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USING ARTIFICIAL INTELLIGENCE TO ENHANCE C4ISR IN THE MILITARY

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Abstract

In this fast-paced world, military operations are heavily reliant on technology. Technologies, on the other hand, are evolving at a pace faster than ever before. Artificial Intelligence (AI) is one such emerging technology that has captured the interest of many and is developing at a rapid pace. The boom of Gen-AI in 2022 opened the doors for the use of AI both for civilian and defence applications.[1] Currently, most nations are trying to utilise it to advance their military and operations. A perfect use case of such a technology in the military, the C4ISR, will give an upper hand in the wars to come.[2] Keeping this in mind this issue brief attempts to understand the role AI can play in shaping the military C4ISR systems and operations and give possible recommendations.

Introduction

Military power has always been an integral component of national power. It has played a crucial role in enhancing a nation's image at the global level.[3] Military advancements have always impacted the country positively and have always played a key role in any

nation's foreign policy.[4] The number of innovations and the amount of R&D (Research and Development) undertaken for the military has greatly benefitted the civilian domain.[5] In the contemporary world, nations with advanced militaries have excelled at the economic level.[6]

One of the key advancements made in the arena of war is the induction of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) in the military. This C4ISR is a group of functionalities and applications of a defence system that integrates multiple commands including troops, tanks, weapon platforms, aircraft, and surveillance stations at the highest level of tactical and strategic information available to assist military decisions and actions.[7] Designed to influence selected aspects of an operating environment, C4ISR systems are made up of six interacting parts as seen in Fig. 1.[8]

This development of C4ISR was inspired by the ideas of Clausewitz[9] about the concept of 'fog and friction' in the battlefield. Accordingly, the US devised C4ISR systems to reduce the 'fog of war'[10] and strengthen the operating environment.

