ISSN 23939729

CLAWS

No. 95

2021

MANEKSHAW PAPER

Leveraging Artificial Intelligence in the Indian Army

Ajinkya Jadhav

CENTRE FOR LAND WARFARE STUDIES

Field Marshal Sam Hormusji Framji Jamshedji Manekshaw, MC, better known as Sam "Bahadur", was the 8th Chief of the Army Staff (COAS). It was under his command that the Indian forces achieved a spectacular victory in the Indo-Pakistan War of 1971. Starting from 1932, when he joined the first batch at the Indian Military Academy (IMA), his distinguished military career spanned over four decades and five wars, including World War II. He was the first of only two Field Marshals in the Indian Army. Sam Manekshaw's contributions to the Indian Army are legendary. He was a soldier's soldier and a General's General. He was outspoken and stood by his convictions. He was immensely popular within the Services and among civilians of all ages. Boyish charm, wit and humour were other notable qualities of independent India's best known soldier. Apart from hardcore military affairs, the Field Marshal took immense interest in strategic studies and national security issues. Owing to this unique blend of qualities, a grateful nation honoured him with the Padma Bhushan and Padma Vibhushan in 1968 and 1972 respectively.

Field Marshal SHFJ Manekshaw, MC
1914-2008

CLAWS Occasional Papers are dedicated to the memory of Field Marshal Sam Manekshaw

Photographs courtesy: The Manekshaw family/FORCE.

MANEKSHAW PAPER No. 95, 2021

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New Delhi

BLOOMSBURY

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ISSN 23939729

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Printed in India by
Bloomsbury Publishing India Pvt. Ltd.
DDA Complex LSC, Building No. 4, 2nd Floor
Pocket 6 & 7, Sector – C
Vasant Kunj, New Delhi 110070
www.bloomsbury.com

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List of Abbreviations

Acronyms	*Full Forms*
ACSFP	Army Commanders Special Financial Powers
ADN	Army Data Network
AGI	Artificial General Intelligence
AI	Artificial Intelligence
ANI	Artificial Normal Intelligence
AR	Augmented Reality
ASI	Artificial Super Intelligence
BMS	Battlefield Management System
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CIDSS	Command Information Decision Support System
COA	Course of Action
COCOM	Combined Commands
DARPA	Defence Advanced Research Agency
DMA	Department of Military Affairs
DRDO	Defence Research and Development Organisation
EMS	Electromagnetic Spectrum
EW	Electronic Warfare
GS	General Staff
HEO	Hyper Enabled Operator
HUMINT	Human Intelligence
HR	Human Resource
IAAIC	Indian Army Artificial Intelligence Centre
IoT	Internet of Things
IPB	Intelligence Preparation of Battle Field
IW	Information Warfare
JAIC	Joint Artificial Intelligence Centre
JCF	Joint Common Foundation
LM	Loiter Munition
MoD	Ministry of Defence
ML	Machine Learning
MS	Military Secretary

Acronyms	*Full Forms*
NCW	Network Centric Warfare
NFS	Network for Spectrum
NLP	Natural Language Processing
SA	Situational Awareness
SR	Speech Recognition
Tech	Technology
Trn	Terrain
UCAV	Unmanned Combat Aerial Vehicle
UGV	Unmanned Ground Vehicle
USSOCOM	United States Special Operations Command
VR	Virtual Reality
Wx	Weather

LEVERAGING ARTIFICIAL INTELLIGENCE IN THE INDIAN ARMY

New India that aspires to become a global leader in [the] digital revolution by leveraging the potential of artificial intelligence (AI) in bringing transparency, inclusiveness, trust, and empowerment to the people.

– Prime Minister Narendra Modi

Introduction

In the current world and the prevailing geo-political situation, the major factor which is a proliferator leading to a conflict, is the Fourth Industrial Revolution (4IR) and the enormous progress made in the development of Disruptive Technologies (DTs). The 4IR has contributed profoundly to the revolutionisation of the character of war of the future. The DTs are being used to exert power in the geo-political dynamics leading to immense competition and creating instability in the world.[1] Information and data are the new strategic weapons of the future. It has also led to the progressive weaponisation and militarisation of the battlespace, thereby establishing a new arena for conflict in the future. The Industry 4.0 norms and capabilities which are being developed and adopted by the Industry, with a strong knowledge back up from the academia, have made their mark in the military.[2] Artificial Intelligence (AI) has evolved as a game-changer in military technology. The AI revolution has transformed the world and its dual-use capabilities are proliferating in all domains of the military to make the current systems and products more efficient and reliable, avoiding human intervention, hence eliminating human error. The United States (US) and China have entered in an AI race to modernise their Armed Forces; Russia is closely following on its heels. AI technologies are already in use in foreign armies and are assisting in military decision-making, reducing human causalities and enhancing the capability of its forces, and in the process dramatically changing, if not revolutionising, the design of military systems. This is especially true in a wartime environment when data availability is high, decision periods are short, and decision effectiveness is an absolute necessity.[3] India needs to think and act fast to imbibe this technology into its military. A multi-pronged approach for imbibing this technology will have to be taken simultaneously to remain in the race in this era of competition.

Layout of the Paper

The paper aims to recommend the role and applications of AI in the Army. The paper describes the advancements made in AI technology from the

military perspective. It then analyses in detail the military approach and its employment by leading foreign armies, and tries to derive lessons for the Indian Army. The paper gives out a possible roadmap for the employment of AI applications in various fields of the Army. Conscious efforts have been made to simplify the complex subject and decode the applications for its practical employment in the Army. Procedural aspects of the implementation of this technology have not been included as it is beyond the scope of study.

Section I: Artificial Intelligence Technology: A Force Multiplier in Future Warfare

The country that leads in AI will be the ruler of the world.
–Vladimir Putin

What is Artificial Intelligence?

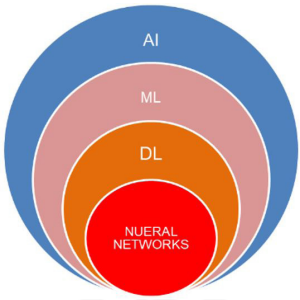
It is teaching machines to learn, act, and think as humans do.[4] Therefore, the machines are imparted cognitive capabilities to think and act as humans. It is a set of technology that allows us to extract knowledge from data. AI systems typically demonstrates behaviour associated with HUMINT such as planning, learning, reasoning, problem-solving, knowledge representation, perception, motion, manipulation, and to a lesser extent social intelligence and creativity.[5] Machine Learning (ML) is a subset of AI that uses computer algorithms to analyse data and make intelligent decisions based on what it has learned, without being explicitly programmed. ML algorithms are trained with large sets of data and the machines learn from examples.[6] They include methods and procedures that are used to develop models using different data sets to imitate Human Intelligence (HUMINT). The common application is in accessing information of tanks or radar images obtained from surveillance database, then processing, matching, and recognising the patterns to arrive at an analysis. In addition to the earlier mentioned tasks, they have to train and retrain themselves much like a human brain, which replaces old data with new information.

Deep Learning is a subset of ML. Deep Learning enables the natural language understanding capabilities of AI systems. It layers algorithms to create a 'Neural Network' that is an artificial replication of the structure and functionality of the brain, enabling AI systems to continuously learn on the job and improve the quality and accuracy of results. This is what enables these systems to learn from unstructured data such as photos, videos, and audio files.[7] This application can be employed in facial, audio and video recognition, image analysis, and language translation in the Army. An artificial neural network is a collection of smaller units called 'Neurons', which are computing

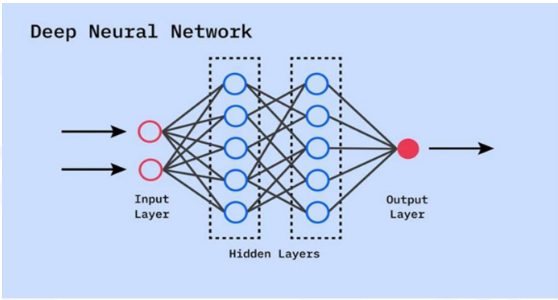
units modelled on the way the human brain processes information.[8] Neural networks can be employed for various tasks such as character recognition, pattern identification, matching, selection of air and artillery targets, flight path correction of guided missiles, and so forth. These technologies have immense potential to aid the commanders and staff in assisting in their functions and reduce their cognitive load.

