GROWTH OF DRONES IN THE COMBAT ROLE

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INTRODUCTION

In the current Russia-Ukraine conflict, both sides have been deploying millions of low-cost drones for reconnaissance as well as for targeting. The importance of air power in modern conflicts will continue as its attributes of speed, precision, lethality, reach, and response will remain relevant in both war and peace. The character of war will keep on changing as technology evolves. The modern battlefield has changed significantly, and the growing number of autonomous and remote-controlled drones are capable of delivering a variety of payloads and providing battlefield transparency to the fighting arms. Today, war-fighting is marked by the proliferation of precision-strike weapons such as cruise missiles, ballistic missiles and drones; and extensive intelligence, surveillance, and reconnaissance capabilities such as satellites and surveillance drones, support these. This shift has significant implications for military operations and deterrence. The article covers the current trends in the application of drones in armed roles, the role of electronic warfare, and a few challenges that the armed forces will have to address.

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TRENDS IN THE USE OF DRONES IN THE BATTLEFIELD

The low cost of drone technology and the capability to penetrate Air Defence (AD) systems have led to the rapid proliferation of the technology by both state and non-state actors. On January 11, 2025, Ukraine claimed to have struck Russia's largest oil refinery in a drone attack, starting a fire at the facility more than 1,100 km deep inside the Russian territory.[1] This came after a drone strike on an oil facility serving a military airfield in the city of Engels in the Saratov region, where Russia's strategic bomber fleet is located[2], on January 8, 2025. Russia retaliated to the attack of January 8, 2025, by pounding Ukraine with a wave of aerial attacks using 500 kg glide bombs and drone strikes, hitting three regions.[3] In the recent past, Russia has fitted thermobaric warheads on the Shahed-136 drones, which caused not only more destruction and damage but also panic among the Ukranian population.[4]

The use of drones has blurred the lines between war and peace. On November 3, 2002, a US drone hovered for the first time in the Yemeni skies and fired a Hellfire missile at a car carrying a suspected al-Qaeda leader in eastern Yemen. Since then, Yemen has become the battlefield for expanded US drone operations, labelled as "A War on Terror". This has resulted in the rise of non-state actors like al-Qaeda and the Houthis.[5] Until March 2022, Saudi AD systems, like the Patriot anti-air systems, could easily intercept missiles. However, the turning point came when the Houthis mounted successful attacks using missiles and kamikaze drones on Aramco in the Jizan region.

1. "Ukraine Says It Has Hit One of Russia's Refineries in a Drone Strike", January 11, 2025, https://edition.cnn.com/2025/01/11/europe/ukraine-drone-strike-russia-oil-refinery-intl-latam/index.html?iid=cnn_buildContentRecirc_end_recirc. Accessed on January 15, 2025.
2. "Ukraine Says It Attacked Fuel Depot Serving Russian Strategic Bombers", January 8, 2025, https://edition.cnn.com/2025/01/08/europe/ukraine-russia-engels-saratov-oil-depot-drone-intl/index.html?iid=cnn_buildContentRecirc_end_recirc. Accessed on January 13, 2025.
3. "Ukraine Hit by Intense Russian Air Raid", January 8, 2024, https://www.newsweek.com/ukraine-hit-intense-russian-airstrikes-zelensky-urges-support-1982687. Accessed on January 16, 2025.
4. "Russia Deploys Deadly New Weapon in Drone Race with Ukraine", November 2, 2024, https://www.newsweek.com/russia-ukraine-drones-shahed-race-deadly-new-weapon-1979040. Accessed on January 13, 2025.
5. "The Humanitarian Impact of Drones", Women's International League for Peace and Freedom, © 2017Women's International League. Accessed on January 12, 2025.nes

Currently, the Houthis are regularly targeting the shipping lines and have even demonstrated that they retain sole authority over decision-making, as they continue to source critical weapons from China while developing independent financing schemes for weapon procurement.[6] The Houthis have also graduated to using Unmanned Surface Vessels(USVs), allowing them to sink a Greek coal ship in June 2024, and do not appear to be susceptible to deterrence.

