4 Indian AI Military Innovation

NATIONAL ASSEMBLY FUTURES INSTITUTE

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1) The Perception on AI and the Future of Warfare

Lessons from Ukraine War

There is an opportunity for India to learn from Ukraine's experience. There are three key lessons from Ukraine's innovations to guide India's approach to current and future conflicts.

The Role of Public-Private Partnerships. Ukraine's agile public-private partnerships have increased flexibility and responsiveness to a rapidly changing battlefield. Innovation works from multiple channels: private industry needs a pathway to inject solutions, and operational units need to be able to identify requirements. Ukraine is leveraging both mechanisms through innovation hubs like Brave1 and from the bottom-up with soldiers procuring off-the-shelf technology. Ukraine's nimble innovation architecture has enabled advancements in all warfare domains.

The private sector has appetite for risk, utilizing agility and market incentives to develop cutting-edge innovations in a way that publicly funded institutions cannot match. India hasn't yet understood the value of such collaborations, investing heavily in the Indian Defense Research and Development Organization (DRDO). There is a need to investigate how engagements with the private sector can be streamlined. Further, there are multiple "innovation" centers within the Indian Military and MoD coupled with the complicated procedures of defense acquisition and contracting, making rapid and agile involvement of private players difficult. India should consider how to allow more direct and flexible

engagement with the private sector in AI based defense technology. A thorough streamlining of regulatory requirements is required to leverage the full benefit of innovation for defense outcomes.

Conventional Warfare Matters. Emerging applications of technology are removing some of the asymmetric advantages between more established militaries and smaller forces. The importance of traditional military might, however, cannot be discounted. Russia's successful defensive entrenched positions rely on traditional conventional warfare: mines, tanks, sniper posts, and layered lines of defense. To attempt to break through Russian lines, Ukraine has merged innovative technology with conventional warfare: small drones conducting reconnaissance for tanks and Starlink connecting units along the front lines. But Ukraine's desperate need for tanks in the counteroffensive shows traditional warfare still has a role and sheer numbers still matter. Both Russia and Ukraine are employing a strategy of attrition – slowly and steadily degrading the enemy's personnel and supplies – the same strategy used in wars spanning back hundreds of years. As British General Sir Patrick Standards put it: "You can't cyber your way across a river."[290] Technology and traditional warfare are linked in the battlespace, evermore in the 21st century.

Employing HUMINT. Local civilians represent increasingly valuable partners to military forces. While India's counterterrorism operations since the 1980s have tried to rely on the goodwill of the citizens, Ukraine showcases the power of a mobilized civilian population armed with technology. Clever use of social media apps like TikTok, Telegram and Twitter (the 3Ts) by the Ukrainian civilian population under occupied territories has been transforming the tactical battlespace like never before[291]. The Ukrainian population acts as one large 'sponge' for collecting intelligence on Russian movements and deployments.

290) Future Soldier, "General Sir Patrick Sanders Opens the RUSI Land Warfare Conference with His Speech," (2022.06.28). https://www.army.mod.uk/news-and-events/news/2022/06/rusi-land-warfare-conference-cgs-speech/.

291) Emmanuel Selva Royen, "From Civilian Sleuths to Military Strategy: Role Of OSINT In The Russia-Ukraine War and Lessons For India," *CENTRE FOR JOINT WARFARE STUDIES*, Issue Brief, (2023.08.06)., 1–21, https://cenjows.in/pdf-view/?url=2023/08/Emmanuel_Royen_Issue_Brief_August_2023.pdf&pID=20847.

Ukraine's tech-savvy citizenry with smartphones has turned the state into a large, distributed and open-source network for information collation. The presence of motivated citizens with smartphones on and around the battlefield provides a wider scope of intelligence collection than any traditional means. The Ukrainian government, for its part, has taken a step further by allowing its citizens to post pictures and videos of troop movements, geo-tagged on its country-wide public service app called DIIA, for instant use by military units on the battlefield. Leveraging HUMINT resources will require the support of local populations and ways to ingest and act on new data sources. Soft power will continue to be a critical component of any effective military campaign, alongside technology solutions that can bring civilian forces into the fight.

Addressing Threats to India's AI Defense Capabilities

India faces several critical threats as it advances its AI-driven defense initiatives, requiring careful navigation to maintain its strategic edge in a rapidly evolving global landscape.

(a) **China's Rapid AI Advancements**: China's aggressive AI ambitions, with a goal to become the global leader by 2030, are supported by substantial investments and vast data resources. China is advancing military applications of AI, including autonomous drones, space-based AI systems, and advanced missile technology. Its centralized governance allows quicker implementation of AI projects, bypassing ethical and legal challenges. To counter this, India is investing adequately (within constraints) in indigenous AI development and strengthening international alliances, ensuring it can keep pace with adversaries' technological advancements.

(b) **Political Instability**: While India has enjoyed political stability at the national level for the past two decades, a return to coalition governments, similar to those seen in the 1990s, could disrupt long-term defense projects. Political instability could also lead to inconsistent resource allocation and policy

shifts, impacting critical AI initiatives. To overcome this, India has more or less established a bipartisan understanding that the development of AI technologies, especially in defense, is a national priority.

(c) **Export Controls and Foreign Dependency**: India's reliance on foreign technology for critical AI systems presents a risk. Export controls imposed by leading AI technology providers could limit access to key components, potentially stalling development. Foreign technologies also carry embedded biases that may not align with India's national interests. India continues to prioritize indigenous development, reducing dependency on foreign technologies, ensuring self-reliance, and safeguarding national interests in the AI domain.

(d) **Geopolitical Tensions**: Geopolitical tensions with nuclear-armed neighbors like China and Pakistan pose risks, potentially disrupting access to international collaborations and technology transfers. Border disputes could further escalate tensions, limiting partnerships critical for AI innovation. India is focusing on diplomatic efforts to manage these tensions while concurrently advancing self-reliant AI technologies to ensure continuous development and resilience even during geopolitical challenges.

(e) **Data Security Risks**: AI systems in defense depend on large datasets, making data security a significant concern. Cyber-attacks targeting AI systems can expose sensitive military data or manipulate information to disrupt operations. Implementing stringent cybersecurity protocols and investing in indigenous countermeasures remain key strategies to protect military AI systems, ensuring the integrity and security of data across all platforms.

By addressing these threats—ranging from China's rapid technological advancements to political challenges, export controls, and data security risks—India is advancing its AI defense capabilities while ensuring resilience against conventional and emerging threats.

2) Comprehensive National AI Strategy to Fight Future AI Wars

The Role of AI in India's Defense Strategy

Artificial Intelligence (AI) is not just a technological trend for India; it's a strategic necessity. Recognizing the transformative power of AI, India has been proactive in integrating this technology into its defense strategy. Here is how AI plays a pivotal role in India's defense sector:

Strategic Importance

India's National Defense Strategy underscores AI as essential for enhancing operational preparedness and strategic capabilities. Specific goals targeted by AI integration include improving real-time decision-making, precision in military operations, and enhanced surveillance to monitor and respond to threats more effectively. AI also plays a crucial role in predictive analytics, forecasting potential security issues and enemy movements, thus bolstering proactive defense measures.

To drive these initiatives, the Indian government has committed significant resources, allocating over Rs 100 crore (1 crore =100 million) annually to AI-centric projects[292]. Furthermore, the establishment of the Defense Artificial Intelligence Council (DAIC) has been a critical move, tasked with spearheading AI initiatives across the defense sector. The DAIC oversees the implementation of AI projects, aligning technological advancements with defense objectives. Notable projects include the development of AI-driven surveillance systems that efficiently process and analyze vast data sets and AI-enhanced predictive maintenance systems for defense equipment, aimed at boosting operational readiness.

