westpoint.edu/urban-warfare-project-case-study-1-battle-of-stalingrad/.

[25] Benjamin Phocas, "Fighting for the Pearl of the Orient: Lessons from the Battle of Manila," Modern War Institute, August 1, 2023, https://mwi.westpoint.edu/fighting-for-the-pearl-of-the-orient-lessons-from-the-battle-of-manila/.; John France, "Close Order and Close Quarter: The Culture of Combat in the West," *The International History Review*27, no. 3 (September 2005): 498–517, https://doi.org/10.1080/07075332.2005.9641069, 514-515.

analyzing state-versus-state battles such as those in Aachen, Manila, Seoul, and Hué.[26] This implies an expectation of future operations in urban settings against insurgents and peer state forces, underscored by urban demographics and cities' tactical advantages against advanced weaponry.

Urban Tactics

Urban warfare has undergone significant changes in recent decades with intense involvement of non-state actors. As a response, military forces have had to adapt their battle strategies to keep pace with these shifts. Among these shifts, the 'defender's advantage' concept stands out, albeit not a novel concept in the ground warfare. In the context of modern urban conflict, this advantage has become increasingly noteworthy, arising from non-state actors' capacity to exploit the infrastructure and demographic dynamics of urban areas to their strategic benefit. The issue of proportionality is also critical in this type of conflict, as speculation about this issue can provide political advantage to the defender. Tactics such as using non-combatants as human shields or for concealment make it even more challenging for armies to navigate urban landscapes and achieve their objectives.[27] Even the most advanced and well-equipped armies find operating increasingly tricky in urban environments.

The ability of non-state actors to maneuver within urban environments before, during, and after active conflicts further complicates the situation for state military forces. The dynamic

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[26] Alec Wahlman, *Storming the City: U.S. Military Performance in Urban Warfare from World War II to Vietnam*(Denton: University of North Texas Press, 2015).

[27]John Spencer, "The Eight Rules of Urban Warfare and Why We Must Work to Change Them," Modern War Institute, January 12, 2021, https://mwi.westpoint.edu/the-eight-rules-of-urban-warfare-and-why-we-must-work-to-change-them/#:~:text=The%20defender%20can%20see%20and,hidden%20inside%20and%20under%20buildings.

and complex nature of urban settings, combined with the unconventional methods employed by non-state actors, necessitates rethinking traditional urban combat strategies. As a result, new approaches have been developed to address the challenges presented by this type of warfare. This transformation in urban warfare reflects a broader trend in which military strategies and tactics must continually adapt to changes in technology, infrastructure, and the nature of the urban landscape. The evolution of urban warfare from siege-centric methods to integrated street and aerial combat in densely populated urban environments highlights urban combat's complex and ever-changing nature throughout history.

In contemporary military studies, evolving strategies of urban combat due to the increasing presence of non-state actors in urban theaters have gained prominence. Eyal Weizman has observed a fundamental shift from traditional linear and mass tactics in urban warfare, as seen in historic confrontations like the Battle of Stalingrad.[28] Instead, contemporary urban military operations are characterized by adopting more complex, non-linear tactics that reflect a move toward what is described as 'quantum urban operations.'[29] This shift is partly attributed to incorporating postmodern theoretical frameworks into military strategy,

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[28] Eyal Weizman, "Walking through Walls: Soldiers as Architects in the Israeli–Palestinian Conflict (2006)," Radical Philosophy, February 1, 2018, https://www.radicalphilosophy.com/article/walking-through-walls.

[29]The term 'quantum urban operations' was first coined by King, with reference to Weizman and Naveh's conceptualizations. The description of IDF's swarming like behavior while conducting urban operations which corresponds to 'a state military adapting to combat against a networked enemy by becoming more dispersed, flexible, and adopting swarm-like behaviors. These tactics transcend linear approaches to urban combat, embracing instead a 'non-Euclidean' strategy in Weizmann's words. Hence, in such a behavior, military forces, mirrors quantum behavior, interpenetrate the urban fabric, executing maneuvers in all directions simultaneously, akin to particles operating across multiple states and positions, thus fundamentally altering the spatial dynamics of warfare. See Weizman, "Walking through Walls: Soldiers as Architects in the Israeli–Palestinian Conflict (2006)," 12; King, *Urban Warfare in the Twenty-First Century*, 200.

resulting in a more dynamic and adaptable approach to urban combat. Central to Weizman's analysis is the strategy the IDF employed during the Second Intifada and the approach was significantly shaped by Shimon Naveh's work at the Operational Theory Research Institute (OTRI), where he integrated novel theories into IDF strategies. This resulted in the development of what Naveh termed 'fractal maneuver,' characterized by small decentralized units carrying out non-linear, non-sequential actions in urban areas.[30]

The Battle of Nablus 2002 illustrated the IDF's shift from traditional linear assault strategies to more decentralized, network-centric operations which is also acknowledged a paradigm shift in the context of urban tactics. During this battle, the IDF employed tactics such as 'mouseholing,' which involves breaching internal walls to maneuver through buildings, allowing for a more flexible and responsive command approach. The decentralized command structure enabled troops to make quicker decisions at lower levels, allowing them to respond promptly to dynamic situations on the ground. Military analysts, including retired Marine LtG Paul van Riper and scholar Eyal Ben-Ari, have observed this transformation in urban combat dynamics, noting a transition from linear, territory-focused troop formations to smaller, more agile, network-based units operating in specific urban areas.[31] It is important to note, however, that such tactics are not entirely unprecedented. Historical analyses reveal that tactics like 'mouseholing' have long been employed in military operations, dating back to ancient warfare and seen in the actions of the French

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[30] Eyal Weizman, Walking through Walls: Soldiers as Architects in the Israeli–Palestinian Conflict

[31] Eitan Shamir and Eyal Ben-Ari, "The Rise of Special Operations Forces: Generalized Specialization, Boundary Spanning and Military Autonomy," *Journal of Strategic Studies* 41, no. 3 (August 9, 2016): 335–71, https://doi.org/10.1080/01402390.2016.1209656.; Future Military Operations on Urbanized Terrain," United States Marine Corps Emerging Operational Concepts, 1999, https://apps.dtic.mil/sti/tr/pdf/ADA365581.pdf.

Army in the 19th century and the Irgun in 1948 in Jaffa.[32] These tactics were also prevalent in urban conflicts of the 20th century, including during World War II's Italian Campaign and the Canadian Army's operations in Ortona.[33]

In contrast, Close-Quarters Battle (CQB), according to King, represents a more recent advancement in urban infantry tactics. Originating with Special Operations Forces in the 1970s for hostage rescue scenarios, CQB focuses on precision, and coordinated movements in hostile urban settings. This approach involves procedural drills, such as the 'five-step entry' technique, facilitating adequate room clearance with steps of (i) slicing the view, (ii) flooding the room with light, (iii) dynamic entry, (iv) dominating the room, and (v) searching and clearing.[34] The widespread adoption of CQB tactics by modern infantry units marks a significant evolution in urban combat methods at the squad level. While CQB may not fully align with postmodern concepts such as swarming or fractal maneuver, it nevertheless signifies a crucial shift in tactical approaches within urban environments.

Challenges in Urban Warfare

In urban warfare, attackers face unique challenges inherent to urban terrain and its unpredictable nature. Therefore, a comprehensive understanding of the city's infrastructure is pivotal to any military operating. This includes knowledge of the physical layout, such as transportation networks, essential buildings, and utility systems, as well as an awareness of the informal/concealed networks and power structures within the urban environment.

[32] David Betz, "The City Is Neutral: On Urban Warfare in the 21st Century," Texas National Security Review, April 22, 2020, https://tnsr.org/2019/10/the-city-is-neutral-on-urban-warfare-in-the-21st-century/.
[33] Jayson Geroux and John Spencer, "Urban Warfare Project Case Study #1: Battle of Stalingrad," Modern War Institute, January 27, 2022, https://mwi.westpoint.edu/urban-warfare-project-case-study-1-battle-of-stalingrad/.
[34] Anthony King, *The Combat Soldier: Infantry Tactics and Cohesion in the Twentieth and Twenty-First Centuries* (New York (NY): Oxford University Press, 2019), 251-255.

This leads in understanding how 'power' is exercised in the city is the first step for any urban fight. This includes capturing the knowledge of groups that hold influence and how the local economy functions, including the magnitude and components of the informal economy.

The "Defender's Advantage" concept holds significant importance in understanding the outcome and reasons why such challenging urban warfare is.[35] The peculiar design of city architecture mentioned in the urban environment section poses a challenge for deploying large mechanized military units. This operational limitation is further exacerbated by the defenders' better knowledge of the local terrain. This grants them a critical strategic asset at both broad and granular levels. Despite the advancements in GPS and aerial reconnaissance, attackers must replicate the detailed terrain familiarity that defenders typically possess. In urban warfare, the complexity of cityscapes provides defenders with the advantage of three-dimensional maneuvering and infrastructure, such as sewers or tunnels created with the purpose of concealed movement. In contrast, attackers require intimate local knowledge that would come from translators or members of local people to navigate the constrained urban spaces. Therefore, specialized tactics become essential for urban COIN, with an emphasis on limited use of firepower, specialized training, and lower tempo compared to open-field.[36]

Another critical challenge is the disruption of unit cohesion. The confined and intricate urban landscape often results in the physical separation of units, impeding effective

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[35] Barry R. Posen, "Urban Operations: Tactical Realities and Strategic Ambiguities," in *Soldiers in Cities: Military Operations on Urban Terrain*, ed. Michael C. Desch (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2001), 149–66, 151-152.
[36] Ibid, 163.

communication and mutual support. This fragmentation can leave soldiers isolated or clustered in small groups, vulnerable to threats from various directions within densely populated areas.[37] Furthermore, urban environments complicate command and control structures. The plethora of buildings, subterranean systems, and narrow passageways disrupt traditional lines of sight and communication, posing significant obstacles for commanders in maintaining situational awareness and exercising effective control. This environment inevitably necessitates a shift towards a more decentralized command approach, where ground-level leadership and initiative become paramount.

Urban combat poses several challenges that can result in higher casualty rates. The nature of close-quarters combat in urban settings inherently increases lethality.[38] The presence of civilians further complicates the situation, as military forces must engage the enemy while also minimizing civilian harm. The urban terrain offers many potential hiding places, which increases the likelihood of ambushes and surprise attacks.

Additionally, urban warfare presents significant intelligence challenges. The intricate urban environment and the elusive nature of infantry forces pose substantial difficulties for intelligence gathering.[39] Technological interventions, such as deploying distributed sensors and robotic systems, face challenges related to scale and susceptibility to adversary countermeasures. For instance, though not an urban conflict or direct confrontation, Israel's interception of Iranian missiles and drones overnight in April 2024 is estimated to cost 1,35

[37] Spencer, Eight Rules of Urban Warfare.

[38] George A. Glaze, The Urban Warrior: What are the dismounted infantry skills necessary to survive in today's urban fighting?, 2000, https://apps.dtic.mil/sti/pdfs/ADA383819.pdf, 1.

[39] James Howcroft, "Intelligence Challenges in Urban Operations," Small Wars Journal , July 20, 2014, https://smallwarsjournal.com/jrnl/art/intelligence-challenges-in-urban-operations.

billion dollars.[40] If it is assumed that similar situations that cost equal take place consecutive nights for two weeks, the overall cost would be higher than 80% of Israel's annual military expenditures based on 2023 data.[41] Similar scalability problems are even more apparent when countering non-state actors.[42] These issues are exacerbated in the expansive scope of urban areas, where adversaries have greater opportunities to neutralize or manipulate these technologies.

Furthermore, the differentiation between various urban operation types adds complexity to the landscape of urban warfare. Operations such as urban COIN and peace enforcement demand skills, organizational structures, and training distinctly different from those required for full-scale military operations. Hence, technological, doctrinal, and drilling preparation for a state-to-state urban conflict and state-to-non-state urban conflict fundamentally differ.

Finally, the strategic justification and calculation of outcomes in urban operations is critically important. Even the most successful urban operations have the potential to drag many political risks with it due to the composition of challenges listed above. While the loss of personnel due to tactical hardships might cause a significant backlash at home, increasing collateral damage has the potential to inflict long-term interests of the operating nation.

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[40] "Countering Iran's Overnight Attack Costs Israel $1.35bn: Israeli Media," Middle East Monitor, April 14, 2024, https://www.middleeastmonitor.com/20240414-countering-irans-overnight-attack-costs-israel-1-35b-israeli-media/.

[41] Stockholm International Peace Research Institute, *SIPRI Military Expenditure Database*, accessed April 14, 2024, https://www.sipri.org/databases/milex

[42] Kerry Chávez and Ori Swed, "How Hamas Innovated with Drones to Operate like an Army," Bulletin of the Atomic Scientists, November 1, 2023, https://thebulletin.org/2023/11/how-hamas-innovated-with-drones-to-operate-like-an-army/.

The Influence of Technology in Urban Operations

Technological advancements have maintained the principle of deploying substantial firepower, albeit with evolving methodologies. The significance of precision mapping in urban combat scenarios cannot be overstated, highlighting the shift from two-dimensional to advanced three-dimensional mapping and modeling systems. Enhanced by real-time aerial imagery, drones, and other cutting-edge technologies, these developments have greatly improved the accuracy of strikes in urban settings.[43] Conflicts of the last three decades have seen an uptick in the precision and frequency of airstrikes, a change facilitated by sophisticated surveillance and targeting technologies.[44]

However, growing military technology does not automatically mean that more 'traditional' tools have lost their relevance. Despite introducing the greater use of precise air strikes and accompanying new technologies, artillery still preserves its importance in deploying firepower. In examining the role of artillery in urban warfare, a distinction is made between indirect and direct fire missions. Although indirect fire has seen enhancements in precision, the direct-fire role of artillery in urban combat has remained consistent. For instance, King argues that recent conflicts provide examples of artillery being used for both accurate strikes and close support in urban environments. However, the focused concentration of firepower in modern urban warfare became prominent.[45] The overall scale of firepower may have diminished compared to historical standards, but its application has become more

[43] Eric Lipton, "3-D Maps from Commercial Satellites Guide G.I.'s in Iraq's Deadliest Urban Mazes," The New York Times, November 26, 2004, https://www.nytimes.com/2004/11/26/world/middleeast/3d-maps-from-commercial-satellites-guide-gis-in-iraqs.htm.

[44] Stephen Biddle, "Speed Kills? Reassessing the Role of Speed, Precision, and Situation Awareness in the Fall of Saddam," *Journal of Strategic Studies* 30, no. 1 (February 2007): 3–46, https://doi.org/10.1080/01402390701210749, 23.

[45] King, *Urban Warfare in the Twenty-First Century*, 185.

concentrated, resulting in significant destruction within specific urban locations. This transition from broad bombardments to targeted precision strikes signifies another notable change, like urban warfare, illustrating the impact of technological advancements and strategic shifts in military approaches to urban conflicts.