ORGANISATIONAL CHANGES

Ukraine took the lead in innovating the role of drones in the conflict, which has been described as the "war lab for the future" with a notable role by the private sector. Kyiv started a new branch of its military dedicated exclusively to drone warfare earlier in June 2024.[7] The Russians were quick to follow up. Russian Defence Minister Andrei Belousov, speaking at the ministry's end-of-year board meeting on December 16, 2024, unveiled plans to form a new military branch, the Unmanned Systems Force (USF), focussed on unmanned systems. His announcement reflects the crucial role played by drones on the battlefield and a determination to institutionalise the role of drones in the Russian armed forces. He added that the USF would be raised in the third quarter of 2025 as a branch of arms (*rod voysk*) but did not say whether it would be independent like the other arms. The US House Resolution 8070, passed in June 2024, included a provision for establishing a Drone Corps as a basic branch of the US Army, which was opposed by the Chief of Staff of the Army, who argued that drones should be integrated into existing formations, not consolidated as a separate branch.[8] The phenomenal pace of technological advancements poses challenges on how best to incorporate these into the armed forces.

6. Allison Minor, "The Danger of Calling Houthis An Iranian Proxy", https://www.brookings. edu/articles/the-danger-of-calling-the-houthis-an-iranian-proxy/, September 3, 2024. Accessed on January 12, 2025.
7. John Haedie, "Russia Announces Plans To Form Unmanned Systems Forces", December 20, 2024, https://www.longwarjournal.org/archives/2024/12/russia-announces-plans-to-form-unmanned-systems-forces.php. Accessed on January 10, 2025.
8. "How To Transform The Army for Drone Warfare", January 9, 2025, https://warroom. armywarcollege.edu/articles/transform-for-drones/. Accessed on January 25, 2025.

There is a trend of a manned-unmanned collaborative model to enhance combat support by combining drones with manned and unmanned and robotic platforms.

THE GROWTH OF DRONES

Drones were deployed in the closing stages of World War II. However, the first notable combat application occurred during the Vietnam War, when American troops began using reconnaissance drones to reduce the possibility of human crew losses in high-risk missions in response to the adversary's growing air defence. Drones also possess extended hovering capabilities, gathering intelligence about intended targets using real-time high-resolution imagery. During the conflict with Syria in 1982, reconnaissance drones were used by the Israeli side for the detection and subsequent jamming of the adversary's air defence weapons. The effectiveness of reconnaissance and its psychological impact on the Iraqi troops was demonstrated thereafter during the Gulf War of 1991. The combat capability of drones was also seen during the so-called Kosovo crisis in 1999, where the drones were used to perform reconnaissance tasks and mark targets to be subsequently attacked by piloted combat aircraft. Finally, using drones for reconnaissance, armed with Hellfire anti-tank guided missiles, led to their growth, mainly due to the economic dimension. A relatively specific category of armed self-destructive units called kamikaze drones is a product of the partial improvisation of reconnaissance drones. These drones have become very popular in the current Nagorno-Karabakh and Ukraine-Russian conflicts as they cause significant human casualties due to their precision and low cost in comparison to conventional weapons. There is a trend of a manned-unmanned collaborative model to enhance combat support by combining drones with manned and unmanned and robotic platforms.[9] China's sixth-generation stealth combat aircraft could

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9. Samuel Bendett and David Kirichenko, "Battlefield Drones and the Accelerating Autonomous Arms Race in Ukraine", January 10, 2025, https://mwi.westpoint.edu/battlefield-drones-and-the-accelerating-autonomous-arms-race-in-ukraine. Accessed on January15, 2025.

serve as a command centre to direct combat drones.[10] In the future, aircraft carriers can operate fixed-wing drones and helicopters.[11] China's Beijing-based Betavolt has developed a nuclear battery using Nickel-63 isotopes that delivers continuous power for up to 50 years without a charge.[12]

Turkey has become a worldwide leader in military drones by concentrating on developing its defence industry. Turkish military drones can carry a lot of ammunition and have sophisticated sensors.

