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Revolutionising Military Operations with Autonomous Systems: An Exploration into AI Integration

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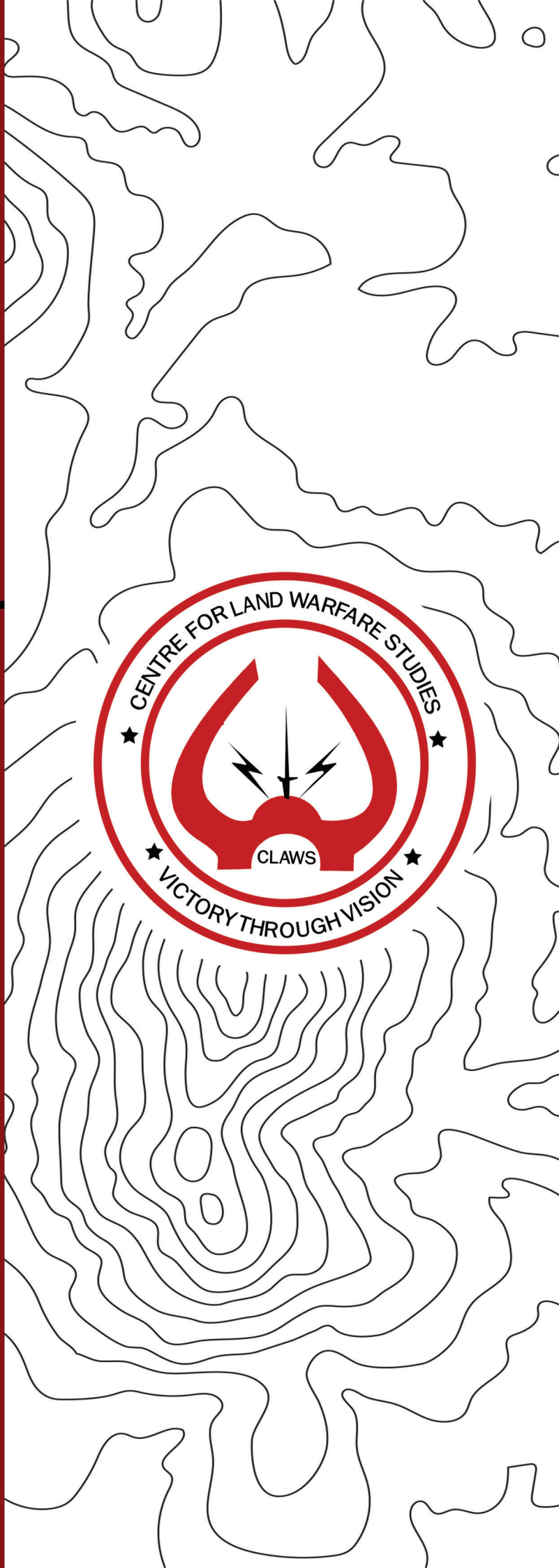


Revolutionising Military Operations with Autonomous Systems: An Exploration into AI Integration

Abstract

Autonomous Systems (AS) have emerged as sophisticated machines, devices, or software designed to carry out tasks and make decisions without human intervention. This paper delves into the world of AS and explores their potential applications in the military context, shedding light on practical and feasible implementations that can significantly augment military capabilities. Key characteristics of AS include their decision-making capabilities, adaptability, and actuation skills, making them invaluable in various military contexts. However, their suitability depends on specific applications, necessitating careful consideration in their implementation.

Keywords: Edge Device, Cross Functional Team, Performance Measure, Problem Statement, Military Training

Introduction

AS represents a significant technological advancement with the potential to reshape military operations and decision-making processes. This paper, explores their capabilities and applications to provide valuable insights into their military integration. AS possess several features that make them invaluable. For instance, AS has decision-making capabilities, which are based on data inputs and learning algorithms. This allows them to function without constant human oversight for each decision. Equipped with various sensors, these systems can effectively perceive and understand their surroundings, thus enabling them to gather relevant information for decision-making. Perhaps the most significant aspect of AS is their actuation capabilities, enabling them to execute real-world actions, such as movement, object manipulation, and even controlling other devices. This adaptability enables AS to operate seamlessly in both physical and digital domains, catering to diverse operational requirements.