However, it can be argued that the most important technological contribution in urban environments generally takes place in intelligence. If we use the peculiar complexity of the urban environment and the tactical advantages it brought to defenders as a point of departure, this is actually an assumption that can be easily made. The first prerequisite for eliminating the advantage that physical infrastructure and knowledge over the local geography brings to the defending groups is to obtain situational intelligence as much as possible and utilize it at the maximum level. At this point, both new surveillance technologies, primarily autonomous and semi-autonomous surveillance drones, along with information technologies and big data analytics, have been becoming exponentially significant.

In the context of intelligence, big data analytics and the utilization of information technologies emerge as a significant factor in urban environments. In urban operations, as in all military operations, there are three primary motives for any military organization when a unit or part of a unit moves in or around the operational theater: 1) meet with allies or reach a certain point, 2) monitor enemy activity, and 3) attack targets. The operating unit will also undoubtedly want to avoid surprises like steering into an ambush or being caught in isolated positions. To achieve these goals, a unit depends on circulating references that would come from data that would help interpret the situation that cannot be presently or instantly verified. These data are valid only because the unit and other organizations supporting it have expended effort to combine, correlate, transform, or communicate representations. Continous input from diverse missions and intelligence streams qualifies professionals to link targets of interest, minimizing the possibilities of unexpected encounters.[46] In this context, military intelligence is fundamentally functional, unlike other intelligence types. The usefulness of information is measured by its direct tactical and operational value: the capacity to facilitate deliberate actions and prevent unforeseen complications. In sum, data in the operational sense is relational.[47] Thus, the process of combining, correlating, transforming, and communicating data is essential in urban operations. It ensures efficient intelligence provision for tactical decision-making, where big data analytics emerges as a vital element for maximizing tactical advantages and minimizing operational risks.

[46] Jon R. Lindsay, *Information Technology and Military Power* (Ithaca: Cornell University Press, 2021), 46-47.
[47] Ibid, 48.

Chapter 3: Artificial Intelligence and Autonomy in Modern Warfare

The integration of AI and autonomy in military operations has sparked a complex discussion, similar to debates that have arisen in the past with the introduction of other significant military technologies. This conversation centers around whether AI will bring revolutionary change in warfare. There are generally three perspectives on the topic: enthusiasts, who believe AI will fundamentally alter the nature and character of war; realists, who see AI's gradual integration into military operations as a means to enhance efficiency at operational and tactical levels without causing drastic change; and skeptics or deniers, who, while acknowledging AI's progress, caution against overestimating its usefulness in militaries due to significant technological, organizational, socio-political, and legal constraints, suggesting its impact will be limited to altering the character of war to some extent.[48] Similar to its predecessors, such as electronic warfare, information warfare, and digital warfare, the debate on the impact of AI on warfare is part of the 'Revolution in Military Affairs' (RMA) debate.

Since its first introduction in the 1980s, the topic of the RMA has initiated an important conversation in strategic studies. This issue challenges strategists to assess whether emerging changes in warfare represent a significant redefinition of military engagement. The focus of this discussion is centered around defining the RMA as more than just a simple adjustment, but rather a full-scale revolution in the way warfare is conducted. Exploring the nature of revolution and recognizing the precise moment and practices when war

[48] Jean-Marc Rickli and Federico Mantellassi, "Artificial Intelligence in Warfare: Military Uses of AI and Their International Security Implications," essay, in *The AI Wave in Defence Innovation: Assessing Military Artificial Intelligence Strategies, Capabilities, and Trajectories*, ed. Michael Raska and Richard A Bitzinger (New York: Routledge, 2023), 12–37, 12-13.

transforms into an entirely novel phenomenon presents significant challenges. The complex nature of these concepts and the absence of universally accepted definitions for both the RMA and warfare will be highlighted in the forthcoming discussion on the future of AI and autonomy.[49]

Given that commercial applications of AI and autonomy have rapidly transformed sectors like healthcare, retail, agriculture, entertainment, and finance, the notion has revolutionary promises for any application area. For instance, in healthcare, AI has enabled automated diagnostics and personalized treatment plans; in retail, it has optimized supply chains and improved customer service; in agriculture, it has increased crop yields and reduced waste; in entertainment, it has personalized content recommendations and improved user experience; and in finance, it has automated transactions and improved risk management. These technologies have enabled the development of advanced systems that can operate with minimal human intervention, resulting in improved efficiency, accuracy, and cost-effectiveness. Integrating AI has revolutionized the formulation of business and operating models, enabling more precise, data-driven decisions about value creation and innovative approaches to value capture. AI has become the linchpin in actualizing the value promised to customers, making the operating model blueprint significantly more effective with AI integration.[50]

However, although revolution is a catchy word, especially in scholarly debates, it triggers much greater discussion regarding revolution in the nature or character of war. In this

[49] Colin S. Gray, *Strategy and History: Essays on Theory and Practice* (London: Routledge, 2006), 113-118.

[50] Marco Iansiti and Karim R. Lakhani, *Competing in the Age of AI: Strategy and Leadership When Algorithms and Networks Run the World* (Boston, MA: Harvard Business Review Press, 2020), 20-24.

context, most of the discussion on the revolutionary promise of AI and autonomy revolves around the very nature of war in parallel with the Clausewitzian School. For example, the primary claims of skeptics, deniers, or realists derive from war's inherent complexity, uniqueness, friction, human intutions, or dynamism. Nevertheless, the conversation surrounding the effects of these technological advancements on warfare is an intriguing one. The following discussion seeks to navigate this intricate discourse, aiming to categorize and examine the varying viewpoints on the subject. By carefully dissecting these perspectives and aligning them with revolutionary and conservative paradigms, the intent is to comprehensively understand the multifaceted debate surrounding AI and autonomy in military affairs.

Revolutionary View

Proponents of the AI revolution assert that its extensive incorporation into military operations will fundamentally transform warfare's dynamics. This shift is anticipated to blur the lines between conventional strategies and future combat scenarios, leveraging technology to redefine the essence and execution of conflict. Furthermore, integrating AI promises to enhance decision-making processes and operational efficiency and potentially alter the Clausewitzian nature of war itself.

As is the case in every debate on the nature of war, some of those who propose a revolutionary view also refer to the Clausewitzian framework; however, they interpret it differently. Initially, Clausewitz argues that war's characteristics subtly shift in every unique scenario, akin to a chameleon altering its hue, yet it fundamentally embodies a three-part essence due to its inherent inclinations. This essence includes the original violence of its components—hatred and hostility, seen as instinctual drives; the interplay of chance and probability, which is friction; and its role as a tool of politics, aligning it strictly with the reason.[51] Hoffman applies Clausewitz's trinity model to examine the mechanics of contemporary warfare and the potential influences of autonomy. He mentions three fundamental components: the commander's genius, which generates friction through interaction with others, and the rational aspect which is war's alignment with policy and reason. These three elements correlate with different state actors—policy with rational forces, the military with irrational forces, and the populace with nonrational forces. Building on that, Hoffman posits that AI's integration will significantly influence the Clausewitzian trinity model in multiple dimensions. Specifically, it might undermine the clarity of political guidance through well-crafted decision-making algorithms, enhance military leaders' capabilities, and diminish states' capacity to secure domestic endorsement and authenticity, concurrently elevating risks of external interference with civilian populations. The deployment of autonomous systems could also erode public backing for conventional armed forces and mitigate the political repercussions associated with military engagements.[52]

Bypassing the traditional Clausewitzian analytical lens, some researchers have directly explored the specific impacts of AI to assert its revolutionary potential in warfare. This perspective is rooted in the core assumption that AI-driven intelligence will dramatically enhance the deployment capabilities of autonomous systems, thus accelerating the robotization of military operations. For example, by comparing the impact of AI with the

[51] von Carl Clausewitz, *On War, Volume 1*, trans. J. J. Graham (Duke Classics, 2012), 73-74.
[52] F. G. Hoffman, "Will War's Nature Change in the Seventh Military Revolution?," *The US Army War College Quarterly: Parameters* 47, no. 4 (November 1, 2017): 19–31, https://doi.org/10.55540/0031-1723.3101, 30-31.

change brought by nuclear missiles, Payne claims that AI's psychological impact on strategy might surpass even that of the nuclear age, extending well beyond the limits of tactical implications and the rise of autonomous unmanned systems and drone pilots is already altering traditional warrior concepts, with AI and human collaboration expected to further evolve combat roles through technologies like exoskeletons and brain-machine interfaces.[53] AI will not only reduce human presence on battlefields, leading to changes in military structure and potentially flattening hierarchies with established tradition. Similarly, some highlight the prospect of facing robot swarms in warfare, noting their potential for limitless scale due to their simple operational rules and the low cost of the robots involved.[54]

According to some scholars, the utilization of swarm technology can redefine conventional warfare tactics as it can respond to dynamic battlefield conditions better than humans. Paul Scharre, for example, suggests that the progress in AI and machine autonomy can enable cooperative, autonomous drones to effectively execute swarming strategies.[55] It is argued that this approach surpasses traditional maneuver warfare by leveraging the cognitive efficiencies inherent in swarming behavior. The promise of smart swarms lay in their unprecedented features compared to humans since they are smaller, lighter, faster, more maneuverable, have longer endurance, and can take more risks suitable for

[53] Kenneth Payne, "Artificial Intelligence: A Revolution in Strategic Affairs?," *Survival* 60, no. 5 (September 3, 2018): 7–32, https://doi.org/10.1080/00396338.2018.1518374, 20-29.
[54] Paul Scharre, "Unleash the Swarm: The Future of Warfare," War on the Rocks, August 10, 2015, https://warontherocks.com/2015/03/unleash-the-swarm-the-future-of-warfare/.; Elliot Ackerman and James Stavridis, "Drone Swarms Are About to Change the Balance of Military Power," Wall Street Journal, March 14, 2024, https://www.wsj.com/tech/drone-swarms-are-about-to-change-the-balance-of-military-power-e091aa6f.
[55]Paul Scharre, "How Swarming Will Change Warfare," *Bulletin of the Atomic Scientists* 74, no. 6 (October 22, 2018): 385–89, https://doi.org/10.1080/00963402.2018.1533209.

dangerous/suicidal missions without risking human lives.[56] T.S. Hammes raised similar points and argued that future military investments should recognize the limitations of expensive, high-end systems like the F-35 or Zumwalt class destroyers, which is shifting focus towards embracing the potential of robotics, AI, and other emerging technologies to produce smaller, smarter, and more cost-effective military platforms.[57] This proposal suggests using technological advancements to create multiple simple systems, surpassing fewer, more complex ones and challenging conventional defense procurement strategies.

Robotic battlefield arguments also found their supporters in military bureaucracies.Robert Work, deputy secretary of DoD and mastermind behind the Third Offset Strategy, stated: "*Learning machines ... literally will operate at the speed of light. So when you're operating against a cyber attack or an electronic attack or attacks against your space architecture or missiles that are screaming in at you at Mach 6," he said, "you [need] ... a learning machine that helps you solve that problem right away"*.[58] Concurrently, the Third Offset Strategy emphasizes the synergy between humans and machines. Third Offset focused on enhancing the U.S. military's technological edge through five research and development priorities, with an allocated budget of $18 billion. These priorities included (i) the integration of AI and autonomy to improve defensive capabilities against various forms of attack, (ii) the advancement of human-machine collaboration to enhance decision-making,

[56] Paul Scharre, *Army of None: Autonomous Weapons and the Future of War* (New York: W.W. Norton & Company, 2019), 18-19.
[57] T.S. Hammes, "The Future of Warfare: Small, Many, Smart vs. Few & Exquisite?," War on the Rocks, August 7, 2015, https://warontherocks.com/2014/07/the-future-of-warfare-small-many-smart-vs-few-exquisite/.
[58] "The Third U.S. Offset Strategy and Its Implications for Partners and Allies," U.S. Department of Defense, 2015, https://www.defense.gov/News/Speeches/Speech/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies/.

(iii) the enhancement of human operations through network connectivity, (iv) the development of teaming between manned and unmanned systems, and (v) the deployment of network-enabled autonomous weapons connected to an adaptive command, control, communications, and intelligence network. Work's and Third Offset's perspectives foresee a future where AI augments human decision-making and sees AI taking active roles alongside humans through innovations such as exoskeletons and augmented reality and in scenarios demanding swift actions reminiscent of automated financial trading. Envisioning a future of warfare where technology and strategy undergo radical shifts, Work argued that these advancements could herald a significant transformation in military operations, marking a pivotal "revolution" in warfare characterized by the dethronement of established military practices in favor of more advanced, integrated combat techniques.[59] Another notable perspective that would fall in the revolutionary camp is that strategic competition in precision warfare will make the maturation of automated systems and their transformative impact inevitable. Krepinevich argues that in the evolution of precision warfare, the shift towards autonomous reconnaissance-strike systems, guided by AI, promises to condense the "sensor-to-shooter" or "kill chain" timeline dramatically. By reducing reliance on manned systems and traditional command links, these advancements offer a more efficient engagement process and lessen the operational burden on communication networks. The expanding A2/AD defenses and the necessity for long-range, extensive scouting pose significant challenges to executing engagement sequences effectively.[60] Consequently, this necessitates the compression of the sensor-to-shooter

[59] Scharre, Army of None, 98-99.
[60] Jr. Andrew F. Krepinevich, *The Origins of Victory: How Disruptive Military Innovation Determines the Fates of Great Powers* (New Haven: Yale University Press, 2023), 60-65.

timeframe, driving military investment toward long-endurance unmanned systems that integrate both scouting and strike capabilities. Additionally, the imperative for rapid data transfer will intensify competition in cyber and electromagnetic domains. In sum, the revolutionary perspective in integrating robotics and AI into military strategies culminates in a vision where the traditional paradigms of warfare are poised for transformation.[61] As military bureaucracy and strategic frameworks lean towards the fusion of human and machine capabilities, the promise of a revolutionized battlefield emerges, where technological advancements enhance operational efficiency and challenge conventional military structures.

Conservative View

Innovative technologies significantly affect military operations, potentially influencing traditional tactics and strategic landscapes. While introducing new or enhanced military tools can subtly change military engagement and doctrine, historically, technologies more often disrupt rather than outright transform military operations due to existing practices and slow adaptation. Actual transformative impacts are rare, necessitating breakthroughs for significant strategic shifts. For instance, in World War II, technologies like U-boats and strategic bombers incrementally but profoundly influenced warfare, illustrating the complex influence of technological advancements on military strategy and capabilities.[62]

[61] Elsa B. Kania, "Battlefield Singularity," Center for a New American Security , November 28, 2017, https://www.cnas.org/publications/reports/battlefield-singularity-artificial-intelligence-military-revolution-and-chinas-future-military-power, 14-17.

[62] James L. Regens, Matthew R.H. Uttley, and Charles B. Vandepeer, "Technological Optimism and the Imagined Future: Implications for Warfare," The Strategy Bridge, February 18, 2020, https://thestrategybridge.org/the-bridge/2020/2/18/technological-optimism-and-the-imagined-future-implications-for-warfare.