GROWTH OF THE DRONE INDUSTRY

Since 2018, Turkey, China, and the United States have jointly sold drones equipped with 69 types of weapons to 40 countries. Turkey's drone exports have grown tremendously since, overtaking China in 2021. Currently, Turkey alone accounts for 65 per cent of the sales of military drones in the world, with China accounting for 26 per cent, and the US lagging with only 8 per cent.[13] According to experts, Turkey has become a worldwide leader in military drones by concentrating on developing its defence industry. Turkish military drones can carry a lot of ammunition and have sophisticated sensors. Other delivery systems, such as the Bayraktar K▢z▢lelma and Baykar Bayraktar TB3, are also utilised in suicide missions against fighter aircraft and ammunition-carrying ships. Iran's drone industry is also developing combat drones with ranges of more than 1,600 km, with stealth and anti-fortification capabilities, in addition to a variety of Ababil and Arash drones which are capable of carrying out

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10. Enoch Wong, "Is China's 6th Generation Stealth Fighter Poised to be A Command Centre For Combat Drones", January 5, 2025, https://www.scmp.com/news/china/military/article/3293421/chinas-mystery-6th-gen-stealth-fighter-poised-be-command-centre-combat-drones?module=top_story&pgtype=homepage. Accessed on January 15, 2025.
11. "China's First Drone Carrier: A Strategic Game-Changer in the Indo-Pacific", August 19, 2024, https://www.financialexpress.com/business/defence-chinas-first-drone-carrier-a-strategic-game-changer-in-the-indo-pacific-3586344/. Accessed on January 15, 2025.
12 "China Unveils Mini Nuclear Battery with 50-Year Power Supply", Twitter on January 10, 2025, https://x.com/MarioNawfal/status/1877566251808989624?t=bsa8mQ6Ro-xuLBf3cGOHNA&s=08. Accessed on January 15, 2025.
13. Tahir Qureshi, "Turkey Has A Secret Weapon that Worries Superpower", November 3, 2024, https://www.india.com/news/world/turkey-has-secret-weapon-that-worries-superpowers-like-us-china-russia-and-israel-the-deadly-weapon-is-drones-ukraine-iraq-iran-7368983/. Accessed on January 12, 2025.

"long-range suicide missions."[14] Russia's drone industry, too, is ramping up production of drones, and it was estimated that Russia would make 1.4 million drones in 2024.

FPV DRONES

In the current Ukraine conflict, both sides are fielding thousands of racing drones invented in 2022 with improvised warheads. First Person View (FPV) is another name for such drones. Based on racing quadcopters, the operator wears goggles that display a video feed from the drone while in flight. These drones are cheap as they use commercially available electronics and components and can be assembled locally. Though the kamikaze drones could fly to the target using a combination of INS (Inertial Navigation System) and SATNAV (Satellite Navigation), these cheap FPV drones were later configured as loitering ammunition using their FPV mode of control and navigation, eliminating the bulky INS and SATNAV systems. In communication and Global Positioning System (GPS)-denied environments, Artificial Intelligence (AI)-enabled autonomous drones can identify their targets.[15] Notwithstanding their limited range, FPVs can supplement artillery attacks by hitting targets behind trees, buildings, ridges, or trenches, thanks to the live transmission to the operator's goggles. The analogue video streaming makes it hard for the defenders to jam them electronically and allows them to fly at low altitudes. The Ukrainian Army spends less than $500 on an average FPV attack drone. The Chinese DJI Mavic 3 Pro costs about $3,000 and is usually used for spying by Ukrainian operators. The price is rising to about $40,000 because of new features, including improved GPS, higher-resolution infrared imaging, automated target tracking, and obstacle avoidance. The more expensive such drones become, the less expendable and less valuable they are. The cycle for

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14. "Iran Gets Major Drone Boost Amid Growing Tensions with Israel", January 13, 2025, https://www.newsweek.com/iran-gets-major-drone-boost-amid-growing-tensions-israel-2013837. Accessed on January15, 2025.
15. Vijainder K Thakur, "AI-Enabled Kamikaze Drones Start Killing Soldiers", *Eurasian Times*, January 19, 2025, https://www.eurasiantimes.com/ai-enabled-kamikaze-drones-start-killing/. Accessed on January 27, 2025.

