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Harnessing Artificial Intelligence: A Decisive Advantage

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Harnessing Artificial Intelligence: A Decisive Advantage

AIM

1. Marine Corps Lt. Gen. Michael S. Groen stated, "…we have a generational opportunity here. For AI to be our future, we must act now."[1] This service paper will inform the Chief of Force Development (CFD) on how the Canadian Armed Forces (CAF) can utilise new and evolving technologies to maintain an advantage over its adversaries. In order to approach the topic in sufficient detail, analysis will be limited to how the application of Artificial Intelligence (AI) and Machine Learning (ML) can enable the CAF to reduce the technological gap between itself, our allies and our adversaries.

INTRODUCTION

2. Artificial Intelligence is a cornerstone of the fourth industrial revolution.[2] AI is no longer limited to the realm of science fiction, and most people living in industrialised nations interact with various forms of AI daily. Predictive text on your cellular phone, Netflix recommendations, Google Search and Amazon Alexa are only a few examples of how AI improves everyday lives. Military acceptance of AI has not occurred as quickly as private corporations, but interest and investment is increasing rapidly. Our allies and adversaries have placed an emphasis on the development and adoption of AI to accelerate the processing of exponentially growing volumes of data, decreasing the requirement for human labour, and reducing the risk to human life on operations. A review of how foreign nations have used, or are planning to use, AI within their militaries will identify common areas of interest and projects that have already achieved some success. The insights from international allies and adversaries will be considered in a Canadian context to determine how they could be best applied within the Department of National Defence (DND).

DISCUSSION

3. "Advances in AI have the potential to change the character of warfare for generations to come. Whichever nation harnesses AI first will have a decisive advantage on the battlefield for many, many years. We have to get there first."[3] Just as cyber was seen as only a theoretical military capability 30 years ago, rapid development in the emerging domain saw its widespread use in the Russian invasion of Crimea in 2014.

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[1] "Honorable Robert O. Work, Vice Chair, National Security Commission on Artificial Intelligence, and Marine Corps Lieutenant General Michael S. Groen, Director, Joint Artificial Intelligence Center Hold a Press Briefing on Artificial Intelligence." *States News Service,* Apr 9, 2021a.

[2] Aboul Ella Hassanien et al., *Fourth Industrial Revolution: Implementation of Artificial Intelligence for Growing Business Success*, Vol. 935Springer International Publishing, 2021, 72.

[3] Mark T. Esper, *Remarks by Secretary Esper at National Security Commission on Artificial Intelligence Public Conference* (Washington: Federal Information & News Dispatch, LLC,[2019]).

Secretary of Defense, Mark Esper, acknowledged the importance of AI and identified that it is likely to go through the same maturation process and achieve the same level of importance to the modern battlefield.

4. **The United States**. For Fiscal Year (FY) 2022, the Department of Defense (DoD) has requested an allocation of (USD) $874 million in the DoD budget specifically to enable AI in defence operations.[4] Joint Artificial Intelligence Center (JAIC) is the lead organisation for AI within DoD.[5] Created in June 2018, its purpose is to "seize upon the transformative potential of Artificial Intelligence technology for the benefit of America's national security."[6] The JAIC supports over 600 projects, including Project Convergence.[7] This project is of particular interest to Canada, as it is expected to become a central component of the Combined Joint Task Forces (CJTF).[8] Although managed by JAIC, Project Convergence relies primarily on support from contractors and private corporations. US DoD, and JAIC in particular, understand the difficulty in obtaining and retaining top talent in an emerging field. Instead, they focus on how DoD can partner with corporations to leverage their expertise.[9]

5. Despite the investment in AI and acknowledgement of its importance, the former Chief Software Officer for the Pentagon resigned due to the slow pace of change within the US military stating, "We have no competing fighting chance against China in 15 to 20 years. Right now, it's already a done deal; it is already over in my opinion."[10,11] DoD has also experienced difficulties partnering with corporations. Google terminated their partnership with DoD in Project MAVEN, following resistance from their employees.[12] The US has embraced AI as a key capability to enable future operational success and ensure information dominance, but has also recognized China's progress in closing the technological gap between the two nations.

6. **The United Kingdom**. In November of 2020, Prime Minister Boris Johnson announced the creation of a new centre dedicated to military uses of Artificial

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[4] Office of the Under Secretary of Defense Chief Financial Officer, "Defense Budget Overview - United States Department of Defense Fiscal Year 2022 Budget Request," (May 19, 2021), 3-2.