Figure 1: Neural Networks

AI and its Subsets



Deep Neural Network



Source: An introduction to AI: Coursera Tutorials

Some of the most common application areas of AI include natural language processing, speech, and computer vision. Natural Language Processing (NLP) can be used in studying documents containing critical data and deliver information according to the need of the user. In case of the Army, NLP can be used by intelligence and defence analysts for obtaining essential information and relevant patterns from situational and intelligence reports.

Speech and handwriting recognition are two different subfields under the broad concept of AI, with both sharing the concept of neural networks (as discussed earlier) as their core learning technology. Speech Recognition (SR) involves the identification, translation, and generation of an output based on the desired language, with input from a different language. It is also used for the conversion of voice files into text for further analysis. The process of SR to the final output is done in three stages, namely, SR (identification of language/voice), speech analysis (conversion of natural language into machine-readable language, parsing, and matching of speech).[9] This technology can be put to use in the field Army to recognise the transmission of adversaries.

Vision recognition technology uses a similar concept for training its systems as with speech and handwriting recognition; however, this sub-area of AI deals with the recognition of human, animal, and terrain features. The level of training is quite high, as the data sets used in training of the neural networks are based on fractal modelling (modelling of terrain features that includes mountains, hills, land surface, coastline, etc.).[10] The recommended

application in the Army is a missile guidance and vision recognition system especially in the Loiter Munitions (LMs) and remote autonomous Unmanned Combat Aerial Vehicle (UCAVs).

Artificial Intelligence Systems

The AI systems are real and hypothetical which can further be classified into three types. These are as follows:

- **Artificial Narrow Intelligence** (ANI), which has a narrow range of abilities.
- **Artificial General Intelligence** (AGI), which is at par with human capabilities.
- **Artificial Superintelligence** (ASI), which is more capable than a human.

These three levels are also critical to the development of various systems and platforms for defence and security applications as much as they are for non-military and commercial applications. ANI, also referred to as 'weak AI or narrow AI', is the only type of AI that is successfully employed to date. Narrow AI is goal-oriented, designed to perform singular tasks i.e. facial recognition, speech recognition/voice assistants, driving a car, or searching the internet, and is very intelligent at completing the specific task it is programmed to do.[11] The various applications of ANI developed and under development by various foreign armies are mentioned in the succeeding paragraphs. These basic functions can be employed in various standalone modules by the Indian Army.

The second level of the revolution for achieving Human Intelligence (HUMINT) in machines is called Artificial General Intelligence (AGI). AGI, also referred to as 'strong AI or deep AI', is the concept of a machine with general intelligence that mimics HUMINT and/or behaviours, with the ability to learn and apply its intelligence to solve any problem. AGI can think, understand, and act in a way that is indistinguishable from that of a human in any given situation. AGI intends to enhance the learning ability of algorithms to accomplish a large number of tasks that are basic, but part of the overall HUMINT.[12] AI researchers and scientists have not yet achieved strong AI. To succeed, they would need to find a way to make machines conscious, programming a full set of cognitive abilities. Artificial Super Intelligence (ASI) is the hypothetical AI that doesn't mimic or understand HUMINT and behaviour. ASI is where machines become self-aware and surpasses the capacity of HUMINT and ability. It is the point at which machine intelligence exceeds HUMINT both qualitatively and quantitatively. In addition to replicating the multi-faceted

intelligence of human beings, ASI would theoretically be exceedingly better at everything we do—Math, Science, Sports, Arts, Medicine, Hobbies, Emotional Relationships, etc. ASI would have greater memory and a faster ability to process and analyse data and stimuli. Consequently, the decision-making and problem-solving capabilities of super-intelligent beings would be far superior to that of human beings.[13] The Indian Army should immediately develop applications based on ANI as this is a dual-use technology and is already being employed in civil life. The work on AGI and ASI should be simultaneously initiated keeping the long-term capability development goals in mind.

Section II: Global Trends in Modern Militaries

I visualise a time when we will be to robots what dogs are to humans, and I'm rooting for the machines.

– Claude Shannon

The evolution of AI is changing the way we will fight future wars. In the late twentieth and early twenty-first centuries, countries harnessed the third Industrial Revolution to develop and employ tanks, fighter aircrafts, ships, machine guns, and artillery mainly focusing on heavy kinetics, to achieve domination. In today's age, hard power can alone not win wars; the advent of DTs such as AI has emerged as the core combat capability and is influencing both the kinetic and the non-kinetic domains. AI revolution is enabling the cognitisation of machines, creating machines that are smarter and faster than humans. Many AI applications are being employed in military decision-making, logistics, cyber defences, medical, surveillance, etc. AI driven automation is also being employed for various functions in weapons, but in most cases, humans are in the loop.[14] Employment of this technology by developed militaries in the world would be elaborated in the succeeding paragraphs.

The United States

Artificial Intelligence is a top modernisation priority for the US Military, with officials envisioning a wide range of applications, from back office functions to tactical warfighting scenarios. The US Army believes in the concept that AI technology will automate a large number of functions and assists the US Army to fight and win wars in the future. The five pillars of the Department of Defense' (DoD) AI strategy are to employ AI enabled capabilities which would deliver key missions; scale AIs impact across DoD through a common foundation that enables decentralised development and experimentation; cultivate a leading AI workforce; engage with commercial, academic, international allies, and partners and lead in military ethics & AI safety. The

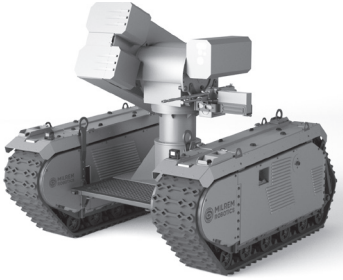
US military is already integrating AI systems into combat via a spearhead initiative called 'Project Maven', which uses AI algorithms to identify insurgent targets in Iraq and Syria. It has created a joint organisation called the Joint Artificial Intelligence Centre (JAIC) in 2018. The aim of the Organisation is to apply AI technology to existing warfighting processes to gain decision, speed, agility, and strategic advantage.[15] The JAIC has formulated an AI policy and a strategy for the implementation in the military. A joint organisation with military persons, academia, and industry fused in identifying and building prototypes, sharing lessons and merging research with ongoing operations, and thereafter, providing ongoing support to its military.[16] Joint Common Foundation (JCF) developed by JAIC, is a DoD authorised, 'ready-to-use development' platform with a 'plug-and-play function' which has all the tools, frameworks, standards, processes, and other resources that DoD entities need to build, test, and field AI projects and applications.[17] The key areas of application includes the following:

- **Improving Situational Awareness.** AI applied to perception tasks such as imagery, voice, video, and terrain analysis can extract useful information from raw data and equip leaders with increased situational awareness. AI can generate and help commanders explore new options so that they can select courses of action that best achieve mission outcomes, minimising risks to both deployed forces and civilians.
- **Decision-making in Battlefield.** The Army's Artificial Intelligence Task Force (AITF) is using its technological expertise and proficiency with future technology to work on a project that could radically transform how the US Military prepares for and conducts battlefield operations. It's called Aided Threat Recognition from Mobile Cooperative and Autonomous Sensors (ATR-MCAS) which is an AI enabled system of networked, state-of-the-art air and ground vehicles that leverage sensors and edge computing.

  The vehicles carry sensors enabling them to navigate within areas of interest to identify, classify, and geo-locate entities, obstacles, and potential threats and generate a common operating picture, which reduces the cognitive load on soldiers. The system is also capable of aggregating and distributing the target data, which can then be used to make recommendations and predictions based on the combined threat picture provided.[18] This ATR-MCAS sytem pushes the existing limits of AI and ML used for image classification and autonomous navigation. The AITF is working intensely towards integrating the technology with the network towards cutting down the decision-making timelines.

Image 1: AI Applications

Ground Vehicle



Scan Eagle Unmanned Aerial Vehicle (UAV)

Source: Kyle Mizokami and John F. Williams, 'AI Moving to Battlefield', available at Bloomberg Govt.com, accessed on October 10, 2019; available at Popular mechanics.com, accessed on 28 January 2020.

- **Project Maven**. Project Maven, also known as the 'Algorithmic Warfare Cross-Function Team' was launched in April 2017. The programme uses algorithms to analyse the drone feeds and provides facial, voice, video, and image recognition. It enhances battlefield situational awareness. The data can also be used by UCAVs to detect and neutralise a target.[19] The ultimate control, however, lies with the humans. Project Maven focuses on computer vision—an aspect of ML and Deep Learning—that autonomously extracts objects of interest from moving or still imagery. The technology has been employed by the US in its war against terror.