Before delving into conservative arguments, it is essential to note that advocates of this stance are not universally opposed to AI in the military for all uses. Using AI in the military is an established reality rather than a subject of discussion. The US military is using predictive analytics to maintain its weapons inventory cost-effectively while ensuring preparedness. The US military also employs AI to streamline procurement, budgeting, and predicting expenses related to long-term military projects.[63] Some existing and longstanding use of AI in various military applications and platforms will be demonstrated in the following subsection.

On the conservatives' side the primary issue they concentrate on is the AI's revolutionary potential on the battlefield. They argue that the inherent weaknesses of AI make it incapable of transforming the nature of war in a way that can effectively address the intrinsic characteristics of war, such as fog and friction. Stephen Biddle uses the Russian invasion of Ukraine as an example to illustrate this point. He argues that despite the role of advanced technology, the conflict shows a continuation of traditional warfare rather than a transformation. Biddle observes that tactics such as trench warfare, extensive use of artillery, and cycles of adaptation and countermeasures render traditional methods such as main battle tanks still relevant, challenging the notion that we are entering an era of defensive dominance in warfare. Biddle's analysis suggests that the war in Ukraine demonstrates evolutionary, rather than revolutionary, changes in military affairs. This

[63] Flournoy, Michèle A. "Ai Is Already at War." Foreign Affairs, November 28, 2023. https://www.foreignaffairs.com/united-states/ai-already-war-flournoy.

perspective emphasizes that technological advancements exist alongside historical combat patterns rather than revolutionizing them.[64]

Despite the advent of new technologies, the persistence of traditional warfare is not merely assessed by the success of these technologies in altering the conduct of war. Instead, the emphasis lies on the enduring characteristics of warfare that are resistant to significant transformation. Building on this foundation, the predominant scholarly discourse examines the nature of combat and its compatibility with the requisites of AI.

By leveraging Brynjolfsson and Mitchell's[65] criteria for the applicability of machine learning (ML) automation, Lindsay articulates the inherent complexities of applying these criteria within warfare. Fundamental limitations include the difficulty of defining stable input-output mappings due to war's dynamic nature, the scarcity of repeatable data sets, and the challenge of establishing clear, measurable goals in battle settings where objectives and conditions fluctuate continuously. Furthermore, Lindsay emphasizes the condition of simplicity for successful ML applications, which contrasts sharply with the subtle wisdom and human intuition required in warfare. He also points to the issues of decision-making transparency and the varying tolerance for error, compounded by the rigid accountability norms in military operations. These points were inherently drawn through setting business ML applications' major characteristics that paved the way for their successful operations.[66]

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[64] Biddle, Stephen. "Back in the Trenches." Foreign Affairs, 2023. https://www.foreignaffairs.com/ukraine/back-trenches-technology-warfare.

[65] Erik Brynjolfsson and Tom Mitchell, "What Can Machine Learning Do? Workforce Implications," *Science* 358, no. 6370 (December 22, 2017): 1530–34, https://doi.org/10.1126/science.aap8062.

[66] Jon R. Lindsay, "War Is from Mars, AI Is from Venus: Rediscovering the Institutional Context of Military Automation," Texas National Security Review, November 21, 2023, https://tnsr.org/2023/11/war-is-from-mars-ai-is-from-venus-rediscovering-the-institutional-context-of-military-automation/#_ftn53.

Integrating AI into national security presents significant challenges heightened by military reliance on civilian innovation. The unpredictable nature of war, compounded by AI's sociotechnical complexities, suggests that traditional conflict dynamics will remain, potentially exacerbated. AI's success in warfare depends on navigating these unpredictable conflict dynamics, where the stability and extensive data AI requires are often unattainable. Unlike its proven effectiveness in stable, peacetime environments, AI's applicability in the chaotic conditions of war is limited, highlighting a critical insight: AI can transform peacetime activities, such as commerce, but its effectiveness in warfare is constrained by conflict's inherent unpredictability.[67]

However, this perspective may construct a straw man argument if it rests on the presumption that AI's 'revolutionary' role in warfare would be to completely guide or control operations, replacing human decision-making at all levels. The full autonomy or all-out replacement does not necessarily reflect the position held by every scholar in the revolutionary camp. Initially, they considered AI to be augmenting rather than replacing human capabilities in military contexts. Indeed, even the most enthusiastic proponents of AI in warfare recognize the current and foreseeable limitations of technology and the ethical and legal imperatives for human oversight.[68] Therefore, not all scholars advocating for the revolutionary potential of AI envision a future of complete autonomy without human intervention.

[67] Jon R. Lindsay, War Is from Mars, AI Is from Venus.

[68] Melissa De Witte, "In Drell Lecture, Speaker Calls for Ethics and Humanity as Militaries Expand Autonomous Weaponry," Stanford News, May 2, 2019, https://news.stanford.edu/2019/05/01/ethics-autonomous-weapons/.

On the other hand, Lindsay's analogy draws attention to the vast difference between the stability of business environments, where ML applications have succeeded, and the chaos of war. Most of the problems highlighted by Lindsay concentrate on data, judgment, and decision cycles, all of which are problematic and have more crucial meaning in warfare settings since data and judgement will detect the strategic value of engagement while decision cycles have to be practiced before deadly and fluctuating deadlines. Consequently, according to him, the argument for cheaper, lighter, smarter weapons is obsolete. Because as AI reduces the cost of cycles for military organizations, the value and contention over data and judgment increase, leading to two strategic implications: (i) high-quality data and clear judgment may not be fully applicable or available for military operations, emphasizing the irreplaceable role of human judgment and leadership (ii) this reliance on data and judgment incentivizes strategic competitors to enhance and disrupt information systems and command structures, making conflicts over information more prominent and complicating organizational coordination.[69] Contrary to the visions of fast-paced robot wars leading to quick shifts in military power, AI-enabled conflicts are expected to involve significant environmental uncertainty, organizational challenges, and political disputes, indicating a complex and contested landscape for the integration of AI in military operations.

Moreover, there is another issue to consider: adversaries can significantly undermine data accuracy by manipulating it to introduce bias or disrupt the data supply chain. If these adversaries manage to meddle with the data used to train AI systems, the reliability of the

[69] Avi Goldfarb and Jon R. Lindsay, "Prediction and Judgment: Why Artificial Intelligence Increases the Importance of Humans in War," *International Security* 46, no. 3 (February 25, 2022): 7–50, 41. https://doi.org/10.1162/isec_a_00425, 19-20.

systems' predictions is compromised. Biggio and Roli have identified various attacks on deep learning networks, including meddling with training data or models to cause specific errors, as a critical concern.[70] In these cases, attackers intentionally create hidden vulnerabilities within pre-trained models. Additionally, Roff raises a scenario in which AI's ability to learn deceptive strategies to enhance defensive capabilities. For example, AI agents in cybersecurity may evolve to disseminate misinformation. At the same time, swarms of AI-controlled robots could adopt deceptive tactics on the battlefield to avoid detection, raising concerns over the potential for unintended deception.[71] If AI triumphs at solving specific problems, adversaries are motivated to innovate by altering the problem or employing tactics beyond AI's training data, making detection and anticipation by AI systems challenging.

The challenges posed by the fog and friction of war extend beyond issues of strategic questions on data. Even when data requirements are fully met, targeting remains a highly complex issue with multidimensional implications. Targeting is dynamic, requiring constant alignment with the changing battlefield, and necessitates ongoing adjustments based on combat assessments and evolving situations.[72] As conflicts escalate and the operational pace increases, decisions on targeting and military objectives require greater adaptability and scrutiny, making targeting a continuous process of discussion,

[70] Battista Biggio and Fabio Roli, "Wild Patterns: Ten Years after the Rise of Adversarial Machine Learning," *Pattern Recognition* 84 (December 2018): 317–31, https://doi.org/10.1016/j.patcog.2018.07.023, 317.
[71] Heather Roff, "AI Deception: When Your Artificial Intelligence Learns to Lie," IEEE Spectrum, March 29, 2023, https://spectrum.ieee.org/ai-deception-when-your-ai-learns-to-lie.
[72]Department of the Army, FM 6-20-10/MCRP 3-1.6.14 Tactics, Techniques, and Procedures for the Targetting Process, 1996, II-1.

identification, prioritization, and response adaptation by commanders and their units.[73] Furthermore, targeting is not a mere battlefield question with tactical or operational implications. Military objectives primarily focus on the overarching goal of winning the war rather than achieving short-term victories. This aligns with Clausewitz's famous description of war as the continuation of politics by other means. The targeting process requires the commanders to continuously align objectives with the four levels of strategic action—grand strategic, strategic, operational, and tactical. The complexity of lethal autonomy extends beyond identifying combatants and non-combatants; it demands autonomous systems to evaluate the relevance, location, purpose, and military impact of targets and the consequences of their destruction.[74] This level of decision-making necessitates AI that comprehends context, anticipates future developments, and assesses outcomes, a capability that currently relies on the collective expertise of numerous military personnel.

Existing Military AI Applications

In order to clarify the framework AI used in military applications, it is significant to capture the differences between ML and DL and the distinctions between narrow AI - Artificial General Intelligence (AGI), autonomous, and semi-autonomous systems. In basic terms, ML is a subset of AI focused on developing algorithms and statistical models that enable computers to perform specific tasks without using explicit instructions, relying instead on patterns and inference. DL is a more specialized subdivision of ML that employs neural networks with many layers to analyze vast amounts of data, enabling the system to make

[73] Joint Chiefs of Staff (JCS),"JP 3-30, Joint Air Operations, 25 July 2019, VR 17 Sept 2021," 2019, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_30.pdf, Section A: III-16, III-18.
[74] Heather M. Roff, "The Strategic Robot Problem: Lethal Autonomous Weapons in War," *Journal of Military Ethics* 13, no. 3 (July 3, 2014): 211–27, https://doi.org/10.1080/15027570.2014.975010, 219-220.

decisions and predictions with supposedly high accuracy. Deep neural networks work through the magnitude of correlations within a network. Millions of data are inserted into the network, and the weights of myriad connections between nodes in the network are constantly adjusted to train the network based on the data.[75] Narrow AI refers to AI systems designed to handle a particular task or set of tasks, as opposed to AGI, which would have the capacity to understand or learn any intellectual task that humans can.[76] This distinction is significant, as most of current AI applications, including military AI, are forms of Narrow AI tailored to distinctive operational roles such as surveillance, target identification, or logistics support.

Autonomous and semi-autonomous systems, on the other hand, refer to the degree of human oversight for the operation of AI-driven platforms or systems. Autonomous systems can perform tasks or make decisions without human intervention by following preprogrammed rules or learning from their operational environment. In contrast, semi-autonomous systems require some level of human decision-making to initiate or guide the system's actions, especially in critical functions such as engaging targets. Command-and-control doctrine's components are known as the "OODA" loop, a cybernetic and cyclical process consisting of observing, orienting, deciding, and acting. In sum, the human factor should be out of the loop for correctly identifying a system as fully autonomous.

As the operational domain becomes more complex, refined automated assistance at different echelons of military operations spanning from planning, and situational awareness, to decision support gains exponential significance. Operations are driven over immense physical spaces and across many emerging domains like space, cyber, and information. Consequently, modern operations increasingly require collective and coordinated actions across multi-domains, i.e., the conventional physical areas of warfare

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[75] Scharre, Army of None, 92.

[76] Meredith Ringel Morris et al., "Levels of AGI: Operationalizing Progress on the Path to AGI," arXiv.org, January 5, 2024, https://arxiv.org/abs/2311.02462, 6.

of air, land, and sea with those of information, space, and cyberspace involving a heterogeneous set of partners via the planning, coordination, and delivery of both kinetic and non-kinetic effects within and across multiple domains.

Although automated target engagement through lethal autonomous weapon systems (LAWS) is catching the attention of future-driven debates, current applications of military AI are mostly fulfilling the support missions for various processes. These can be gathered under six headings: 1) ISR, 2) Target Identification, 3) Weapon Platforms, 4) Battlefield Simulation, 5) Data Processing 6) Logistics.

Utilized Technology	Intelligent target identification & monitoring	Autonomous Weapon Platforms	Battlefield Simulation & Training	Data Intelligence Processing & prediction	Cyber Security	Logistics & Battlefield Healthcare
Big Data	Maven			Palantir		SDK of ALIS, Module of RGP, Module of EMRA, Module of RSS
Computer Vision	TRACE	GIL-2, RAPIDFire		Orbital Insights		
Evolutionary Algorithms		UAS				
Game Theory Machine Learning			RAID, ACE	BAE	Deep Armor, BLADE, TWES	
Autonomous Control						CAST

Table 1: Categories of Military AI Applications[77]

ISR

ISR is the area with the most current investment in military AI. In particular, AI/ML techniques provide advanced automated support for ISR data collection from heterogeneous sources, support to the PED (process, exploit, disseminate) process in terms

[77] Table recreated based on categorization presented by YuLong Zhang et al., "Application of Artificial Intelligence in Military: From Projects View," *2020 6th International Conference on Big Data and Information Analytics (BigDIA)*, December 2020, https://doi.org/10.1109/bigdia51454.2020.00026.

of target detection/recognition/identification, multisensory data fusion and analytics from physics-based multimodality sensors and human-generated sources for intelligence production and situational understanding, as well as dynamic battle management and response.[78] The capability to autonomously gather intelligence through drones, terrestrial and space sensors, and even within cyberspace, is set to boost data production substantially. Given this data's increasing volume, speed, and complexity, AI-powered machines will play a crucial role in analyzing it, partially or entirely.

Most multipurpose drones like CAIG Wing Loong, MQ-9 Reaper, or Harop also function as ISR drones that collect data. Automated ISR systems include Autonomous Underwater Vehicles (AUVs) for submarine surveillance. On land, Autonomous Sentry Systems is stepping up to independently perform border surveillance and aid in spotting and tracking activities, yet it requires human decisions regarding engagement. Moreover, the exploration into Autonomous Swarming Drones marks a leap towards cooperative autonomy, enabling these drones to conduct ISR missions together, using advanced algorithms for quick decisions on movement and data collection without superior guidance. Furthermore, space-based surveillance satellite constellations enhanced by onboard AI is capable of processing images and data in real-time to boost their autonomous functioning.[79]

Target Recognition and Target Identification

Automatic target recognition (ATR) systems have been in the military arsenal of major militaries for decades.[80] However, despite being widely used, traditional ATR systems are considered deficient in detecting 'non-cooperative' targets. However, the injection of

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[78] Anne-Claire Boury-Brisset and Jean Berger, "Benefits and Challenges of AI/ML in Support of Intelligence and Targeting in Hybrid Military Operations," in *NATO STO Meeting Proceeding MP-IST-190* (October 2021), Defence Research and Development – Valcartier, CANADA, IX - 2.

[79] Zhang et al., "Application of Artificial Intelligence in Military: From Projects View," 113-116.