By strategically investing in AI and establishing dedicated oversight through the

[292] Indian Aerospace & Defence (blog). "AI In Defence: A Game-Changer For Military Strategy & Security - Indian Aerospace and Defence Bulletin - News for Aerospace and Defence in India," (2023.06.30)., https://www.iadb.in/2023/06/30/ai-in-defence-a-game-changer-for-military-strategy-security/.

DAIC, India is ensuring that these advanced technologies are seamlessly integrated into the national defense framework, enhancing the country's ability to manage and respond to contemporary security challenges on the digital battlefield.

Decision-making and Intelligence

The integration of AI into military intelligence within the Indian defense sector has fundamentally transformed strategic decision-making processes. AI algorithms, particularly those based on neural networks and machine learning, are deployed to sift through and analyze vast amounts of intelligence data swiftly. These technologies excel in pattern recognition, enabling the identification of subtle trends and anomalies that could indicate enemy activities or shifts in strategy.

Advanced machine learning models, such as convolutional neural networks (CNNs), play a crucial role in interpreting satellite imagery and aerial reconnaissance data, detecting unusual troop movements or infrastructural developments that could signal potential threats. Similarly, predictive analytics utilize both historical data and real-time inputs to forecast enemy movements and pinpoint potential conflict hotspots, aiding commanders in making informed tactical and strategic decisions.

Advanced Technology Deployment in the Indian Army for Enhanced Decision Making

The Indian Army has made significant strides in incorporating Artificial Intelligence to streamline battlefield operations. Storm drones and drone feed analysis systems are pivotal for real-time battlefield monitoring and intelligence gathering. Additionally, AI-based Mandarin translators[293] and Project Prism

[293] Dinakar Peri, "Soon AI-Based Mandarin Translation Devices for Troops on LAC," *The Hindu*, (2022.07.11). sec. India, https://www.thehindu.com/news/national/soon-ai-based-mandarin-translation-devices-for-troops-on-lac/article65626423.ece.

enhance communication and target identification[294], breaking down language barriers and improving operational accuracy.

Systems such as Project V-logger and Silent Sentry are employed to monitor activities and enhance perimeter security effectively[295]. The Intercept Management System (IMS) and Sapper Scout are integral for advanced threat detection and area surveillance, providing essential data to command units. Moreover, technologies like mine detection unmanned ground vehicles (UGVs) and swarm drones are being developed to be used for clearing minefields and conducting extensive area surveillance without direct human intervention, significantly reducing risk to human life and increasing operational efficiency.

Indian Navy's AI Initiatives to Augment Situational Awareness

In parallel, the Indian Navy's AI-driven projects aim to bolster its capabilities across various strategic and operational areas[296]. The Autonomous Fast Intercept Boat, capable of autonomous operation at speeds up to 25 mph, is being developed in collaboration with Bharat Electronics and Goa Shipyards Limited, handling tasks such as surveillance and countermeasures.

The Navy is also advancing in natural language processing with the development of offline language translator technologies for Mandarin, Hebrew, and Russian, which are vital for enhancing communication and intelligence operations. Computer vision technologies are employed for critical security applications, including biometrics and face recognition, thus strengthening the Navy's ability to monitor and secure its assets.

Project Proton transforms 2D images of handwritten text into machine

294) Abhinandan Mishra, "Indian Army Gets Future Ready with AI-Based Equipment," *The Sunday Guardian Live*, (2022.07.16).https://sundayguardianlive.com/news/indian-army-gets-future-ready-ai-based-equipment.

295) Prem Lal Joshi, "From a Nation of 'snake Charmers' to a Global Power: The Rise of India - Indiaweekly," *India Weekly*, (2022.12.07). https://www.indiaweekly.biz/from-a-nation-of-snake-charmers-to-a-global-power-the-rise-of-india/.

296) Nivash Jeevanandam, "Exploring the Significance of AI in the Indian Navy," INDIAai, (2023.12.05) https://indiaai.gov.in/article/exploring-the-significance-of-ai-in-the-indian-navy.

-readable formats, increasing the efficiency of data processing. Anwesh and Hawksecure further enhance the Navy's decision-making and cybersecurity frameworks, employing advanced AI engines for behavioral and trend analysis. Additionally, establishing a Centre of Excellence in Artificial Intelligence at INS Valsura underscores the Navy's commitment to advancing AI and machine learning technologies, with a strong inclination towards fostering partnerships with private entities to augment AI capabilities.

Military Strategy with AI-based Games

In May 2022, the Army Training Command established a significant collaboration by signing a Memorandum of Understanding (MoU) with Rashtriya Raksha University (RRU) and Tech Mahindra to develop the Wargame Research and Development Centre (WARDEC) in New Delhi. This center is dedicated to innovating within military strategies by developing new war strategies, practicing tactics, and assessing combat formations. The primary goal is to enhance warfare skills through simulated environments that allow for comprehensive tactical training and strategy development without the risks associated with live combat exercises[297].

Lethal Autonomous Weapons (LAWS)

Lethal Autonomous Weapons Systems (LAWS) are engineered to enhance the precision, speed, and effectiveness of military responses. Capable of engaging targets based on predefined criteria and conditions, LAWS process real-time data through advanced AI algorithms, facilitating rapid responses crucial in dynamic combat environments. The deployment of such systems raises significant strategic, ethical, and operational questions. The Indian military is addressing these concerns through stringent protocols and oversight, ensuring any development or

297) Parth Shastri, "To Hone Defence, RRU to Help Set up Wargame Centre in Delhi | Ahmedabad News - Times of India," *The Times of India*, (2022.05.15). https://timesofindia.indiatimes.com/city/ahmedabad/to-hone-defence-rru-to-help-set-up-wargame-centre-in-delhi/articleshow/91571128.cms.

deployment aligns with international norms and regulations.

While India continues to explore the potential benefits of LAWS, it is mindful of the global arms race in autonomous weaponry. Instead of competing on technological advancements alone, India is charting its own path. This approach focuses on developing and incorporating LAWS technology in a manner that reflects India's unique strategic needs and ethical considerations as part of the global south.

One proposed system under consideration is akin to South Korea's SGR-A1 robotic sentry, adapted with embedded proportionality considerations and capabilities for human override. Such systems could significantly aid in managing India's extensive and heavily militarized borders[298]. India's borders stretch roughly 15,106.7 km, requiring a substantial deployment of the Border Security Force (BSF), which includes over 2.5 million personnel. The financial burden of such a large force is significant, with salaries and pensions forming a major portion of the defense budget.

Employing LAWS could act as a force multiplier, supplementing human border patrols with enhanced surveillance and detection capabilities. For instance, India's recent acquisition of advanced aircraft like the MQ-1B Predator, which can autonomously track and engage targets, points towards a future where Sentry Guard Robots could be deployed along contentious borders like those with Pakistan, improving security and operational efficiency.

Cybersecurity and Information Warfare

In the evolving landscape of modern warfare, cybersecurity and information warfare are becoming increasingly pivotal. The integration of Artificial Intelligence (AI) in these domains is transforming how military operations are conducted, particularly in the areas of threat detection and response.

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298) Sarvjeet Singh and Sharngan Aravindakshan, "Killer Robots or Soldiers of the Future: Legal Issues and India's Role in the Lethal Autonomous Weapons Debate," *Indian JL & Tech.* (2020). 16: 103.

AI's role in cybersecurity is crucial for defending against the rising threat of cyber-attacks. Machine learning algorithms are adept at detecting anomalies in network behavior, which enables the early identification of potential cyber threats. These AI systems continuously learn from new data, improving their predictive capabilities and helping to safeguard critical military networks and infrastructure.