Image 2: Project Maven

MQ-9 REAPER

US Troop's operation with ground sensors and robots

Source: Joel Hruska, 'Extreme Technology', September 7, 2017; Robert Button, 'Rand Corporation', March 7, 2018.

- **Hyper Enabled Operator.** The United States Special Operations Command (USSOCOM) defines Hyper Enabled Operator (HEO) (Robot buddy of Special Operations Force SOF Operator) as a SOF professional

empowered by technologies that enhance the operator's cognition at the edge by increasing situational awareness, reducing cognitive load, and accelerating decision-making. In short, HEO hyper-enables the operator by providing technological aids to shorten the time within his Observe Orient Decide and Act (OODA) loop, thereby providing him with cognitive overmatch. The goal of HEO is to give the right information to the right person at the right time. The HEO enabled technologies include data assets, adaptive and flexible sensors, scalable tactical communications, edge computing, embedded algorithms, and tailorable human-machine interfaces.[20] These technologies will be integrated into architectures that will sense, monitor, transport, process, and analyse data to aggregate information that will inform tactical decisions at the edge. These capabilities will enhance the fighting potential of an SOF soldier allowing him to focus on operations.

Image 3: HEO-USSOCOM

Source: Alex MacCalman, *Small Wars Journals*, June 6, 2019

- **Logistics.** Army's Logistics Support Activity (LOGSA) has contracted IBM's Watson to develop tailored maintenance schedules for the Stryker Vehicle Fleet based on information pulled from 17 sensors installed on each vehicle. Preventive maintenance is, hence, a major application of AI in the US Army. LOGSA began a second project in 2019 that will require Watson to analyse shipping flows for repair parts distribution, attempting to determine the most time and cost-efficient means to deliver supplies.

This task is currently done by human analysts, who have saved the Army around US$ 100 million a year by analysing just 10 per cent of shipping requests; with Watson, the Army will have the ability to analyse 100 per cent of shipping requests, potentially generating even greater cost savings in a shorter period.[21]

- **Cyberspace Operations.** Artificial Intelligence is being developed as a key technology in advancing military cyber operations. Conventional cybersecurity tools look for historical matches to known malicious code, therefore, the hackers would only have to modify small portions of that code to circumvent the defence.[22] AI enabled tools, on the other hand, are being trained to detect anomalies in broader patterns of network activity, thus presenting a more comprehensive and dynamic barrier to attack.
- **Information Operations.** Artificial Intelligence is enabling increasingly realistic photo, audio, and video forgeries, or 'deep fakes', that adversaries could deploy as part of their information operations.[23] Artificial Intelligence is being used to create full 'digital patterns-of-life', in which an individual's 'digital footprint' is "merged and matched with purchase histories, credit reports, professional resumes, and subscriptions" to create a comprehensive behavioural profile of service members, suspected intelligence officers, government officials, or private citizens. As in the case of deep fakes, this information could, in turn, be used for targeted influence operations or blackmail.[24]
- **Command and Control.** The US Military is seeking to exploit AIs analytic potential in the area of command and control. The Air Force is developing a system for Multi-Domain Command and Control (MDC2), which aims to centralise planning and execution of air-, space-, cyberspace-, sea-, and land-based operations. In the immediate future, AI may be used to fuse data from sensors in all these domains to create a single source of information, also known as a 'common operating picture', for the decision-makers.[25] Similarly, DARPAs Mosaic Warfare programme seeks to leverage AI to coordinate autonomous forces and dynamically generate multi-domain command and control nodes.[26]
- **Challenges.** The main challenge faced by the US Army is to get the data ready. Measures are being taken by JAIC to collect data around relevant systems, equipment, and procedures; and storing and curating that data in a way that makes it easily accessible to others for use in future AI applications. The ultimate key to AI success will be the COCOMs' willingness to share data and products with the Joint Common Foundation (JCF) so they can collaborate with other Joint Forces and leverage each

other's innovation and lessons learned. This is where USASOACs 160th Special Operations Aviation Regiment has taken the lead. DoD and the defence industry also face challenges when it comes to recruiting and retaining personnel with expertise in AI due to research funding and salaries that significantly lag behind those of commercial companies.[27] An apparent cultural divide between DoD and commercial technology companies may also present challenges for AI adoption.[28] Creating a common network for a seamless flow of intelligence is another major challenge. Integration of data, networks, and the cloud is another major challenge across the services especially when the forces are deployed across the globe.

China

Achieve Supremacy in AI by 2030.

– Xi Jinping

China's 2017 'Next Generation AI Development Plan' describes AI as a "strategic technology" that has become a "focus of international competition". According to the plan, China will seek to develop a core AI industry worth approximately US$ 21.7 billion by 2020—which it has largely achieved, and will soon 'firmly seize the strategic initiative' and reach 'world leading levels' of AI investment by 2030.[29] China's concept of employment of AI includes enhancing battlefield situational awareness and decision-making, conducting multi-domain offence and defence, and facilitating advanced training, simulation, and wargaming practices. The People's Liberation Army (PLA) believes that the form of warfare is changing from 'informatised' warfare to 'intelligentised' warfare, and Chinese military scientists & strategists are exploring new concepts of operations and emerging capabilities in pursuit of potential operational advantage. The PLA aims to use AI for exploiting large troves of intelligence, generating a common operating picture, and accelerating battlefield decision-making.[30] The Chinese Government has direct means of guiding AI development priorities and accessing technology that was ostensibly developed for civilian purposes. To further strengthen these ties, the Chinese Government has adopted a 'whole of government approach' and created a Military-Civil Fusion Development Commission in 2017, which is intended to speed the transfer of AI technology from commercial companies and research institutions to the military.[31] The salient aspects of its capabilities are as follows:

- **Chinese Ecosystem.** The PLA is of a firm belief that Science and Technology will strengthen PLA capability to fight future wars. It has

hence adopted the strategy of MCF. The PLA Strategic Support Force (PLASSF) and its Cyber and Space System Departments have tremendous Research and Development (R&D) support from the Academy of Military Science, National Institute of Defence Technology, seven sisters which are double first-class universities, startups, quasi-private laboratories, subsidiaries, and acquisitions.[32]

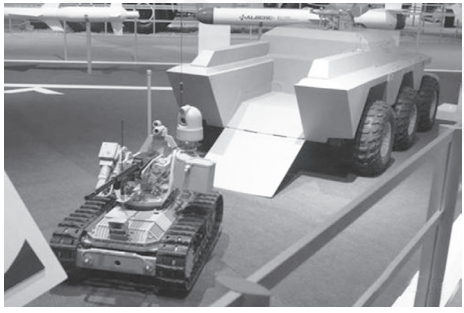
- **Harnessing Disruptive Technology by People's Liberation Army.** Artificial Intelligence and Big Data have been incorporated in Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) to achieve its awareness and enhancing the capabilities of leaders to make quick decisions thereby shortening the OODA loop. It is building capacities to develop biotechnology, intelligent helicopters, intelligent unmanned vehicles and aerial systems, suicide drones including swarms, and AI enabled wargaming solutions. It has made considerable progress in building space and cyber warfare capabilities.
- **National Defence Big Data and Artificial Intelligence standardisation.** PLA is significantly strengthening its ability to store, transmit, and analyse national defence Big Data. Its policy of Social Credit system has leveraged dual-use DT by employing language and facial recognition technologies for social mapping to build domestic surveillance networking quest to develop smart cities.[33] Such technologies could be used to counter espionage and aid military targeting. It has developed common standards for AI to ensure its applicability laterally.
- **Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR).** Big data and AI projects have been commissioned to analyse inputs from satellite, visual, radar, infrared, sonar, and other sensors, as well as publicly available intelligence leading to target identification and generating a common operating picture. AI technology is being employed to collect, fuse, and transmit Big Data for more effective battle management system to generate optimal courses of action.
- **Swarm Technologies.** China is actively pursuing swarm technologies, which could be used to overwhelm the adversary's missile defence interceptors. Moreover, open-source publications indicate that China is developing a suite of AI tools for cyber operations.[34]
- **Equipment Management.** The PLA believes that national defence Big Data and AI will be helpful in both procurement and maintenance of military equipment. The PLA has planned a Big Data enabled organisation of China's defense industry. This initiative would identify business departments' big data needs and create a model system that uses legal and

technologically feasible methods for these departments to obtain, store, analyse, and visualise those data. This system would help with equipment, logistics, mobilisation, recruiting, training, technological innovation, and civil-military joint business work.[35] AI projects are being developed for predictive maintenance of equipment.