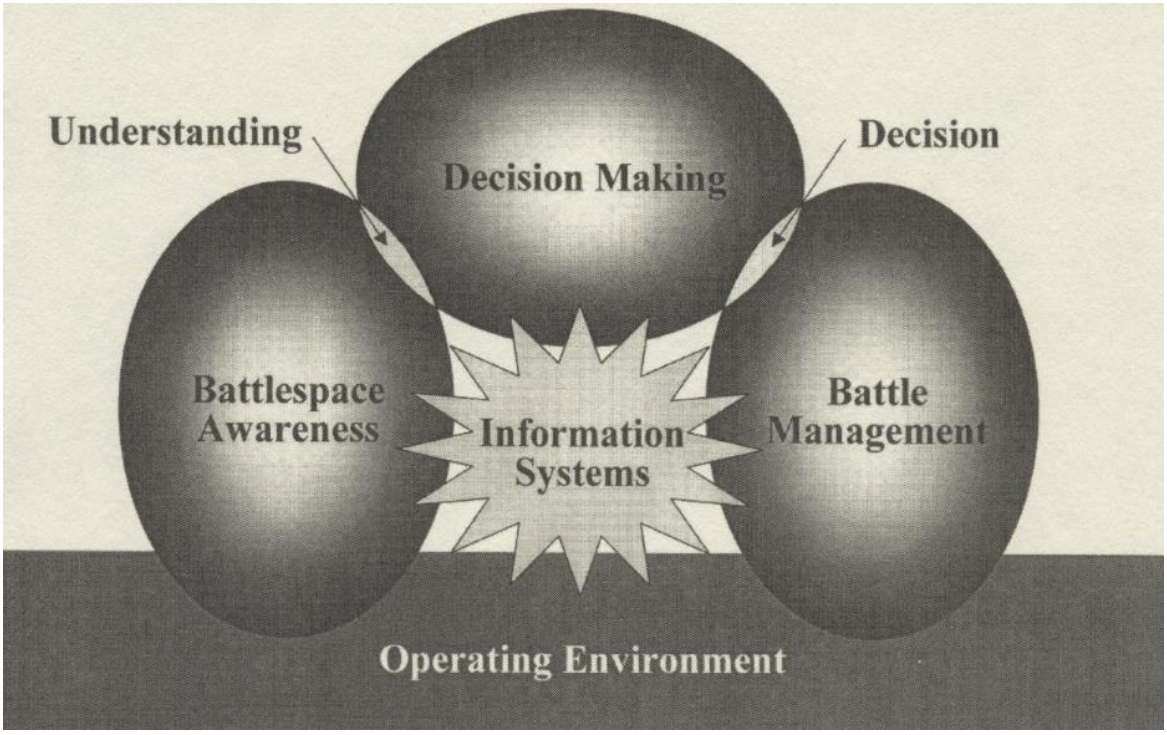

Figure 1: Traditional C4ISR Process[11]

With the advent of ICT (Information and Communication Technology), the C4ISR model today accounts for better interoperability for multi-domain operations.[12]

Currently, the C4ISR architectural framework provides a relationship between three views namely, operational, system and technical as shown in Fig. 2.[13]

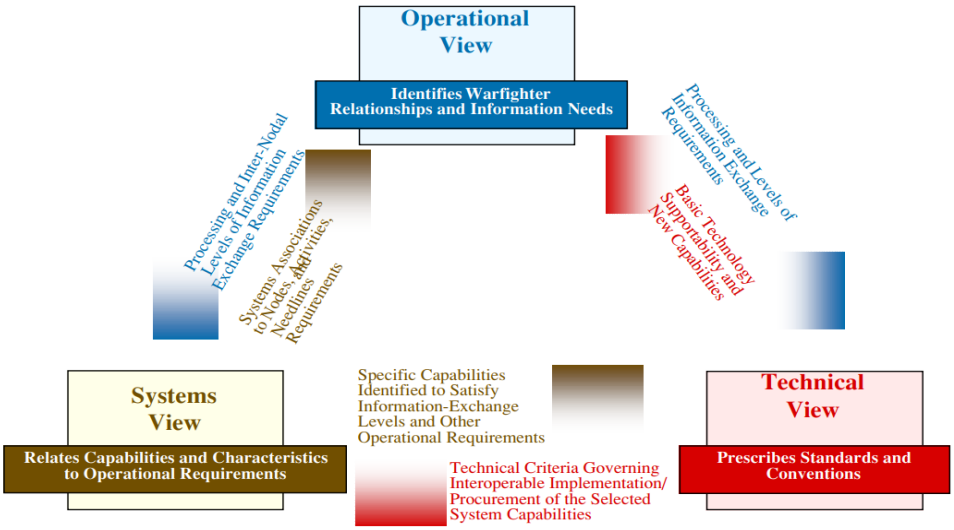

Figure 2: Unified Architecture for C4ISR[14]

Over the years, these C4ISR systems have evolved due to new and advanced technologies which have deeply impacted the paradigm of war.[15] This has led to militaries of today to become heavily reliant on information, intelligence and continuous communication to operate in the hostile war environment.[16] It is believed that with the induction of disruptive technologies such as Artificial Intelligence (AI), which are cheaper than traditional systems,[17] the way wars are fought would transform as activities such as intelligence gathering and synthesis, communication systems and combat training will see a transformation. Leveraging such technologies thus is crucial for militaries across the globe as it can process data more efficiently than traditional systems.[18]

Of these, ISR (Intelligence, Surveillance, and Reconnaissance) in C4ISR is heavily impacted by these emerging technologies.[19] With advancements in AI, it is essential to align strategies, systems, and operations, especially in the realm of C2 and ISR of the military, to enhance effectiveness. With the current state of AI being in the artificial narrow intelligence (ANI) stage, there is a plethora of applications available for both civilian and military domains.[20] Accordingly, this issue brief will focus on the possible role that AI can play in shaping military C4ISR and provide suitable recommendations.