In the military context, employment of AS is virtually limitless, spanning across various aspects, including combat planning, execution, combat support, operational logistics, administration, and human resource development. By exploring the potential applications of AS in the military's immediate future, the paper aims to identify practical and feasible implementations that can significantly augment military capabilities. This analysis hopes to

contribute to the advancement of AS technologies, ensuring effective integration into military operations.

Essentials of AI Development

In the context of military product development, fundamental principles and concepts underpin the design and implementation of AI solutions and these essentials form a core that drive the AI system's functionalities and capabilities.

AI Play Book

An AI playbook (Andrew Ng, 2020) serves as a central tool for establishing a clear direction and standardised reference point within the organisation and it empowers all members of the organisation to align their efforts toward shared objectives.

The launch of a pilot project should be considered an initial step. This project, with a gestation period ranging from 6 to 12 months, can be outsourced if the in-house capacity is insufficient. To achieve this goal, it is advisable to assemble a robust, cross-functional team consisting of AI/Machine Learning (ML) practitioners and domain experts. This team's responsibility is to thoroughly evaluate the relationship between the organisation's aspirations and its capabilities. It is worth noting that the pilot project should primarily focus on demonstrating the feasibility of AI product rather than striving for full usability at this initial stage with an aim to enhance traction and user engagement.

Following successful completion of the pilot project, the next suggested step is to provide training for in-house Cross-Functional Teams (CFT), subsequently expanding AI training initiatives to encompass all levels and roles within the organisation. This broader approach ensures the widespread dissemination of AI knowledge, thus making it an integral part of the organisational culture.

The playbook finally emphasises the importance of clear and effective communication for the success of AI initiatives. It is advisable to communicate the AI strategy through robust two-way internal and external channels to ensure alignment and engagement throughout the environment.

AI Labs

A lean and efficient core team can commence the AI Lab. It should be capable of handling the virtuous AI cycle which runs through product development to user experience to feedback to improved product and redevelopment. The lab should consist of the following members:

- A Team Leader to oversee the project, set objectives, and manage resources. He could also act a domain expert to provide user specific intrinsic knowledge and guidance.
- A Data Scientist/Analyst to handle data collection, analysis, and insights generation. Dataset management will also rest with this vertical, though it may be overwhelming, if the AI Lab undertakes wider research. In such a case, small user sub teams should be instructed to handle data validity while the Data Scientist/ Engineer ensures data integrity.
- A ML Engineer to focus on building and deploying ML models.
- A Software Developer/Engineer to create the software infrastructure for integrating AI models.
- Compute Capability is widely discussed as a primary hurdle for AI development. The CFT could examine "Now vs Future" option and work towards the final compute architecture. Interim measures like lighter AI and shared computing resources should be considered as essential milestones on the AI Lab development highway. Computational power is the life-blood of AI, powering its evolution from simple rule-based systems to the intricately woven neural networks of deep learning. The synergy between cutting-edge hardware and sophisticated software algorithms is the driving force behind AI development. Obviously, such secured environment and computational power resource are financially intensive and not universally available. The National PARAM Supercomputing Facility (NPSF) and Param Siddhi AI (PSAI) provides a high performance computing-artificial intelligence (HPC-AI) supercomputer (Dept of Science & Technology). It offers reliable and suitable parallel and distribute processing technologies and resources to AI researchers and developers.

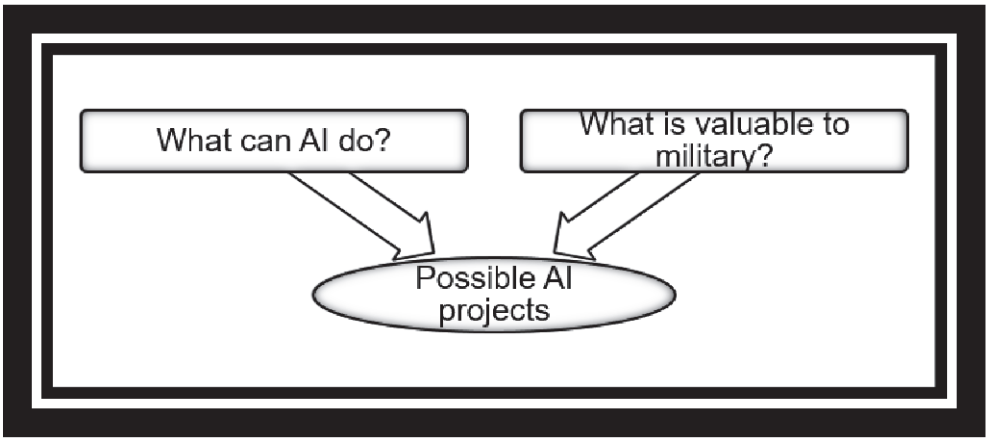
Defining AI Problems

Similar to any other tool, the military identifies its requirements based on strategic goals, objectives, and threats. An AI tool, due to its advanced analytical capabilities, and efficiency in automating tasks, should be capable of effectively addressing the most critical military challenges. The Leader defines goals, challenges and