The impact of AI extends significantly into the domain of information warfare. AI algorithms are employed to detect vulnerabilities, predict cyber-attacks, and enhance the security of critical infrastructures. By analyzing patterns and inconsistencies in data, AI helps to preemptively identify and mitigate potential breaches before they can cause harm.

In India, the government's commitment to enhancing cybersecurity is evident through its investment in AI-driven solutions. The Defense Cyber Agency, a tri-service command, plays a crucial role in coordinating these cybersecurity operations. It has been actively exploring AI technologies to bolster the nation's cybersecurity defenses[299].

Furthermore, AI is also being leveraged in information warfare to monitor and analyze social media trends, detect disinformation campaigns, and counteract propaganda. The Indian military is developing capabilities to use AI for psychological operations, aiming to influence or disrupt the decision-making processes of potential adversaries[300]. This strategic use of AI could be transformative in grey zone warfare, where the boundaries between war and peace are blurred.

This strategic integration of AI enhances India's capabilities to respond to and manage the complex challenges of modern cybersecurity and information

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299) Indian Aerospace and Defence Bulletin (blog), "India Reinforces Cyber Defences & Embraces AI For Modern Military Transformation - Indian Aerospace and Defence Bulletin - News for Aerospace and Defence in India," (2023.07.15) https://www.iadb.in/2023/07/15/india-reinforces-cyber-defences-embraces-ai-for-modern-military-transformation/.

300) Nihar Kulkarni, "AI for National Security: Indian Military Perspective." FINS India, (2022.10.12). https://finsindia.org/ai-for-national-security-indian-military-perspective.html.

warfare, ensuring that it remains prepared against both conventional and unconventional threats.

The Role of AI in India's Surveillance and Reconnaissance Operations

The Indian military is actively investing in AI-powered technologies to enhance its surveillance and reconnaissance capabilities. Here's a structured overview of how AI is integrated into these operations:

- **Data Management and ISR Capabilities**: The Indian military collects vast amounts of data daily, which might be underused. AI technologies are now being employed to sift through this data efficiently, transforming it into actionable intelligence for the armed forces. This process ensures that critical data points are utilized effectively, supporting strategic decisions and operational readiness[301].
- **Enhancing C4ISR Capabilities**: AI is playing a crucial role in enhancing the capabilities of the C4ISR systems (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) within the Indian Army. By integrating AI, these systems can process and analyze information faster, leading to more accurate and timely decisions[302].
- **Funding Startups for AI Initiatives**: Recognizing the potential of innovative technology in defense, the Indian government is supporting startups focused on AI, sophisticated imaging, sensor systems, big data analytics, autonomous unmanned systems, and secure communication systems. This funding aims to foster technological advancements that can be directly applied to enhance defense operations. The program supports

301) Shashank Reddy, "Artificial Intelligence in Defence," INDIAai, (2019.08.22). https://Indiaai.gov.in/article/artificial-intelligence-in-defence.

302) Huma Siddiqui, "Adoption of Artificial Intelligence in Indian Army's C4ISR: Here Is What the Chief Said," News, *The Financial Express*, (2022.05.09). https://www.financialexpress.com/business/defence-adoption-of-artificial-intelligence-in-indian-armys-c4isr-here-is-what-the-chief-said-2518093/.

projects with budgets ranging from Rs 1.5 crore to Rs 10 crore, promoting a thriving ecosystem of defense innovation[303].

- **Indian Army**: The Army is increasingly integrating AI into its C4ISR capabilities to improve operational efficiency. AI-powered drones and satellites are employed for real-time surveillance across various terrains, providing actionable intelligence that is critical in both peacetime and combat scenarios. Additionally, technologies like facial recognition and object detection algorithms are used to identify persons of interest and potential threats, enhancing the Army's capability in field operations and security measures[304].
- **Indian Navy**: The Navy is incorporating AI and machine learning to bolster its maritime domain awareness and intelligence, surveillance, and reconnaissance (ISR) capabilities. This integration supports a deeper understanding of the battlespace, improving the Navy's ability to monitor vast oceanic areas and conduct detailed reconnaissance missions. The use of AI helps in analyzing maritime data more effectively, ensuring the Navy remains alert to any potential threats or irregular activities[305].
- **Indian Air Force**. The Indian Air Force is significantly enhancing its C4ISR capabilities through the deployment of small satellites[306]. These satellites are instrumental in providing high-resolution imagery, real-time data, and broader surveillance coverage, crucial for maintaining situational awareness and strategic edge over large geographic areas. Furthermore, collaborative efforts between the US and IAF are underway to explore and

303) Kumar Gandharv, "Top Three AI Initiatives for Indian Defence Forces in 2022," Broadcast, INDIAai, May 24, 2022, https://Indiaai.gov.in/article/top-three-ai-initiatives-for-indian-defence-forces-in-2022.
304) Ibid.
305) Oishee Majumdar, "Indian Navy Looks to Bolster AI, ML Capabilities," News, Janes.com, (2022.04.22). https://www.janes.com/defence-news/news-detail/indian-navy-looks-to-bolster-ai-ml-capabilities.
306) Kartik Bommakanti, "Strengthening the C4ISR Capabilities of India's Armed Forces: The Role of Small Satellites," OCCASIONAL PAPERS, ORF, (2020.06.15). https://www.orfonline.org/research/strengthening-the-c4isr-capabilities-of-indias-armed-forces-the-role-of-small-satellites-67842/.

expand the use of artificial intelligence in military operations. These discussions aim to strengthen military ties and technological exchanges between the two nations, focusing on leveraging AI to improve operational efficiency, decision-making processes, and overall mission success in various military contexts[307].

Advanced Autonomous Systems in Combat Operations

The Indian military is actively developing and deploying advanced autonomous systems driven by artificial intelligence that enhance its capabilities across multiple domains of warfare.

- **Autonomous Fast Intercept Boat**: The Indian Navy is making strides in maritime security with the ongoing sea trials of its indigenously developed Autonomous Fast Interceptor Boats (A-FIBs)[308]. These unmanned vessels mark a significant advancement in India's coastal defense capabilities. A-FIBs are designed for high speed and maneuverability, making them ideal for patrolling vast swathes of India's coastline. Their autonomous operation allows them to function without a crew on-board, reducing risks and expanding operational reach. The A-FIB project highlights was jointly developed by the Navy's Weapons and Electronics Systems Engineering Establishment (WESEE) and Bharat Electronics Limited. Their autonomous capabilities will free up crewed vessels for more complex missions, while their speed and agility will provide a robust deterrent against maritime threats.
- **Autonomous Underwater Vehicles (AUVs)**: In Mar 2024, the Indian Navy issued a Request for Information (RFI) for an advanced autonomous

307) Colin Demarest, "US and India Launch Talks about Military AI," C4ISRNet, (2022.04.18). https://www.c4isrnet.com/artificial-intelligence/2022/04/15/us-and-india-launch-talks-about-military-ai/.

308) IDRW, "Indian Navy Tests Indigenously Developed Autonomous Fast Interceptor Boats," Indian Defence Research Wing, (2024.05.05). https://idrw.org/indian-navy-tests-indigenously-developed-autonomous-fast-interceptor-boats/.

underwater vehicle (AUV) that can be launched from a submarine. This initiative, known as the Underwater-Launched Autonomous Underwater Vessel (ULAUV) project, aims to enhance the Navy's capabilities in intelligence, surveillance, and reconnaissance (JSR), as well as mine-countermeasures (MCM) deception operations. The deployment of AUVs marks a significant enhancement in India's underwater capabilities. These vehicles are equipped with sophisticated AI that enables them to perform complex tasks such as seabed mapping, mine detection, and surveillance of underwater assets. AUVs operate independently of surface conditions, providing critical intelligence and operational support in environments that are challenging for human divers[309].