Artificial Intelligence: Concept and Its Relevance

To date, AI has not been developed to its full potential. However, a number of applications using AI have been developed for both the civilian and the military domain. These applications and ChatGPT (Generative Pretrained Transformers)[21] show that AI can synthesise, process, reason, analyse and give results which are at par with the intelligence of a human being and in some cases even better than them.[22]

In layman terms, AI is the technology that simulates human intelligence and problem-solving capabilities.[23] The major objective of AI is to endow machines with human intelligence, for which AI highly depends upon learning; some of the learning techniques include:

- **Machine Learning (ML)**: It is the branch of computer science that enables computer systems to learn automatically from data collected from past experiences to identify patterns and make predictions. This enables computer systems to operate autonomously without explicit programming.[24] Here, ML helps in implementing AI by using algorithms to parse data, learn from data and make possible predictions and decisions.[25]
- **Deep Learning (DL)**: It is a classification under machine learning[26] that provides greater autonomy to computer systems. DL helps in furthering the scope of ML in realizing applications by complex analysis from large data sets.[27]
- **Reinforcement Learning (RL)**: RL trains software to help make decisions and achieve optimal results.[28]
- **Deep Reinforcement Learning (DRL)**: This form of machine learning lies at the intersection of DL and RL and gives out the combined results of DL and RL to the ML for optimal learning.

The learning techniques discussed above thereby, share a complex relationship in which AI takes input from ML which is supported by DL and RL. The relationship, thus shared, between these has been pictorially represented in Fig. 3.

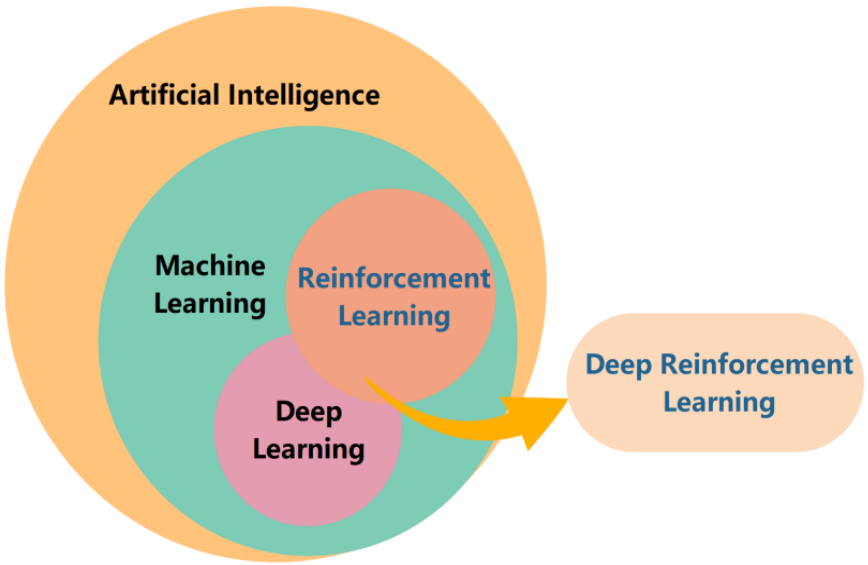

Figure 3: Relationship between AI, ML, DL, RL and DRL[29]

The above discussion of various subsets of AI helps us understand that a large amount of data is required for these models to be built.[30] The greater the number of data points, the better the learning process and hence an improved AI model.

Through AI, tasks can be made autonomous and precise. AI has to be understood as a technology that supports existing functional applications and is eventually based on algorithms designed to solve specific problems, collecting, organizing, processing, analyzing, transmitting, and responding to larger data sets, suitable and capable of corresponding to the cognitive ability of the human intellect, and operations approaching it.[31]

The relevance of AI systems is quite large which includes applications like chatbots, automated drones and weapons systems, virtual assistants, facial recognition, predictive and big data analytics, surveillance etc.[32] All of the applications that came out are based on broadly seven patterns (shown in Figure 4). These patterns are relevant in synthesising AI for the particular use case.

