

Artificial Intelligence in Warfare

Amidst the global race to develop weapons and defence systems, India has started to introduce Artificial Intelligence in its defence forces. AI is a broader term involving machine learning techniques that involves creating algorithms that learn from raw data and also deep learning models consisting of multiple layers of nonlinear processing units. Introducing AI in defence is not going to replace the existing system, it will rather, just enhance the already existing system. Machine guns will now be replaced by autonomous machine guns, or robotic aircrafts. Today, major research in AI is mainly into the civilian sector. Now is the time to use this knowledge that has been gained into Defence Forces. As India has picked up the pace in AI research recently, it will be easy to catch up with other countries in the race of making smarter weapons. This will help our defense forces in tactical level as well as strategic level for national security, whether its border area or an incoming threat. In this Article, we will learn about how AI and robotics provides advantages in warfare. With the introduction of AI, what are the new emerging warfare dynamics and lastly how DRDO is using these technologies. The time has come to shift the paradigm from automated machines to autonomous machines.

Advantages of Robotics and AI in Combat

Started in 1956, Artificial Intelligence is not a new term, as supposed by the people. Intelligent systems were always present and providing us better and accurate results to enhance the warfare dynamics. Now, the research and advancement in the field of AI is so huge that it is the need for the hour in national security otherwise the one who doesn't adopt it will be left behind and then it will be really difficult to catch up with others who realised its importance at the early stage. AI is basically what a human infant does. It learns from the data given and predicts outcome and even makes decisions for its own.

AI is now present for all the three spheres of the military. Artificial Intelligence(AI) can be really helpful in handling new-upcoming warfare technology like hypersonic missiles or Dassault nEUROn which are very difficult to operate by humans as they require very fast processing and decision making to automate loading and ballistics calculations required for accurate predicted fire. Also, introducing AI in the Air Force has resulted in high-speed Autonomous Fighter Aircrafts and Drones which were otherwise not possible due to a high amount of G-force, and designs that do not require a life support system. For Marine Defence, testing of onboard "AI Captain", developed by IBM and ProMare, has started that will navigate the Mayflower Autonomous Ship (MAS) this year across the Atlantic using power of edge computing. Lastly and most importantly, this approach will reduce the loss of life and risks of our war fighters as Military Robots can play a vital role in the battlefield as factors such as fatigue, stress, emotion, adrenaline, etc. that affect a human soldier's rash decisions are removed.

Emerging Warfare Dynamics

Though Cyborgs and Exoskeletons are not a practical solution yet, some of the weapons which we used to see in sci-fi movies are now a reality. Broadly speaking, AI is used in two specific areas of Military: Non-Weapon purposes such as Simulations, Monitoring, Training of Soldiers, and tedious tasks like to sift hours of full-motion video looking for suspected terrorists and insurgents and Weapon purposes such as Drone Attacks, Autonomous tanks, Anti-Ballistic Missiles etc.

- **Drones:** Today, drones are part of conventional fighting in war zones. Groups of tiny quadcopters can simulate a model of Swarm Intelligence which is based on biology-inspired algorithms and reinforcement learning, enabling these groups of unmanned vehicles to work together in an adaptable fashion in order to achieve mission objectives. Other than that, the bigger drones support us in counterinsurgency and counterterrorism operations by collecting a sheer volume of full-motion video data which can be analysed using computer vision algorithms. Surveillance-Project MAven and DRDO Rustom are some notable examples of Unmanned Air Vehicles.
- **Autonomous Tanks, Warships, Machine Guns, Unmanned Vehicles :** Injecting AI to lethal weapons can help us in remote surveillance, perimeter patrol, communications relay, mine detection and clearing, bomb disposal, hitting the bull's-eye of a target every time and as a light weapons platform. Unmanned Surface Vehicles like Seahunter use Fuzzy ARTMAP neural network architecture to model normal vessel speed based on port location. Another approach uses associative learning of motion patterns to predict vessel movement based on its current location and direction of travel. Others use unsupervised clustering based on Gaussian mixture models (GMM) and kernel density estimation (KDE). More recent approaches use Bayesian networks to detect false ship type, as well as discontinuous, impossible, and loitering vessel movement. These high performance of DNNs for image classification has created an interest in how such approaches may be useful for automatic mine detection. Unmanned Ground Vehicles like DRDO's Daksh, Autonomous Machine Guns like Super Aegis-II and fully automated Mortars like Dragon Fire II are of great help in shooting down drones, aiming tank guns, coordinating resupply and maintenance, planning artillery barrages, stitching different sensor feeds together into a coherent picture, analyzing how terrains, suggesting fields of fire and warning commanders where there are blind spots in their defenses are all military applications for which the Army will test AI. Today, Unmanned Surface Vehicles works on a path following algorithm that is usually used to describe the target, compute in the controller and minimize as well as to zero the distance between USV; and the angle between the vessel speed and the tangent to the path. USV needs to follow a time-parameterized reference curve defined as trajectory tracking. AI can be of great advantage in defence of USVs. Dutch Goalkeeper is a noticeable Close-In weapon system that is an autonomous and completely automatic weapon system for short-range defence of ships against highly maneuverable missiles, aircraft and fast-maneuvering surface vessels. In Unmanned Ground Vehicles a reinforcement-learning controller combined with a conventional PID