- **Artificial Intelligence based Hardware.** The penetration of AI into PLA military system is like using AI-driven weapons platform for "remote, precise, miniaturised, large-scale unmanned attacks" as it is all about the fundamental method of attack.[36] PLA has moved away from attrition type warfare involving debilitating mass attacks that causes heavy casualties, to non-contact warfare involving long-distance and standoff range delivery

Image 4: AI based Hardware
Swarm Technology-CH901

Ruizhao II UCVs



CH-5 UCAV

Source: CAS Magazine, May 1, 2020, China-plus, June 26, 2017; *Forbes*, October 14, 2020.

of accurate and lethal firepower that enables the PLA to secure a quick, low-cost, and decisive victory.[37] This is a highly critical lesson, especially for India.

PLA is developing military hardware, such as smarter AI cruise missiles; highly autonomous UAVs; swarming UAVs; highly autonomous off-road armed and unarmed unmanned ground vehicles; anti-artillery or missile laser systems capable of autonomously identifying, tracking, and engaging low altitude targets; and highly autonomous long-range surface and underwater unmanned vehicle.[38] The development of anti-satellite weapon systems, cyber forces, anti-ship missile (msl), long-range Precision Guided Munitions (PGMs), hypersonic msl systems, prepare the PLA for a high-end military conflict. The Wing long Mark II UAVs, Medium-Altitude Long-Endurance (MALE) manufactured by Aviation industries (China) are already in service and are also being supplied to other countries. The CH-5 Armed Unmanned Combat Aerial Vehicle (UCAV) with a range of 10,000 kilometre is under induction. These lethal machines are integrated with AI based detection systems. China's 'drone powered' Air Force includes supersonic drones, unveiled at the 2019 National Day Parade. According to the *South China Morning Post*, "This suggests the PLA (People's Liberation Army) is prioritizing the development of the most cutting-edge technologies that will change the game of war". The PLA has also developed autonomous killer robots, cloud based drone squadrons, and autonomous landing vehicles. All these systems use ML to make independent decisions, such as plotting routes and avoiding obstacles.[39]

- **Cyber and Artificial Intelligence.** Cyber technologies and computer software uses AI for better performance. China is harnessing AI applications in the cyber domain; cyber networks require enhanced data processing capacities from multiple sources. AI can enhance the security of a cyber network and computer grid as well by detecting intrusions quickly and accurately—a task that will take humans longer. The PLA thus views cyberspace—with all its associated elements of software and network security on one hand, and AI and Machine Learning on the other—to be a composite entity.[40] Its offensive employment of Cyber and AI is visible in the suspected cyber attacks conducted in recent times.
- **Miscellaneous.** Artificial Intelligence and Big Data applications are being developed by PLA in the fields of medical, Human Resource (HR), training, and simulation.
- **Challenges.** China faces challenges in harnessing HRs for R&D, the heavy reliance on reverse engineering, Russia for procuring, stealing

technology from the US in the past which has deterred homegrown research for many years. The civil industry and academia are finding it hard to adapt to the technological changes. The "one son policy", lack of combat experience, corruption, education, non-availability of skilled manpower to develop high-end technology are the few challenges it faces.[41] Although the estimates of investments in military budgets are ambitious, but the actual spending on the ground is less as it has an effect on the social development of the country.

Russia

Russia has released a national strategy for AI, which outlines 5- and 10-year benchmarks for improving the country's AI expertise, educational programmes, data sets, infrastructure, and legal regulatory system. Russia also continues to pursue its 2008 defence modernisation agenda, with the aim of robotising 30 per cent of its military equipment by 2025.[42] Russia's concept of developing AI as a key technology will eventually replace 'a soldier on the battlefield and the pilot in the cockpit'. Russia is establishing number of organisations devoted to the development of military AI. In March 2018, the Russian Government released a 10-point AI agenda, which calls for the establishment of an AI and Big Data consortium, a Fund for Analytical Algorithms and Programs, a state-backed AI training and education programme, a dedicated AI laboratory, and a National Center for Artificial Intelligence.[43] Russia recently created a defence research organisation, roughly equivalent to DARPA, dedicated to autonomy and robotics called the Foundation for Advanced Studies, and initiated an annual conference on "Robotization of the Armed Forces of the Russian Federation". The major highlights of its capabilities are as follows:

- **Robotics and Autonomous Systems.** Russia appreciates the US as its competitor and has appreciated eastern Europe as its area of conflict. It has developed number of semi-autonomous and autonomous unmanned vehicles, aerial systems, and robots for operations in urban areas. According to official reports, AI will be able to replace 'a soldier on the battlefield and a pilot in an aircraft cockpit'. Its premier project of Nehereta—an unmanned vehicle system—is designed for combat, intelligence gathering, and transportation/logistical support, is ready for induction.[44] Russia has also reportedly built a combat module for uninhabited ground vehicles that is capable of autonomous target identification—and, potentially, target engagement—and plans to develop a suite of AI enabled autonomous systems.[45] All the models of weapons and equipment are being actively tested in Syria.

Image 5: Russia's AI capabilities

Nehereta: UCV

Kalashnikov Combat Module

Source: Defense Technology Connect, November 2018; Russian News Agency, July 5, 2018.

- **Robotic Tank.** It has reportedly developed a fully robotic version of next-generation T-14 Armata tank with autonomous AI sensors, an active protection system, and a robotic turret.[46]
- **Iron Men.** Russia has tested a battlefield 'exoskeleton' known as 'Ratniks' that will turn its soldiers into an Army of Iron Men. The battery-powered 'Robocop' suits allow squads to fire machine guns one-handed with computer accuracy. The project is assisted by AI enabled software installed in the command-and-control suite.[47] The design of the exoskeleton being the 'third hand' ensures the possibility of using heavier and more powerful weapons, such as a machine gun, with one hand. Uran-6 is a tailor-made exoskeleton for anti-Improvised Explosive Device (IED) operations.[48]

Image 6: Russian exoskeletons

Ratnik-Iron Men

URAN-6

Source: New York Post, August 28, 2018: *Forbes*, August 19, 2020

Israel

The Israeli Defense Forces (IDF) have developed an AI based engine called the C4i to enhance its capabilities in AI. The Sigma branch, which is part of the IDF, employs this technology to develop, research, and implement the latest in AI and advanced software research to keep the IDF up-to-date.[49] Its Spice-250 munitions have an Automatic Target Recognition capability; it uses 'Deep Learning and AI' with the pilot or operator in the loop. It also has developed Wide Area Persistent Surveillance capabilities on drones in the year 2020, employing a system that can build a 3D model from the surveillance.[50] 'Fire Weaver' is a revolutionary technology to digitise the modern warrior on the frontline. The System "enables closing rapid, precise, effective and secure sensor-to-shooter loops". It works in Global Positioning System (GPS) denied environments and is based on open architecture so that it can be flexibly integrated into other western hi-tech armies depending on how they want to use it. This new technology integrates electro-optical systems, fast calculations, AI networked through software defined radios to the tactical land force level.[51]

Harpy Loiter Munition is an autonomous system also known as the 'kamikaze drone', can acquire and engage targets from the air. It has also developed a number of ground based autonomous robots such as 'the guardian' for surveillance and to assist ground troops in action. Largely, these technologies have been employed in Gaza and also by Azerbaijan during the Nagorno-Karabakh war. Carmel armoured vehicles being developed will be autonomously driven with functions of auto navigation. They will blow up roadside bombs on the way, detect targets, and prioritising threats automatically as also advising the soldiers on which weapon to use against which target. Just two personnel will be onboard, managing the entire system, because the vehicle's AI will be able to do much on its own. After receiving human approval, the vehicle can fire on targets with a speed and accuracy that are unknown today.[52]

Having studied the evolution of AI in the leading militaries, it is pertinent that we draw lessons to leverage this potent technology in the Indian Army. We are in close cooperation with the US through the Defence Trade and Technology Initiative (DTTI), so is with Israel and Russia too. The technology being software driven is recommended to be developed indigenously under the flagship programme of '*Atmanirbhar Bharat*'. The technological assistance can be taken from foreign countries but it will have to be developed indigenously.