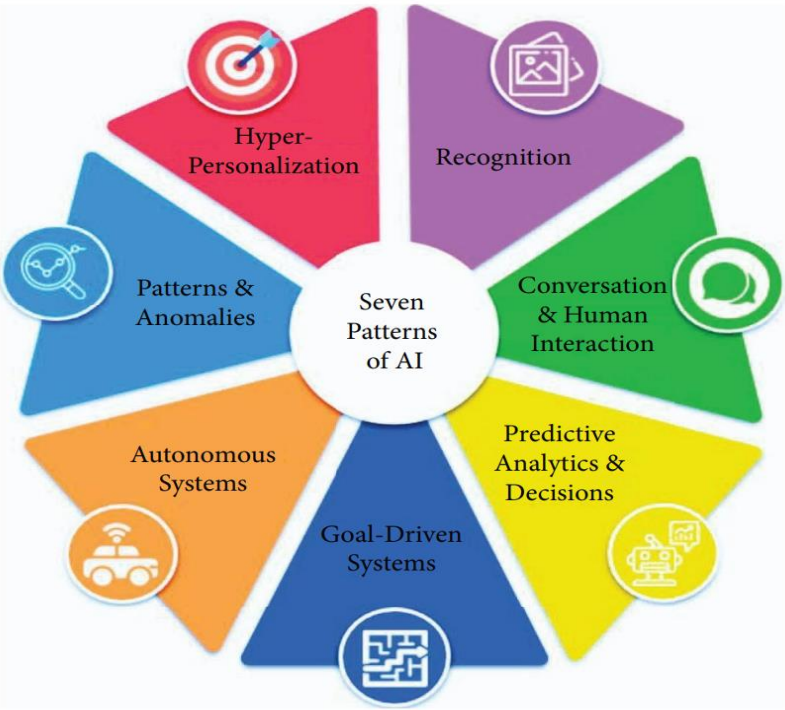

Figure 4: Seven Patterns of AI[33]

- **Hyper-personalisation**: This pattern includes the creation of a personalised profile that learns and adapts over time for various processes such as processing, analysing, and giving recommendations based on the data fed to the AI model. Such a pattern helps in assessing the user's needs in a better and more efficient way. For the military, this would help in analysing the best strategy, increase efficiency and enhance teamwork.[34]
- **Pattern Recognition**: This is a data analysis process in which ML algorithms classify data into objects, classes, or categories based on the patterns, features and irregularities in the data.[35] Such a pattern can be formulated either by supervised ML (which requires human intervention to identify and separate the patterns) or unsupervised ML (which does not require human intervention). In the military context, AI can help in quickly filtering useful data from non-useful ones and allow military personnel to identify patterns more efficiently, draw better conclusions and create the course of action that best suits the situation.[36]
- **Conversation and Human Interaction**: Ever since the inception of ChatGPT and similar AI bots into our lives, the interaction between humans and software has become more life-like. Generative AI (or Gen-AI) has eased lives as it can do thinking, processing and responding like humans and in some cases, even better them.[37] These Gen-AI models are trained on huge amounts of data that allow in-depth analysis before answering to any query. For the military, this can help in large language models (LLMs) that enable better training through

conversational software interaction. Moreover, this can help in improved strategic decision-making for the soldiers as the LLM-trained model can provide analysis of the surroundings, formulate a better course of action based on the situation and provide outputs through continuous conversation.[38,39]

- **Pattern and Anomalies**: As highlighted in the above sections, an AI model can analyse data both in the supervised and the unsupervised mode which can help in segregating data into classes, groups etc. In extension, the identification of anomalies in the data is one of the key areas where AI can help in better analysis. The Artificial Neural Network (ANN) can be designed to pinpoint the particular anomalies that can be found while processing data. Anomaly recognition runs on the basic principle of understanding patterns in data, finding high-level connections in the data and flagging the ones that do not fit in the connections.[40] These patterns are highly useful in the identification of friend or foe via Unmanned Aerial Systems (UAS).[41]
- **Autonomous Systems**: AI models are about providing increased autonomy. Autonomous intelligence is considered the most sophisticated form of AI pattern as it allows data analysis and production independently from human interaction. Reducing humans from dangerous roles is the prime goal of autonomous systems. Hence, Unmanned Aerial Vehicles (UAVs) that operate on autonomous AI patterns can provide tactical and strategic advantages to the military.[42]
- **Goal-Driven Systems**: This pattern of AI is designed to address a few specific queries. Developing a goal-driven AI autonomy helps in narrowing the use case of available data. The AI model devised on such patterns searches only for the data that fits the required problem. Proper articulation of such patterns in the military context can help in creating models that address specific problems for specific battlefields.[43]
- **Predictive Analysis and Decisions**: Predictive analysis uses AI methods to predict the value or status of something of interest. It helps in answering questions that are put forward by a data set.[44] These aim to derive predictions from the data that improves the decision-making process. Thus, use of predictive analysis in the military can be used for estimating the effectiveness of soldiers in the battlefield based on their performance in the past, estimating the amount of care required during military operations and scanning battlefields with the help of AI-enabled UAS.[45]