controller so that the robustness of PID control and the optimization ability of learning control can both be utilized. The method uses an adaptive-critic learning controller with two outputs to tune the PD parameters in real time. The architecture of the learning controller includes a critical neural network and two action neural networks and the adaptive-heuristic-critic (AHC) learning algorithm is used to adjust the weights.

- **Radars, Intelligent Missiles and Ballistic Anti-Missiles:** Air surveillance is usually based on real-time radar tracking systems. Using machine learning techniques like object classification and identification on data from secondary radars and ADS-B, these systems are able to provide object positions, kinematics, a short time history of ballistic missiles, recognize flight characteristics and moving patterns used as evidence for a military aircraft, which unfortunately are not often recognizable easily in real-time by an operator. The classifiers can be used within real-time systems. Satellite imagery, terrain information, and data from multiple sensors can be used to create situational awareness by applying deep learning, statistical analysis, and probabilistic algorithms to such data.
- **Cyber Security:** With introducing new technology to warfare dynamics, confidential information is being generated every second. Terrorists might attempt to steal this sensitive information through Cyber Attacks. Thus, we need a system such as Intrusion Detection System (IDS) that classifies the network traffic as normal or intrusive. In India, DIT&CS operates and maintains DRDO Organizational Network and Centralized Internet Access Gateway for all labs and establishments of DRDO. However, since normal network traffic often has a similar signature as actual attacks, cyber security analysts analyze the situation for all intrusion alerts to determine whether there is an actual attack. Senseon is a great example to mention for a cyber security platform that uses advanced machine learning and AI Triangulation algorithms to weave into the fabric of your organisation for highly accurate threat detection and response. The first thing in warfare we need is information about the enemy, so it can really help a lot for handling BigData as it can provide us fast and accurate results for example in surveillance. But some challenges like information overload or sensitivity of the information are yet to be solved.

DRDO and other competitors

“Excellence is a continuous process and not an accident,” believed the former President of India, and that is exactly what he did in DRDO and ISRO in order to make India a superpower in space science and technology.

Since ages, DRDO has been pioneering India's defence missions and is competing shoulder to shoulder with its competitors. It has recently established laboratories across the country which will augment innovation in artificial intelligence (AI), quantum technologies, cognitive technologies, asymmetric technologies and smart materials to pep-up the country's high-tech warfare. Out of them, Indian AI research in defense is housed within the Center for Artificial Intelligence and Robotics (CAIR). DRDO-CAIR is involved in research and development in the areas of artificial intelligence, robotics,

command and control, networking, information and communication security leading to the development of mission-critical products for battlefield communication and management systems.