Image 7: Israel AI applications

Carmel Combat Vehicle

Fire Weaver: Sensor to Shooter System

Source: Jewish News Syndicate, August 6, 2019; Army Technology, February 3, 2020

Section III: Leveraging Artificial Intelligence in the Indian Army

Artificial Intelligence technologies are urgently required to enhance the combat potential of not only the Indian Army but also the Indian Defence Forces. The technology can be leveraged in almost every field of operations, administration, and training. It has great potential for facilitating timely military decisions, minimising human causalities, and enhancing the combat potential of forces. This part analyses the journey so far and the scope for future employment of this technology in the Army.

Initiatives So Far

NITI Aayog released its national AI strategy called the 'National Strategy for Artificial Intelligence' in 2018; however, defence failed to find a mention in it. In February 2019, the Ministry established a high-level Defence AI Council (DAIC) under the Chairmanship of the Minister of Defence and was assigned with the task of providing strategic direction towards the adoption of AI in defence. The DAIC headed by Raksha Mantri and participation by all key stakeholders from the three services and the defence industry will guide the partnership between the government and industry and also review the recommendations concerning the acquisition of technology and startups. It has also formulated a Defence AI Project Agency (DAIPA) as the central executive body chaired by Secretary of Defence Production.[53] Formulation of the two loose committees was intended to integrating the AI strategy into India's Defence Strategy with an allocation of Rs 100 crore annually to the three services. The outcomes and progresses are lesser-known; however, the three services have taken initial steps to leverage this technology in

independent silos. The recommendations made in this part are purely from the military application point of view to enhance the capabilities in warfighting and can be studied to absorb this technology in the present system.

Artificial Intelligence Strategy

Leveraging DTs is vital for the Indian Army to remain in competition with adversaries leading to winning conflicts in future wars. AI can't be seen in isolation; it is a technology that is driven by Big Data, efficient networks such as 5G, Internet of Things (IoT), and its integration in quantum computing are all interwoven and related when it comes to implementation. A 'Disruptive Technology Strategy' which includes AI needs to be formulated giving out a clear roadmap for the implementation of the technology. Some salient aspects specific to AI for crafting the scope of the strategy are mentioned as follows:

- Facilitate AI specific policies, structures, cybersecurity measures, ethics, and safety.
- Key mission specific deliverables in each terrain and sector.
- Integration of Big Data and data driven networks for efficient functioning of AI modules.
- Need and requirement of an integrated organisation or structure which is a tailor-made organisation with civil-military fusion to develop AI modules/prototypes.
- Clear roadmap to build AI applications through AI prototypes/modules scalable to production-grade in conjunction with the defence industry.
- Roadmap to integrate the legacy structures, defence procedures towards building scalable AI modules.
- Integration of all the AI laboratories in the training establishments for cohesive training to create an AI workforce.
- Budgetary estimates for capability development over a 5-year Long Term Intergtaed Prespective Plan (LTIPP).
- AI specific research incorporating academia and defence experts.

Indian Army Artificial Intelligence Centre or Indian Army Disruptive Technology Centre

The Indian Army has very earnestly embarked on the journey to leveraging the technology. Efforts are being made, at all levels, to integrate this technology into the mainstream. However, a consolidated approach is recommended to leverage all the DTs. An integrated organisation structure is the need of the hour to drive the initiative towards a possible futuristic development of the prototypes. The organisation can be created within the existing structures to involve the researchers, planners, developers, trainers, industry, and most

importantly the users to develop the strategy, policy, rules, and integrated prototypes/modules. The noble initiative has already been taken by the Army Design Bureau (ADB); however, from the long-term perspective it will have to be seen as a whole of government approach.

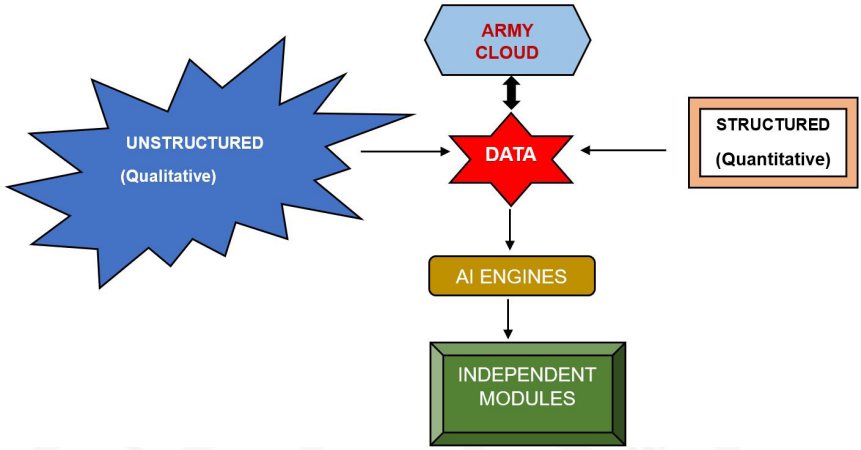
Data Management

Data Management is the most critical part of developing this technology. Big Data is the way ahead if we have to leverage this technology to develop military applications to be used in combat. There are two forms of data—Structured and Unstructured, and more recently a Semi-structured nomenclature is in vogue. The common examples of 'Structured Data' are Excel files, Google Sheets, and traditional Database Management Systems (DBMS). The common examples of 'Unstructured Data' are text data, social media comments, documents, presentations, phone call transcriptions, various log files like server logs, sensor logs, image, audio, video, etc. Most of the data is in silos and are in 'Unstructured format' such as situational reports documents, MS Word documents, large files with noting sheets, PowerPoint presentations, etc.

To analyse Structured vs Unstructured Data, a new generation of Business Intelligence (BI) tools has emerged that uses advanced coding languages, as well as ML and AI to help humans make sense of these huge data sets. Both types of data potentially hold great value and these tools are pivotal to help aggregate, query, analyse, and create business value from them.[54]

Cloud data warehouse is the new era of storage and processing data. Cloud data warehouses aggregate data from different sources into a central, consistent data store to support various business, analytics, visualisation, AI, and ML purposes. A data warehouse enables an organisation to run powerful analytics on huge volumes of data in ways that a standard database cannot.[55] The recommended solution for the Army is an Army Cloud that stores the data centrally and is accessible to the required authority on authentication. The recommendation of BADAL, cloud service as recommended in CLAWS Issue Brief *Engagement and Estrangement: Gauging India's Relationship With Technology* is highly recommended.[56] The major challenge here is of the security classification and the sharing of data, adequate measures will have to be in place in terms of creating a separate sub-set of Data Cloud with adequate security measures for classified data. Till such time this infrastructure or upgrade current systems is created, there will be a void. To fill this void, the work can commence with processing data at field formation levels to run the AI engines for a particular module. A Data model is shown in Figure 2. The research on Data Management is not the scope of this paper and hence only AI based applications will be discussed.

Figure 2: Data Model



Source: Annotated by Author

Artificial Intelligence Applications

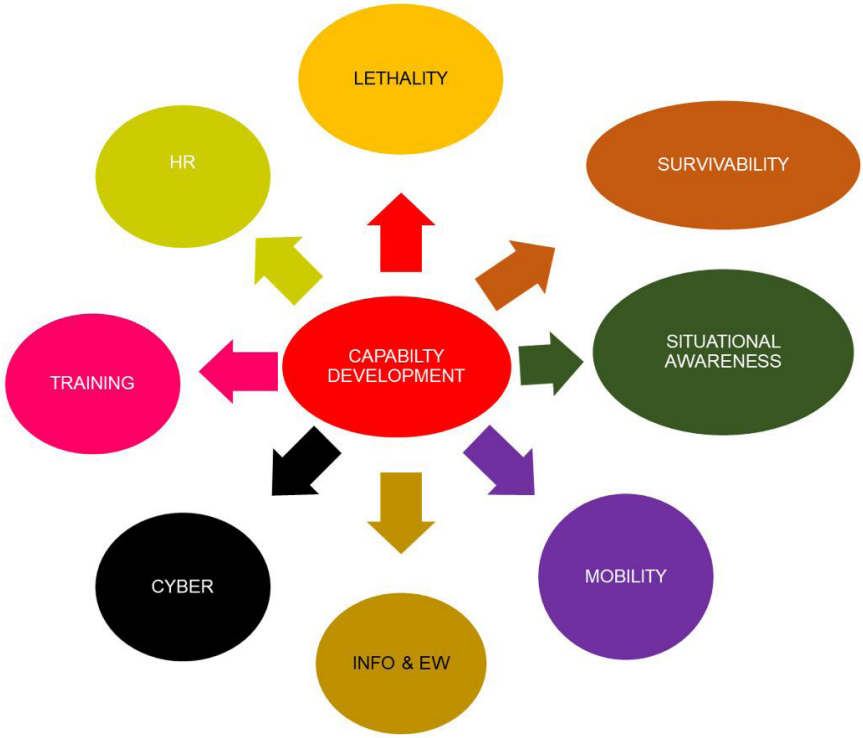
To enhance the overall combat potential of the Army, AI technology must be leveraged. This technology has the potential to bring transformation in every field in the Army. The good news is that, unlike a platform or a weapon system, AI technology is software and can be incorporated into every system. This will have an impact on the procurement procedures, the traditional Defence Procurement Procedures (DPP) mindsets will have to change to incorporate this technology. The Defence Acquisition Procedure (DAP) 2020 has incorporated "Acquisition of Systems Products and ICT Systems" as a separate chapter and the same needs to be leveraged. The low-cost software development entails building prototypes and testing them to upscale them into established systems. Low-end projects can be initiated at the theatre level through Army Commanders Special Financial Powers (ACSFP) and also at the training establishments as the cost involved is minimal. However, building an AI or DT ecosystem in the Army is highly recommended to have a consolidated approach. The work will have to be undertaken simultaneously. The module-based approach is what is recommended. Start small, build modules, deliver prototypes, scale-up, and then integrate into the larger system one agency and one cloud could be the way ahead.