updating the designs in the Ukraine conflict is as short as a little over a month.[16]

DAWN OF UNMANNED UNDERWATER VEHICLES

Ukraine's use of nine air and seven USV naval drones in the Black Sea base of Sevastopol on October 29, 2022, resulted in the loss of around a third of the Black Sea fleet vessels, showcasing "asymmetrical warfare at sea." These attacks by Underwater Unmanned Vehicles (UUVs) have highlighted a playbook for war planners eyeing conflict scenarios around the global maritime chokepoints by using first person view drones, each armed with a small payload of explosives.[17] On February 14, 2024, Ukraine used the "MAGURA V5" USVs to sink the *Caesar Kunikov*, a Pr.775 landing ship.[18] Weeks later, a joint GUR-Navy operation used five of the same type of drones to destroy a patrol boat, the *Sergey Kotov*. UUVs are classified as either Remotely Operated Underwater Vehicles (ROVs) or Autonomous Underwater Vehicles (AUVs), depending on how they operate. AUVs differ from ROVs in that they are self-propelled and retain some degree of human control autonomy. The US Navy is developing UUVs of all sizes, which will revolutionise undersea warfare[19] as operating in the undersea domain is more complex than in other domains. Recent advances in sensor, communication and processing tools like big data and machine learning could impact underwater warfare, from defensive to offensive roles.

16. "Ukrainian Battalion Officer Issues Warning Against Western Drones", November 3, 2024 https://www.newsweek.com/urkaine-achilles-battalion-drones-electronic-warfare-russia-kharkiv-kupiansk-1979304. Accessed on January 15, 2025.
17. Ashish Dangwal, "Ukraine's Satellite Controlled 'Drone-Launched Drone' Emerges Big Threat To Russian Navy", *Eurasian Times*, January 25, 2025, https://www.eurasiantimes.com/devastating-ukraines-satellite-controlled-drone-launched-drone-emerges-big-threat-to-russian-navy/. Accessed on January 27, 2025.
18. Jon Hemler and Derek Bisaccio "Ukraine's USVs Write New Rules For Asymmetric Naval Warfare", June 13, 2024, https://dsm.forecastinternational.com/2024/06/13/ukraines-usvs-write-new-rules-for-asymmetric-naval-warfare/. Accessed on January 13, 2025.
19. Geoff Ziezulewicz, "What The Navy's Massive Orca Submarine Drone is Actually Capable of", January 14, 2025, https://www.twz.com/news-features/what-the-navys-massive-orca-submarine-drone-is-actually-capable-of. Accessed on January 16, 2025.

ROLE OF ELECTRONIC WARFARE

The growth of FPV drones has also increased counter-measures that aim to stop them. Electronic Warfare (EW) acts as a force multiplier by creating a protective dome around their location and sending out powerful radio frequency signals that disrupt communication between drones and their pilots, causing them to lose control of the craft and miss their target.[20] In the current Ukraine conflict, the market for EW systems has grown exponentially, and faster iteration to adapt to new frequency ranges has been observed. This has resulted in the replacement of antennae and design modifications to address emerging threats utilising AI algorithms. The aim is to decentralise the operation of EW systems to jam the FPVs. A few of the current trends in the field of EW are summarised as follows:

- The Ukraine conflict has seen an overall trend of growth in the FPV drones towards using larger frames to accommodate more prominent antennae to extend their operation ranges to counter Russian EW.

- Drones can have their electronics hardened to resist jamming, which increases the price, and is undesirable.

- In the event of jamming during the last phase of flight, drone pilots acquire the capability of autonomous object recognition, even if they are cut off from the control station. Russia's Ovod (Gadfly) FPV supposedly uses a similar AI-based "terminal guidance" system.[21]

- To counter the threats of frequency hopping, software-defined radios can make communication systems more jam-proof.