- **Unmanned Ground Vehicles (UGVs)**: The Indian Army's Design Bureau has been pivotal in fostering collaborations with private firms to develop a range of UGVs[310], which are crucial for diverse ground-based military operations. One such initiative was 'UGV Experiment-2021', an event that showcased advancements in autonomous ground technology:
  - **Enhanced Collaborative Autonomous Rover System (ECARS)**: Developed by the Kalyani Group, the ECARS exemplifies cutting-edge engineering in UGV technology. This multi-terrain vehicle is equipped with an array of sensors for positioning, mapping, path planning, and obstacle detection, ensuring robust operation across varied terrains.
  - **Innovation by Start-ups**: Reflecting the dynamic growth in Indian defense innovation, start-ups are also making significant contributions:
    - **Torus Robotics**: Based in Tamil Nadu, this start-up is known for its work on robotics and indigenous disruptive power-train technologies.

309) IDRW, "Indian Navy Seeks Advanced Autonomous Underwater Vehicle," Indian Defence Research Wing, (2024.07.13). https://idrw.org/indian-navy-seeks-advanced-autonomous-underwater-vehicle/.
310) Atul Chandra, "Indian Army Accelerates Efforts to Develop Unmanned Ground Vehicles," *FORCE* (blog), https://forceindia.net/cover-story/unmanned-rovers/. accessed 2024.09.13.

Recognized by Start-up India, Torus Robotics is actively developing AI-based UGVs that promise to redefine ground operations.

- **Combat Robotics**: Another innovator from Chennai, Combat Robotics, is developing the Arista UGV, termed the world's first chassis-less UGV. This platform features an integrated motor drive and a modular design, enhancing its portability and ease of deployment in various military contexts.

These developments highlight the Indian defense sector's commitment to integrating sophisticated AI technologies in UGVs, enhancing operational capabilities, and supporting the modernization of ground forces.

3) India's Structural and Organizational Changes for Future AI Warfare

As the future of warfare increasingly becomes defined by artificial intelligence (AI) and autonomous systems (AS), it is essential for military organizations to undergo structural and organizational changes. India's defense strategy is evolving with a focus on integrating cutting-edge AI technologies across all branches of the armed forces, ensuring that the country can meet the demands of modern warfare. This transformation involves a combination of strategic policy adjustments, structural reforms, and capacity-building efforts aimed at fostering innovation, streamlining decision-making processes, and enhancing joint operational capabilities.

Strategic Evolution of India's Defense Infrastructure for AI Integration

Centralized Leadership and Institutional Frameworks

India's commitment to AI in defense is reflected in the establishment of centralized bodies like the **Defence Artificial Intelligence Council (DAIC)**. The DAIC plays a pivotal role in coordinating AI-related initiatives across the

tri-services—Army, Navy, and Air Force ensuring that AI integration is aligned with the broader national defense objectives. Its responsibilities include the development of AI policy frameworks, overseeing research and development, and facilitating collaboration between the military, academia, and private sector.

In addition, Directorates of AI are being set up within individual services, enabling dedicated focus on AI research, operational implementation, and data management. These directorates ensure that AI technologies are being deployed in a manner that enhances force readiness and operational effectiveness while maintaining oversight of ethical and legal considerations surrounding AI deployment in military contexts.

AI-Enhanced Command and Control Structures

AI integration is leading to a transformation of command and control structures within the Indian military. The traditional hierarchical model of decision-making is being augmented with AI-enabled Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems. These systems utilize machine learning algorithms to process vast amounts of sensor data in real-time, providing commanders with accurate, actionable intelligence. This allows for quicker decision-making, enhances battlefield situational awareness, and improves coordination between different military branches.

The restructuring of India's Integrated Defence Staff (IDS) to include AI-focused divisions further demonstrates a shift towards network-centric warfare. By streamlining information flows and providing integrated operational oversight, these divisions ensure that AI-powered platforms can operate seamlessly across multiple domains—land, sea, air, space, and cyberspace.

Cross-Domain AI Integration for Future Combat

AI in the Indian military is not confined to any one domain; rather, it spans across land, naval, and air operations, reflecting a cross-domain integration strategy. The Indian Army's use of swarm drones, AI-powered logistics management, and autonomous ground vehicles (UGVs) for mine detection and surveillance illustrates the growing reliance on AI for operational efficiency.

The Indian Navy's Autonomous Fast Interceptor Boats (A-FIBs)[311] and AI-enabled maritime surveillance[312] systems reflect the transformative impact of AI on naval operations, while the Indian Air Force's C4ISR upgrades demonstrate the importance of AI in air combat and surveillance. The creation of joint AI task forces across these domains ensures that India's armed forces can respond cohesively to future threats, leveraging AI to coordinate strategies across the board.

AI-Driven Cybersecurity and Information Warfare

As warfare becomes increasingly digitized, AI plays an essential role in cybersecurity and information warfare. AI is being integrated into India's cyber defense systems to enhance capabilities in identifying vulnerabilities, detecting intrusions, and responding to cyber-attacks with remarkable speed and precision. These AI-powered systems can continuously monitor and analyze large-scale networks, quickly identifying anomalies and neutralizing threats before they cause significant harm. The Defence Cyber Agency[313], established to lead cyber operations, utilizes AI to strengthen India's cyber resilience by supporting real-time threat detection and response measures, ensuring a robust

311) ET Online. "Indian Navy to Unveil New Autonomous Boat Swarms and AUVs at Swavlamban Seminar," *The Economic Times*, (2023.10.03). https://economictimes.indiatimes.com/news/defence/indian-navy-to-unveil-new-autonomous-boat-swarms-and-auvs-at-swavlamban-seminar/articleshow/104120477.cms?from=mdr.

312) IMR Reporter, "Indian Navy Leading in AI Technologies," *Indian Military Review* (blog), (2022.01.15).https://imrmedia.in/indian-navy-leading-in-ai-technologies/.

313) PIB, "CYBER WARFARE," Press Information Bureau Government of India Ministry of Defence, https://pib.gov.in/Pressreleaseshare.aspx?PRID=1742322. Accessed 2024.10.17.

defense against evolving cyber threats. This integration is critical as it enhances India's ability to manage and mitigate risks in the increasingly complex domain of cybersecurity[314].

In addition to defending against cyber threats, AI-based information warfare systems are being developed to counter disinformation campaigns and influence operations. These systems analyze social media patterns, detect fake news, and identify malicious content, helping India protect its digital sovereignty in both peace and war[315].

In conclusion, India's strategic transformation for AI-enabled warfare reflects the country's commitment to staying ahead of evolving military challenges. Key changes have been implemented to integrate AI across all defense sectors. The establishment of pivotal bodies like the Defence Cyber Agency (DCA), the Defence Artificial Intelligence Council (DAIC), and AI Centres of Excellence demonstrates the structural shift toward AI-powered military operations. These institutions oversee critical areas such as cyber defense, intelligence analysis, and decision-making, with initiatives like AI-driven maritime surveillance and autonomous systems. Additionally, the formation of AI-centric Directorates within the Army, Navy, and Air Force ensures a focused and coordinated effort across the tri-services, with each branch tailoring AI adoption to its specific operational needs.