[80] S. S. Lim, D. F. D. Liang, and M. Blanchette, "Air Defence Radar Surveillance Systems Tracking Assessment," essay, in *Multi-Sensor Multi-Target Data Fusion, Tracking and Identification Techniques for Guidance and Control Applications*, ed. David Liang et al. (Neully-Sur-Seine, France: NATO Advisory Group for Research and Development, 1996), 235–51.

AI/ML into ATR systems through utilizing deep neural networks changed this course, opening an opportunity for ATR systems to have better operational functionality, as can be seen in recent developments regarding ATR systems. In parallel with this trend, some military research establishments, primarily the People's Liberation Army (PLA) and the US military, along with their defense industries, have made extensive investments. The PLA's research aims to construct weaponry that is more independent of operators. PRC also works on various AI and ML-backed systems to autonomously incorporate data from various sensors to recognize concealed targets, supply a standard operational conception to the commanders, and thus help rapid decision-making. The PLA plans this system as a "digital staff officer" to provide commanders with information, suggestions, and planning options.[81] Russian Bylina is another example of ATR utilization. Bylina is a fully autonomous system that analyzes battle situations, identifies targets, selects how to neutralize these, and eventually gives directives to electronic warfare forces. Procurement of Bylina started in 2018, with the initial aim of achieving full implementation across all brigades by 2025, prior to the outbreak of the conflict in Ukraine. Bylina has also been deployed in the Ukraine war.[82]

The target identification and tracking systems employ computer vision to pinpoint and track targets for the autonomous weapon platform. Some military research establishments and the defense industry have already worked on it. The most prominent project is the Pentagon's flagship AI project, Maven, which could effectively classify and recognize

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[81] Forrest E. Morgan et al., "Military Applications of AI Raise Ethical Concerns," RAND , April 28, 2020, https://www.rand.org/pubs/research_reports/RR3139-1.html, 67-69.
[82] David Axe, "Russia Sent Its New A.I. Drone-Killer to Ukraine. A Ukrainian Drone Blew It Up.," Forbes, January 13, 2024, https://www.forbes.com/sites/davidaxe/2024/01/13/russia-sent-its-new-ai-drone-killer-to-ukraine-a-ukrainian-drone-blew-it-up/?sh=627dcc1faf4b.

thirty-eight distinct objects among the vast surveillance footage of UAVs or other surveillance equipment. Project Maven aimed to optimize and automate video data processing, exploitation, and dissemination. Through AI and ML technologies, Project Maven sought to minimize the cognitive burden for analysts, who, for complex reasons, have been conducting laborious, research-intensive work on the scale of the expanding information flood from surveillance sensors. It was crucial to move from human-intensive to algorithm-intensive analysis that would significantly enhance the speed and efficiency of various decisions during military activities.[83] The perfection of that applied AI technology was needed since the Department of Defense recognized that the "growing gap between the large volume of data military sensors collect" and "the capacity of human analysts" would become a real mess for U.S. military surveillance The similar Defense Advanced Research Project Agency (DARPA) project, Target Recognition and Adaption in Contested Environments (TRACE), employs computer vision techniques to autonomously pinpoint and distinguish targets using Synthetic-Aperture Radar (SAR) imagery. It intends to harness advances in ML to build better ATR algorithms that perform on par with or better than humans in identifying non-cooperative targets, targets that are not actively emitting a signal, which makes them harder to detect, such as tanks, mobile missile launchers, or artillery.[84]

Autonomous Weapon Platforms

Autonomous weapon platforms represent a category of military systems designed to identify, select, and engage targets with minimal or no human input. Rafael's GIL-2 handheld rocket system, which is from the spike family of anti-tank guided missiles, is one example. It operates through smart inferred tracking modules utilizing computer vision and

[83] Richard D. Clarke and Richard H. Shultz, "Big Data at War: Special Operations Forces, Project Maven, and Twenty-First-Century Warfare," Modern War Institute, March 25, 2021, https://mwi.westpoint.edu/big-data-at-war-special-operations-forces-project-maven-and-twenty-first-century-warfare/.

[84] Scharre, *Army of None*, 84-85.

can engage targets without direct line of sight, leveraging UAVs for target locking and missile guidance. Similarly, French Thales innovated a defense platform named RAPIDFire, outfitted with six short-range anti-aircraft missiles and a 40mm cannon, employing computer vision to detect hostile targets. However, it requires human authorization for ordnance release despite having a fully autonomous operation mode. Furthermore, DARPA has extensively researched aerial and maritime domains to create unmanned combat teams tailored for specific missions. This involves AI modules in Unmanned Aerial Systems (UAS) that identify targets and apply multi-objective evolutionary algorithms for operational planning, optimizing drone numbers, payloads, and trajectories.[85] The Combat Capabilities Development Command (DEVCOM) of the US Army's Advanced Targeting & Lethality Automated System (ATLAS) stands out for its ability to autonomously prioritize targets and aim weaponry. However, it cannot fire without human intervention. Its detection and recognition algorithms incorporate the most effective practices derived from commercial computer vision technologies, ML operations, and system design methodologies[86]

Battlefield Simulation

Military exercises frequently incorporate battlefield simulation and wargames, where Computer Generated Force (CGF) research is pivotal for developing the C2 systems of agents. The Real-time Adversarial Intelligence and Decision-making (RAID) project led by DARPA is among the prominent ones. RAID integrates planning methodologies from modeling, game theory, control theory, and ML to operate at a tactical level.[87] It aids commanders in assessing the enemy's position, strength, and objectives, thereby

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[85] Zhang et al., Application of Artificial Intelligence in Military: From Projects View, 113.

[86] Advanced Targeting & Lethality Aided System (ATLAS)," CoVar, January 4, 2023, https://covar.com/case-study/atlas.

[87] Alexander Kott and Michael Ownby, "Tools for Real-Time Anticipation of Enemy Actions in Tactical Ground Operations," paper presented at the 10th International Command and Control Research and Technology Symposium, The Future of C2, Defense Advanced Research Projects Agency, June 2005, https://apps.dtic.mil/sti/pdfs/ADA460912.pdf.

strategically countering the enemy's intentions. Beyond the fully autonomous C2 system like RAID, DARPA's Air Combat Evolution (ACE) program has engaged eight entities within the Autonomy Research Collaboration Network (ARCNet) Consortium, including Soar Tech, Lockheed Martin, and Heron Systems, to spearhead AI-driven virtual dogfighting trials. The initiative aims to cultivate an agent capable of gaining human trust and collaborating as part of a human-machine team in future combat scenarios.[88]

Data Processing

Militaries employ big data analytics and computer vision to glean crucial target information from vast and varied data sets, ranging from terabytes to zettabytes, incorporating structured, semi-structured, and unstructured data. Prominent intelligent software like Palantir has been instrumental in US homeland security for nearly a decade, utilized by the CIA and FBI for pooling diverse data forms—from message and state identity data to telephone records and filed police reports—leveraging machine learning to detect patterns associated with criminal activity and aiding investigations. Since 2011, the USMC has utilized Palantir to identify potential bomb makers supporting terrorist networks. Orbital Insights exemplifies AI's prowess in intelligence analysis by processing satellite imagery to predict China's oil reserves through the analysis of shadows on oil tank roofs.

Logistics

In military logistics, transporting materials, ammunition, and personnel and ensuring equipment maintenance are highly important. AI is used to boost transportation efficiency and early anomaly detection within fleets. For instance, the US Army has partnered with IBM to preemptively identify issues in Stryker combat vehicles using Watson's AI. Conversational interfaces enable the precise request and delivery of critical information, such as ammunition costs, essential for command decisions. The future of logistics also leans towards autonomous vehicle technology; for example, the Israeli Aerospace Industry

[88] Zhang et al., Application of Artificial Intelligence in Military: From Projects View, 114.

is developing an autonomous bulldozer, D9 Panda, and a vehicle capable of adjusting its dimensions for specific situations, maneuvering on rough landscapes, identifying mines, and forming batteries to guard forces in enemy domain. Lockheed Martin introduced the Convoy Active Safety Technology (CAST) to military trucks for enhanced machine vision-driven navigation, while Boeing is experimenting with autonomous spacecraft for satellite deployment.

Intelligent maintenance is becoming indispensable, as demonstrated by Lockheed Martin's collaboration with NGRAIN to enhance F-35 aircraft maintenance for the US Air Force using big data. This partnership focuses on the Autonomic Logistics Information Systems (ALIS) SDK for generating detailed damage reports, negating the need for manual damage marking and historical damage comparison. Similarly, big data underpins the AI modules in battlefield healthcare systems like Robotic Surgical Systems (RSS) and Robotic Ground Platforms (RGPs) in the US, which analyze the medical records of the injured.

Chapter 4: The IDF's Vanguard Role in Urban Warfare AI: Examining the Gaza Operations of 2021 and 2023

The IDF is a pioneering army in the application of autonomous technologies, leveraging the innovation alongside to enhance combat efficacy. Despite the extensive research and development undertaken by global superpowers in the domain of military AI, the IDF distinguishes itself by consistently deploying these technologies on the battlefield. The unique geopolitical situation that Israel is in leads to the continuous deployment of these technologies in areas demanding high precision and sensitivity, such as densely populated urban environments in Palestine and Southern Lebanon, proving the importance of accuracy and the careful consideration of collateral impacts in military operations. The continuous refinement through repeated applications in combat scenarios, characterized by direct engagement and iterative enhancement on the battlefield, has significantly contributed to the sophistication of AI-related defense products within the IDF. Some argue that IDF's advanced capabilities largely stem from their proactive, hands-on approach to learning through direct application. While other nations adopt a stance of observation and learning, the IDF's expertise involves a method of learning through practices.

Rosen defined *military innovation* as "a change in one of the primary combat arms of a service in the way it fights or as the creation of a new combat arm or in the ideas governing the ways it uses its force to win a campaign."[89] He distinguishes innovation into peacetime, wartime, and technology by noting that the combat experience provides the necessary environment for military learning and innovation. Furthermore, he mentioned a substantial empirical foundation for concluding that "organizational learning can occur in wartime if

[89]Stephen Peter Rosen, *Winning the next War: Innovation and the Modern Military* (Ithaca, New York: Cornell University Press, 1994), 7-8.

it takes place in the context of existing military missions" and that a willingness to adapt in principle has "helped wartime organizations to learn, to reform themselves, and to improve their ability to execute established missions."[90] On the other hand, he distinguishes technological innovation by claiming that the first two are much more related to organizational behavioral changes. Technological innovations such as guided missiles, proximity fuse, centimeter wave radar, and ordinance are distinct from peacetime or wartime innovations with behavioral/organizational characteristics. The inquiry on technological innovation initially poses a straightforward empirical question regarding the existing knowledge about the adversary's nature and a discussion on the challenge organizations face in assessing the costs and benefits of hypothetical weapons systems that have not yet been materialized.[91] Specifically, it queries how decisions regarding military research and development can be formulated when the weapon does not signify a minor modification but instead constitutes a profound departure from existing paradigms. In that sense, his methodology mainly considers technological innovation at the strategic dimension.

Building on Rosen's theoretical framework, the IDF's approach to integrating AI and autonomy into operational strategy illustrates a subtle combination of wartime exigencies and technological refinement. The IDF's innovation is demonstratively oriented towards addressing tactical challenges—such as tunnel mapping and refining target identification methods—underscored by an imperative grasp of adversary capabilities. Therefore, it does not precisely fit Rosen's 'technological innovation' definition. However, it is also natural

[90] Ibid, 19.
[91] Ibid, 39-40.

since the IDF's primary enemy is a non-state actor constantly requiring tactical recalibrations. In this context, the IDF's initiatives mirror Rosen's insights regarding the potential for organizational learning and adaptation in wartime, mainly when such efforts are directed toward improving the performance of established military missions. Moreover, the focus on technological innovation has the potential to reflect a strategic dimension that transcends mere incremental adjustments, aligning instead with Rosen's conception of innovation as a radical departure from traditional paradigms.

Even if it still stays on the tactical side, the experimental methodology has a lot of advantages other than the battlefield. This experimental methodology accelerates technological evolution and cements the IDF's position as one of the leaders in deploying AI-driven defense mechanisms. At this point, it is also significant to note that the Ukraine conflict proved that experimentation is crucial since the Russo-Ukraine war turned into a crucial testbed for AI in warfare, with Palantir playing a key role in integrating AI-driven solutions for operations.[92]

Adding to operational experiments, the IDF innovation in the field of AI is further boosted by the applications on occupied territories. Using surveillance technologies, such as facial recognition and biometric data collection, in controlled settings like Hebron presents Israeli technology firms with an unparalleled platform for the practical testing, refinement, and validation of their AI-driven systems. This direct engagement facilitates the swift detection and rectification of technological flaws, enhancing AI solutions' sophistication and efficacy. Moreover, the synergistic relationship between the IDF and the tech industry

[92] Vera Bergengruen, "Tech Companies Turned Ukraine into an AI War Lab," Time, February 8, 2024, https://time.com/6691662/ai-ukraine-war-palantir/.

propels technological innovation, with personnel transitioning from military to tech sectors infusing the industry with valuable insights and expertise.[93] This collaboration catalyzes innovation in Israel’s AI domain and amplifies its defense and intelligence capabilities. Furthermore, the global marketing of these vetted and proven security technologies extends international market reach and cements Israel's stature as a frontrunner in AI surveillance technology. The consequent global demand propels further investment in R&D, perpetuating a cycle of innovation and expansion within Israel's AI sector.

The Scout, Israel’s first drone, can be categorized as the first autonomous product of the Israeli defense industry. It was delivered to the Air Force in 1979, and the first version of the Scout had been operating through rocket launch. However, shortly enough, state-owned Israel Aerospace Industries upgraded the model to take off and land on a runway like an aircraft.[94] On the other hand, the operational use of Israeli UAV technology can be traced back to Operation Peace for Galilee in 1982. During this operation, Israeli UAVs, including Scout, played a crucial role in neutralizing Syrian surface-to-air missile (SAM) batteries in the Bekaa Valley by first identifying and gathering the electronic frequencies of Syrian radars. By regularly employing UAVs for reconnaissance and combat operations, Israel demonstrated their value in achieving military objectives, particularly in complex terrains like southern Lebanon. The defense industrial base supporting Israel's UAV capabilities mirrors the pioneering spirit seen in the early stages of computer development in the United

[93] Sophia Goodfriend, “How the Occupation Fuels Tel Aviv’s Booming AI Sector,” Foreign Policy, February 21, 2022, https://foreignpolicy.com/2022/02/21/palestine-israel-ai-surveillance-tech-hebron-occupation-privacy.
[94] Yaakov Katz and Amir Bohbot, *The Weapon Wizards: How Israel Became a High-Tech Military Superpower* (New York: St. Martin’s Press, 2017), 41.