- First introduced in 2024, most fibre-optic drones are FPVs and quadcopter uncrewed aerial vehicles fitted with fibre-optic cables connected with the controller, one of the leading solutions to extensive EW used by both sides. The fibre optics transmit information and energy as light

20. Reuters, "Ukraine Rolls Out Dozens of AI Systems to Help Its Drones Hit Targets", October 31, 2024, https://www.deccanherald.com/world/ukraine-rolls-out-dozens-of-ai-systems-to-help-its-drones-hit-targets-2-3257443. Accessed on January 10, 2025.
21. "How Cheap Drones are Transforming Warfare in Ukraine", February 5, 2024, https://www.economist.com/interactive/science-and-technology/2024/02/05/cheap-racing-drones-offer-precision-warfare-at-scale. Accessed on January15, 2025.

pulses down very thin strands of glass.[22] The cables can stretch up to around 10 km and are immune to jamming, with high bandwidth, low latency communication, and stealthy operation.[23] The Ukraine conflict has seen the use of lithium polymer batteries on board FPVs for high-altitude operations at heights of more than 1.6 km and ranges of 40 km.

- Ukraine has inducted the V-BAT drones. In the case of GPS jamming by the adversary, using their optical sensors and image correlation algorithms, V-BAT drones can accurately fix the ground positions of their targets and relay target coordinates to the artillery battery. In the case of communications denial, they can move out of the jamming area and relay the coordinates.[24]

- Large numbers of Russian camera-based reconnaissance drones are being shot down using interceptor drones, which are aiding Russian artillery and missile strikes on Ukrainian targets behind the lines. Ukraine will soon test a low-cost, AI-enabled miniature missile designed and fabricated by an Estonia-based tech firm to counter low-flying drones flying at a height of about 2 km.[25]

- The role of AI is finding relevance in EW. The generative AI is intended to disrupt the adversary's radio communications and radar signals. The Large Language Model (LLM) driven system outperforms the dynamics of warfare by doing better than traditional AI and human experts. China has

22. "Russia-Ukraine Drone War Enters New Phase", January 12, 2025, https://www.newsweek.com/russia-ukraine-fiber-optic-drones-kursk-2010960. Accessed on January15, 2025.
23 Vijainder K Thakur, "Big Leap in Drone Warfare: Russia Accelerates Production of Vandal Kamikaze Drones Seizing Fiber Optic Advantage", January 18, 2025, https://www.eurasiantimes.com/drone-warfare-seizing-fiber-optic-advantage/. Accessed on January 19, 2025.
24. Vijendra K Thakur, "Grinding Halt, For Russian Offensive?", November 13, 2024, https://www.eurasiantimes.com/american-v-bat-a-i-piloted-drones-could/. Accessed on January 12, 2025.
25. Sumit Ahlawat, "100X Faster To Produce, Ukraine to Test AI-Enabled, Anti-Drone Missile Designed To Defeat Russian UAVs", November 5, 2024, https://www.eurasiantimes.com/ukraine-to-test-estonian-low-cost-ai-enabled-mk1-anti-drone-missile/. Accessed on January 11, 2025.

Swarm drones still pose challenges, especially when a drone in a swarm does not have a recognisable radio frequency signature.

developed an LLM for drones that can disrupt enemy radar and radio communication.[26]

• Radar-absorbing material paint on the surface of the drones can reduce the radar cross-section, making them less detectable by enemy radar systems and enhancing stealth features.[27]

• A swarm of drones carrying a radar reflector can create a significantly increased radar cross-section to mask the characteristics of real targets and effectively create tactical goals such as anti-reconnaissance and anti-attack by drones.[28]

COUNTER-DRONE SYSTEMS FOR SWARM DRONES

Drone detection systems have been developed using options like soft kill, hard kill and physical catching to counter different types of drones in critical airspaces. The detection and classification are achieved using machine learning based on inputs from various sensors, including radars, visual, acoustics, and radio-frequency sensors, with a growing reliance on AI[29] at the edge. However, swarm drones still pose challenges, especially when a drone in a swarm does not have a recognisable radio frequency signature. Once the swarm drones are detected by recognising minor air disturbance