- DRDO has major breakthroughs in the area of Anti-Satellite weapons, Anti Ballistic Missiles(ABM) and even intelligent missiles which are pretty good at target recognition. To make India's ABM system smarter, models like Long Short-Term Memory Recurrent Neural Network (LSTM RNN) for High Resolution Range Profile (HRRP) are used to analyse and predict the path of enemy satellites or incoming ballistic missiles based on Radar data.
- Advanced Unmanned Aerial Vehicles are being made by DRDO such as AURA (or Ghatak-UCAV) which employ deep neural networks combined with Q-learning to achieve the accurate results at the air combat platform. Their AI guidance algorithm performance is compared against standard guidance algorithms like Proportional Navigation Guidance (PNG) algorithm. The increasing complexity of the air combat environment leads to a curse of dimensionality when using reinforcement learning to solve the air combat problem.
- DRDO is excellent in communication and cyber security and Robotics. Intelligent Systems technologies development at CAIR primarily helps it in keeping abreast of technological advances in the fields of Artificial Intelligence (AI) & Neural Networks (NN), Computer Vision (CV), Signal Processing, Robotics, and Virtual Reality. CAIR is currently developing a number of Data Mining tools using Artificial Intelligence & Neural Networks and is building software libraries to create a Data miner's toolbox.
- In the area of computer vision, CAIR has developed some prototype products for specific problem solving. Work is ongoing in the area of image registration using 2D, 1D and point features, progressive transmission and compression of images, content based image retrieval and multi-sensor image fusion. Research focus of CAIR in this area has been in automatic target recognition using methods like Fast Fourier transform and Boosted Butterworth high pass filter to read data from multi-sensor images and long Infrared videos, and then generate super-resolution images from low resolution images for alertness and prediction. Another important application that is being looked into is the build a mosaic of images taken from various angles. This is for the generation of panoramic and large scale image piecing together many small images seamlessly.
- Other robots developed by CAIR are for Non-destructive testing, Ammunition loading, and Hot slug manipulation. Both wheeled and legged miniature mobile robots have been developed. Intelligent Systems technologies development at CAIR primarily helps it in keeping abreast of technological advances in the fields of Artificial Intelligence (AI) & Neural Networks (NN), Computer Vision (CV), Signal Processing, Robotics, and Virtual Reality.
- Amongst Military Robots DRDO's DAKSH, as discussed earlier, is a very famous fully automated robot on wheels that was created with a primary function of bomb recovery. MarkV-A1 or Mark5-A1, WheelBarrow are similar examples of its competitors. Uses for this

robot include clearing obstacles, removing explosives, hauling cargo and disabled vehicles, and serving as a platform for various other tasks, such as clearing buildings and disarming landmines and lasermines. CAIR has developed a variety of controllers and manipulators for Gantry, SCARA and other types of robots. These were supplied to Public Sector Units such as HAL and sister DRDO labs. CAIR has gone on to develop a prototype Unmanned Ground Vehicle (UGV) with the aim of attaining autonomous capability. This involved in-house construction of mobile robot platforms, integration of infrared sensors with the vehicle, and the development and integration of path planning software. But, DARPA's collaboration with Boston Dynamics resulted in robots like ATLAS, the best and promising prototype of a military robot the world has ever seen.

Public-Private Partnership

India must view machine intelligence as a critical element of its national security strategy. Partnership with the private sector is very serious as the military will be providing confidential data to them. India should start amalgamating private and public organisations together to make a dedicated system. DRDO is very successful in its Integrated Guided Missile Model that has delivered many strategical missiles to all the armed forces. A model much similar to integrated guided missile program should be implemented in India's AI program for the armed forces also so that AI can be implemented in all areas of military to get a dedicated system in delivering AI related systems to all the levels of military. A multi-stakeholder model is must because the requirement is immense be it NN research, robotics engineering, BigData handling. At a time when AI is being viewed as a key component of foreign policy between the United States and Japan, with similar proposals of treatment being floated in India, the Indian government must formulate a national strategy on emerging technology trends with long-term strategic consequences. India must seriously evaluate the DARPA model of defense research in conjunction with private sector and university collaboration in order to create dual-purpose technologies with a scope large enough to allow for development of civilian technology applications. Specifically, the Cyber Grand Challenge model of DARPA needs to be examined for its successful incentivization of academia and the private sector. With this collaboration, research in Generative Adversarial Networks, the real game changers, can boost up.

Ethics

The world had made serious moral, ethical errors in chemical, biological and nuclear weapons. We have to ensure we don't make those errors again. War and technology have always been intertwined. Tomorrow's war will be very different from the past. It will be chaotic and unpredictable. Since computer codes are vulnerable to hacking, attributability will be a very important factor in the coming times. Questions like “Can we allow a robot to kill a human being?”, “Who will you blame for any mishappening? ”, are still open to debate. An open letter calling for the ban of lethal automated weapons systems has been signed by tens of thousands of citizens, including scholars such as physicist Stephen Hawking, Tesla magnate Elon Musk, and Apple's Steve Wozniak as they are worried about the fatalities an uncontrolled AI could bring us. No one wants to see a future in which warfare is unpredictable and unaccountable as AI is a bunch of computer codes prone to errors. So, until the AI is not mature enough, the correct start is to involve it into intelligence gathering and logistics rather than their direct involvement into lethal weapons. Thus, we have to take steps very responsibly and quickly at the same time because we don't want a AI system just to mimic human behavior; we want it to form a deeper understanding of what motivates human actions.