Artificial Intelligence Modules

Artificial Intelligence modules are the AI software engines that can be infused into systems to enhance potential in every tenet/pillar of capability development. AI modules will develop prototypes for testing in specific

sectors. The recommended modules related to each tenet of capability development of the Army are listed in the succeeding paragraphs.

Figure 3: Artificial Intelligence:
Capability Development Focus Areas in Army



Source: Annotated by Author

Lethality

Lethality is the most researched field in military technology where the AI technology can be employed with a high degree of impunity. The technology has to be developed with caution with human in the loop to avoid bias and collateral damage. The following areas of employment are applicable to lethality:

- **Lethal Autonomous Weapon Systems.** Lethal Autonomous Weapon Systems (LAWS) are the weapon systems (primarily aerial drones) that can independently search, detect, analyse, and engage the target without human intervention.[57] The AI engine use the algorithms to execute the task. The employment of a fully autonomous system is still under a

scanner and being debated but a semi-autonomous system that analyses the target and presents it to the human to pull the trigger is the option which the Army should invest and develop. The employment of this technology onboard high-end armed drones to detect, analyse, and track Iranian General Qasem Soleimani and then neutralise him remotely is the evidence of exploitation of semi-autonomous AI enabled technology.[58] This is a high-end project and will require time and energy to develop into a complete system. Development of this high-end System is critical to enhance the capabilities along the borders and also in combating terrorism.

- **Unmanned Combat Aerial Vehicles/Unmanned Ground Vehicles.** The UCAVs are classified into aerial and ground vehicles. The aerial version is discussed earlier, the ground version can be developed for fighting in urban areas in conventional and to counter the terrorist threat. Mechanised warfare can undergo a major paradigm shift in its modus operandi with the development of semi-autonomous combat Infantry Combat Vehicles (ICVs) or tanks. The reduction of cognitive load on a human mind is the final aim. The employment of AI with a remote controlled machine gun to neutralise Iranian nuclear scientist Mohsen Fakhrizadeh is a classic example.[59]
- **Swarms.** Swarm or fleet of UAVs is a set of aerial robots i.e. drones that work together to achieve a specific goal. Each drone in a 'swarm' is propelled by a specific number of rotors and can Vertically Hover, Take-off, and Land (VTOL). The flight of the drone swarms is controlled either manually i.e. by remote control operations (semi-autonomous), or autonomously by using processors deployed on the drones. The drones can communicate with each other and are programmed with AI enabled algorithms. The swarm drones provide real-time situational awareness by enhancing the widespread Intelligence Surviellance and Reconnaissance (ISR) capabilities. They possess a unique battle-winning factor of surveillance and targeting on a single platform. Aerial drone swarms provide tremendous advantages in the battlefield to include provisioning of a common operating picture, real-time decision-making to the leaders, and precision targeting. The mass swarming with speed and lethality has a psychological dislocation of the enemy and also increases the sensitivity of the leaders by reduction of casualties and the most critical part is that it is cost-effective.[60] This is a low-hanging fruit and can be developed indigenously especially in trans-Line of Control (LC) and counter-terrorist operations.

- **Loiter Munitions.** Loiter munitions are low-end aerial drones that can be employed at operational and tactical depths by both the infantry and the mechanised forces. These platforms carry out real-time surveillance and can destroy the target with integrated warheads simultaneously. The AI technology can be incorporated at the operator end or the server end which can help detect, analyse, and track the hostile target. The employment of loitering munitions has to be embedded in the existing doctrines immediately and this was a major lesson drawn out of the battle at Nagorno-Karabakh.[61] The technology can be developed indigenously and scaled into inventory to be employed in conventional and counter-terror operations.

Survivability

AI can be effectively integrated to enhance survivability of the soldier in the battlefiled with development of a number of AI based software applications. The certain enumerations are explained below:

- **Anti-IED Operations.** AI enabled robots are most suited buddies for anti-IED operations. Apart from physically neutralising the IED, the robots act as a cognitive buddy who is trained by ML technology with huge IED based data sets that not only predicts the type of threat but also neutralises them. These are most suited in counter-terror operations. This technology can also be developed for mining and de-mining operations in the conventional scenario. This is a low-end technology that can save precious lives.
- **Medical.** The Indian Armed Forces have tremendous operational experience in combating conventional and counter-terror operations. There are considerable amount of data sets available in administering life-saving treatment immediately on the occurrence of casualty. Automation and AI modules can be specifically built to provide critical medical support to frontline troops and nursing assistants. AI modules can assist in casualty treatment and evacuation by automation of location, valid analytical techniques for diagnosis, provisioning of decision-making by selecting suitable treatment procedures, and the deliberate integration and ethical use of both. AI and, more specifically, ML techniques combined with traditional analytic methods from the field of operations research, provide valuable tools to automate and optimise casualty-evacuation location and dispatching procedures.[62] AI can also assist in complex medical cases to diagnose, aid clinical judgements, image

analysis, in military hospitals by specialists thereby reducing the cognitive load on doctors and the time lag for treatment.

- **Exoskeleton.** Indian soldiers operate in difficult terrain and weather conditions wherein they have to traverse rugged terrain features over long distances. Exoskeletons are gadgets worn as a harness by a soldier to augment his strength. These body gadgets are fitted with powered special devices and AI to enhance the capability of a soldier. A soldier rigged with an exoskeleton, also called 'Exo-suit' is capable of faster movements and possesses an extra load-bearing capability.[63] AI enabled powered exoskeleton is an optimum solution for load carriage and also provides lightweight protection.

Situational Awareness and Military Decision-Making

One of the most essential applications of AI is its employment in enhancing situational awareness at all levels in the Army to bolster decision-making by creating a common operating picture, thereby reducing the OODA loop. This aspect will be discussed in detail in the next section.

Mobility

Mobility is an aspect that encompasses operational logistics and supply chain management. A lot of work and used cases are available in the civil market and can be leveraged by the Army.

- **Auto Vehicles.** AI can be leveraged to enable forward operating robotic land vehicles to acquire targets, make decisions, surveillance of combat zones, and fire weapons when directed by a human.[64] This technology can be employed for semi-autonomous tanks, combat vehicles, logistics vehicles, and other vehicles. Although fully autonomous vehicles like Tesla are yet to prove their worth, automation can take place leaving the decision to the driver on navigation, terrain details, threat perception, fuel data, maintenance data, etc.
- **Logistics and Supply Chain Management.** A significant amount of work has already been done for deploying AI in logistics and Supply Chain Management for civilian purposes. Military-Civil Fusion is recommended for transferring the knowledge, technology, and expertise to meet the defence needs. An efficient logistics system lies at the core of a well-equipped military.[65] The vast expanse and diversity of terrain along borders provide numerous challenges to the Army. AI supported systems could have a long journey in terms of increasing efficiencies, reducing wastage along overall costs in the defence's logistics management. The

entire management of convoy, train, and air movement during peace and war can be bolstered by building AI modules for operational logistics. AI can be incorporated in a 'push model system' in routine logistics management. The case studies from Amazon, Big Basket, Flipkart can be studied to build tailormade AI modules for logistics.