26. Shubhangi Palve, "China's J-20 Designer Unveils 'ChatGPT Military' That Can Attack Enemy Radars with EW Drones", November 5, 2024, https://www.eurasiantimes.com/chinas-j-20-mighty-dragons-designer/. Accessed on January 17, 2025.
27. Raghav Patel, "CSIR-NAL Develops Radar-Absorbing NiRaLA Laminate and ADRISHYA Paint for Enhance Stealth Capability", January 16, 2025, https://defence.in/threads/csir-nal-develops-radar-absorbing-nirala-laminate-and-adrishya-ram-paint-for-enhanced-stealth-in-aircraft.12345/. Accessed on January 17, 2025.
28. "China's EW Gadget Turns Small Drone Into a Flying Stadium on Radar", January 17, 2025, https://www.scmp.com/news/china/science/article/3294661/chinese-military-tests-electronic-war-gadget-turns-drone-giant-ufo?module=top_story&pgtype=homepage. Accessed on January 18, 2025.
29. Asish Dangwal, "Russia Develops New AI-Powered Interceptor DronesThat Can Counter Ukrainian Drones", *Eurasian Times*, January 25, 2025, https://www.eurasiantimes.com/ukraines-advanced-v-bat-drone-faces-new-threat-from-russia/. Accessed on January 27, 2025.

signatures caused by drones, the kamikaze anti-swarm system[30] will have to function as follows:

- **Detection**: The system will utilise advanced sensors and radar to detect incoming drones.
- **Tracking**: Once detected, the system will track the swarm's trajectory and predict its path.
- **Interception**: The kamikaze drones will be launched to intercept the incoming swarm.
- **Neutralisation:** The kamikaze drones will collide with the enemy's drones, detonating their explosive payloads and neutralising the threat.

Additionally, armed drones are being employed in domestic law enforcement operations by several states, such as for border patrols, operations against organised crime, and crowd control during demonstrations and protests.

LEGAL AND ETHICAL IMPLICATIONS OF DRONE WARFARE

Recent ongoing armed conflicts have demonstrated that more and more countries are incorporating drones as their weapon of choice. Some states have used high-technology armed drones to target individuals overseas. Several non-state armed groups too are using drones, which poses an increasing threat to regional and international security. Additionally, armed drones are being employed in domestic law enforcement operations by several states, such as for border patrols, operations against organised crime, and crowd control during demonstrations and protests.[31] A few states have used armed drones in self-defence in counter-terrorism operations and later tried to justify the targeted killing.[32]

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30. "India Successfully Tests Indian Army's First Bhargavastra", January 15, 2025,' http://timesofindia.indiatimes.com/articleshow/117262056.cms?utm_source= contentofinterest&utm_medium=text&utm_campaign=cppst. Accessed on January 16, 2025.
31. The UN Basic Principles for the Use of Force and Firearms by Law Enforcement Officials set out the international legal standard for the use of force by the police: "Law enforcement officials shall not use firearms except in self-defence or defence of others against the imminent threat of death or serious injury,…. In any event, intentional lethal use of firearms may only be made when strictly unavoidable in order to protect life."
32. In 2015, the British government engaged in a targeted killing operation against one of its citizens in Syria as part of its counter-terrorism campaign against the Islamic State of Iraq and the Levant (ISIL). Reyaad Khan was killed in the first drone strike of its kind in an action that

The use of drones poses serious challenges to international law and global sovereignty. Drones are not illegal weapons and are not banned by any international treaty. However, the customary principles of International Humanitarian Law (IHL), such as military necessity and proportionality, govern the use of lethal drones in armed conflict[33] Lethal drones are also governed by International Human Rights Law (IHRL). For instance, the targeted killing of individuals by a drone raises the issue of extrajudicial executions, which violate the fundamental right to life under the IHRL Treaties. The statutes of international organisations such as the International Criminal Court (ICC) place virtually no restrictions on the use of lethal drones and other hi-tech weaponry.