[5] Department of Defense, *Summary of the 2018 Department of Defense Artificial Intelligence Strategy*, 2018, 9.

[6] "About the JAIC," accessed Jan 20, 2022, https://www.ai.mil/about.html.

[7] Office of the Under Secretary of Defense Chief Financial Officer, "Defense Budget Overview - United States Department of Defense Fiscal Year 2022 Budget Request," 3-2.

[8] Congressional Research Service, *The US Army's Project Convergence*, 2021, 2.

[9] JAIC, *2020 Department of Defense Artificial Intelligence Education Strategy*, 2020, 1.

[10] Nicolas M. Chaillan, *It is time to say Goodbye!* Sep 2, 2021.

[11] "United States has Lost AI Battle to China, Pentagon's Ex-Software Chief Says." *National Post (Online),* Oct 11, 2021b.

[12] Daisuke Wakabayashi and Scott Shane, "Google Will Not Renew Pentagon Contract that Upset Employees," *New York Times (Online),* Jun 1, 2018.

Intelligence.[13] Less than a year later, the United Kingdom (UK) published their 10-year National AI Strategy.[14] Both the UK Army and Navy have recently employed AI tools on exercises as a proof of concept. During Ex SPRING STORM, as part of Op CABRIT in Estonia, the Royal Army employed AI software to analyse different courses of action and provide feedback on possible areas of concern.[15] Ex FORMIDABLE SHIELD saw the introductory trial of the Royal Navy's new Combat Management System (CMS). The CMS employed AI to analyse incoming threats and recommend the optimum self-defence mechanism.[16] The self-defence system determined the best defensive measure to the current threat based on responses to prior threats and their relative effectiveness.

7. **Australia**. Similar to the UK, Australia published their National AI Action Plan, which includes (AUD) $10 million for the investment of AI capabilities within the Department of Defence.[17] The Australian Navy has drafted a Robotics, Autonomous Systems and Artificial Intelligence (RAS-AI) strategy to plan for the development and incorporation of autonomous systems by 2040.[18] As part of the RAS-AI strategy, the Australian Navy has stood up the "Autonomous Warrior" program as a method to trial and demonstrate emerging robotics, autonomous systems and artificial intelligence.[19] The Australian Air Force has partnered with Boeing on the "Loyal Wingman" project. The loyal wingman is an uncrewed aerial vehicle (UAV) supporting a crewed aircraft, augmenting its capabilities, and acting as a force multiplier. The (AUD) $155 million contract will ensure the UAV is designed and built in Australia - An investment in the development of local expertise within a high-growth field.[20] The loyal wingman project has been progressing rapidly. Project approval was only received in 2018, and the first prototype completed its maiden flight in February 2021.[21]

8. **China**. The 14th five-year plan (2021-2025) outlines the main objectives for the People's Republic of China, with Artificial Intelligence appearing prominently within

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[13] (UK) Prime Minister's Office, "PM Statement to the House on the Integrated Review: 19 November 2020," Nov 19, 2020. https://www.gov.uk/government/speeches/pm-statement-to-the-house-on-the-integrated-review-19-november-2020.

[14] Her Majesty's Government, *National AI Strategy (UK)*, 2021.

[15] (UK) Ministry of Defence, "Artificial Intelligence used on Army Operation for the First Time," Jul 5, 2021b.

[16] (UK) Ministry of Defence, "A.I. Tech Trialled during Exercise Formidable Shield," Jun 03, 2021a. https://defencehq.medium.com/a-i-tech-trialled-during-exercise-formidable-shield-e39cb29ceafc.

[17] Australian Government, "Australia's AI Action Plan," (Jun, 2021), 18.

[18] Royal Australian Navy, "RAS-AI Strategy 2040," (2020), 3.

[19] (AUS) Department of Defence, "Autonomous Warrior Enhances Navy's Fighting Edge," Jun 09, 2021b. https://news.defence.gov.au/technology/autonomous-warrior-enhances-navys-fighting-edge.

[20] Honourable Marise Payne, "Loyal Wingman Aircraft Takes First Flight," Mar 02, 2021. https://www.minister.defence.gov.au/minister/melissa-price/media-releases/loyal-wingman-aircraft-takes-first-flight.