provides higher-level guidance and directions. The CFT understands the specific challenge, calls for insights from users and developers, combining with historical evidences. CFT then aligns the insights with overall strategy and seeks clarifications from leaders, if any, finally documenting the actual Problem Statement. Creating a succulent problem statement is the first and essential step. Examples of good and excellent problem statements are given below for predicting avalanche in a snow bound road stretch.

- ***Good Problem Statement.*** 'Develop an AI-powered predictive model for avalanche forecasting in snowbound roadway, leveraging real-time weather, snowpack, and terrain data to enhance safety measures and minimise travel disruptions'. This problem statement outlines the scope, goals, and data sources for the project, providing a clear direction.
- ***Better Problem Statement.*** 'Develop an AI-powered avalanche prediction and mitigation system tailored to snow-covered road, integrating meteorological, snowpack, and terrain data for real-time risk assessment. This system should provide timely alerts and also recommend proactive safety measures, such as road closures or controlled avalanches, to safeguard lives and ensure uninterrupted transportation services'. This problem statement is highly specific, outlines the objectives, and emphasises the importance of proactive safety measures, setting clear and ambitious goals for the project.
- ***Developing AI Solutions.*** From Concept to Implementation, as in case of any other tool, the military identifies its 'honest' needs, which stem from National Objectives, Aims and Threats. A simple layout below establishes a broad but essential decision point.

Picture 1. Military Need Identification Model



Source: Prepared by Author

Performance Measure, Environment, Actuator and Sensor (PEAS) Analysis

AI system is a complex integration of various attributes. The developers aim to keep the complexities to manageable level by undertaking PEAS Analysis (Russel, J Stuart & Norvig, Peter, 2010). It helps a rational agent (colloquially AI Tool) to consider all possibilities and select the most efficient action which is the shortest path with least cost for high productivity. Unsurprisingly, this framework also offers alternative options to create a simpler tool. A modified Framework is attached as Appendix A to this paper. Case studies of use case with regard to PEAS Analysis serve as practical examples for the development of AI solutions, ensuring a more informed and successful integration of AS into military practices.

- ***Managing Change.*** The Australian Defence Forces (ADF) went on to deploy a cross-functional Deloitte (2020) team to establish a scope, design, configure, test, and pilot the automated assistants. The team identified and classified all current and anticipated work types, then mapped them according to the level of importance of the work and the cognitive power required to do it. This map provided options about which work could be augmented with AI, to what extent, and in what sequence. AI assistants were selected based on 'high return, rapid realisation, and low risk'. Two AI assistants were initially built as proofs of concept, and 10 percent of the people previously doing the work were able to be redeployed to higher-value tasks. Over last few years, more than 20 AI assistants are functional across all three services in ADF (Deloitte) . PEAS analysis of such 'AI at Rest' assistants have been documented in the table below: -

Table 1: PEAS Analysis of ADF AI Assistants

Performance Measure	Environment	Actuator	Sensor
Understand the query Provide legal and correct answers Maintain record of the query and answer	Highly controlled One query at a time	None	Camera/ Biometric device/ card reader to authenticate the query seeker Microphone/Camera to understand a verbal or written query Display device/speaker/ printer to deliver the answer

Source : *Author's Interpretation*

- ***Supply Autonomous Robotic Assistant Hardware (SARAH) (Australian Defence Force, 2020)***. As a robot, it delivers parts from the Logistics Section to Flight Line in ADF. It is an autonomously moving, spares and aircraft parts delivery system as part of a strategic transport squadron and Air Force modernisation plan (Jericho). SARAH is successfully transporting parts within the unit building— transporting 200 kgs on predetermined paths and slows down in vicinity of obstacles and humans. PEAS analysis for SARAH (AI in Motion) would be as the table below:

Table 2: PEAS Analysis of SARAH

Performance Measure	Environment	Actuator	Sensor
Understand the spare part required Pick up the correct part Avoid other transporters Avoid Humans	Warehouse Other moving transporters	Wheels Accelerator Brakes Horns Blinking lights Lift arm Clasper to hold the load steady	Wifi/Radio based instruction receiver Camera Range Finder RFID reader for loads

Source: *Author's Interpretation*

- ***Preparation for Combat.*** AI also played a key role during Israel's 'Guardian of the Walls' (INDIAai, 2021) operation against Hamas in Gaza in May 2021. The Israel Defence Forces (IDF) relied heavily on machine learning and data gathering over the preceding weeks to collect vital targeting information. Advanced AI centralised all militant data on one system to help analysis and intelligence, prioritising knowledge-building ML systems. Special programs like 'Gospel' recommended 'quality targets' which the Israeli Air Force successfully struck. AI algorithms predicted enemy rocket launches, place, and time, helping soldiers to target in real time. PEAS analysis for such an 'AI at Rest' system could be as under:

Table 3: PEAS Analysis of Guardians of the Wall

Performance Measure	Environment	Actuator	Sensor
Monitor person of interest Maximum reliability Prioritise inputs based on authenticity	Uncontrolled Multi-sensor inputs Highly secure	Recommend priority targets Possible None in physical world	Web data extraction with SM analysis Cellular/ tele monitoring Cameras Drones and LEO satellites Special Forces

Source: *Author's Interpretation*

AI in Indian Army

Militaries struggle between 'AI Now' and 'AI for Future' constantly. Released in 2023, 'Oppenheimer', introduces Edward Teller as an early member of the 'Manhattan Project', which developed the first atomic bomb – a fission weapon. During the development, he made a serious push to develop a fusion weapon, but was politely side-lined by the main protagonist and allowed to continue with parallel research, without delaying the development of the fission atomic bomb. The leader knew the difference between 'Now' and 'Future'. Fusion bombs came up much later after World War II. In context of AI, answering two fundamental questions will reduce the dilemma somewhat. Firstly, which AI tool will improve delivery of what is valuable to the Indian Army? And secondly, how does PEAS framework recommend a workable AI Tool to create 'Bang for Buck'? Following two highly valued fundamentals are instructive in case of AS.

- Sensitive borders including coastlines require constant monitoring and firm physical control so Border Management Systems are primary requirements. There has to be a good mix of surveillance and retaliation systems. Rough terrain supports infiltration, and small team operations and salami slicing, can be easily 'controlled' by Autonomous Systems. Operational logistics and administration in such areas also affects combat efficiency. This uncertainty and adversity thus require well planned prediction and delivery mechanism, served best by AS.
- Grey Zone and cognitive operations are a constant threat in India. It is vital to identify and monitor future perpetrators and this is a truest interpretation of 'AI Now'. Monitoring

Persons of Interest (POI) with adversarial interests will be a major value addition to the military arsenal.

Analysing AS for the Indian Army

AS will play a pivotal role in military operations by streamlining essential tasks and separating aspirational features from critical necessities. They can reduce clutter in complex systems, enabling military forces to focus on vital objectives efficiently, allocating resources to the most valuable tasks, and ultimately strengthening military effectiveness. There is a necessity to declutter 'needs' and simplify the AI tasks, even breaking them down into small forms and structures.

- ***Composite Border Surveillance System.*** It is obviously the most important AI tool for border managements along the entire stretch. A quick PEAS Analysis provides insights into the mega structure required for such an enterprise. In itself it is a highly complex, multi agent system, dependant on a huge dataset, affecting communication and power management. It is clearly not an optimal tool. Following details proves that this type of system is a complex interplay of multiple intelligent agents.
    - ***Performance Measure.*** Identify movements of vehicles and personnel towards border without clutter of normal civilian movement. Identify armour vehicles, artillery guns, military load carriers, specialised vehicles and communication vehicles separately; group the movements into enemy formations; identify lateral movements of all vehicles and personnel, which can later join up to a common area/ location near border; identify exodus of civilians, if any; and co-relate all electromagnetic spectrum inputs to generate a composite picture across the border.
    - ***Environment.*** Physical environment will include sandy areas, developed, riverine, low and high hills, forests and shrubs, valleys and high ridges, finally snow bound and glaciated areas.
    - ***Actuator.*** 'AI at Rest' actuators comprise algorithms to indicate exodus, conterminous lateral movements, and concentrations of armour and artillery vehicles finally co-opting inputs into a composite picture. AI will also create 'Intelligence Void'.
    - ***Sensor.*** All EO Sensors of the military formations, troops in contact reports (SITREPS), Intelligence Analysis Reports from Neighbouring Formations and Higher HQ, Drones, Aircraft Reports, LEO, Aerostats, EW Assets and Open-Source Reports.

