ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR THE INDIAN NAVY

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Introduction

Artificial Intelligence (AI) — and its attendant term, 'Machine Learning' (ML) — is described as the capability of a computer system to perform tasks that normally require human intelligence, such as visual perception, speech recognition and decision-making. Almost all AI/ML examples in commercial as well as military use today rely on data stores that drive deep learning and natural language processing.[1]

The defining feature of an AI/ML system is its ability to learn and solve problems. There has been a gradual change in our understanding of what exactly constitutes AI. While advancements in computer hardware and more efficient software have led to the development of AI systems, hitherto computer-resource-intensive tasks, such as optical character recognition (OCR) are now considered a routine technology and, hence, no longer included in any contemporary discussion of AI/ML.

Modern AI/ML techniques are gaining rapid acceptance in almost all fields in which intellectual tasks are involved. Amongst these are autonomous vehicles, medical diagnoses, solving complex mathematical theorems, playing strategy-based games (Chess or Go, for example), web search-engines, etc. Adapting AI/ML in the defence forces has been pursued by almost all advanced nations. Most of this is in the realm of surveillance and autonomous vehicles.

Commander Amrut Godbole, in his absorbing paper titled, "AI & Machine Learning for the Indian Navy",[2] has put forth four usable cases for the adoption of AI and ML for the Indian Navy:

(a) Inventory Management.
(b) Training.
(c) Prescriptive Maintenance.
(d) Security and Surveillance.

Adoption of AI and ML in the Indian Navy

Contrary to popular movie lore, AI can never replace humans; rather, it augments our abilities and makes us better at what we do. AI algorithms learn differently than humans; therefore, they look at things differently. They can see relationships and patterns that often escape us. There are, of course, limitations to what can be accomplished by AI. The principle limitation being 'data'. AI learns from the data presented to the algorithm and the mathematical model it is built on. It therefore follows that any inaccuracies in the data will be reflected in the results. The other limitation to AI is its single purpose – an algorithm designed to play chess can never detect financial fraud. These systems are very specialised and focused on what they can achieve, and this is far from how humans behave.

Of the four use cases proposed by Cdr Godbole, this author opines that two have been incorrectly identified. 'Inventory management' and 'training' utilise systems and technologies that would not readily benefit from the adoption of AI or ML technologies.

Inventory Management.

(a) In our desire to attribute AI/ML to anything and everything, we end-up creating systems that were efficient to begin with and gain precious little by having AI/ML models strapped on to them. Inventory-management is one such system. The problems associated with the present inventory-management system as outlined in the paper by Commander Godbole have little to do with the technology behind the system *per se*. Organisations and industries (automobile-manufacturing, with its large supply chains and multiple processes, immediately comes to mind) have been using these traditional systems with great efficiency. The drawbacks of the present system used by the Indian Navy stem more from the processes rather than the technology driving it. An AI/ML-based system, with the existing infirmities of data processing and labelling, would certainly not address the lacunae as brought out by the CAG report quoted in the paper by Commander Godbole.

(b) An inventory-management system has a flat, structured database at its heart, with queries either built-in or generated 'on the fly' to solve the problem of providing the product (spares, in this instance) when needed and where needed. The strength of an AI/ML system is its ability to parse large, unstructured data and detect patterns. The mathematical model or the algorithm is then trained to detect variations in this data by feeding it labelled parameters. An inventory-management system, on the other hand deals with a very specifically structured database. A measure of its effectiveness is the 'just-in-time availability' of the stores. An accurate prediction model can be developed around the existing system by carefully considering the variables associated with it. These would include consumption patterns, supply chains, types of stores needed and the available capacity, etc.

(c) What is needed to correct the weaknesses in the present system is a process of feedback of consumption patterns, correct labelling, regular weeding out of redundant stores and stock verification. An AI/ML-based system cannot address these issues, as they are largely human-process-based ones. Cdr Godbole's prescription for the adoption of AI models for the inventory management may not address what are essentially systemic-problems in the process itself.

Training.

(a) Commander Godbole correctly summarises the basic dilemma that the Personnel Branch of the Indian Navy — or for that matter, any other defence force — faces. That is, what should be the primary focus — manning ships with good officers and men so that the Fleet is at its peak efficiency, or to send the best available human-resources to training establishments so that future generations of personnel become better? His panacea for this and the other problems associated with crew efficiency is to incorporate AI and ML in training as well.

(b) The solutions proposed include the use of Virtual/Augmented/Mixed Reality. These technologies provide a near-realistic environment in the absence of actual systems on which to train. While being resource intensive in terms of computing power, these are not AI/ML-driven technologies. The investment that the Navy would do for the development of AI/ML-based training can be better spent on IT-based training systems. The other lacunae of the present training system, too, are more of an administrative nature rather than a technological one.

The other two 'use-cases', namely, maintenance, and, security and surveillance, are much more amenable to adoption by AI/ML technologies. Both rely on large amounts of unstructured data with multiple parameters. The Indian Navy has been maintaining its platforms for quite sometime now as well as conducting diverse operations. Therefore, the data required for building a robust mathematical model for these use cases exists with the Navy.