[21] (AUS) Department of Defence, "Australia's Loyal Wingman Surges Ahead," Nov 04, 2021a. https://news.defence.gov.au/media/media-releases/australias-loyal-wingman-surges-ahead.

their plans for growth and innovation.[22] In 2017, Xi Jinping stated that China must "…accelerate the development of military intelligentization, and improve joint operations capabilities and all-domain combat capabilities based on network information systems."[23] From this direction, each of the services of the People's Liberation Army (PLA) have created a plan to incorporate AI and autonomous systems within their service.[24] PLA Army (PLAA) is focusing their research on uncrewed ground vehicles in support of logistics.[25] PLA Navy (PLAN) is developing uncrewed, autonomous undersea vehicles (UUV).[26] PLA Air Force (PLAAF) currently operates uncrewed systems that have limited autonomy but are performing iterative development to include greater levels of autonomy.[27] Finally, the PLA Rocket Force (PLARF) is researching the use of AI to enhance the precision of their hypersonic weapons. At hypersonic speeds, minor variations in manufacturing can result in significant variations in flight. Following launch and prior to reaching hypersonic speeds, the system will leverage Machine Learning to adjust the factory default settings to better align with the variations in each missile. This error correction would allow for more accurate control of the missile once it has reached hypersonic speeds.[28]

9. Chinese researchers at the National University of Defense Technology have created image recognition software that automatically categorizes still images to detect military equipment.[29] An initial scan will detect all aircraft within satellite imagery, and a subsequent pass will identify the aircraft within each picture. When aggregated, the automated process allows the creation of a timeline illustrating the types and quantities of aircraft located on each airfield. This information can be extrapolated to detect strategic movements of aircraft between airfields or to identify high maintenance periods when the fewest aircraft would be available for operational deployment.

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[22] Asian Development Bank, *The 14th Five-Year Plan of the People's Republic of China -Fostering High-Quality Development Observations and Suggestions 观察与建议* (Manila, Philippines: Asian Development Bank, 2021), 3.

[23] Elsa B. Kania, "Chinese Military Innovation in the AI Revolution," *The RUSI Journal* 164, no. 5-6 (Sep 19, 2019), 26-34, 29.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Ibid.

[28] Stephen Chen, "China Military Researchers Pinpoint AI for Hypersonic Weapons Accuracy," Oct 15, 2021. https://www.scmp.com/news/china/military/article/3152179/china-military-researchers-pinpoint-ai-hypersonic-weapons.

[29] Yunsheng Xiong et al., "Non-Locally Enhanced Feature Fusion Network for Aircraft Recognition in Remote Sensing Images," *Remote Sensing (Basel, Switzerland)* 12, no. 4 (Feb 19, 2020), 681-704.

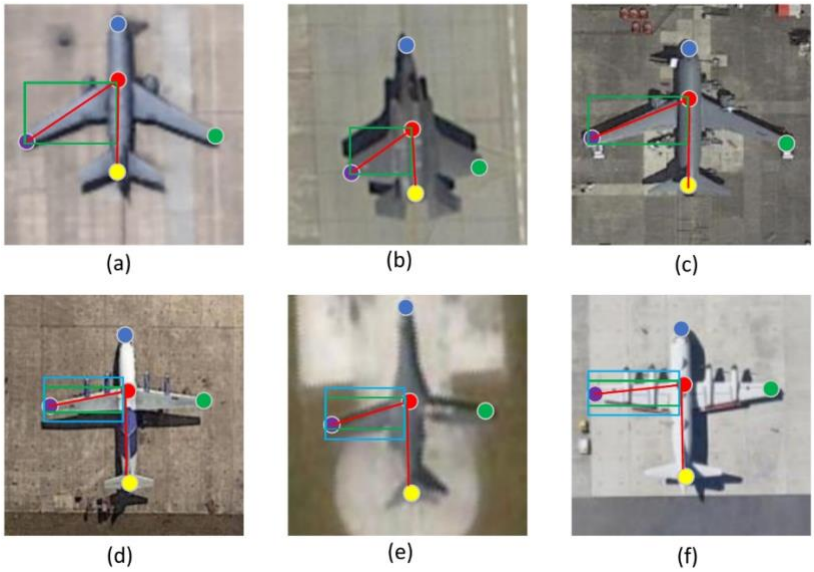

Figure 1 – Feature Extraction using Maps and Feature Fusion of Parts
Xiong, *Non-locally Enhanced Feature Fusion Network for Aircraft Recognition in Remote Sensing Images*, 10.