- ***Decluttered Border Surveillance System.*** It is also possible to model a light and equally quicker AI system by redefining the optimal Performance Measure to finite objectives and outputs. The end user has to analyse and identify this 'optimal measure' with a motto- 'deliver what is valuable'. The abstract model could be developed as follows: -
    - ***Performance Measure.*** Identify movements of all military vehicles and personnel towards Desert Border between Point A and B. Identify lateral movements of all vehicles and personnel, which can later join up to a common area/ location near border.
    - ***Environment.*** Physical environment will include Desert Border between Point A and B and 50 km (BFSR-XR) into enemy territory
    - ***Actuator.*** 'AI at Rest' actuators include algorithms to indicate exodus, conterminous lateral movements, and concentrations of armour and artillery vehicles finally co-opting inputs into a composite picture. This AI will autonomously create 'Intelligence Void' report for query.
    - ***Sensor.*** Only EO Sensors of military formations and troops in contact reports (SITREPS).

- ***Missing the Bigger Picture.*** Often quipped for 'Missing the Bigger Picture', these decluttered systems/Tiny AI systems are in fact otherwise. They will provide a similar bigger picture to initial envisaged complex system. Decluttering simplifies the AI architecture without decreasing its utility. An AI designer retains the desired value by creating another AI to read the insights of all other 'mini-AI' systems mentioned in the preceding paragraph. Known as 'Federated Learning AI' (Martineau, K., 2022) , it trains on multiple local datasets contained in local nodes without explicitly exchanging data samples. It is the perfect AI solution to problems of large datasets, multiple-agents and dynamic environment, and communication-power management. AI is decluttering its own responsibilities, and yet providing a common operating picture to the decision makers at the end of the cycle.

Decluttered AS for the Indian Army

Military can utilise Federated AI to meet its AI needs. Few examples of Military AI Autonomous Systems using Federated AI are mentioned in the Appendices attached to the paper.

The list is a vision of what is possible and is not a completed work in any manner. Each AS in the instant case has been analysed with a Federated AI under PEAS framework subsequently.

- ***Autonomous Weapon System (Appendix B)***. Theoretically speaking this is the simplest and most necessary AS in Indian context. Contested borders, rugged terrain and out of proportions ramification of local conflicts make up for a strong case to produce Autonomous Weapon Systems. Unlike other countries fighting for regime change and GWOT, Indian military decisions are remarkably sublime and always oriented to 'Defence of India'. In that context, any violation of the borders is violation of the 'Defence' and any action there off is fully constitutional and legal.
- ***Prediction of Landslides and Rockall (Appendix C).*** Due to loose shale mountain side, the border roads are prone to landslides which reduces tactical mobility. AI solution is a good option to predict landslides, rather than sending out an advance team to physically scout the area. The system will require a database of images or videos of roads in different conditions, including some that show signs of landslides or rock falls. Simple and light algorithms, namely logistic regression, decision trees, random forests, and gradient boosting, are powerful and widely used in various machine learning tasks. These algorithms can build simple and light prediction model, even with limited data. By using simple and low technology sensors like QR codes, the user can identify exact spots on the ground QR codes can be placed at regular intervals, like in every 250 meters, along the mountain roads to serve as markers for precise location data. It is a cost-effective and accurate method for collecting location data without relying on GPS technology. However, the QR should be securely placed, remain visible and scannable, even in adverse weather conditions or challenging terrain. Insights are highly dependent on the data received from sensors and AI systems' access to its database. Deploying edge computing devices will reduce the need for extensive data transmission and can provide real-time responses. It is also possible to train AI models to identify initial indicators of a landslide/mudslide/ roadblock and then deploy it offline to generate alerts, reducing the need for communication. IA can combine multiple communication protocols for redundancy and robustness, like IOT SIM cellular communication for critical real-time data and mesh networking for backup data transmission.
- ***Autonomous Tracking of Person of Interest (POI) (Appendix D).*** Given the persistent actions of adversarial neighbours engaging in grey zone operations against