India's approach includes fostering partnerships with the private sector, international collaborations (like the Indo-US Defense AI Partnership), and integrating AI across command, control, and operational structures. Furthermore, an integrating agency, such as the DAIC, ensures that AI initiatives are unified across all branches, promoting cohesion and efficiency in AI development and deployment. Ethical AI governance is also prioritized, ensuring responsible use of

314) Majumdar, (2022.04.22). Op. Cited.

315) Ministry of Electronics and Information Technology Digital India Dialogues, (2023) "Proposed Digital India Act, 2023," Ministry of Electronics and Information Technology §, https://www.meity.gov.in/writereaddata/files/DIA_Presentation%2009.03.2023%20Final.pdf.

technologies like lethal autonomous weapons and information warfare systems.

These structural changes position India to effectively leverage AI for modern warfare, ensuring rapid decision-making, enhanced security, and cross-domain military integration that spans land, sea, air, and cyberspace. This transformation will be crucial as India continues to defend against both conventional and unconventional threats in an increasingly digital and interconnected world.

4) The Governance for India's AI Military Technology Innovation

As artificial intelligence (AI) increasingly shapes the future of military technology, India has undertaken several structural and governance reforms to integrate AI into its defense strategy. These reforms ensure that AI adoption aligns with the nation's security objectives while also addressing ethical, operational, and technological challenges.

Leveraging India's Strength in AI for Defense Innovation

India's strengths in AI provide a solid foundation for advancing its defense capabilities, with strategic initiatives in place to harness these advantages effectively.

(a) **Skilled AI Workforce**: India's large talent pool of engineers, data scientists, and AI specialists is a significant asset. The country is home to a wealth of expertise in AI technologies, with many professionals applying their skills to defense applications. The Indian Navy, DRDO, and private research centers are working with startups like NewSpace Research & Technologies to develop AI-driven solutions such as swarm drones and AI-powered surveillance platforms. India's talent pool is further leveraged through government initiatives like the iDEX programme, which supports entrepreneurs and startups in contributing innovative solutions to defense. These efforts help develop an agile, tech-driven workforce ready to tackle

modern military challenges.

(b) **Government Push for AI**: The Indian government's active role in promoting AI growth reflects a strong commitment to harnessing AI for defense. Projects like the US-India AI Initiative and the Applied AI Research Centre focus on fostering AI talent, while the National Research Foundation (Anusandhan) aims to bridge gaps between academia, industry, and R&D. These policies ensure India's defense sector remains at the cutting edge of AI development, with a focus on indigenous solutions. iDEX and DRDO are prime examples of how government-backed innovation is transforming the defense landscape by encouraging the private sector to collaborate on advanced AI technologies.

(c) **Growing AI Ecosystem**: India's rapidly expanding AI ecosystem, driven by a vibrant startup culture and research institutions, is being integrated into the defense sector. The government has rolled out initiatives like iDEX to fast-track AI-driven military technologies through public-private partnerships. This integration allows military forces to leverage advancements in AI, ranging from logistics management systems to predictive maintenance and fault detection tools for complex systems like aircraft and naval vessels. Collaboration with industry giants like Microsoft, Dassault Aviation, and BEL ensures the defense sector benefits from the best AI technologies available.

(d) **Strategic Partnerships**: Strategic partnerships have been pivotal in strengthening India's AI capabilities for defense. Collaborations with Thales and HAL to integrate AI in avionics and partnerships with Dassault Aviation to develop AI applications in the Rafale fighters are key examples. Furthermore, under the Indo-U.S. Defense Technology and Trade Initiative (DTTI), a roadmap is being developed to co-create autonomous drones. These partnerships and collaborations in sectors like cloud computing with Microsoft are helping India gain access to the most advanced AI technologies and integrate them into its defense apparatus.

(e) **Indigenous Development (आत्मनिर्भरभार)**: India's focus on self-reliance is a driving force behind its AI innovation for defense. DRDO and private firms like Tata Advanced Systems and Mahindra Defence are developing AI-powered systems like autonomous drones and missile guidance technologies. The Indian Navy is also working on AI-based underwater autonomous vehicles and swarm boats for maritime defense. This emphasis on indigenous development reduces reliance on foreign technologies and ensures that solutions are customized for India's specific defense needs.

(f) **Experience in Software Services**: As a global leader in software services, India's extensive experience in this sector provides a unique advantage in AI development. Companies like Infosys, Wipro, and TCS have been at the forefront of software innovation, and their expertise is being channeled into defense AI systems. By applying the principles of quality, scalability, and reliability from the software services sector, India is developing robust AI systems tailored to military applications, ensuring they are both scalable and secure.

India is leveraging these strengths to build a strong AI-enabled defense system that is adaptable to future military needs, ensuring it can remain competitive in the rapidly evolving landscape of AI-driven warfare. Through strategic investment, government initiatives, and public-private collaborations, India is well-positioned to harness its strengths and become a global leader in AI for defense.

Addressing Infrastructure Challenges

India's defense AI systems face several infrastructure-related challenges that need strategic governance and investment to ensure AI's effective integration into military operations.

(a) **Outdated Hardware and Software**: One of the primary barriers is the reliance on legacy systems within the defense sector, which are not compatible with

modern AI algorithms. Many of these systems require significant upgrades or replacements to support AI-based defense capabilities. Additionally, India is highly dependent on foreign software and operating systems, which poses security risks. In response, India is focusing on indigenous development to reduce reliance on foreign technologies, with institutions like DRDO and private firms driving the development of homegrown solutions.

(b) **Connectivity in Remote Areas**: Poor connectivity in remote regions where the military operates limits the deployment of real-time AI systems for operations such as surveillance and data analysis. India is investing in satellite-based communication systems and expanding its network infrastructure in challenging terrains to address this. The Indian government is also pushing to deploy 5G technologies to facilitate faster, more reliable connections in remote areas critical for military operations.

(c) **Data Management**: AI systems require vast amounts of data for both training and operational tasks. India is building high-performance computing (HPC) facilities and data centers designed to handle large-scale data processing. In addition, the National Centre for Transformational AI focuses on secure and efficient data handling for AI applications, especially for defense purposes.

(d) **Energy Demands**: The energy requirements of AI systems are significant; it is a challenge, particularly in remote areas where access to reliable energy sources is limited. To address this, India is exploring renewable energy solutions like solar-powered grids to support AI operations in difficult terrains. Mobile power units are also being tested to ensure that military AI systems can run uninterrupted even in isolated locations.

(e) **Interoperability Between Services**: AI solutions often lack interoperability between the Army, Navy, and Air Force, which limits cross-domain coordination. The establishment of AI-centric Directorates within each branch, along with efforts led by the Defence Artificial Intelligence Council

(DAIC), aims to ensure seamless integration and operational efficiency across the services.

(f) **Funding Constraints**: Although the government has allocated 100 crore annually for AI in defense, this funding is inadequate given the scale of AI investments needed to keep pace with global powers. To overcome this, India is increasingly relying on public-private partnerships and international collaborations to attract more funding and expedite AI development in the defense sector. Furthermore, proposals to increase long-term defense budgets for AI projects are under consideration.

(g) **Regulatory Framework**: The absence of a clear regulatory framework specifically addressing AI in military applications creates uncertainty, particularly regarding the ethical and legal implications of autonomous systems, like drones. India's Ministry of Defence is working with international bodies such as the UN Group of Governmental Experts (UN GGE) to establish global norms, while domestically, the Defence Artificial Intelligence Council (DAIC) is formulating guidelines to ensure AI's ethical deployment in warfare, with clear responsibilities defined for developers and operators.

(h) **Cost-Conscious Procurement Practices**: India's focus on selecting the lowest bidder in defense contracts (L1 system) often results in compromises on quality, hindering innovation. Efforts are underway to revise procurement policies to encourage innovation, allowing for higher investments in advanced AI technologies. The Make in India initiative is also geared towards enhancing domestic production and reducing costs by promoting indigenous AI development.