The patterns discussed above highlight the potential of AI in the military for intelligent monitoring, greater autonomy and decision-making. However, dealing with such technology requires utmost caution as AI is heavily reliant on data. Unbiased datasets are required to be used while training such AI models to maximise the probability of a desirable output. Biased datasets, on the other hand, will give out results that are biased and may not give relevant solutions. Measures to verify the data used should be taken to devise AI models that are robust and precise.[46]

Indian Military's Effort in Making AI-Enabled C4ISR

In the Indian context, disruptive military technologies are being closely curated and continuously worked with to modernise the military. More and more emphasis is being laid on creating self-reliance in these domains to enhance the indigenous defence base.[47] To create a strategic advantage in AI, the Department of Defence Production of the Ministry of Defence (DDP, MoD), in February 2018, constituted a task force to study the future use of AI in defence applications. Based on the recommendations given by the task force for 'Strategic Implementation of AI for National Security and Defence' in 2018 June, a Defence AI Council (DAIC) and a Defence AI Project Agency (DAIPA) were set up in 2019. The council is headed by the defence minister, with tri-service chiefs, NCSC (National Cybersecurity Coordinator) and members of DRDO and allied industries as its key members. A budget of ₹100 Crore has been allocated to bolster AI development in India.[48]

However, the formal inclusion of Artificial Intelligence in the development of the Indian armed forces came after the launch of 75 new artificial intelligence products/ technologies during the first-ever AI in Defence Symposium conducted in 2022.[49] These products, developed by the Indian armed forces and DPSUs, aim to enhance military capability, efficiency, data analytics and domain awareness.[50] The use of these AI products particularly in the C4ISR has been listed below:

- **Command and Control**: Command and Control (C2) refers to the supreme authority of the commander. Systems involving C2 leverage technologies to cyclically perform OODA (Observe, Orient, Decide and Act) functions.[51] Leveraging emerging technologies like AI can help both the commander and the troops gain valuable insights and enable decision-making at speed and scale.

AI-enabled systems can help in enhancing domain awareness, give tactical perspective and assist in ground operations.[52]

- **Communications**: Military communication systems use advanced encryption systems (AES), often referred to as military-grade encryption,[53] which is highly secure and reliable. But enabling speech-to-speech translation (accents, clarity etc.) cannot be resolved just via encryption. The Ministry of Defence launched AI-enabled speech-to-speech translation (DYSL AI Translator) in the defence symposium[54] which allows smooth and seamless communication among the military personnel. A communication intelligence (COMINT) system alongside has been launched that will identify and intercept audio data for security and surveillance purposes.[55]
- **Cybersecurity**: The emergence of internet-based technologies poses a significant threat online. As data has become crucial in the 21st century (being considered the 'next oil'), cyber threats are becoming more and more prevalent in the contemporary world.[56] Cyber-attacks pose a high risk to the nations' CIIs (Critical Information Infrastructure) as they can be launched by anyone from anywhere. The recent BSOD (Blue Screen of Death) incident[57] provided a glimpse of how an error in a single line of code could disrupt economies within seconds. Creating solutions that involve automated models driven by AI can help in analysing and assessing threats better.
- **Surveillance and Reconnaissance (SR)**: The Indian armed forces use SR systems which include radar systems, satellite systems, UAVs, Signal Intelligence (SIGINT), ground-based surveillance etc. Traditionally, the systems require human supervision but AI systems can help in surveillance that is free from that. The initiative by Indian defence forces includes:
    - Drone feed analysis system which is a DL based model for object identification;
    - AI-enabled STORM Drones that provide surveillance in GPS-denied areas;
    - AI-based motion detection and identification system[58]
- **Intelligence**: Intelligence is the combined outcome of surveillance and reconnaissance along with other data. It aims to provide information and assessments to aid mission completion by supporting decision-making, military planning, enemy deception, identifying adversaries and evaluating combat