India and its military, exemplified by incidents like Pathankot, Pulwama, and Uri, it becomes imperative to maintain continuous surveillance over Persons of Interest (POIs) across both the physical and digital realms. The military must adopt a mindset wherein virtually any suspicious human activity could potentially serve as a tool for military objectives. This expanded perspective includes non-military entities like social media, financial institutions, and critical infrastructure, that are easily exploitable. The increasing prevalence of grey zone operations, strategically positioned between peace and war, underscores the urgency of identifying these POIs and their proponents. To effectively counter such threats, the military should proactively monitor and track POIs, thereby enhancing its non-contact and non-lethal capabilities. This strategic augmentation will render the military a more versatile instrument of power in confronting the emerging challenges.

Recommendations

The Indian Army should leverage its unique strengths and resilience to spearhead AS development. However, it is crucial for the military to embrace the reality that AI is a rapidly evolving and collaborative field. While the military can be a pioneer, it need not bear the sole burden of AI development. Embracing non-military progress is essential as the civilian sector often drives innovation and diversification, ultimately benefiting the military with dual-use technologies. Thus, a strategic partnership between the military and civilian AI ecosystem can maximise the advantages of both sectors, ensuring rapid and responsible evolution of AI technologies for the benefit of society at large. Following suggestions relate to the Indian Army.

- ***Edge Computing.*** Huge database dependant AI may not be a good option for the Indian Army. In itself a different class of research, data curation is a tedious job. Regional Data Centres have a long way to curate data in the manner that is readily usable for AI mapping. To support communication with such data lakes, cloud computing solution infrastructure is required which is hardware intensive activity and hence will take time. An immediate effective solution would be to prioritise 'Edge computing' (AI Now) and continue research on 'Fog computing' for military cloud-based technologies for the future.

- ***Military Training.*** A good AI strategy also advocates integration of AI awareness and understanding within training programs, commencing from the foundation military training. Unless the military incorporates the employment of AI in conceptual discussions, it may just end up in a digital store, forgotten in time. Anecdotal analysis of the Information Warfare (IW) Course at Army War College (AWC) provides a compelling rationale for development of a composite AI Course. AWC was selected to conduct the course to bridge the gaps between Psychological Operations (Military Intelligence forte), Perception Management (organised by ADG Public Information [PI] and media cells of the formations), Electronic Warfare (Army Air Defence and Signal Intelligence specialty) and Cyber Warfare (Signals capability). It is now well understood that an IW operative must think across all realms and dimensions with an aim to design and launch an effective campaign. Similarly, the AI developmental, deployment, and result delivery cycle will fall short if the user and developer are disconnected from each other. While the cross-functional necessity of AI product development is proven, it is equally crucial that a combined effort be used for preparation of concepts and actual employment.
- ***Collaborative Effort.*** The "You don't know about wars" quip will not bode well for military planners. On the contrary, an all-out joint effort involving AI academia will prove highly beneficial. In house efforts to encourage academic debates will be even better.
- ***Rogue AI.*** There is an ubiquitous caution about the use of 'Rogue AI'. An AI tool is created to produce a defined outcome and it cannot perform anything beyond, unless of course a self-aware AI manifests. Nick Bostrum (2017) theorised that Artificial Super Intelligence (ASI), when developed, will have a sense of self and could understand its own current state. He also predicted that 50% of all AI will be ASI by 2070. Nick Bostrum, 2017). In reality, AI is yet to touch the lower levels of intelligence predicted so far. ASI requires powerful hardware, rich sensory training input and reimagined architecture. Development is much slower than what was theorised. So, the fear is misplaced, and should not slow down the AI development cycle.
- ***Ethical AI.*** Ethical use of AI is often exploited to push insular agenda, for which India should be prepared. USA mentions such discussions as a communication tool with partners and negotiation with competitors especially China and Russia while

maintaining crisis communication protocols – much like SALT and START (Morgan, Forrest E. et al., 2020). Tracking the evolving positions held by stakeholders provides a look into development vulnerabilities (technology, ethical and legal) of the adversaries, which could be exploited later. Illustratively, USA participates in the United Nations' Group of Governmental Experts to examine the technological, military, ethical, and legal aspects of Lethal Autonomous Weapon Systems (LAWS), but, does not support a ban. It believes that automated targeting and engagement carries less risk of collateral damage. Undue leverage to such issues in Indian context will be like a "steeple chase race with a nail in the shoe and an elastic band anchored to the starting block".