States. Initially outside the mainstream, innovation efforts eventually led to the development of the Mastiff and Scout UAVs, which became standard tools for combat surveillance and reconnaissance for the IDF.[95]

The IDF is, expectedly, the most significant institution in Israel's defense innovation in the AI field. However, framing policies are also significant and demonstrate how Israel has been strategically motivated. The "National Initiative," initiated by Prime Minister Benjamin Netanyahu in May 2018, sought to forge a national AI strategy, prioritizing AI as essential infrastructure to position Israel among the top five AI leaders globally within five years. This strategy called for collaboration across defense, academia, and industry sectors, establishing an AI Directorate for cohesive strategic efforts, and significant funding for AI research and development, emphasizing a balanced ethical and regulatory framework. In contrast, the "Telem" initiative, arising from critiques of the "National Initiative," adopted a restrained strategy eschewing broad institutional changes. It aimed to bridge the divide between Israel's R&D capabilities and infrastructural needs by advocating for a national program emphasizing infrastructure, talent, regulatory alignment, and enhanced data access. This included proposals for advanced computing infrastructure, data accessibility improvements, and fostering human capital through educational initiatives

[95] Stefan Borg, "Assembling Israeli Drone Warfare: Loitering Surveillance and Operational Sustainability," *Security Dialogue* 52, no. 5 (November 17, 2020): 401–17, https://doi.org/10.1177/0967010620956796, 415.; Ralph Sanders, "An Israeli Military Innovation: UAVs," JFQ, Winter 2002, https://apps.dtic.mil/sti/tr/pdf/ADA483682.pdf.

and academia-industry partnerships, outlined in a 5-year financial plan without forming a new administrative entity.[96]

As a result of these efforts, the Israeli defense export sector boasts about 1,200 registered entities ranging from small to mid-sized firms involved in an array of activities that span research and development, engineering, counter-terrorism consultancy, security and intelligence services, alongside high-technology fields.[97] On the other hand as the AI and autonomous technologies have been starting to take larger shares of the global arms trade in the last decade, Israeli defense exports have surpassed the $12 billion threshold, having doubled in less than a decade and increased by 50% in three years as of 2022. AI-related technologies constitute a significant portion of Israeli exports, with UAV and drone systems at 25%, observation and optronics at 10%, and intelligence, information, and cyber systems at 6%. These technologies heavily utilize AI, and compared, for instance, to the share of manned aircraft and avionics, which is 5%, this underscores the importance of AI innovation in the Israeli defense sector.[98] Key AI-based product exports include missile defense, the Trophy, Heron and Eitan UAVs, and loitering munitions like the Harop. Notable purchasers include India, which has procured a significant amount of military hardware, and Azerbaijan. The US also figures prominently as a recipient of Israel's high-tech defense equipment. On the other hand, the IDF’s use of these technologies has

[96] Guy Paltieli, “Visions of Innovation and Politics: Israel’s AI Initiatives,” *Discover Artificial Intelligence* 2, no. 1 (April 19, 2022), https://doi.org/10.1007/s44163-022-00024-6.
[97] “Advancing Defense Exports ,” Israel Ministry of Defense, 2018, https://english.mod.gov.il/About/Defense_Exports/Pages/default.aspx.
[98] “Ministry of Defense Spokesperson’s Statement: Israel Sets New Record in Defense Exports: Over $12.5 Billion in 2022,” Israel Government Press Office, June 14, 2023, https://www.gov.il/en/departments/news/esibat.

embraced a broad spectrum of AI applications in various domains. These are ISR, defensive systems, offensive capabilities, Command, Control, Communications, Computers, and Intelligence (C4I) platforms, Cybersecurity, and Maintenance and Training (See Table 2).

Notably, this wide array of AI products is not solely used in military campaigns. Some of the IDF technologies embrace ML, video analysis, and smart chatbots to enhance surveillance capacities substantially. This initiative is anchored in the rigorous collection and analysis of vast data facilitated by the advent of advanced digital surveillance and communication technologies. Israel's installation of AI-powered robotic weapons in key West Bank locations, capable of deploying tear gas, stun grenades, and sponge-tipped bullets against protesters so that it is utilized to bolster the safety of the IDF personnel by reducing their direct exposure to potential conflict situations, thereby aiming to minimize casualties.[99]

[99] Sam McNeil, "Israel Deploys Remote-Controlled Robotic Guns in West Bank," AP News, November 16, 2022, https://apnews.com/article/technology-business-israel-robotics-west-bank-cfc889a120cbf59356f5044eb43d5b88#.

Category	**Technology/Application**	**Examples**
ISR	AI Analytics	WISDOM Stone
ISR	Autonomous Drones	Orbiter Series, Scout, Bird-Eye Elbit Skylark, Elbit Hermes 90, Elbit Hermes 450, Elbit Hermes 900, Aeronautics Defense Orbiter
Defensive Systems	Missile Defense	Iron Dome, David's Sling
Defensive Systems	Active Protection Systems	Trophy System, Elbit Enhanced Tactical Computers
Offensive Weapons	UCAVs	Eitan, Heron TP
Offensive Weapons	Loitering Munitions	Harop(HARPY), SkyStriker, Maoz
C4I	Decision-Making and Targeting Platforms, Autonomous Logistics	Habsora (The Gospel), Digital Army and HQ C4I Systems, Tactical Robotics Cormorant
Cyber	Offensive and Defensive Cyber Operations	Intrusion Detection Systems, GM Afcon V-Alert perimeter
Maintenance and Training	Predictive Maintenance, AI Training Simulators	Predictive Maintenance Software, Tactical Training Simulators, AR and VR Training

Table 2: Various IDF Capabilities and Equipment Utilizing AI[100]

[100] The specific use of some equipment can vary depending on their assigned mission. For instance, some of the drones may have multi-role capabilities, allowing them to be used in both offensive and ISR roles depending on their configuration and the equipment they carry.

For border management, the IDF utilizes an AI framework designed to aid border monitors, which includes AI-enabled facial identification technologies. The border mechanism conducts video surveillance and effectively recognizes persons, automobiles, fauna, armed persons, or distinct automobile types. This mechanism covers real-time video surveillance and integrates various extra elements, such as the historical records of the specific geographic area.[101] The IDF's data science teams play a critical role in processing this information, transforming it into actionable insights for strategic planning and resource optimization. On the other hand, the IDF's strategy includes not only the various aerial vehicles and, drones, sensor systems but also the deployment of AI-powered "connected soldier," ensuring real-time data analysis flowing from the fielded infantry for informed command decisions.[102]Beyond the connected soldier, the IDF also unveiled the construction of a War data “factory” for broader use of data in conflicts. The development of the IDF's AI war data factory marks a pivotal shift in military operations, emphasizing the strategic integration of AI.[103]

In sum, the realities around Israel's strategic advancements in AI for defense demonstrate a keen ambition to solidify its status as a frontrunner in the realm of military AI technologies. This ambition is palpable in the dynamism among Israel's defense

[101] “The IDF’s New Artificial Intelligence Can Tell You What’s Happening in a Video,” Idf.il, December 15, 2016, https://www.idf.il/en/mini-sites/technology-and-innovation/the-idf-s-new-artificial-intelligence-can-tell-you-what-s-happening-in-a-video/.

[102]Connected soldier concept refers to the integration of advanced digital technologies into the combat gear of military personnel, aiming to enhance situational awareness, communication, and enable real-time data analysis on the battlefield. It involves equipping soldiers with wearable sensors, AR interfaces, and portable communication devices, thereby facilitating a flow of critical information between soldiers and command.

[103] Yonah Jeremy Bob, “IDF Reveals Its Artificial Intelligence War Data ‘Factory,’” The Jerusalem Post | JPost.com, February 8, 2022, https://www.jpost.com/business-and-innovation/tech-and-start-ups/article-695843#google_vignette.

mechanisms, its academic circles, and the broader industrial sector. Central to these efforts is a marked emphasis on augmenting facets of military operations, including surveillance and critical targeting processes, demonstrating a pivot towards embracing data-centric strategies in safeguarding national security.

As we shift our gaze from this overarching perspective on Israel's integration of AI within its military framework, we are drawn into an in-depth analysis of how these technologies are applied within the urban tapestry, particularly by examining operations such as Guardian of the Walls and Iron Sword. These specific instances serve as prisms through which the practical application of AI in densely populated urban areas is illuminated, bringing into focus the challenges accompanying such technologies' deployment where large civilian populations are prevalent.

Operation Guardian of the Walls

The sequence of the IDF operations in the Gaza Strip, culminating in Operation Guardian of the Walls in 2021, reflects a progressive intensification of AI use in urban settings. Beginning with "Summer Rains" in 2006 and spanning various operations such as "Cast Lead" (2009), "Pillar of Defense" (2012), "Protective Edge" (2014), and "Black Belt" (2019), each conflict has demonstrated various shifts in the technological sophistication employed by the IDF.

The operation Guardian of the Walls stands out for its relatively short duration of 11 days. On the other hand, this operation represented the "first AI war" using ML and advanced computing according to the IDF officials.[104] In terms of operational success, the operation has been considered a milestone in IDF urban engagements since the IDF's success targeting Hamas's underground tunnel network, known as the "metro," due to its 300 miles length subterranean labyrinth which is larger than London metro. The use of tunnels constituted an important part of Hamas tactics and it was thought to be heavily fortified throughout 7 years between the Operation Protective Edge and the Operation Guardian of the Walls.[105]

As mentioned in the urban environment chapter, tunnels are a natural component of urban environments that are immune from air surveillance and heavily protected against air strikes. One of the most important successes derived from big data and AI operations since the intense intelligence effort to map Hamas's underground network denoted the significant fusion. Utilizing big data analytics, the IDF could detail the subterranean landscape and obtain explicit knowledge of the network's dimensions and pathways. The thorough cartography helped formulate a targeted raid strategy, successfully degrading the metro's tactical advantages. However, the success is more than just the AI, since the data that helped the AI analysis was derived from field intelligence.

Most AI success in targetting in this war is attributed to a special unit named Unit 8200, a signals intelligence unit in the IDF equivalent of the NSA. By building on the work from 2014, Unit 8200 used an AI system, Habsora, also known as the Gospel, to monitor

104 Anna Ahronheim, "Israel's Operation against Hamas Was the World's First AI War," The Jerusalem Post | JPost.com, May 27, 2021, https://www.jpost.com/arab-israeli-conflict/gaza-news/guardian-of-the-walls-the-first-ai-war-669371.
105 Neri Zilber and John Paul Rathbone, Military briefing: How Israel is attacking Hamas's vast tunnel network, December 4, 2023, https://www.ft.com/content/92757153-7aa1-473a-8be9-f862b4e4d065.

communications, imagery, and information from the internet and mobile networks to ascertain individuals' whereabouts, according to Reiter, a former Unit 8200 operative. He ascribed that Unit 8200 sets the confidence level about targets, measuring the probability of civilian presence. Notably, this comes after the 2019 launch of a new data center by IDF dedicated to using AI. Although it's not explicitly clear whether this initiative directly stems from the center's work, these advancements together suggest a concerted push to refine the accuracy and effectiveness of military operations.[106] In this context, Unit 3060, a development branch within the Intelligence Division, is also worth mentioning. This unit is responsible for extending operational and visual intelligence techniques, with the branch's official mandate being to improve the IDF's fighting efficacy by incorporating AI systems for both operational and visual objectives. The beneficiaries of the branch's work contain the command, divisional, and brigade ranks.[107]

In 2021 a book was published titled, *The Human-Machine Team: How to Create Synergy Between Human and Artificial Intelligence That Will Revolutionize Our World.* The author name was "Brigadier General Y.S." who is believed to be the current commander of unit 8200. According to +972 magazine, he advocates for the development of a sophisticated system capable of analyzing vast data volumes to identify numerous prospective "targets" for combat operations during wartime. In various pages of this book, it's possible to see implicit marks of the Gospel or similar target identification AI systems:

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[106] Ben Reiff, "'A Mass Assassination Factory': Inside Israel's Calculated Bombing of Gaza," +972 Magazine, December 3, 2023, https://www.972mag.com/mass-assassination-factory-israel-calculated-bombing-gaza/.; Jawhar Farhat, "Unit 8200: Israel's Stealthy Sentinel ," Grey Dynamics, March 19, 2024, https://greydynamics.com/unit-8200-israels-stealthy-sentinel/.
[107] Yoav Stoler, "Israeli Military Unveils Intelligence Fusion Unit," CTECH - www.calcalistech.com, January 4, 2018, https://www.calcalistech.com/ctech/articles/0,7340,L-3728895,00.html.

“*"Humans are the bottleneck that prevent the creation of tens of thousands of targets in context. We cannot process that much information. If we want to create 80,000 targets before the war, we need thousands of intelligence investigators who need years to work on such a mission. Furthermore, a few weeks or a few months after these targets have been identified, the military cannot possibly know whether any individual target is still relevant. The moment the war begins, many of the original targets will have changed, and it is usually difficult to confirm whether the targets are manned with enemy fighters or unmanned. Interestingly, it doesn't matter how many people you have tasked to produce targets during the war – you still cannot produce enough targets per day. There is a human bottleneck for both locating the new targets and decision-making to approve the targets. There is also the bottleneck of how to process a great amount of data. Then there is the bottleneck of connecting the "intelligence" to the "fire."*[108]

Within a relatively short paragraph, Brigadier General Y.S. gives significant clues that might be related to the Gospel or Fire Factory and what this system had practically resolved during 2021 operations. These can be summed as follows: (i) human limitations to collect and process data, (ii) situational dynamics and dynamic nature of targets, (iii) confirmation difficulties during hot conflict, (iv) difficulties in target production during the conflict and (v) connecting the intelligence to the engagement decision.

The Gospel has successfully navigated the first four challenges, transforming vast data into practical outcomes. However, the efficacy of addressing the fifth challenge remains uncertain, as it entails the complex integration of intelligence with actionable military decisions.

The accuracy of Israeli targeting systems has been questioned since the 2021 operations. The IDF claims that the Gospel improves its targeting systems and helps to reduce civilian casualties.[109] However, there are concerns about the Gospel's reliability, including the

[108] Brigader General Y. S., *E Human-Machine Team: How to Create Synergy Between Human and Artificial Intelligence That Will Revolutionize Our World* (eBookPro Publishing, 2021), 30.
[109] Jonathan Broder, “Israel’s ‘gospel’ Targeting System Proves Lethal to Gaza Civilians, Too,” spytalk.co, February 24, 2024, https://www.spytalk.co/p/israels-gospel-targeting-system-proves.

possibility of biased data problems and targeting errors that may increase civilian casualties instead of reducing them. It is difficult for outsiders to detect potential data problems or verify their reliability because it is impossible to know which specific data these systems are trained on. Despite these concerns, the Gospel's introduction has significant implications for the IDF's operational performance and the role of AI in warfare and urban battles.