(i) **Limited Private Sector Involvement**: While the public sector, especially DRDO, has been leading AI initiatives, the pace of innovation can be slow due to bureaucratic constraints. The involvement of private companies, which are often more agile and innovative, is limited. The government is now creating incentives for the private sector to participate more actively in defense AI development, through tax breaks, joint ventures, and easier

access to defense contracts.

(j) **DRDO's Slow Pace of R&D**: The DRDO is often criticized for delays in the research and development of new technologies. In response, India is pushing for a more agile operational model within DRDO, with increased collaboration with academic institutions and private players to fast-track AI projects. Public-private partnerships are also being expanded to leverage private sector speed and expertise in R&D.

By addressing these infrastructural challenges, India is laying a foundation for integrating AI into its defense framework. Strategic investments in indigenous technology, regulatory frameworks, and public-private collaborations are key to overcoming these barriers and ensuring India's military is well-prepared for future AI-enabled warfare.

Accelerating AI R&D through Public-Private Collaboration

India's defense ecosystem has opened its doors to public-private partnerships in AI research and development. Private sector companies like NewSpace Research & Technologies are playing a crucial role in developing AI-driven technologies for the military, such as swarm drones and AI-enabled surveillance platforms. Such collaboration helps bring fresh innovation, flexibility, and risk-taking abilities often absent in traditional military research and development.

Furthermore, India has initiated joint research programs with international partners, such as the Indo-US Defense AI Partnership[316] and the Indo-Taiwan Joint Research Centre on AI and ML[317]. These collaborations allow for the exchange of expertise and resources, helping India fast-track the development and deployment of AI solutions in military contexts.

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316) IUSSTF, "Indo-U.S. Science and Technology Forum (IUSSTF) - Iusstf," https://iusstf.org/usiai. accessed 2024.10.16.

317) Kelvin Chen. "Taiwan, India Ink MOU on Science Research," *Taiwan News*, (2023.12.08). https://taiwannews.com.tw/en/news/5055468.

Leveraging Opportunities for AI Integration in India's Defense Sector

India has several key opportunities that can significantly advance its AI capabilities in the defense sector. Tapping into these opportunities will position the country as a leader in AI-driven military technologies globally.

(a) **Strategic Alliances**: India's partnerships with technologically advanced nations like the United States, Israel, and France offer a great opportunity to access cutting-edge AI technology. India can fast-track its AI capabilities for defense applications by engaging in joint research and development and resource-sharing. Partnerships like the Indo-U.S. Defense Technology and Trade Initiative (DTTI) provide platforms for the co-development of technologies, such as autonomous drones. These strategic alliances not only enhance technological advancement but also strengthen diplomatic and military cooperation, helping India stay ahead in AI innovation.

(b) **Defense Exports**: India's growing AI ecosystem presents an opportunity to become a global supplier of AI-driven defense solutions. By developing a robust policy framework for defense exports, India could generate significant revenue from exporting indigenous AI-based technologies to friendly nations. Such exports would bolster the country's economy and contribute to further research and development, fostering innovation. The move to establish 'Brand India' in the global market will also enhance the country's strategic influence and position it as a leader in advanced AI military technology.

(c) **Strengthening Alliances and Collaborations**: To fully leverage the potential of these opportunities, India must strengthen its existing alliances and seek out new collaborations with global partners. Platforms like the Quad Alliance (India, the U.S., Japan, and Australia) and India-Japan-U.S. Trilateral Dialogue offer avenues for joint AI research and development, fostering technological growth. These collaborations will not only help India access advanced technologies but also establish it as a key player in the AI-driven defense landscape, enabling the exchange of expertise and resources on a

global scale.

By leveraging these strategic opportunities, India can enhance its AI capabilities, drive global partnerships, and secure a significant role in the international defense technology market. These efforts will also contribute to developing a more robust and future-ready defense infrastructure.

In conclusion, India is making significant strides in integrating AI into its military framework through strategic investments, policy reforms, and collaboration with global partners. Leveraging its skilled workforce, robust AI ecosystem, and strong government push for technological innovation, India is well positioned to address its infrastructure challenges and tap into the potential of AI for defense. By mitigating threats such as geopolitical tensions, reliance on foreign technologies, and data security risks while capitalizing on opportunities for international partnerships and indigenous development, India is poised to become a key player in AI-driven military advancements. This forward-looking approach ensures that India remains competitive in the rapidly evolving landscape of AI-enabled warfare, safeguarding national security and enhancing its global defense capabilities.

5) The Educational Innovation for Future AI Warfare: India's Talent Ecosystem

India's journey towards establishing itself as a leader in AI-driven military innovation requires a robust and adaptable talent ecosystem capable of meeting the demands of future warfare. To this end, several educational innovations have emerged, ensuring that India's workforce is well-prepared to develop, implement, and operate AI technologies in defense contexts.

Investment in Talent and AI Education for Defense

Recognizing that the future of warfare depends on human-AI collaboration, India is investing heavily in creating a skilled AI workforce capable of developing,

operating, and maintaining advanced AI systems. The Centres of Excellence for AI[318] established by the Ministry of Defence (MoD) are tasked with fostering a new generation of AI researchers, engineers, and military officers who are well-versed in AI and autonomous technologies.

Military academies and defense research institutes are revising their curricula to include AI and data science as core subjects. These institutions are collaborating with leading academic organizations, both domestic and international, to ensure that the armed forces have access to cutting-edge AI knowledge. Additionally, India's Quantum Lab[319],[320] and other initiatives, such as the Defense Institute of Advanced Technology (DIAT), are at the forefront of educating military personnel in next-gen technologies like quantum computing, machine learning, and robotics[321], all of which are integral to AI warfare

AI Education and Military Training

One of the pillars of India's AI ecosystem is its focus on enhancing education and training in AI at both the institutional and military levels. The Indian government has launched initiatives like the National AI Portal (INDIAai) and National Institute of Electronics & Information Technology (NIELIT)[322], which offer AI training programs aimed at developing skilled AI professionals across various sectors, including defense. The INDIAai mission, a collaboration between the Ministry of Electronics and Information Technology (MeitY) and NASSCOM,

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318) Aayog NITI, "National Strategy for Artificial Intelligence - Discussion Paper", (2018.06) https://indiaai.gov.in/documents/pdf/NationalStrategy-for-AI-Discussion-Paper.pdf.

319) PIB, "Indian Army Establishes Quantum Laboratory at Mhow (MP)," Press Information Bureau, GoI, (2021.12.29). https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1786012.

320) Express News Service, "DIAT to Research, Develop Robotics Platforms for Armed Forces," *The Indian Express* (blog), (2021.02.07). https://indianexpress.com/article/cities/pune/diat-to-research-develop-robotics-platforms-for-armed-forces-7178681/.

321) DIAT, "School of Defence Technology – DIAT," https://diat.ac.in/school-of-defence-technology-2/. accessed, 2024.10.16.

322) National Institute of Electronics & Information Technology (NIELIT), "Artificial Intelligence Courses," Text, National Institute of Electronics & Information Technology (NIELIT), (2022.11.28). https://www.nielit.gov.in/content/artificial-intelligence-courses.

provides a hub for AI resources, education, and skill development programs[323]. These efforts help build the necessary talent pool to support the nation's AI innovation, particularly in the defense sector[324].