The use of drones has created a new ethical issue never encountered earlier in an armed conflict. In the past, military commanders remained with their troops on the battlefield to inspire their subordinates. However, in the case of drone wars, it has become possible for commanders to sit in an office and watch the conflict unfold on a computer screen, which is fed by video footage from a drone. This removes the commander from the battle scenes and prevents him from personally inspiring his troops. The commanders and their remote operators do not share the dangers and hardships of combat. This also allows the commander to make decisions far removed from the battlefield. He cannot visualise the full reality of the armed conflict, depending only on the limited information displayed on the video screen. The use of drones has been criticised for the drone

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was officially taken in self-defence against an imminent threat in an area where the United Kingdom was not engaged militarily at the time. The then-Prime Minister David Cameron explained that the strike was a 'new departure' for the United Kingdom. Andrea Birdsall, "New Technologies and Legal Justification: The United Kingdom's Use of Drones in Self-Defence", *Global Constitutionalism* 2022, pp. 197-216.

33. The principle of distinction demands that the parties to the conflict only engage military targets, whether these are objects or individuals. The principle of proportionality requires that even when military targets are engaged, the expected collateral damage (i.e. adverse impact on the civilian bystanders or the civilian infrastructure) is not excessive in relation to the direct military advantage anticipated from the attack. The parties are also required to take a range of practical measures of precaution in the attack, to make sure that the principles of distinction and proportionality are met. This includes the duty to verify that the targets of planned attacks are not civilian objects or civilians.

operators' physical, psychological and emotional distance from the combat zone. It has been claimed that the greater physical and psychological distance between the drone operator and the adversary could affect the former's moral judgements and make him trigger-happy. Drone operators or pilots can never be considered combatants; they foster a generation of operators with a 'Play Station' mentality, divergent from the warrior ethos and values.

CHALLENGES FOR THE ARMED FORCES

Warfare is inherently complex, involving the integration of multiple domains and intricate kill chains. Human-machine teaming rests on the idea of a key attribute of both humans and AI, called cognition. The decision support systems' AI-enabled human-machine teaming construct is based on collective thinking. The current wars in Ukraine and Gaza have demonstrated that the interaction between the two is significant as the debate on the level of autonomy given is left to the designer of the system. The perception of decision-making by AI is that using AI to support war-fighting is a science, whereas war-fighting is an art. It requires a deep understanding of technology and its creative application to defeat the enemy. The challenges for the armed forces are:

- To adopt and integrate technology for drone warfare quickly and ensure that drones remain integrated with the other arms while encouraging innovations in tactics and technology.
- The Israeli Defence Forces (IDF) used the Lavender decision support system where the most uncomplicated individuals to locate Hamas were the foot soldiers. A drone operator not only needs to learn to fly a drone but should be trained to infiltrate by the ground into frontline areas undetected by enemy drones and navigate the web of electromagnetic defences of the adversary to perform various functions. The military capabilities of drones require sensor fusion of information from a host of sensors, and human intuition and judgement, shaped by years of experience, to drive tactical and operational decisions. War-gaming will

Biases based on race, ethnicity, or other characteristics may inadvertently influence the drones' decision-making if the people creating these devices have them.

facilitate assessing risks and dispel myths and inaccurate assumptions to produce the desired outcomes.

• In the context of drone warfare, especially Loitering Attack Munitions (LAMs) or suicide drones, the use of AI becomes particularly alarming. Autonomous drones, driven by AI, are increasingly utilised in military operations. AI technologies such as facial/visual identification and decision-making tools can execute combat roles like air interdiction, amphibious ground assaults, long-range strikes, and maritime operations independent of human intervention and supervision. Biases based on race, ethnicity, or other characteristics may inadvertently influence the drones' decision-making if the people creating these devices have them. Strict laws and moral standards are urgently needed to control the use of AI in delicate situations like combat, emphasising accountability and openness as cornerstones.

• Artificial intelligence has the potential to transform cyber defence by rapidly identifying new vulnerabilities, increasing the scale of threat detection techniques, and automating cyber defence. AI offers the armed forces a unique opportunity to tackle the next generation of threats.