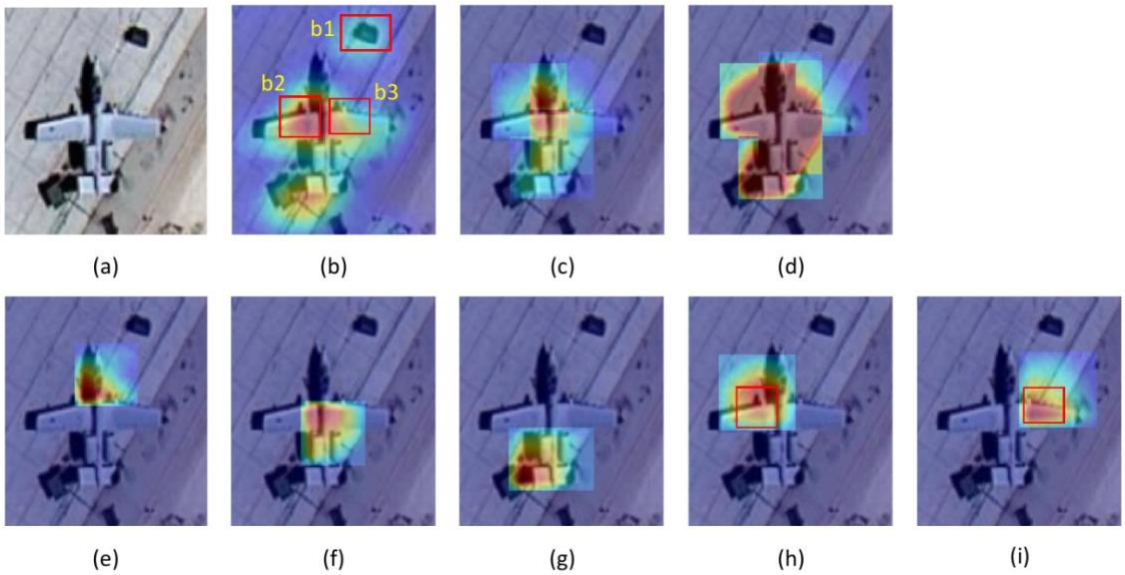

Figure 2 – Feature Extraction using Heatmaps on an A10
Xiong, *Non-locally Enhanced Feature Fusion Network for Aircraft Recognition in Remote Sensing Images*, 15.

10. Bytedance, through TikTok, has the best "recommending engine" in the world. Through repeated interactions with the application and comparisons to similar users, TikTok can learn the personality of each individual and determine which videos the user

is most likely to prefer.[30] The Chinese national strategy of Military-Civilian Fusion (MCF) enforces close collaboration between private corporations and the military.[31] Therefore, it is possible that the same best-in-class engine could be used to learn the "tactical personality" of every foreign Commander. Given a tactical situation, the engine could determine the likely course of action based on the Commanders' choices in previous tactical situations.

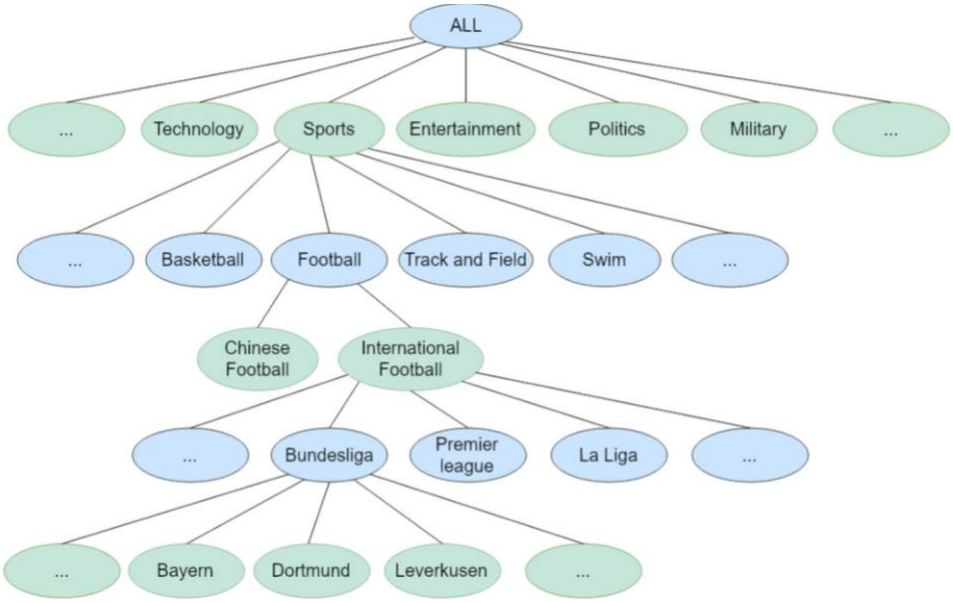

Figure 3 - TikTok Hierarchal Interest Label Tree
Zhao, *Analysis on the "Douyin (Tiktok) Mania" Phenomenon Based on Recommendation Algorithms*, 4.