- **Predictive Maintenance.** Predictive analytics is forecasting future events based on what happened in the past. Machine Learning algorithms can be useful when it becomes necessary to employ more sophisticated and comprehensive techniques and statistical models to tease these out of the huge unstructured available data.[66] The Indian Army has a huge fleet and variety of vehicles, machines, equipment, and weapons to be maintained, therefore an AI based module will be highly useful. It will also make the Supply Chain Management efficient. The challenge will be data management and integration with the legacy systems. The Indian Air Force has already embarked on this journey to ensure that its huge aircraft fleet is optimally maintained by the employment of AI in predictive maintenance.[67]

Information and Electronic Warfare

The applications to support Information and Electronic Warfare are highly critical and are being employed widely by countries short of war. In this important phase of competition, leveraging this technology will give the desired psychological edge to the Indian Army.

- **Information Warfare.** AI can be optimally utilised in Information Warfare (IW). The employment of its 'facial and voice recognition' technology can generate decoys or 'Deep Fakes' that adversaries could deploy as part of their information operations. AI can be used to create full 'digital patterns-of-life', in which an individual's 'digital footprint' is "merged and matched with purchase histories, credit reports, professional resumes, and subscriptions" to create a comprehensive behavioural profile of service officers, suspected intelligence officers, government officials, or state leaders. As in the case of deep fakes, this information could, in turn, be used for targeted information operations.
- **Electronic Warfare.** AI can be optimally utilised in Electronic Warfare (EW) to quickly and accurately rank the incoming data by filtering out the 'less important signals'. AI tools can save time by decluttering the user interface and enhancing soldiers' ability to 'zero in' on whether the emitter is from a "red" or enemy source, is a "blue" or friendly force signal, or just 'grey' noise.[68] By employment of AI in EW, the systems can

observe a threat pattern presented by an adversary. The EW systems can characterise the adversary system on the fly and devise a countermeasure to that adversary system in real-time. Cognitive technologies play an important role in the Electro-Magnetic Spectrum and have to be leveraged as an independent AI module development project, not only for the radio frequency but also through the entire spectrum.

Cyber

Artificial Intelligence modules, specifically developed for cyber operations, could prove to be more efficient and effective than humans for tasks like protecting the military's assets, communication links, etc. Scale and speed of the responses are essential for evolving cyber operation domains that could be unlikely for humans to tackle the emerging threats effectively. AI is going to be the future of cyber operations supported by increased norms of 'machine-on-machine engagements' to tackle the lower degree or routine threats.[69] AI can be adopted in cyber defence to understand what is 'normal' for their digital environment and identify behaviour that is anomalous and potentially threatening. ML Algorithms can autonomously interrupt fast-moving attacks. This active, defensive use of AI can change the role of security teams fundamentally, freeing humans to focus on higher level tasks.[70] Offensive AI prototypes can be developed to autonomously determine an organisation's most high-profile targets using NLP Technology. The AI can craft 'contextualised phishing emails' and select a sender to spoof and fire the emails away, tricking victims into clicking on a malicious link or opening an attachment that will grant further access into the target organisation. AI combating AI is essentially a war of algorithms and development of AI tools to counter enemy's cyber AI threats is vital to our sytems.[71] Social media monitoring AI tools are available to monitor huge data sets, draw out analysis and patterns, and such modules can be built for counter-terror operations, anti-radicalisation measures, and crowd control operations.

Training

AI is everywhere in our daily lives and has to be adapted quickly in military way of life. There is immense potential in young fertile minds to absorb this technology and develop the AI modules suggested in this paper. The understanding and absorption of this technology is also essential across the hierarchy. Recommendations for absorbing AI in the Indian Army by training are mentioned below:

- **Imbibing AI.** AI is here to stay and as discussed earlier will be absorbed in every military function. To embrace these DTs, each soldier has to be

prepared to walk the path of change and that starts with training at each level. Technology is no longer the domain of the technical experts. It is an essential lifeline for every soldier who undoubtedly adapted so easily the smartphone technology. There has to be a paradigm shift in training process to imbibe these DTs at all levels at all rank structures.

- **Centres for Excellence.** A noble step has been taken by each of the Military-Technical schools and colleges to initiate centres for excellence to develop key technology in-house by service personnel. They can develop independent AI modules and these can be upscaled to prototypes. However, there is a need for integration and culmination in a rollout, driven centrally for the complete Army. An AI workforce could be generated which could further integrate into a larger organisation as and when it is created.
- **Simulation Training.** AI can be leveraged to design Virtual or Real-Life Military Exercises in a more realistic or challenging manner, allowing Commanders and Staff Officers to prepare better for Combat Operations, particularly in the fields of engaging 'Enemies' who are capable of thinking dynamically. Through highly complex simulations, AI can help to predict the best ways to use new technology and integrate them into existing systems. Especially in combination with advances in Virtual Reality (VR), 'Complex Algorithms' will considerably improve the Realism of Tactical Training. Virtual and Augmented reality (VR/AR) models can be easily developed for provisioning simulated training in a real-life scenario in depicting various terrains in different operations of war.
- **Wargames.** The 4IR has changed the character of warfare. DTs provides a decisive edge to combat potential. The organisation of the wargames requires a twofold transformation—first is the absorption of the DTs to conduct a simulated wargame and the second is involving the effect and impact of these DTs in actual combat. The DTs will show their impact much before the actual conflict stage i.e. in the competition phase itself.

Human Resource Management

- **Military Secretary Automation.** AI technology can augment the existing capabilities which the Military Secretary (MS) branch already possesses in automation by reducing the cognitive load on the officers. It will ensure that promotions and postings are carried out more objectively, based on an improved ability to assess officers holistically and avoiding any biases. ML technology is suited for predictive analysis objectively which will enable quick decision-making and easier career management of

officers. The technology can be used for data management and predictive analysis only to facilitate decision-making by staff officers.

- **Recruitment.** There is a requirement to analyse the existing methodology for recruitment, selection, and training to automate employing AI technology. AI is playing a vital role in Human Resource Management (HRM) in the corporate world, thereby making the task of HR Managers easier by adapt assessments and decisions without bias and programme that can locate potential candidates.[72] HR recruitment specific AI software can perform the crucial function of identifying specific skills and matching those skill sets with required qualities. It can go a long way in plugging the skill gaps in the organisation and positioning each candidate as a valuable asset capable of achieving actionable outcomes in alignment with organisational goals and objectives. AI has the potential to transform both Services Selection Board (SSB) system for officers and also Other Ranks (OR) recruitment.
- **Man Management.** Automation of low value, easily repeatable administrative tasks will enable more time to be dedicated towards contribution to strategic planning and policymaking at the organisational level. The routine tasks executed at the units, records, and formations can all be upgraded by developing AI modules. Complex HRM at the highest level can be automated using AI by predictive analysis that will bring in objectivity in planning and execution. Used cases or examples of implemented AI prototypes are available in the corporate world and adequate expertise exists for developing these low-end technologies.

Challenges

The challenges which the Indian Army is likely to face in planning and implementation of this technology are as under:

- **Mindset.** The deep understanding of change in the character of warfare, which has caused a global race leading to intense competition, needs to be realised by the hierarchy. The urgency to embrace this technology will come with a need of changing mindsets and shed the stigma of the status quo. Strategic deterrence can be achieved if a decisive edge is attained in our capabilities.
- **Data Management.** Data management is the single most challenge to adopt AI in any systems. AI modules can be built to start with but eventually, a cloud based system has to be implemented for eventual integration. Sharing of data and classification of data are the other two main challenges.