Prescriptive Maintenance.

(a) Commander Godbole correctly brings out the need for data for the development of a robust AI/ML model. However, if a fault is to be found, it lies in the architecture proposed. It is proposed that the analytics would be performed on systems that would be a combination of platform-based as well as a shore-based cloud infrastructure.

(b) The AI/ML model is trained on the parameters extracted from the data. This is a computer-resource-intensive activity and would necessarily have to be an offshore infrastructure. Once the model is developed, it is ported to the decision system that would take in the current parameters and based on the model and give its decision. An analogy can be derived from the modern AI/ML-based antimalware-based systems. The ML model, once trained with enough data, is transferred to the computer system as an update. The file size of this update is generally around 1 Gb and is well within the capability of most PCs available today.

(c) It is felt that this architecture will suffice the needs of both, ship-based operators as well as shore-based maintenance planners.

Security and Surveillance.

(a) At the present point in time, perimeter-security of naval units is an overwhelmingly manual process. The paper discusses various technologies that can be incorporated to develop a technical alternative to the present system. These include trip wires, facial and feature recognition cameras and underwater autonomous systems for surveillance and security.

(b) While such systems are certainly technically advanced as compared to the present manual system, the development of AI/ML technologies along with these systems could vastly improve the outcomes desired. Facial-recognition systems and the associated AI/ML model would map an individual's normal entry and exit points. Any deviation or abnormal behaviour would be detected by the AI/ML technology and appropriate alarms raised. This is just one illustration of the benefit that would accrue towards a more robust security system by the adoption of AI/ML technologies.

Additional AI/ML 'Use-Cases' for the Navy

Apart from the use-cases proposed by Commander Godbole, it is felt that the maximum advantage of adopting AI/ML would be derived in the area of Maritime Domain Awareness (MDA) and autonomous vehicles (on surveillance as well as offensive missions). While the Indian Navy operates many automated systems, these are markedly different from autonomous systems. An automated system processes an input to produce a desired output and if the input is same, the results would always be the same. Autonomous systems on the other hand deal with a set of inputs to make a guess on the best possible course of action depending on the inputs. Given the same input, autonomous systems may not necessarily produce the exact same outcome every time; rather, such systems will produce a range of behaviour-patterns.

MDA is a near-ideal candidate for the adoption of AI/ML models. The inputs are diverse and numerous, the environment affects the presence or absence of other units, and there are a variety of sensors that provide information. The inputs could come from shore, ship or space-based sensors, various ship tracking and monitoring systems (AIS, VMS, LRIT to name three), and open-source information.[3] AI/ML algorithms could then fuse this data to present a single coherent picture of the area of interest. The benefits that could accrue from this adoption could be in the form of enhanced visibility of activities of units at sea, determining patterns of deployment, the determination of risks arising from anomalous behaviour of ships, particularly small craft, and so forth.

The Indian Navy is quite correct in pursuing this path in the development of the TRIGUN software suite, to enhance Maritime Domain Awareness with Artificial Intelligence.[4] It is understood that the development of this system would progress in incremental stages, with full operationalisation being planned for 2024.

Unmanned vehicles are another strong contender for the adoption of AI/ML technology. These could by way of Unmanned Underwater Vehicles (UUV) or Unmanned Surface Vehicles (USV).[5] These systems generally have a man-in-the-loop to take decisions for navigation or targeting.

In case of autonomous vessels, its ability to execute tasks without human intervention is enhanced using AI/ML algorithms to accept inputs from the environment and from its own sensors, and take decisions involving either its locomotion or weapon use or both.[6] Such AI/ML systems further shorten the time taken for the commander to decide on a course of action that would be unimaginable were this process were to be undertaken manually.

Lethal Autonomous Weapon Systems (LAWS) constitute yet another class of autonomous vehicles that utilise an onboard sensor suite coupled with AI/ML algorithms to detect targets and employ their onboard weapon systems to engage a target without human intervention.[7] The US Navy and DARPA's *Sea Hunter*, which was launched in April of 2016, is an example of this type of vessel. Designed as an Anti-Submarine Warfare Continuous Trail Unmanned Vehicle (ACTUV), the *Sea Hunter* can travel the oceans for months at a time with no onboard crew, searching for enemy submarines and reporting their location and findings to remotely-located human operators.[8] Other nations developing similar systems include Russia, Israel, China and the UK.[9]

Conclusion

Advances in computing hardware and efficient programming-languages have enabled the development of a range of technologies that have contributed immensely to our professional activities as well as leisure ones. Systems leveraging AI/ML have grown in scope to offer a richer experience to almost all our Internet engagements. Traditionally, the defence industry has been in the forefront of innovation and the private sector has utilised these technologies for commercial use. In the IT domain, however, the defence sector, particularly the Indian defence sector is playing catch-up with private entities. Machine Learning and Artificial Intelligence plays an increasing part in our lives today. We need to harness these technologies to defence systems as well, albeit with due care that we do not end-up overplaying or exaggerating their application.

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