Moreover, public-private partnerships are playing a key role in addressing challenges in AI skilling and implementation. For example, initiatives like the FutureSkills Prime program[325], led by MeitY and NASSCOM, are focusing on improving AI skills for both IT and non-IT fields, ensuring that India remains competitive in the global AI landscape. These initiatives demonstrate India's commitment to building an ecosystem where education, policy, and industry collaborations come together to foster innovation in AI, specifically in defense applications. This emphasis on education and skilling helps position India as a leader in AI-enabled military technologies and ensures a steady supply of skilled professionals to meet future defence challenges

Further, Military academies, such as the Defence Services Staff College (DSSC) and the Indian Military Academy (IMA), are integrating AI into their curricula, ensuring that future military leaders are well-versed in the strategic and operational applications of AI.

Institutions like the Defence Institute of Advanced Technology (DIAT) play a pivotal role in training military personnel in AI, machine learning, and robotics. DIAT's specialized courses focus on areas such as autonomous systems, cyber defense, and AI-driven surveillance systems. These initiatives prepare the armed forces to adapt to the rapid technological shifts expected in future combat scenarios.

India's National Strategy for Artificial Intelligence[326] has made significant

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323) Pratyusha Tripathy, "Union Minister Rajeev Chandrasekhar Launches Future Skills PRIME," *National Skills Network- NSN* (blog), (2021.11.01). https://nationalskillsnetwork.in/union-minister-rajeev-chandrasekhar-launches-future-skills-prime-programme/.

324) Anjali Raja, "Understanding the Nature and Scope of AI Skilling Programs in India," INDIAai, (2024.07.25). https://indiaai.gov.in/article/understanding-the-nature-and-scope-of-ai-skilling-programs-in-india.

325) Nasscom, "FutureSkills Prime – India's Technology Skilling Hub," Future Skills Prime, (2024) https://futureskillsprime.in/home. accessed 2024.10.17.

326) NITI Aayog, "National Strategy For Artificial Intelligence," INDIAai, (2019.08.21). https://Indiaai.gov.in/research-reports/national-strategy-for-artificial-intelligence.

strides in enhancing educational services by offering personalized learning experiences, automating administrative tasks, and providing real-time feedback to both educators and students. A notable example is BYJU's, India's leading online learning platform, which harnesses AI to tailor individual learning paths. The platform dynamically adjusts the complexity of content based on a student's comprehension, allowing for a customized and more effective learning experience. This demonstrates how AI-driven education platforms are elevating the quality and accessibility of learning, creating a skilled talent ecosystem well-suited for future AI challenges, including in the defense sector.

Emerging AI Educational Initiatives

(a) **Centers of Excellence**: The establishment of these centers is pivotal in fostering AI research and development, contributing to sectors such as defense. With key milestones like the announcement of three new Centers of Excellence in February 2023[327], and the creation of a central project management unit at IIT Jammu, these initiatives align with India's strategic vision of 'Make AI in India and Make AI Work for India.' Further support comes from established institutions like the International National Centre for Transformational AI, which plays a crucial role in AI innovation.

(b) **AI-focused Education**: Initiatives such as the *Responsible AI for Youth* [328] program are designed to nurture AI talent from an early stage, equipping future generations with the skills necessary for AI in defense applications. The National Research Foundation's *Anusandhan* initiative[329] further bridges academia, research, and industry, ensuring a steady development of expertise in AI.

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327) Bhuvana Kamath, "Union Minister Dharmendra Pradhan Launches Three AI Centres of Excellence," Your Story, (2024.10.15). https://yourstory.com/2024/10/union-minister-dharmendra-pradhan-launches-3-ai-centres-of-excellence.

328) YUVAi, "YUVAi - Youth for Unnati & Vikas with AI," Responsible AI for Youth, , https://responsibleaiforyouth.negd.in/home. accessed 2024.10.17.

329) NRF, "Anusandhan National Research Foundation,", https://www.psa.gov.in/nrf. accessed 2024.10.17.

(c) **Defense-oriented AI Research**: India's commitment to integrating AI into its military capabilities is evident with the creation of specialized research centers, such as the National Institute for Robotics and Artificial Intelligence[330], as well as dedicated AI laboratories within the Indian Navy and Air Force. These institutions are tasked with ensuring AI technologies align seamlessly with the defense strategy.

Collaborative Ecosystem between Academia, Defense, and Industry

India's educational framework for AI warfare is also characterized by deep collaborations between academic institutions, the defense sector, and private industry. Centers of excellence, such as the Indian Institutes of Technology (IITs), Indian Institutes of Information Technology (IIITs), and universities, are working closely with defense organizations like DRDO and private defense contractors to build cutting-edge AI applications for military use.

Initiatives like iDEX (Innovations for Defense Excellence) enable students, researchers, and startups to collaborate on defense challenges, fostering an innovation-driven culture. These partnerships help bridge the gap between theoretical AI research and its practical, real-world applications in defense.

Upskilling and Reskilling Existing Personnel

As AI technologies continue to evolve, the upskilling and reskilling of existing personnel are essential. Various Indian military institutions have incorporated advanced AI training modules for officers, engineers, and soldiers.

Over the last few years, Indian Naval personnel have been involved in AI-focused courses, including predictive maintenance, data analytics, decision support systems, and autonomous maritime systems. This training is conducted in collaboration with prominent institutions like the Indian Institutes of Technology

330) "National Institute of Robotics & Artificial Intelligence | NIRA," National Institute of Robotics & Artificial Intelligence | NIRA, https://nira.ac.in/. accessed 2024.10.17.

(IITs) and involves hands-on projects in AI applications relevant to naval operations[331]. Moreover, the Indian Navy has formed an AI core group to drive these efforts, ensuring that personnel at all levels—officers, engineers, and sailors—receive continuous education in AI and machine learning.

AI training in the Indian Army is part of a broader initiative to modernize and digitize the forces. For example, AI is utilized in artillery systems to calculate factors like wind speed, temperature, and air density for more precise targeting, as well as in logistics to predict potential disruptions in supply chains. AI technologies are expected to significantly reduce time and improve decision-making in battlefield environments by factoring in multiple real-time variables for a more accurate operational picture. AI in Army operations is expanding through collaborations with academic institutions, where specialized programs in AI are helping personnel learn and apply these technologies for enhanced operational efficiency and strategic planning[332].

The Indian Air Force (IAF) has taken notable steps to incorporate AI technologies into its operations, with a significant focus on upskilling personnel. AI is being integrated across several domains, including predictive maintenance of aircraft, autonomous systems, and real-time threat analysis. One prominent initiative is the establishment of the Centre of Excellence for Artificial Intelligence (CoEAI) at Air Force Station Rajokri. This center is part of the IAF's broader digital transformation efforts under UDAAN (Unit for Digitization, Automation, Artificial Intelligence, and Application Networking). It focuses on developing AI capabilities in areas like supply logistics, intelligence gathering, decision support systems, and mission planning, all of which are integral to modern air operations.

Moreover, IAF personnel, including engineers and pilots, are being trained in

331) Pritam Bordoloi, "Indian Navy's Quest to Become an AI-Enabled Force," AIM, (2022.07.25). https://analyticsindiamag.com/ai-origins-evolution/indian-navys-quest-to-become-an-ai-enabled-force/.

332) Pritam Bordoloi, "How Does the Indian Army Want to Use AI?," AIM, (2022.08.04). http://analyticsindiamag.com/ai-breakthroughs/how-does-the-indian-army-want-to-use-ai/.

AI-based systems, including predictive maintenance for aircraft and UAV operations. Predictive maintenance allows crews to preemptively identify potential failures in aircraft systems, enhancing operational efficiency and safety. AI-powered training simulations are also used to prepare pilots and ground crews for real-world scenarios, enhancing decision-making capabilities in complex operational environments. These training programs are often conducted in collaboration with academic institutions and public sector undertakings to ensure that personnel are adept at using cutting-edge AI technologies in their roles.

