REDEFINING NAVAL OPERATIONS: THE TRANSFORMATIVE POTENTIAL AND UNFORESEEN CHALLENGES OF AI

Today, Artificial Intelligence has widely become part and parcel of our day-to-day life. From personalized social media feeds to face recognition today, smart gadgets use AI to track users' online footprints to enhance their operations and functioning. In addition, our life's critical private aspects are being intruded by AI based tools and gadgets introduced by worldwide competitive corporations. At the same time, the employment of AI has recently been debated and investigated vigorously. Consequently, the application AI has also been incorporated in the Defense Industry, particularly in navies. However, developing military AI systems that are transparent and resistant to manipulations would be difficult to manage.

While the impacts of these technological advancements are felt across various fields, the Naval domain is no exception, rather more profound developments have taken place in navies. The growing recognition of AI's potential to transform naval operations has led to an increase in research, experimentation, and implementation. AI's ability to improve decision-making processes, enhance situational awareness, activate autonomous systems, and improve cyber security has made it a crucial component of naval strategic and operational planning. From advanced decision support tools to autonomous systems, surveillance, underwater mine warfare, and cyber security solutions, AI is rapidly transforming how navies operate and defend their maritime interests.

Maritime surveillance is not just a critical aspect of naval operations, but it is also a matter of global security. As oceans are the lifeline of world's economy, ensuring the safety and security of these sea routes is paramount to global stability.

To achieve this goal, navies around the world have been leveraging advanced technologies such as satellites, advanced radars, electronic tracking systems and unmanned vehicles to monitor and detect any potential threats. However, the sheer volume of data generated by these systems can be overwhelming for even the most skilled operators. This is where AI comes in.

By incorporating AI into maritime surveillance systems, navies can now automatically process and analyze vast amounts of data in real-time, enabling them to quickly identify potential threats and respond accordingly. For example, Autonomous Surface Vehicles (ASVs) equipped with AI can detect anomalies and suspicious activities, such as vessels operating in prohibited areas or exhibiting abnormal behavior. Automated target recognition systems (ATR) and Geospatial Intelligence (GEOINT) systems can also automatically analyze and interpret maritime data, providing navies with actionable intelligence to protect their personnel, assets, and maritime borders.

AI is also showing great potential in underwater mine countermeasures. Mines pose a persistent threat to Naval assets, obstructing their operations and causing catastrophic damage. To mitigate the risk of mines and ensure the safety of naval operations, Mine Countermeasures (MCM) teams utilize an array of sophisticated techniques to detect and neutralize mines. One such technique involves using Autonomous Underwater Vehicles (AUVs) equipped with Synthetic Aperture Sonar (SAS), which generates high-resolution acoustic images of the seafloor, aiding in the detection and neutralization of mines. To enhance the effectiveness of mine detection, MCM teams are turning to AI to help classify potential mine targets, as processing the large amounts of data collected by AUVs can be challenging. While the automatic classification of mine targets has been a focus for some time, recent advancements in Deep Neural Networks (DNNs) have shown promise in significantly improving the accuracy of automatic mine detection. By utilizing AI-powered systems, MCM teams can more efficiently identify and neutralize mines, ensuring safer and more effective naval operations.

In addition to its applications in Surveillance and Navigation, AI has enhanced logistics in the Naval domain by automating processes and optimizing resources. AI algorithms are assisting Navies in forecasting supply chain requirements, demand forecasting, and predictive maintenance to monitor the health of critical ship components, such as engines and turbines, and predict when they need maintenance. The US Navy has used the IBM Watson AI system to analyze sensor data and predict equipment failures before they occur. Leading to reduced costs, increased efficiency, and improved readiness for naval operations.

The expanding use of AI in naval operations necessitates the identification and resolution of its associated challenges. Foremost among these challenges are transparency, vulnerabilities, and learning with limited training data. These issues require heightened scrutiny and targeted mitigation strategies to ensure the effective and ethical application of AI in naval domain.

Ensuring transparency is one of the crucial challenges which is critical for building user trust and understanding. The required level of transparency depends on the users' needs. It can include trust in situations where it is difficult for users to question system recommendations, insight into previously unknown causal relationships, and knowledge of system performance limits. Therefore, creating effective and user-friendly transparency mechanisms is an ongoing challenge that needs further research.

Another challenge associated with the Application of AI in naval operations is system vulnerabilities that can be exploited by adversaries. After all AI is based on machine learning and cannot surpass human mind which is active, continuously thinking, dynamic and does not rely on limited datasets.

The inherent characteristics of AI systems and their underlying data render them particularly susceptible to a range of security threats, including data poisoning, model inversion attacks, adversarial attacks, and data exfiltration. Furthermore, the integration of AI systems with other mission-critical naval systems, such as navigation, communication, and weapon systems, introduces new attack surfaces that adversaries may exploit. As such, robust security measures are necessary to safeguard essential naval assets and maintain operational integrity.

The lack of high-quality and sufficiently large datasets is another significant challenge in developing applications based on Machine Learning for military and naval purposes. Military organizations, training facilities, sensor networks, weapons, and platforms were not designed for Machine Learning purposes, making data collection procedures in this domain particularly challenging. Finding real-world data which is large enough to learn from, can be difficult, especially since datasets may be scarce or restricted due to National Security concerns.

As navies around the world seek to maintain their edge in an ever-changing geopolitical landscape, the rise of AI offers an unparalleled opportunity to transform naval operations. From enhancing situational awareness to improving decision-making processes and enabling autonomous systems, AI is rapidly changing the way we defend our maritime interests. However, with the potential benefits come significant challenges, including ethical considerations, cyber security risks, and the need for transparent and reliable systems. The AI advantage in naval operations is clear, but as with any new technology, it must be approached with caution and foresight Because No matter how intelligent the Artificial Intelligence systems may be. They cannot defeat and subdue the human capabilities and faculties.