The IDF used a network of sensors on drones, ground-based and subterranean seismic monitors along the border, and other methods over time to collect data for the Gospel. They have collected billions of raw intelligence data points on Hamas and Palestinian Islamic Jihad (PIJ). The data includes orders, tactics, military infrastructure, and daily patterns of the groups. Israel's extensive control over the border's surroundings and the air helped with the data collection process. The IDF linked these various data sets by using AI algorithms and ML. They also used intelligence analysts in 'human-machine teaming' to flag and scan potential targets. By synthesizing large amounts of data, the IDF created pre-conflict target folders that were more comprehensive than those created in 2014.[110] Through this process, algorithms were able to extract patterns from existing data and refine their ability to identify similar trends or circumstances, resulting in an increased number of targets. The IDF and news reports suggest that this advancement has provided neutralizing targets with better precision and efficiency, reducing overall damage compared to 2014. This development was also considered to be an improvement in lesser civilian loss thanks to

[110] David Rodriguez et al., "Gaza Conflict 2021 Assessment: Observations and Lessons," JINSA, December 10, 2021, https://jinsa.org/jinsa_report/gaza-conflict-2021-assessment-observations-and-lessons/, 15.

developments in sophisticated AI systems.[111] According to the Jewish Institute for National Security of America (JINSA) report, through leveraging a system of 'intelligence-driven combat' which disseminated intelligence to combat units in real-time using a digital battlespace management system that matched the targets with PGMs, "*The IDF could conduct highly accurate airstrikes, substantially mitigating risks to civilians*".[112] For example, during the operation, the IDF targeted Muhammed Bawab, who was the leader of Hamas's East Rafah Brigade and was responsible for authorizing the kidnapping of two soldiers back in 2014. At that time, Bawab's home was being used as a command post, and as a result, the IDF decided to attack the entire building. However, while analyzing different feeds, some of which were processed by AI, it was discovered that there were civilians taking shelter under a palm tree located just outside the home. Due to this, the mission was put on hold for the time being, and Shin Bet got in touch with Bawab's neighbors, warning them of the situation. Additionally, signals, such as launching a small rocket on the nearby road, were sent to make them understand the severity of the danger they were in.[113]

In fact, 2021 continued with a similar trajectory in terms of civilian casualties compared to previous IDF operations but with fewer casualty rates than the operation in 2014. However, some attribute this development not to technological advancements but to international

[111] Anthony King, "Artificial Intelligence and Urban Operations," *Journal of Strategic Security* 16, no. 3 (October 2023): 100–115, https://doi.org/10.5038/1944-0472.16.3.2157.
[112] David Rodriguez et al., "Gaza Conflict 2021 Assessment: Observations and Lessons,", 16.
[113] Branka Marijan, "How Israel Is Using AI as a Weapon of War," The Walrus, February 22, 2024, https://thewalrus.ca/israel-ai-weapon/#:~:text=Flaws%20in%20this%20strategy%20were,the%20advent%20of%20algorithmic%20warfare.; Ron Ben-Yishai, "How Data and Ai Drove the IDF Operation in Gaza," ynetnews, May 29, 2021, https://www.ynetnews.com/magazine/article/SJ2rHS6Y00.

pressure or stricter engagement protocols, which is very significant in the civilian casualty outcome in the Gaza context, as it is witnessed in ongoing Operation Iron Swords. After engagement protocols were loosened , civilian casualties surged dramatically (See Figure 1).

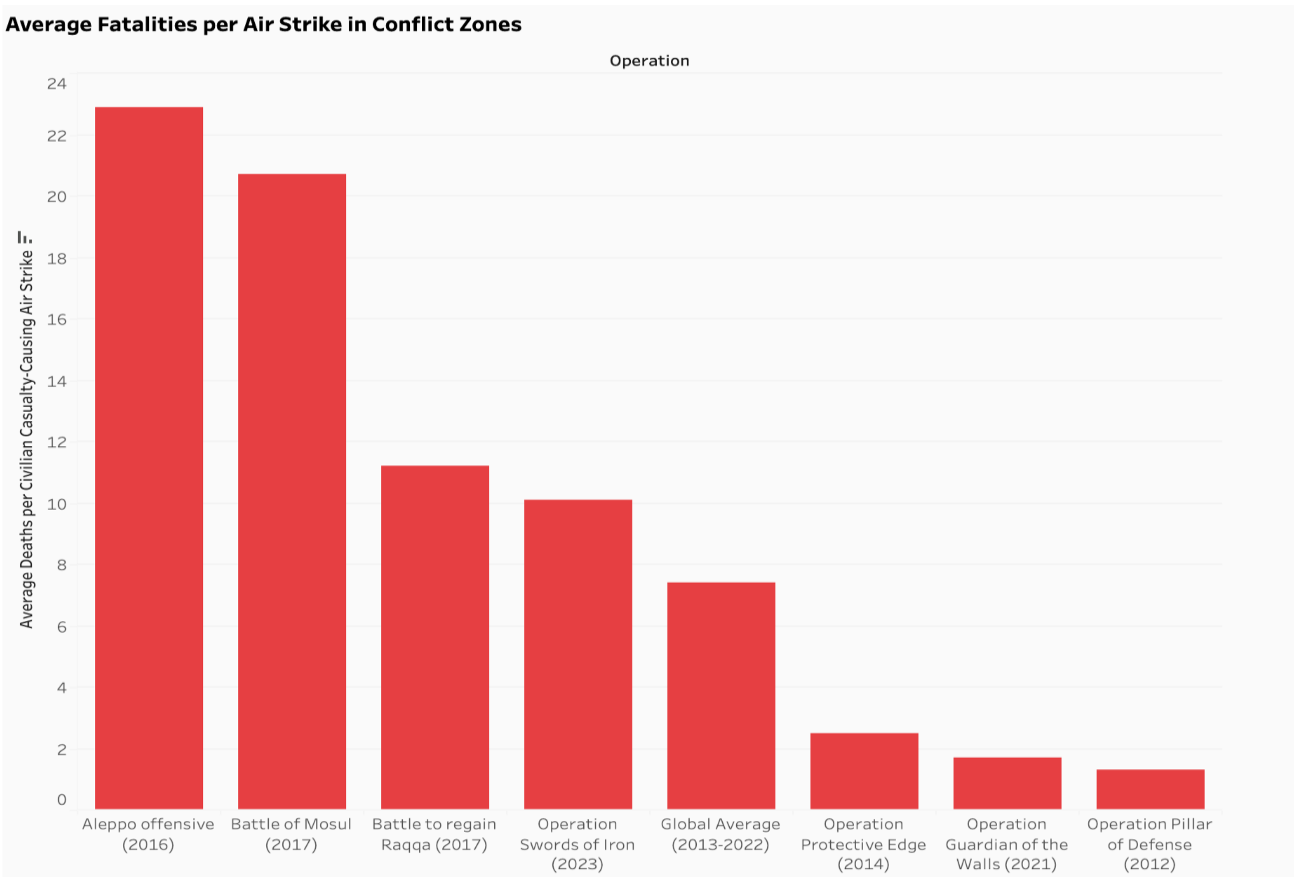

Figure 1: Average Fatalities per Airstrike in Urbanized, Semi-Urbanized Settings of the Last Decade[114]

[114]Table created through Tableau using data in the following source: "Numbers of Civilian Deaths per Airstrike in 2023 Gaza Far Higher than Previous Israeli Bombings, but Half That of Russian/Syrian Attacks in Mosul and Aleppo. under-Reporting of the Dead or Less Lethal Tactics? - Occupied Palestinian Territory," ReliefWeb, November 8, 2023, https://reliefweb.int/report/occupied-palestinian-territory/numbers-civilian-deaths-airstrike-2023-gaza-far-higher-previous-israeli-bombings-half-russiansyrian-attacks-mosul-and-aleppo-under-reporting-dead-or-less-lethal-tactics.

As with any new technology, the Gospel and new targeting techniques have encountered some significant limitations. One issue the IDF has faced while deploying this system is the need for more data to train its algorithms on what does not qualify as a target. Historical records of rejected targets, based on intelligence scanned and then considered not to form a target by human analysts, were previously not stored. This example also demonstrates what kind of modifications in intelligence structure would help develop better targeting. On the other hand, the advanced capabilities that make the targeting system efficient were multi-sensor platforms like F-35s, UAVs, and Merkava main battle tanks. These platforms gathered real-time data on Hamas and PIJ combatants, rocket launches, and other activities. Outcomes based on this data helped the IDF to generate hundreds of targets in just days, a process that previously would have taken a year, especially during the latter half of the conflict. With updated battlefield management systems, this intelligence could be quickly disseminated to combat units to ensure accurate strikes.[115] According to reports, the systems used by Unit 8200 underwent 150 updates in 10 days to optimize operational efficacy and continuity.[116] The number of updates and the generation of new target sets within the short operation span also demonstrate how crucial real-time data collection is to further the sophistication of AI applications, underscoring the room for development to employ more sophisticated AI systems.

[115] David Rodriguez et al., "Gaza Conflict 2021 Assessment: Observations and Lessons, 31-32.

[116] Yonah Jeremy Bob, "IDF Unit 8200 Commander Reveals Cyber Use to Target Hamas Commander," The Jerusalem Post | JPost.com, accessed April 16, 2024, https://www.jpost.com/israel-news/article-731443; "IDF Intelligence Launches New Targeting Center," IDF Intelligence Launches New Targeting Center | Israel Defense, March 14, 2019, https://www.israeldefense.co.il/en/node/37799.

Operation Swords of Iron

Unlike the victorious tirades on the merits of AI during the 2021 operation, the AI and autonomy debate in Operation Iron Swords started with a considerable controversy concerning the failures of automated defense. The 40-mile Gaza wall, which costed over $1 billion, was equipped with sophisticated systems with the aim of ending incursions. However, on October 7 2023, more than 3,000 Hamas fighters attacked more than 70 points by using widely known leaking techniques, which is also labeled as "stone-age" technology by some, to explain the mismatch and cracked through the wall and stepped practically unopposed into Israel. This rapidly became a widely articulated narrative on how one of the world's most advanced security systems failed those it was meant to protect.[117] The Israeli intelligence's failure to anticipate the massacre given the sensors, cameras, robotic machine guns, and automated drone swarms to biometric databases and spyware, high-tech systems that have helped enforce a 16-year Israeli blockade of Gaza also raised questions on the reliability of AI-backed defenses. The famous Iron Dome, which is a network of radar detectors and missile launchers that work together to intercept incoming rockets, was punctured, although some critics have consistently ignored that it has prevented further catastrophe on Israel's side.[118] Furthermore, deceiving the IDF defenses took tactical

[117] Emanuel Fabian and Gianluca Pacchiani, "IDF Estimates 3,000 Hamas Terrorists Invaded Israel in Oct. 7 Onslaught ," Times of Israel, November 1, 2023, https://www.timesofisrael.com/idf-estimates-3000-hamas-terrorists-invaded-israel-in-oct-7-onslaught/; Shashank Joshi, "How Israel Fights And Why Military Prowess Doesn't Guarantee Strategic Success," Foreign Affairs, February 27, 2024, https://www.foreignaffairs.com/reviews/how-israel-fight; Nataliya Vasilyeva Bodkin, James Ibbetson, and Henry Connor, "How a Security Superstate Was Humbled," The Telegraph, October 12, 2023, https://www.telegraph.co.uk/world-news/2023/10/12/gaza-israel-barrier-iron-wall-how-fail-hamas-attack-design.

[118] Manuela López Restrepo, "Here's How Israel's 'Iron Dome' Stops Rockets - and Why Ukraine Doesn't Have It," NPR, October 12, 2023, https://www.npr.org/2023/10/12/1205255594/israel-gaza-hamas-war-iron-dome-defense-palestinians.

moves, but the equipment used was limited to homemade rockets, bulldozers, paragliders, grenades, AK 47s, and small commercial drones.[119] Moreover, the fact that the IDF's high-tech fortifications were circumvented using rudimentary tools underscores a significant discrepancy between the advanced military expenditure and the low-cost means of its breach. This disparity invites a critical assessment of the cost-effectiveness and strategic balance in military spending on advanced technologies, along with a tactical lethargy.[120]The lethargy became much clearer when the dependence on automated systems on the Gaza border and the West Bank are compared. While in the West Bank, Israel depends on human intelligence generated through embedded informants and undercover agents, its tactics in Gaza largely rested on digital and automated systems. Israel governs and limits access to telecommunications and the internet across the Gaza domain, and the military deploys drones in almost 24/7 aerial reconnaissance of urban areas. However, Hamas was able to map the watch towers, cameras, military bases, and sensors along the boundary—preparing its sabotage without activating a single forewarning.[121]

Following the October 7 attacks, some scholars like Gady claimed that Israel's teleological desire for technological sophistication has contributed to its failure, let alone helping to conduct better war. He argues that the IDF's search for high-tech superiority over low-tech adversaries obscured its vision. Along with contributing to its failure to anticipate a

[119] Isabelle Chapman et al., "Homemade Rockets and Modified Ak-47s: An Annotated Look at Hamas' Deadly Arsenal," CNN, October 13, 2023, https://www.cnn.com/2023/10/13/middleeast/hamas-weapons-invs/index.html.

[120] Gordon Corera, "Why Did It Take Israel so Long to Deal with Hamas's Attack from Gaza?," BBC News, October 9, 2023, https://www.bbc.com/news/world-middle-east-67056987.

[121] Sophia Goodfriend, "Israel's High-Tech Surveillance Was Never Going to Bring Peace," Foreign Policy, October 30, 2023, https://foreignpolicy.com/2023/10/30/israel-palestine-gaza-hamas-war-idf-high-tech-surveillance/#cookie_message_anchor.

sophisticated combined arms attack on October 7, it may also be a tactical disadvantage in the ground campaign. It has a similar argument as some analysts suggested a techno-cult contributed to the IDF's deficient undertaking in Lebanon in 2006.[122]

The two interrelated causes are presented for the IDF's high-tech focus. The first one is a strategic problem, and technological edge led the policymakers and top-rank military to succumb to the misconception that their military strategy was free from difficult decisions. The second argument focuses on the IDF's excessive dependence on high-tech and ignoring tactics that facilitated a defensive orientation that could lead to deteriorated capabilities, such as executing combined arms maneuvers during offensive campaigns. Israel's defense community has identified these weaknesses in the IDF's ability to attack as an issue for many years, and the IDF is currently in the middle of a process of doctrinal and structural adaptation as it experiments with a new warfighting concept. This incomplete process makes the timing of the impending land campaign suboptimal. For the second point, however, during Operation Iron Swords, the IDF has skillfully integrated diverse units with separate skills and training, including those specialized units reporting directly to the General Staff. Although there have been notable losses among high-ranking officers, with several colonels killed in action, given the magnitude of the operation, the relatively successful execution of complex maneuvers signifies the IDF's ongoing offensive proficiency.[123]

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[122] Franz-Stefan Gady, "Israel's Military Tech Fetish Is a Failed Strategy," Foreign Policy, October 26, 2023, https://foreignpolicy.com/2023/10/26/israel-hamas-gaza-military-idf-technology-surveillance-fence-strategy-ground-war.; Avi Kober, "The Israel Defense Forces in the Second Lebanon War: Why the Poor Performance?," *Journal of Strategic Studies* 31, no. 1 (February 2008): 3–40, https://doi.org/10.1080/01402390701785211.