Conclusion

AS are sophisticated machines which will deliver the 'most valued outcomes' to Indian Army, provided they are well designed with optimal characteristics. Cross functional teams, intra organisation coordination (rather than competition) combined with collaborative effort with AI academia will also overcome obstacles.

Adopting industry standards will ensure successful product development, starting from the proof-of-concept stage to the final delivery mechanism. In-house communication, standardised training for rank and file, and a clear concept of operational employment will facilitate transactional growth of users and developers. Caution is warranted for those who attempt to segregate the users from the developers by claiming - "It is too technical, and let it be handled by a few". Emphasising collaboration and inclusivity is crucial for the effective implementation and utilisation of the product. Stove pipe efforts will reduce AI to a mere technology demonstrator. Undue fear of ethicalities and legalities will also decrease the AI growth in Indian Army.

Appendix A

PEAS Analysis Framework[i]

Task		**Name of the AS or an Agent or a Tool**			
Performance Measure		What is expected to be done? What is the desired output or action? List out the desired tangible outcomes.			
			Options		
			1	**2**	**3**
Environment	Fully & Partially Observable	Does agent's sensors give it access to the complete state of the environment at each point in time?			
	Episodic & Sequential	The agent's experience is divided into atomic "episodes". Does Agent receive precepts and perform single action, while next action is not dependant on present percept or action			
	Static & Dynamic	Does the environment remain unchanged while an agent is deliberating?			
	Discrete & Continuous	Is there a limited number of distinct, clearly defined precepts and actions?			
	Deterministic & Stochastic	Is the next state of the environment completely determined by the current state and the action executed by the agent?			
	Single & Multiple Agent	Is the agent operating by itself in the environment?			
	Know & Unknown	Does the designer of the agent have knowledge about the environment makeup?			
Sensors		A device which detects the changes in the environment (physical or synthetic) and sends the information to AI system.			
Actuators		Converts electronic current (AI decision) into physical action within a system. A physical action affecting the environment is also termed Effectors.			
Overall priority					

[i] **Note:** The actual framework assists in designing an intelligent agent, however in the present instant the author of this paper has included 'Options' columns much like 'Options in Military Appreciation' to identify which 'Course of Action' would provide optimal benefit. In context of AS, this modified framework will suggest architecture of 'quick-build' AI Tool.

Appendix B

Autonomous Weapon System (Type 1)

A variation to the framework at Appendix A, this format connects the expected Performance Measures to other factors, reducing the technology burden and suggesting an optimal but useful AS Tools, which will add 'Value to Military' endeavours.

Performance Measure		Engage enemy armour in Desert Terrain It is a fairly simple requirement and the AS is activated during hostilities. Deployed ahead of defences, it will detect enemy at first instant, without prejudice. There is no concern of IFF, since the hostilities are declared and the deployment is ahead of Forward Line of Own Troops (FLOT).
Environment	Fully & Partially Observable	Fully observable beyond IB
	Episodic & Sequential	Episodic
	Static & Dynamic	Static
	Discrete & Continuous	Discrete
	Deterministic & Stochastic	Deterministic, because the enemy armour will reduce in numbers after engagements
	Single & Multiple Agent	Single
	Know & Unknown	Yes, well known
Sensors		Camera/ Range Finder/ Drone
Actuators		• ATGM/ 30 mm AK 630/ Tracked Carrier (remotely controlled)

Autonomous Weapon System (Type 2)

Performance Measure		Engage enemy on LC and LAC This a simple system, since the deployment area is devoid of non-military collateral. Prepositioned deployment at 'most dangerous option' provided immediate destruction action. Proximity of own 'Vulnerable Points and Areas' near LC and LAC are ideal locations for such a deployment. Galwan skirmish is a suitable site for such weapon system, which is weapons free at all times in the designated fire lanes.
Environment	Fully & Partially Observable	Fully observable beyond LC and LAC
	Episodic & Sequential	Episodic