In conclusion, India's talent ecosystem for AI warfare is supported by a growing synergy between educational institutions, the defense sector, and private industries. This multifaceted approach ensures that the country's military is equipped with the knowledge, skills, and tools required to leverage AI in future combat scenarios. Through continuous investment in education, training, and public-private partnerships, India is developing a dynamic workforce that will play a critical role in shaping the future of AI-driven warfare.

6) The Discourse and Strategy for the "Human in the Loop" in India

As India continues to integrate AI into its defense strategy, the "human in the loop" approach remains a central tenet. This approach ensures that while AI systems provide support, critical decisions—especially those involving the use of lethal force—are made by human operators. The balance between AI-driven automation and human oversight is essential to maintaining ethical standards, ensuring accountability, and mitigating risks associated with fully autonomous operations.

Human Oversight and Ethical Concerns

India's commitment to maintaining human oversight over AI-driven systems reflects broader international concerns regarding the ethical implications of fully

autonomous weapons. The Indian Ministry of Defence and the Defence Artificial Intelligence Council (DAIC) have formulated guidelines to ensure that autonomous systems, including lethal autonomous weapons systems (LAWS), operate with a human in control[333]. This focus on human oversight aligns with India's participation in international forums like the UN Group of Governmental Experts (UN GGE), which promotes discussions on maintaining human control over AI in warfare.

India's stance on LAWS has been a balancing act the need to develop emerging technologies with ethical and legal concerns. India has repeatedly stressed the importance of a governance framework that avoids widening the technology gap, while also cautioning against over-regulation that could stifle innovation. Ambassador D.B. Venkatesh Varma's 2014 statement at the UN GGE highlighted the need for regulation that would neither restrict technological advancements nor make the cost of warfare so low that it could encourage the use of lethal force to settle disputes[334].

Ethical AI and Governance in Military Applications

As India moves forward with the integration of AI into its defense strategy, ethical considerations are being prioritized. The Defence Artificial Intelligence Council (DAIC), alongside the Ministry of Defence, is developing AI governance frameworks that ensure the responsible and ethical use of AI in military applications. This includes the development of AI safety standards, protocols for the use of lethal autonomous weapons systems (LAWS), and guidelines on maintaining human oversight in AI-enabled decision-making processes.

India's focus on AI ethics also extends to its international stance, where the

333) Richa Bhatia, "If The Future Of Warfare Is With Automated Weapons – Where Does India Stand In The Race?," AIM, (2018.03.27). https://analyticsindiamag.com/ai-origins-evolution/if-the-future-of-warfare-is-with-automated-weapons-where-does-india-stand-in-the-race/.

334) Kashyap Raibagi, "In Conversation With Trisha Ray, Associate Fellow At The Observer Researcher Foundation," AIM, (2021.01.15). https://analyticsindiamag.com/intellectual-ai-discussions/in-conversation-with-trisha-ray-associate-fellow-at-the-observer-researcher-foundation/.

country has been advocating for global norms and regulations on the use of AI in warfare. This diplomatic engagement highlights India's commitment to the responsible use of AI, particularly in areas such as autonomous weapons, cyber warfare, and data privacy.

Operational Strategy and Application

India's operational strategy follows a "human in the loop" model for key military AI applications, ensuring that final decisions in battlefield scenarios rest with human operators. For instance, AI systems provide real-time data processing, target identification, and threat analysis, but decisions on engagement remain with human commanders.

A relevant example of this approach is the MQ-9B Sea Guardian drones, including the MQ-9 Reapers, which India has acquired. These drones are capable of being configured for fully autonomous operations, where they could independently identify, track, and engage targets. However, India has so far refrained from employing these drones autonomously, opting instead for human oversight in all operational decisions. This cautious approach ensures that ethical standards and strategic control are upheld, even as technology advances towards full automation.

Challenges and Opportunities

The "human in the loop" approach, while essential for ethical reasons, presents challenges, particularly in balancing the speed of AI systems with human decision-making processes. AI can process vast amounts of data much faster than humans, and the need for human intervention can introduce delays in critical situations. To mitigate this, the Indian military is focused on training personnel in the operation of AI systems, ensuring they can make rapid, informed decisions when necessary.

By retaining a human in the loop, India ensures accountability and adherence

to international law while leveraging AI for enhanced operational efficiency. This strategy reflects India's commitment to maintaining ethical oversight as AI-driven systems play an increasingly significant role in modern warfare.

7) Conclusion: India's Roadmap to AI-Driven Warfare

The strategic integration of Artificial Intelligence (AI) into India's defense ecosystem is not only inevitable but essential to ensuring the nation's security in the face of evolving global threats. It is evident that India's AI military innovation is progressing on multiple fronts, leveraging national strengths while addressing infrastructural, operational, and ethical challenges.

India's journey toward AI-driven warfare is grounded in a comprehensive approach that incorporates global perspectives, ethical considerations, indigenous innovation, and human oversight. India's perception of AI aligns with global trends, where rapid advances in AI are reshaping modern warfare, exemplified by the ongoing conflicts in Gaza and Ukraine. These conflicts underscore the urgent need for countries like India to embrace AI to stay competitive and prepared for future challenges.

India's comprehensive national AI strategy underlines the importance of investing in AI research, fostering public-private partnerships, and building a skilled workforce. India's National Strategy for Artificial Intelligence enables the country to capitalize on opportunities across sectors while emphasizing the development of indigenous solutions tailored to defense needs.

AI is transforming the Indian military's operational capabilities, spanning land, air, and naval domains. Integrating AI-powered autonomous systems, enhanced C4ISR structures, and cutting-edge decision-making tools marks a significant shift towards network-centric warfare. As India's defense infrastructure evolves, it is important to create centralized bodies like the Defence Artificial Intelligence Council (DAIC) and dedicated AI directorates to ensure a cohesive,

forward-looking AI strategy for military modernization.

While India is embracing AI-driven innovation, the critical role of human oversight and governance in this transition is a crucial consideration. Ethical concerns, especially regarding Lethal Autonomous Weapons Systems (LAWS), remain at the forefront of India's AI discourse. By maintaining a "human in the loop" in key military AI applications, India strikes a balance between leveraging technological advancements and adhering to international law and moral principles.

Furthermore, India's talent ecosystem is essential to achieving success in AI-driven defense. By integrating AI into education and military training, the country ensures that its future workforce is prepared for AI-enabled warfare. The collaboration between academia, defense institutions, and private industry ensures that India remains agile, innovative, and competitive in the global AI race.

India's commitment to developing an AI-enabled military ecosystem through the lens of governance, international collaboration, and talent development. This multifaceted approach ensures that India's AI-driven warfare strategy is technologically sound and strategically robust, resilient, and adaptable to future conflicts.

In conclusion, India's roadmap for AI-driven warfare rests on the pillars of innovation, collaboration, ethics, and human oversight. The nation's ability to develop and deploy cutting-edge AI technologies while ensuring that ethical standards and international regulations are upheld places India at the forefront of global AI military innovation. As AI continues to reshape the landscape of warfare, India's preparedness for future conflicts will depend on the successful execution of the strategies outlined in this chapter—ensuring security, resilience, and operational excellence in the era of AI-enabled defense.

2024.12.30.

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Global AI Military Innovation and Future of Warfare

How Global Military Powers Are Preparing for Future AI Warfare

: Strategy, Governance and Technology Ecosystem

Edited by **Jungmi Cha**

National Assembly Futures Institute

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