• The armed forces have experimented with AI, which helps speed up the process of selecting and attacking targets using image recognition. A 2021 test revealed an accuracy of as low as 25 per cent.[34] In the next five years, generative AI and large language models will see the emergence of a new paradigm shift, which will see new applications of technology.[35] It will combine robots and AI, overcoming the current

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34. Sam Whitney, "The Rush to AI Threatens National Security", *The New York Times,* January 27, 2025, https://www.nytimes.com/2025/01/27/opinion/ai-trump-military-national-security.html?s=08. Accesed on January 27, 2025.

35. *"*Nobody In Their Right Mind Will Use Gen AI, LLMs In The Next Five Years*", India Today Tech,* January 24, 2025, https://www.indiatoday.in/technology/news/story/nobody-in-their-right-mind-will-use-genai-llms-in-the-next-5-years-meta-chief-ai-scientist-yann-lecun-2669493-2025-01-24. Accessed on January 27, 2025.

limitations like lack of awareness and understanding of the physical world, lack of continuous memory, power of reasoning, and inability to perform complex tasks.

- Swarm drones present a challenge when a drone in a swarm does not have a recognisable radio frequency signature. Hence, technological solutions include detecting swarms by recognising minor air disturbances

The Indian MUMT project is known as the Hindustan Aeronautics Limited (HAL) Combat Air Teaming System (CATS). It is an ongoing project to develop a manned and unmanned aircraft system that can work together in various operational scenarios.

caused by drones. To exploit this facility, creating a drone signature database is essential.

- Developing sensors to tackle threats from various underwater platforms is critical to expanding capabilities. The development of light-fidelity technology capable of transforming communication networks for secure communication with the UUVs must be explored.[36]
- The development of Manned-Unmanned Teaming (MUMT) will transform warfare by synchronising manned and unmanned platforms. Russia has used drones integrated with manned aircraft, such as the Su-34, to improve engagement efficiency, primarily in regards to the overall awareness and target acquisition. However, the operations are susceptible to communication delays, network topologies, cyber attacks, poor situational awareness, and increased workload between the pilot and drones. The Indian MUMT project is known as the Hindustan Aeronautics Limited (HAL) Combat Air Teaming System (CATS).[37] It is an ongoing project to develop a manned and unmanned aircraft system that can work together in various operational scenarios. Hence, the

36. Commander Ayush Kumar, "Emerging Communication Technology Light Fidelity for Modern Maritime Operations", October 21, 2024, https://cenjows.in/wp-content/uploads/2024/10/Cdr_Ayush_Kumar_Web_Article_Oct_2024_CENJOWS.pdf. Accessed on January 27, 2025.
37. Group Captain (Dr) DK Pandey, "Manned-Unmanned Teaming", January 9, 2025, https://cenjows.in/manned-unmanned-teaming-enhancing-lethality/. Accessed on January 25, 2025.

system should be able to combine technologies to achieve the desired results optimally.

- The challenge for the Indian armed forces is to adapt to drone warfare either by creating a new arm to be developed and employed independently or by integrating technology for drone warfare with the other arms.

CONCLUSION

Unmanned systems are becoming 'the main battlefield' between modern forces, focussing on the platform's autonomy, detection and strike capabilities. Mid-sized platforms will transition between coordinating manned-unmanned systems to fully manned operations, while swarms of small drones will become indispensable weapons. There will be a race for a 'denial strategy' wherein the domain will be denied to the enemy while allowing the use of the domain for oneself. Swarm drones present a challenge when a drone in a swarm does not have a recognisable radio frequency signature.

The essence of an ongoing conflict is reflected in the uncertainty that permeates military operations, where a military institution can never be completely prepared. Therefore, military organisations must possess the critical adaptability attribute during the conflict. By introducing new technologies and creating strategies to take advantage of them, Russia and Ukraine have shown that they are capable of adaptability. Developing new technologies and integrating them into war-fighting takes a long time. The Russian Army has been a fast follower of what Ukraine achieved by integrating aerial drones into large-scale ground combat operations. Drones should be game-changers by adding meaningfully to the combined arms. The armed forces and other security establishments must synergistically integrate drones for combat roles.