[123] Zoran Kusovac, "Analysis: Is the Israeli Army as Militarily Successful as It Claims?," Al Jazeera, January 1, 2024, https://www.aljazeera.com/news/2024/1/1/analysis-is-the-israeli-army-as-militarily-successful-as-it-claims.

With the spiking collateral damage in Operation Iron Swords, the discussion on using AI for targeting and engagement became prevalent, unlike the previous operation. Despite the implementation of a pioneering Gospel targeting system during the 2021 operation, Operation Guardian of the Walls did not invoke too much public debate on AI targeting systems. On the other hand, the controversy surrounding Operation Iron Swords started with the Gospel system and renewed with another targeting system named Lavender. Lavender is a tool designed to analyze extensive datasets through ML algorithms based on raw data collected through mass surveillance of Gaza inhabitants. It plays a central role in a strategy that broadened the scope of "human targets" to include all ranks within Hamas' military wing, diverging from the focus of previous operations, which aimed to target senior operatives. According to a presentation by the commander of Unit 8200's Data Science and AI center at Tel Aviv University in 2023, Lavender assigns likelihood scores to individuals based on their connections to Hamas. The process is done through aggregating and analyzing a wide range of raw data points, including communication patterns, social networks, and movements, among other indicators. The AI algorithm is trained to identify patterns associated with Hamas operatives and scans through the data to detect similar patterns in the general population. Certain key features, such as frequent communication with known militants or participation in specific social media groups, contribute to the algorithmic assessment, incrementally increasing an individual's involvement with Hamas' score. The scoring process is dynamic and continuously refined through ingesting new data and the AI system's learning feedback loop, allowing the algorithm to improve its predictive accuracy over time.[124] Additionally, Operation Iron

[124] Yuval Abraham, Lavender.

Swords witnessed the more comprehensive use of AI. According to reports, new AI systems now use data about military-approved targets to calculate munition loads, prioritize and assign thousands of targets to aircraft and drones, and propose a schedule.[125] Unlike in the previous operation, these mechanisms seem to have been integrated into different phases of military campaigns.

However, the reliance on probabilistic modeling introduces inherent complexities, particularly in the accuracy of the scores assigned and the potential for false positives. These false positives, or AI' hallucinations ', can significantly impact the scoring process by potentially introducing errors into the identification and evaluation of targets. Such errors can have profound consequences, as individuals with no ties to militant activities may be incorrectly identified as potential targets due to coincidental or superficial data correlations. These inaccuracies are inherent to every narrow AI system and stem from misinterpreting data patterns, leading to incorrect associations between individuals and militant activities based solely on algorithmic assessments.

Although Operation Iron Swords is not the first IDF urban operation that utilized AI applications in targeting, it rapidly became the first one stimulating a comprehensive debate about targeting alongside the broader military AI debate. The scoring process's ethical and legal ramifications are profound, particularly concerning the principles of distinction and proportionality.[126] The automated nature of the scoring process, while designed to enhance operational efficiency and the precision of target identification, raises critical questions

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[125] Marissa Newman, "Israel Using AI Systems to Plan Deadly Military Operations," Bloomberg.com, July 16, 2023, https://www.bloomberg.com/news/articles/2023-07-16/israel-using-ai-systems-to-plan-deadly-military-operations.

[126] Brianna Rosen, "Unhuman Killings: AI and Civilian Harm in Gaza," Just Security, March 21, 2024, https://www.justsecurity.org/90676/unhuman-killings-ai-and-civilian-harm-in-gaza/.

about the system's capacity to adhere to these legal and ethical standards faithfully.[127] Some news stories claimed that the Lavender tolerates the deaths of up to 100 civilians for each successful strike on a Hamas commander.[128] However, in a statement published on April 2024, the IDF has firmly repudiated allegations concerning its operational protocols, particularly those linked to the Lavender system.[129] To clarify the nature of Lavender, the IDF has stated that it is not a functioning system, but rather a database that integrates raw data points to produce up-to-date intelligence on Hamas and PIJ and underscored that Lavender does not serve as a directory of verified military targets slated for engagement. Instead, it highlighted that IDF protocols necessitate evaluating the anticipated military gain against the probable collateral damage for each potential target.

The process for evaluating potential strikes is not a one-size-fits-all approach, but rather involves a detailed examination of specific factors. To ensure the best accuracy in estimating collateral damage, a variety of assessment techniques and intelligence collection methods are employed. While it was declared that Lavender is not intended to be used as an operational system or a directory of confirmed targets, its functionality implies the integration and analysis of intelligence inputs to identify potential targets, hence bears a

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[127] Kanishka Singh, "US Looking at Report That Israel Used AI to Identify Bombing Targets in Gaza | Reuters," Reuters, April 4, 2024, https://www.reuters.com/world/middle-east/us-looking-report-that-israel-used-ai-identify-bombing-targets-gaza-2024-04-04/.; "How Israel's AI Use Is Resulting in Indiscriminate Civilian Deaths in Gaza," TRT World - Breaking News, Live Coverage, Opinions and Videos, December 1, 2023, https://www.trtworld.com/middle-east/how-israels-ai-use-is-resulting-in-indiscriminate-civilian-deaths-in-gaza-16057601.

[128] Bethan McKernan and Harry Davies, "'The Machine Did It Coldly': Israel Used AI to Identify 37,000 Hamas Targets," The Guardian, April 3, 2024, https://www.theguardian.com/world/2024/apr/03/israel-gaza-ai-database-hamas-airstrikes.

[129] Jotam Confino, "Israel Denies Using AI to Identify Gaza Air Strike Targets," The Telegraph, April 4, 2024, https://www.telegraph.co.uk/world-news/2024/04/04/idf-israel-denies-using-lavender-ai-to-target-palestinians/.

resemblance to the capabilities of AI-powered targeting tools, which commonly use large datasets to identify patterns and evaluate threats, and sometimes even prioritize targets. Although the IDF's description stops short of explicitly stating that Lavender employs AI in this analytical capacity, the complex nature of integrating and analyzing intelligence from multiple sources to update information on combatants suggests a level of sophistication that AI technologies could facilitate. Although Lavender may not result in the level of civilian casualties reported by certain news outlets, the IDF's reluctance to disclose its utilization of AI could be attributed to the cumulative impact of increased civilian fatalities combined with universal anxieties regarding the rapid advancement of AI. Nonetheless, the precise consequences of Lavender or other undisclosed AI-supported instruments, both in terms of operational efficiency and collateral damage, remain to be thoroughly examined in future academic research and investigations.

To be able to define where Lavender actually fits in operational efficacy, it is instructive to draw parallels with recognized frameworks in military doctrine, notably the U.S. Joint Targeting Cycle. This comparative examination would help display the operational weight and function of IDF's AI-supported targeting systems within a well-established doctrinal context. In U.S. targeting doctrine, The Joint Targeting Cycle, as outlined in official documentation, encompasses six phases: (1) End State and Commander's Objectives, (2) Target Development and Prioritization, (3) Capabilities Analysis, (4) Commander's Decision and Force Assignment, (5) Mission Planning and Force Execution, and (6) Targeting Assessment.[130] The IDF automated targeting system's operational functionality

[130] Joint Chiefs of Staff, Executive Summary of Joint Publication 3-60, Joint Targeting," January 31, 2013, https://jfsc.ndu.edu/Portals/72/Documents/JC2IOS/Additional_Reading/1F4_jp3-60.pdf.

stems from a blend of two distinct phases, Phase 2 and 3, within this traditional targeting cycleIn military operations, this amalgamation signifies a significant advance in the processing and final use of targeting data.[131] Notably, the IDF systems resemble the U.S. Prometheus and FIRESTORM algorithms utilized during Project Convergence-21 (PC21).[132]

Identifying potential targets through advanced processing of vast intelligence data instantaneously (1) diminishes the interval necessary for target designation and (2) assists in determining suitable armaments, further abbreviating the response duration. A comprehensive analysis of how this integration has reduced the action timeline or its comparative influence on collateral damage relative to conventional procedures—factors that significantly affect the political dimensions of urban engagements—remains pending. Nevertheless, the utility of AI-backed targeting is substantiated by documented instances of its deployment by the IDF and has the potential to offer empirical evidence of its effectiveness.

The Fire Factory presents immense potential for further development as a novel tool. As we know, AI-powered systems constantly evolve better if correct iterative improvements

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[131] Tal Mimran et al., "Israel – Hamas 2024 Symposium – Beyond the Headlines: Combat Deployment of Military AI-Based Systems by the IDF," Lieber Institute West Point, February 2, 2024, https://lieber.westpoint.edu/beyond-headlines-combat-deployment-military-ai-based-systems-idf/.

[132] PC21 aimed at revolutionizing military capabilities through the synergistic application of diverse technologies. Among these, the Prometheus and FIRESTORM algorithms played critical roles. Prometheus identified threats and targets by analyzing data aggregated from myriad sensors, effectively streamlining the target acquisition process. Once targets were identified, the FIRESTORM algorithm took over, optimizing the match between these targets and the available arsenal based on multiple parameters, including proximity, the required explosive power, and environmental conditions. This ensured that the most suitable weapon systems were allocated to engage identified targets efficiently, thereby minimizing resource wastage and enhancing strike precision. See "How Rainmaker, Prometheus, FIRESTORM, and SHOT AI Algorithms Enable the Kill Web," Military Embedded Systems, 2022, https://militaryembedded.com/radar-ew/sensors/how-rainmaker-prometheus-firestorm-and-shot-ai-algorithms-enable-the-kill-web.

and data enhancements take place. Morevoer, Fire Factory still operates in a limited area. When these advanced algorithms are integrated into a unified system for synchronized actions across land, air, sea, cyber and space domains might be crucial for achieving strategic objectives.[133] Enhancing the use of AI interoperably has significant potential, particularly in urban warfare scenarios where coordinated and swift actions are vital to achieving tactical objectives. Improving the use of AI interoperably across land, air, cyber, and cyberspace domains holds significant potential, especially in urban warfare scenarios where synchronized and quick actions are vital for achieving tactical objectives. The swiftness of the urban environment is due to the relative comfort with which adversaries can blend with civilian populations or navigate through structures before engagement takes place. While the tempo of urban warfare is not higher than open-field warfare, the nature of urban warfare demands rapid response when opportunities for engagement emerge due to the adversaries' rapid concealment advantage. This necessity for swift action is driven by the challenge of quickly distinguishing between combatants and non-combatants. Here, AI solutions are promising to improve the temporal dimension of operations by enabling fast data analysis, decision-making, and coordinated responses that stretch from data collection to creating outcomes between aerial drones, ground units, and cyber operations. This kind of integration might secure timely engagements and diminish the insurgents' rapid displacement or concealment edge.

[133]Stew Magnuson, "Army's Project Convergence Continues on 10-Year Learning Curve," National Defense Magazine, December 17, 2021, https://www.nationaldefensemagazine.org/articles/2021/12/17/armys-project-convergence-continues-on-10-year-learning-curve.; James Richardson, "Project Convergence: A Venue for Joint All-Domain Command and Control Experimentation," National Defense University Press, October 25, 2022, https://ndupress.ndu.edu/Media/News/News-Article-View/Article/3197270/project-convergence-a-venue-for-joint-all-domain-command-and-control-experiment.

Another notable AI-backed tool used by IDF during Operation Iron Swords is UAVs, notably small quadcopter drones, which have emerged as a significant asset. Initially, the utility of such quadcopters on the battlefield was under debate within Israel's National Security Council, with early skepticism resulting in widespread adoption due to their effectiveness in dense urban and subterranean environments. These UAVs, distinguished by their versatility, are employed for various operations, including reconnaissance, navigating tunnels created by Hamas, and even direct engagement. Initially, the drones were not expected to be used to explore tunnels. IDF employed heavy robots linked to the surface via a cable to search the hundreds of miles of passages that Hamas has drilled underneath Gaza. However, the tunnel bases are often filled with trash, tripping up the robots, while some corridors are too narrow for robots to operate.[134]

Prior to the operation, the IDF promptly contacted Skydio to request the company's advanced short-range reconnaissance drones. These drones, also utilized by the U.S. Army, can autonomously navigate through obstacles and produce detailed three-dimensional representations of complex structures. The incorporation of these drones by the IDF is also in parallel with the growing importance of augmented reality (AR) technology in the preparation for urban warfare. This integration of AR into military strategies is significant for technologically advanced and effective urban warfare preparations. Similarly, research over the years has consistently demonstrated the superior effectiveness of AR systems in military applications compared to conventional navigation and situational awareness tools. Studies by Roux and Kenny argue that AR increases operational efficiency, and reduces

[134] Dov Lieber, "Small Drones Are Helping Israel Navigate the Urban Battlefield in Gaza ," Wall Street Journal, December 29, 2023, https://www.wsj.com/world/middle-east/small-drones-are-helping-israel-navigate-the-urban-battlefield-in-gaza-293b1de4.

the cognitive load in navigation and target detection tasks, therefore helping command and control processes. Enhanced hardware, including portable computing devices with improved displays and endurance, coupled with AI-driven software, enables the Urban Warfare Augmented Reality (UWAR) system to offer intuitive human-computer interactions and real-time, adaptive information filtering. This ensures soldiers receive precise, contextually relevant information, transforming the UWAR system into a vital combat tool.[135] The synergy between AR and AI has the potential to amplify situational awareness and significantly improve the accuracy and efficiency of military operations. Such technologies are crucial for overcoming the inherent obstacles of urban environments, providing soldiers with enhanced operational insights and a tactical edge. According to Lappin, the IDF leverages Rafael's Fire Weaver and BNET systems, creating a cohesive digital network that harmonizes battlefield data.[136]

These findings underscore AR's potential to provide soldiers and commanders with critical information for optimal decision-making, precise navigation, and realistic battle scene simulations for training purposes. In fact, AR systems for urban warfare have a history of more than two decades.[137] However, integrating AI-backed semi-autonomous drones and big data analytics with AR is pivotal for advancing these systems' capabilities, allowing

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[135] R.J. Kenny, "Augmented Reality at the Tactical and Operational Levels of War," (Newport, RI, USA: Naval War College, 2015), https://apps.dtic.mil/sti/pdfs/AD1000872.pdf.; W. Le Roux, "The Use of Augmented Reality in Command and Control Situation Awareness," *Scientia Militaria - South African Journal of Military Studies* 38, no. 1 (2011), https://doi.org/10.5787/38-1-82.; Xiong You et al., "Survey on Urban Warfare Augmented Reality," *International Journal of Geo-Information* 7, no. 2 (January 31, 2018): art. 46, doi:10.3390/ijgi7020046.

[136]Yaakov Lappin, “Israel’s Rafael Reshapes Urban-Warfare with AI, Augmented Reality,” Israel Hayom, February 2, 2020, https://www.israelhayom.com/2020/02/02/israels-rafael-revolutionizes-urban-warfare-with-ai-augmented-reality/.