- **Integration.** Integration of data emanating from legacy systems is the next challenge. Most data is analogue and converting it to a digital form and then structuring it for the AI engines to process, is a major challenge.
- **Infrastructure.** AI runs on complex algorithms backed by a large volume of data; thus, it becomes quite essential to have robust hardware that enables the data banks to be present within the territorial boundaries of India. If critical AI based military technologies are to harness the data present on the remote servers that exists outside the Indian borders, then it could damage the objectives of India's foreign policies.[73]
- **Network.** To process and transmit data, there is a need for a network that is highly robust with adequate speed. Maximum data, be it the sensor data or operational data, is generated by the units deployed in actual combat along borders in difficult terrains. The need for an infrastructure-less data driven network is the need of the hour and that can only be achieved by the Mobile Adhoc Network (MANET) created by the SDRs which can process the high volumes of data through a network till the battalion level. Beyond battalion and upward, hopefully, Network for Spectrum (NFS) integrated with Army Data Network (ADN) can handle the data.
- **Budget.** AI modules have to be developed within the budgetary constraints, the good news is that it's a software and hence the costs involved in building high-end hardware are not involved. The budgets for the creation of infrastructure will be high.
- **Whole of Government Approach.** It is good 'to start small and evolve big', 'to fail fast to succeed early'. The need for harnessing DT is for the entire Armed Forces of the country and an eventually integrated approach involving the best minds and industry will be vital.
- **Resource and Development.** Resource and Development (R&D) has been India's biggest challenge in the field of defence. The Defence Research and Development Organisation (DRDO) manned Centre for Artificial Intelligence and Research (CAIR) facility has been gradually developing AI based products; however, the relevance and integration in the mainstream in combat is essential. A multi-pronged approach needs to be adopted to develop AI modules by involving researchers from academia, industry, and DRDO.
- **Procedures.** The transformation from the Industrial Age warfighting to the Digital Age era is contrarian to Defence Procurement Procedure (DPP) and Defence Procurement Manual (DPM) mindsets. AI based software development is a continuous dynamic process and needs a different approach. A multi-pronged approach with a strategy driven by

the Strategic Planning (SP) directorate, software prototypes developed by a joint team at the Indian Army Artificial Intelligence Centre (IAAIC) or by the Centre of Excellence at technical schools, and then development by the industry in conjunction with ADB and user directorate is a possible way forward. Chapter VIII introduced in DAP 2020 could be studied to develop systems and Information and Communication Technologies.

Section IV: Role and Application of Artificial Intelligence in Enhancing Situational Awareness and Military Decision-Making

Surveillance

Owing to the country's geographical layout and the geo-political scenario, we are bound by two hostile neighbours with a history of conflicts. The land borders have compelled intense deployment of troops and resources to protect the sovereignty of the nation. The plethora of ground and aerial sensors which are deployed along the borders, observe and lend the commanders to orient themselves. The observation and orientation part is carried out in silos by independent soldiers manning the sensors and the staff on behalf of their commanders with each utilising their cognition to manually collate and interpret the data in isolation. There are tonnes of data that has gathered over the years which can be utilised to train machines to analyse and provide predictive analysis. There is a popular saying that the staff officer who is the custodian of data, after termination of his tour of duty, leaves an unavoidable void as he along with his cognitive mind which has been trained over a period of few years leaves that organisation. This is exactly the task that can be taken over by AI.

The basic AI engines at the unit level can be built by ML and NLP techniques utilising the old data from the area of operations. These AI modules then can be trained to analyse fresh sensor data such as images, videos, radar signals, voice, weather, and terrain data.

Situational Awareness and Common Operating Picture

At the formation level, there is more intelligence gathering resources and agencies which again provide various information in unstructured formats that needs to be processed and integrated. The situational awareness can be achieved at various formation levels by incorporating the analysis of all the inputs received from units by incorporating various AI based softwares such as facial recoginition, image interpretation, object recognition, voice

recognition, terrain interpretation, weather interpretation, to provide analysis and predictive patterns. These modules can be built at formation level.

The AI modules at the formation level can be bolstered by training the machines with previous intelligence based data such as Intelligence Preparation of Battlefield (IPB), situational reports, intelligence reports, and various unstructured analytical documents to assist the module to predict the outcomes. These consolidated inputs can then be fed into an AI enabled automated IPB module to derive accurate intelligence about a target area.

To create a common operating picture, the requirement of an infrastructure-less Software Defined Radios (SDR) based network at the unit/battalion level and below, and a high-speed data network for unit level and above is a must. The high-speed network will enable the real-time flow of AI processed intelligence inputs across the medium to all concerned.

Decision-making

After the AI based intelligence module has provided accurate intelligence by covering the 'observe and orient' part of the OODA loop, the onus on taking a decision lies with the commanders at all levels. The employment of an AI based module to predict a course of action with multiple options can be developed to assist the commanders and their staff to arrive at a most probable course of action.

The AI based decision-making module can be largely developed by training the machines on the previous database, the terrain conditions, time constraints, weather conditions, troops required, and the enemy profile. The human i.e. the staff and the commanders should be the humans in the loop to take the appropriate decision for action. The adoption of weapon systems and force levels suited can also be predicted by the AI module specifically developed for this purpose.

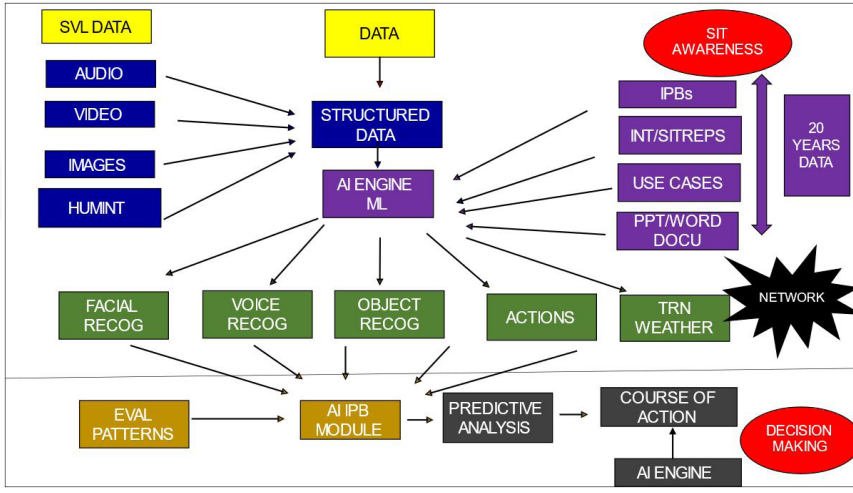
AI has the potential to augment the four stages of the OODA cycle. In the case of war, apart from men and equipment (weapons and platforms), management (higher defence management) plays an important role across all levels (tactical, operational, and strategic) of battle. The management is backed by intelligence apparatus and oversees the entire command and control of the formations right from the strategic to the tactical level. This has brought the onus of efficient and optimum decision-making on commanders across all the levels—from a unit to that of an operational command. Interestingly, this imperative has led to a change in thinking at the strategic level, effecting a revolution in strategic affairs.[74]

AI based decision-making software such as Computational Military Reasoning (Tactical Artificial Intelligence) is a computer solving the

human-level military problem and concentrates on tactical AI or battlefield decisions. Tactical AI analyses the battlefield and acts on that information, by creating a set of coherent orders (commonly known as a Course of Action or COA), that exploits the weaknesses in the enemy's position that were found during battlefield analysis.[75] These developments of AI based software for every terrain and in different operations of war will bolster our decision-making.

The most credible location for employment of these prototypes is along the LC and in counter infiltration/terror operations. The forces have been operating in these areas for over three decades and have huge experience in terms of cognition and the same needs to be leveraged by machines to fight and gain ascendancy over the adversaries and the terrorists. These independent modules at various levels can be developed and integrated into one major AI module, the smaller modules are low-hanging fruits; however, the integration into a larger module to derive important military decisions will require a cloud and a robust secured network as it involves dissemination of operational orders and intelligence. A suggested AI model is presented in Figure 4.

Figure 4: AI-Based Situational Awareness and Decision-Making Module



Source: Annotated by the Author

Conclusion

The Indian Army is one of the most battle-hardened and experienced armies in the world. Its superior leadership and highly trained & patriotic soldiers are the epitome of success it has achieved in all its endeavours to date. The

character of war is altering fast, the country has to adapt to these changes and keep pace with the modification. The variation starts with the change in the mindset to adopt the revolution in warfare which will enable us to keep pace with the fast-evolving technology. The earlier we adopt these DTs, better it is for national security of the country. This Manekshaw paper has attempted to simplify AI and brought out the likely areas of employment of this technology. As it is evident from the research, this transforming technology is going to affect and influence every sphere of military capability. Hence, it is recommended that we start small but aim big with simultaneous actions at all levels to embrace this technology for the better future of our Armed Forces.

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About the Paper

Artificial Intelligence (AI) is a path-breaking technology of the future and has a tremendous role in future wars. The paper recommends the role and applications of AI in the Army. It describes the advancements made in AI technology from the military perspective. It also analyses in detail the military approach and its employment by leading foreign armies, deriving lessons for the Indian Army. It gives a possible road map for the employment of these applications in various fields in the Army. This paper puts forth recommendations for exploitation of AI in future wars and conflicts with an aim to enhance the warfighting capacity of the Indian Army.

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