effectiveness.[59] Project Drone Feed Analysis launched by the DDP, MoD is an object identification system that will help in improving ISR missions.[60]

Recommendations

To gain better ground in the AI race, necessary steps have to be taken. Possible ways are listed below:

- **Lessons from contemporary conflicts**: The ongoing Israel-Hamas war and the Russia-Ukraine war have brought out the use of AI technologies that can be beneficial for India. Some of these include:
    - **Russia-Ukraine War:** The war highlighted the significant use of AI in future warfare. In the case of Russia, AI-driven drone systems and satellite systems were used to gather real-time intelligence and identify targets with high precision. Moreover, sophisticated cyber-attacks, powered by AI were used to compromise Ukraine's CIIs. In the case of Ukraine, AI algorithms were used to process vast amounts of surveillance data to identify and prioritize targets, which in turn, eased military strikes.[61] Inducting the use of such patterns will assist in improving the surveillance of our borders.
    - **Israel-Hamas War**: Like Russia, Israel deployed the use of AI-powered drones for better surveillance and threat detection. In addition, the AI-enabled Iron Dome defence system helped Israel intercept foreign attacks in a better manner.[62]
- **Policy Framework**: The CDS (Chief Defence of Staff) must oversee the formulation of an AI strategy that will provide a strategic roadmap for AI development and use in the military.[63] It should encompass the goals and objectives, the scale of application and possible loopholes with AI. Collaborating with private industries and academia for R&D will help in easing the process.
- **Big Data Advanced Analytics (BDAA)**:[64] BDAA encompasses methods to understand and visualise vast amounts of data. It has four basic components namely, collection (sensors), communication, analysis and decision making. Sensors collect data, they communicate with the model to analyse and give out the best possible responses. BDAA can provide efficient ISR, better situational awareness, identify new capabilities and predictive assessments through advanced modelling and simulation. This will allow improved operational and strategic awareness for the Indian armed forces.

- **Public-Private Partnership (PPP)**: Civil-military fusion is the key to providing Atmanirbharta and modernisation to the Indian military. Atmanirbhar Bharat in defence production will help in attaining sustainability. This can be boosted to a great extent by involving SMEs, MSMEs, large industries and academia.[65] PPP can help in building innovative and articulated solutions for the Indian armed forces by sharing resources while building C4ISR solutions on AI-driven models.[66]
- **iCET-like Initiatives with other nations**: Innovation on critical and emerging technologies (iCET) elevated the strategic technological and defence partnership between India and the United States.[67] The initiative laid a key focus on ISR and joint venture defence production. Such agreements not only promote manufacturing but bring a lot of technology, the most critical one today being AI. India should look forward to bettering its position in emerging critical technologies by partnering up with other nations (apart from the US) that have an upper hand in these technologies. Technology Transfer agreements with Israel, the USA, the UK and France can help in building the required self-reliance.

Conclusion

Artificial Intelligence has been in discussion since 2022. In the context of the military, AI has the ability to serve numerous applications like automation, analysis and prediction. It has the potential to transform the way operations are done and revolutionise the military. In the Indian context, steps are being taken to leverage the technology to better C4ISR systems. With more research and development, the use of AI can be broadened. Such an effort can be enhanced through international collaboration and joint ventures that would help in modernising and developing self-reliance in the domain of emerging technologies for the Indian military.

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