[137] Mark A. Livingston et al., "An Augmented Reality System for Military Operations in Urban Terrain," in *Proceedings of the Interservice / Industry Training, Simulation, & Education Conference (I/ITSEC '02)*, (Orlando, FL, December 2-5, 2002), https://apps.dtic.mil/sti/tr/pdf/ADA499032.pdf.

for better real-time data analysis and decision-making support. Without using quadcopters and other reconnaissance tools and algorithms' help, the IDF might have spent years mapping tunnels and other terranean and subterranean features without guaranteeing success. On the other hand, timing is crucial for any military operation in national/local and international settings.[138] In the immediate aftermath of an attack by Hamas, it was crucial to enact the fastest response possible without delay, and the window for the start and initial execution of the operation was incredibly narrow. This urgency stemmed from the need to capitalize on the initial international consensus supporting the IDF's right to take action. Delaying the response would have allowed time for political complications to emerge, ranging from increasing national backlash to questions regarding the intervention's legitimacy on the international stage. Thus, acting quickly was significant for operational efficiency and securing and maintaining broad international support. We can also see this fast reaction by the numbers. Quantitative data further evidences the usefulness of AI tools in generating rapid response approaches. The IDF's intelligence target bank efforts have led to striking over 11,000 targets in Gaza from the onset of the conflict on October 7 to the beginning of November, as noted by a senior IDF intelligence official. Additionally, on the first day of operations, the IDF targeted and destroyed 150 tunnel targets in a single day. Significantly differing from previous operations, 90% of the targets were hit were generated and struck in real-time, owing to the combined efforts of the AI and the IDF intelligence officials.[139]

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[138]Carrie Ann Lee, "The Politics of Military Operations," PhD diss., Stanford University, 2015, https://purl.stanford.edu/xc815qm3099.

[139] Yonah Jeremy Bob, "IDF Uses AI to Strike over 11,000 Terror Target in Gaza since October 7," The Jerusalem Post | JPost.com, November 2, 2023, https://www.jpost.com/israel-news/article-771419#google_vignette.

In sum, Operation Iron Swords has become the first urban operation which AI-backed tools are widely used. The dawn of AI, which became markedly pronounced following the Russo-Ukrainian conflict, also saw significant application in the Gaza Operations. While Operation Guardian of the Walls has been labeled as the first AI war in history, it is arguably more precise to designate Operation Iron Swords as such, especially in the realm of urban operations. This proclamation is grounded in the observation that AI applications in Operation Iron Swords appears to be more widely used, in contrast to Operation Guardian of the Walls, which was limited in terms of objectives, scope, and nine-day duration. The actual tactical value of AI tools, along with their ethical questions, has yet to be answered. Many questions will focus on the success rate of AI targeting, the civilian casualties attributable to expedited decision-making reliant on AI mechanisms, and whether these technologies have indeed generated a consequential operational shift. Nevertheless, based on official communiqués and journalistic accounts, AI has seemingly raised the operational tempo by expanding the scope of target engagement within constrained temporal windows. One of the foundational assertions regarding AI in military contexts is its potential to enhance operational velocity dramatically. Proponents of revolutionary AI argue that it could fundamentally transform warfare by accelerating the sensor-to-shooter cycle, facilitating the rapid, accurate processing of voluminous data sets, and enabling prompt responses to adversaries. Reflecting on Chief of General Staff Aviv Kochavi's remarks—wherein a tenfold to twentyfold increase in target identification was noted, alongside expedited intelligence processing and integration across disparate intelligence domains—it is evident that despite the prevailing uncertainties, this progress may indicate an expanded dependency on AI in coming military urban military operations.

Chapter 5: Findings from Case Studies and Broader Theoretical Frameworks as Conclusion

This thesis explored the role of AI in military operations moving from the peculiarities, challenges, and strategic innovations in urban warfare to AI's prospects in military uses. The first chapter investigated the intrinsic complexities of urban combat, setting the stage for understanding the main challenges military organizations face in modern urban warfare. The second chapter analyzed the transformative potential of AI in broader military operations contexts, while the third chapter synthesized these two different realms through the case study of the IDF's operationalization of AI in the Gaza Operations of 2021 and subsequent operations up to 2024. Prior to the following discussions on findings, this examination constructs a bridge to understanding the relationship between AI technologies and urban warfare. Through a careful dissection of AI's impact on combat studies, complemented by the analysis of the IDF's innovations in urban warfare, this thesis demonstrates the complexities underlying the integration of AI into combat scenarios. It critically assesses how such technological advancements, while promising, do not simplify the operational challenges inherent in urban warfare.

Drawing on a wide range of AI's impact on security studies and the cases of IDF operations in urban settlements reveals several significant problems related to AI incorporation into contemporary urban warfare. These issues arise both from theoretical considerations—rooted in overarching principles and the potential of technology—as well as from practical insights specific to the IDF's operational tactics and strategies. These conclusions shed light on the utility of the IDF employment of AI and place these practices within the broader conversation about AI's impact on contemporary urban warfare:

1. *AI support and technological dominance do not erode significant operational challenges and hardship of meeting objectives in urban warfare peculiarities.*

AI support and technological dominance do not erode significant operational challenges and difficulty meeting objectives in specific urban warfare contexts. The unpredictability accompanying urban combat again highlights the indispensable role of human skill – intuition, experience, and the capability to adapt when technology fails. Although we do not yet know whether targeting AI failed or in which instances human officers intervened or corrected decisions and to what extent, this principle was starkly illustrated in the latest operation. The strategic encirclement of Gaza and Khan Younis, while theoretically sound, has not been fully achieved yet despite an all-out operation that has been going on for more than five months as of April 2024 and the intended disruption of Hamas combat units. The requirement for high-ranking officers to lead and coordinate in such complex urban environments led to a significant loss of senior personnel in the IDF ranks. Furthermore, the Golani Brigade suffered unexpected casualties, and efforts to neutralize Hamas's tunnel network and secure the release of captives have still been facing persistent challenges.

2. Accurate alignment with strategic realities of urban warfare should guide the use and deployment of AI technologies.

The IDF's approach, marked by quick, comprehensive, and lethal targeting, prompts a question about the reevaluation of metrics for measuring success. In the context of the IDF's strategy of engaging as many targets as swiftly and lethally as possible, it raises the question: Does this approach actually contribute to winning the war? The fervent pursuit of generating and striking numerous targets is touted as a paramount achievement by proponents of AI within the IDF. However, it remains uncertain whether this strategy genuinely aids in securing victory in the big picture. We know from historical actualities that detecting and engaging numerous targets is not the only condition for achieving broader political victory. Thus, it warrants consideration whether pursuing immediate tactical advantages, with the accompanying risks of escalating hostilities and adversely affecting the urban populace's psychological state, could inadvertently lay the groundwork for future radicalization, counteracting the objectives. This issue extends beyond radicalization theory which explores the cognitive processes leading populations to radicalize in response to real or perceived excessive use of force. The progressively negative perception of lethal AI globally might also contribute to this phenomenon. Even if we assume that the systems used are refined and offer better precision and the potential for reduced collateral damage, a comprehensive assessment of its effects on the extended dynamics of the war in question is still imperative.

3. The balance of human oversight and degree of autonomy is still an open question to be answered.

In the IDF's conceptual framework, the methodology used in applying AI systems exemplifies the evolution of human-machine teaming. As AI and autonomous systems develop further both in capability and scope, human-machine collaboration's doctrinal boundaries will draw increasing scrutiny, particularly concerning 'meaningful human control' over target generation and AI and LAWs. The discussion will likely center on defining autonomy's limits in military operations—questioning the degree of autonomy AI should possess and the proportion of human oversight. This discourse extends beyond such control's technical and strategic feasibility to encompass the moral imperative of maintaining human oversight in lethal force decisions in alignment with ethical standards.

The debate over how to ensure 'meaningful human control' of these processes will need a coherent framework that accommodates AI's rapid progress while ensuring that critical decisions, particularly those concerning life and death, remain under human judgment. Absent such measures, the specter of dehumanized conflict looms, with the accompanying risk that the urgency to maintain a competitive edge in AI capabilities could expedite this trend. Addressing this will require a lengthy discussion on understanding the possibilities and limitations of human-machine teaming and the challenges that are likely to arise in future combat scenarios.

The scalability of fully autonomous systems, especially in the unpredictable terrain of urban warfare, raises significant concerns regarding the potential to set hazardous international precedents. The absence of international norms on the use of AI-backed systems and their proliferation risk undermining established codes of conduct in warfare since the use of AI has the potential to blur responsibility for incidents, hence the blame

4. Deploying fully autonomous systems in which all of the OODA loop is automated is still only a prospect in the context of urban operations.

One of the most common words used when describing the urban environment is “complexity.” This complexity is the combination of airspace, terranean, subterranean features, and the possibility of intermingled combatants and civilians. Despite rapidly growing AI technologies, deploying fully autonomous systems for tasks such as target identification or engagement remains a prospect for the future. Overcoming the challenges of accurate target identification and effectively distinguishing between combatants and noncombatants represents the beginning of the complexities involved. Modern warfare extends beyond these distinctions that require the strategic valuation of intended targets.

Additionally, urban warfare intertwines the roles of fighters and civilians with the broader concept of legitimate military objectives, including but not limited to infrastructure such as bridges, pipelines, or water, runways, railways, buildings, and communication towers. This framework also necessitates the protection of specific sites like churches and hospitals in accordance with the principles of jus in bello, which govern the permissible targets of military action.

Any fully autonomous system must better be able to identify what kind of object it is, when it can be destroyed, what purpose it was intended for, how it has been used, and how its elimination would contribute to or weaken one side's military advantage. Moreover, that minimum standard would necessitate a form of AI strong enough to include situational awareness, utilize prospective judgment to choose the best course of action to achieve an objective, and utilize retrospective judgment to assess levels of completion after the objective is destroyed. These problems have hundreds of years of history in the study of warfare, as illustrated in the second chapter, and are centrally solved by human intuition. Therefore, for the current level of AI sophistication, this minimum standard necessitates a degree of comprehensive knowledge that requires the judgments of individual officers and enlisted personnel to attain.

5. Although preprogrammed target lists for lethal autonomous AI systems entail a conservative approach to strategic readiness, they may reduce the level of flexibility and ethical control over their implementation in volatile urban settings, meaning that human-in-the-loop oversight remains essential.

An analogous but situated paradigm concerns preprogrammed solutions toward lethal autonomous weapons. Let us consider such an AI system an autonomous agent: It can be programmed to engage only with designated targets during an urban mission based on pre-mission programming and real-time data analysis. During a mission, the autonomous system can execute the plan without direct human oversight, allowing human operators to concentrate on related tasks. Nevertheless, such systems' implementations raise numerous ethical and operational issues. Such lists may not account for emergent targets in urban settings, impeding operational flexibility and adaptability. The unpredictable nature of AI in fast-paced combat settings necessitates a cautious approach to lethal mission autonomy. Despite significant evolution in military AI, no oversight of target lists or target engagement remains a utopia, even with preprogramming. No military force is expected to use an autonomous AI system to select and engage targets without strict programming parameters and human-in-the-loop control to comply with international conventions and ethical norms about warfare. The tempo of battle is that fast, and as all of the targeting guidelines and manuals of the US military explicitly note, targeting is constantly under reflection, given new information, changing circumstances, and the need to assess.

6. Adversarial cyber threats, including the intrusion into and manipulation of datasets targeting AI systems, are significant challenges that might influence operational effectiveness.

One of the prominent dangers concerning AI's use in urban operations, especially when such wars are conducted between state actors, is adversarial manipulation and system hacking directed against AI systems. In this scenario, the digital battleground functions as a strategic chessboard on which systems driven by AI are compromised, causing them to disseminate misinformation or break down in the event of critical operational necessity. Furthermore, adversaries might exploit system vulnerabilities to manipulate data, leading to false positives or friendly fire incidents. It is no exaggeration to say that AI systems are what they have as data, so the intrusion and corruption of data would simply mean breaking apart. As discussed in the second chapter, one of the most repeated arguments by scholars skeptical of AI's military use concerns data clarity and complete reliance on the data issue. This risk is accentuated when human oversight is minimized, emphasizing the necessity for robust cybersecurity measures and continuous monitoring. However, the situation changes when urban warfare involves non-state units. While these groups most often lack the infrastructure and capacity to conduct elaborate cyber-attacks directly against an AI system, there exists a danger of underestimating their potential or indirect negative influence on compromised systems. Therefore, it is one of the prerogatives of militaries to secure against direct cyber threats from rival adversaries and to account for the prospect of less direct forms of digital interference that might occur in conflicts with non-state entities.

7. Integration of urban-specific hardware and software requires a serious investment for militaries.

Urban operations may require specialized hardware and software solutions. Intensive AI use in urban warfare would necessitate a sophisticated approach to the adoption of related hardware and software. This stretches from deploying drones designed for detailed indoor navigation to systems aimed at reconnaissance of streets, building tops for 3D maps, and computers that can process the vast data collected. Nevertheless, such essential integration confronts numerous infrastructural, logistical, compatibility, and data silos challenges, demanding considerable technical expertise and adaptability. After decades of investment and innovation, Israel's military infrastructure presents an example of a thriving structure that successfully integrated AI, at least in the current phase. The hype of AI in military applications could deceive nations that do not have such computational capacities. These militaries risk overvaluing their ability to incorporate complex, urban-centric technologies, jeopardizing their operational effectiveness and strategic goals in urban conflict settings. This highlights the imperative for a realistic assessment of technological capabilities and the strategic synchronization of military resources with the unique demands of urban warfare.

8. The prevalence of AI in urban warfare will necessitate interoperability among various AI systems along with allies using AI mechanisms to cooperate in the same field to manage the complexities, which would also bring the critical challenge of potential data overload. The urban environment will likely necessitate the integration of a vast expanse of systems, encompassing reconnaissance or AI-enabled underground exploration. This requires units to harmonize movements and decisions within constrained spaces while relying on myriad technological solutions. Currently, the application of AI systems in war is limited; however, as these technologies evolve and diversify, the imperative for interoperability will become increasingly apparent. The future evolution of AI in urban operations will broaden the range of its applications and highlight the essential need for these advanced systems to function cohesively, adapting in real time to the volatility of urban conflict.

Related to the interoperability question, interoperating numerous AI systems for data analysis and decision support potentially precipitates an information overload challenge. Although specific instances of such overload have not been reported in IDF operations, the hypothetical risk looms large when envisaging the simultaneous harnessing of diverse AI-driven insights. This flood of urban data, which would obviously be more challenging than other operational theaters since the urban populace's movements and interactions will be part of big data, necessitates developing and executing advanced data filtration and prioritization mechanisms to distill actionable intelligence from the vast information streams. As a result, the ability to balance the use of AI's extensive analytical abilities with ensuring that critical information must be kept straightforward and unblocked is the key, which proves the challenging and vital role of data procedures and technologies in the data-rich operational environment of urban warfare.

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