	Static & Dynamic	Static
	Discrete & Continuous	Discrete
	Deterministic & Stochastic	Deterministic, because the enemy movements will be reduced after engagements
	Single & Multiple Agent	Single
	Know & Unknown	Yes, well known
Sensors		Camera/ Range Finder/ Drone
Actuators		30 mm AK 630/ This will be a static location and capable of sustained fire even under enemy fire

Autonomous Weapon System (Type 3)

Performance Measure		Engage enemy surreptitiously. A sniper based, man portable smaller autonomous system will provide additional capabilities during special operations, both during war and grey zone period.
Environment	Fully & Partially Observable	Fully observable when deployed against a specific personnel or material target.
	Episodic & Sequential	Episodic
	Static & Dynamic	Static
	Discrete & Continuous	Discrete
	Deterministic & Stochastic	Stochastic, since it is trained for a specified mission
	Single & Multiple Agent	Single
	Know & Unknown	Yes, well known
Sensors		Specialised EO device
Actuators		Beretta .338 Lapua Magnum Scorpio TGT/ Barrett .50 M95

Appendix C

Autonomous Prediction of Landslides and Rockall

Task		Predict Landslides and rock falls which cause road blocks	
Performance Measure		What is expected to be done? What is the desired output or action? List out the desired tangible outcomes.	
		Generate an alert or warning if the model detects any signs of a potential landslide or rock fall.	
		Provide the user with an interface for interacting with the system, such as a mobile app or a web portal, to view alerts and take appropriate action.	
		Options	
		1	**2**
Environment	Fully & Partially Observable	Partial	Fully
	Episodic & Sequential	Yes Episodic	Yes Episodic
	Static & Dynamic	Yes Static, in terms of Agent deliberations	Yes Static, in terms of Agent deliberations
	Discrete & Continuous	Yes, it is Discrete	No, it is Continuous
	Deterministic & Stochastic	No, it is stochastic	No, it is stochastic
	Single & Multiple Agent	Yes Single	No Multiple
	Know & Unknown	Yes, known	Yes, known and supported with geological and engineering inputs
Sensors		Cameras	• Rainfall Gauge • Soil Moisture Sensor • Piezometers to identify ground water pressure • Seismometers • GPS • Weather Station • Cameras • QR Codes of the affected zone
Actuators		Alert Generator	Alert Generator
Overall priority		**II**	**I**

Appendix D

Autonomous Tracking of Person of Interest (PoI)

	Open Source AI	**Social Media AI**	**HUMINT AI**	**Special Operations AI**	**Control AI or Federated AI**
Performance Measure	• Collate, highlight common time and place stamp. • Generate linkages with other POI.	• Collate, highlight common time and place stamp. • Generate linkages with other POI.	• Collate, highlight common time and place stamp. • Generate linkages with other POI.	• Collate, highlight common time and place stamp. • Generate linkages with other POI.	• Collate, highlight common time and place stamp from other AIs. • Generate linkages with other POI. • Generate waning. • Generate query over intelligence gaps
Environment	• Print and Digital media, vernacular media.	• Social Media Accounts • Hashtags • Photographs • AV and Reels	• Physical realm • Most authentic and confirmatory in nature	• Physical realm • Highly contested, and surreptitious	• Controlled environment of the insight generated by other four AI systems

				• To acquire confirmed inputs	
Actuator	• Generate insights • Generate variations.	• Generate insights • Generate variations.	• Generate insights • Generate variations.	• Generate insights • Generate variations.	• Generate common insights • Generate common variations. • Prioritise insights
Sensor	• Web scrapper • NLP for radio transmissions • CV and NLP for print media	• Web scrapper • NLP • CV	• Human agents	• Camera • Digital bugs • Trojan Horse	• Insights from previous four AI systems

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About the Author

Brigadier Pawan Bhardwaj has 31 years of operational experience along all border of the country, in the Siachen Glacier, in the High Altitude Areas, and Counter Insurgency in Jammu and Kashmir, Assam, Manipur and Nagaland. He was a Teaching Faculty at the Army War College and the Infantry School, both in Mhow (MP). He has a unique distinction of serving twice with the tri service Strategic Forces Command. His reading interests include Technology Trends, Information Warfare and Military Training. He holds a Master Degree from Madras University. He is now a Research Fellow at United Service Institution of India, New Delhi studying 'Employment of Artificial Intelligence (AI) at a Tactical Level' and a PhD Candidate at Manipal Academy of Higher Education (MAHE).