11. The Government of Canada is a world leader in its support to the development of national AI capabilities. In 2017, the Government of Canada appointed CIFAR (not an acronym) to lead and develop the Canadian Artificial Intelligence Strategy, the world's first national AI strategy.[32] Through the FY 2021-2022 Departmental Plan, DND plans to invest in AI through the Innovation for Defence Excellence and Security (IDEaS) program.[33] Unlike our allies, the national AI strategy has not encouraged DND to create a department dedicated to AI or an overall guiding strategy. DND is taking advantage of domestic corporations through internally funded initiatives, the IDEaS program, and the Search and Rescue New Initiatives Fund (SARNIF).

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[30] Zhengwei Zhao, "Analysis on the "Douyin (Tiktok) Mania" Phenomenon Based on Recommendation Algorithms," *E3S Web of Conferences* 235 (2021), 4.

[31] U.S. Department of State, *Why is MCF so Important to the Chinese Communist Party? Military-Civil Fusion and the People's Republic of China*, 2020.

[32] CIFAR, *AICan 2020 CIFAR Pan-Canadian AI Strategy Impact Report*, 2020, 2.

[33] Thomas Juneau, "The Department of National Defence and the Canadian Armed Forces (DND/CAF)," in (Toronto: University of Toronto Press, 2021), 201-218, 210.

a. The Royal Canadian Navy (RCN) signed a (CAD) $500,000 contract with Kraken robotics for an ultra-high resolution seabed survey service. [34] The Canadian investment does not match the earlier (CAD) $36 million contract with the Danish Navy, or the (CAD) $900,000 contract with the German government for autonomous underwater vehicle (UUV) AI control software.[35,36]

b. IDEaS has funded several AI-enabled investments, including an AI-Enabled Multiband Vehicle Situational Awareness System.[37] This system, to be designed by Thales Canada, has not yet been trialled by the CAF. Development of this system trails similar allied projects, which have already been employed on various exercises.

c. Through the use of the SARNIF, the CAF has signed an agreement with Kongsberg Geospatial and Larus Technologies to develop Beyond Visual Line of Sight (BVLoS) UAV machine vision techniques.[38] The project aims to enable more effective use of small UAVs during SAR rescue missions in remote communities.

12. Coordination between these programs could reduce the duplication of effort and encourage service integration and interoperability. An empowered Office of Primary Responsibility (OPR) could promote and support the adoption of emerging technologies in ongoing procurements and projects.

13. **Investment Opportunities**. Using inspiration from our allies and adversaries and maximising the use of Canadian corporations with proven commercially available products, the CAF could rapidly adopt AI-enabled platforms across a variety of projects and organisations.

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[34] GlobeNews, "Kraken Awarded Robotics as a Service (RaaS) Contract from Government of Canada," *GlobeNewswire,* Oct 25, 2021. https://krakenrobotics.com/kraken-awarded-robotics-as-a-service-raas-contract-from-government-of-canada/.

[35] GlobeNews, "Kraken Signs $36 Million Danish Navy Contract," *GlobeNewswire,* Sep 8, 2020. https://krakenrobotics.com/kraken-signs-36-million-danish-navy-contract/.

[36] GlobeNews, "Kraken Awarded $900,000 Contracts for Evaluation of SeaVision Sensors and Artificial Intelligence Software," *GlobeNewswire*Jun 4, 2018. https://krakenrobotics.com/kraken-awarded-900000-contracts-for-evaluation-of-seavision-sensors-and-artificial-intelligence-software/.

[37] "Innovation for Defence Excellence and Security (IDEaS) - Detection and Classification of Objects of Interest," last modified Jul 21, accessed Jan 20, 2022, https://www.canada.ca/en/department-national-defence/programs/defence-ideas/element/competitive-projects/challenges/detection-and-classification-of-objects-of-interest.html.

[38] Kongsberg Geospatial, "Kongsberg Geospatial to use AI and Drones to Enhance Search and Rescue Operations in Canada," *PR Newswire,* May 21, 2020. https://www.kongsberggeospatial.com/company/news/69-kongsberg-geospatial-to-use-drones-and-ai-to-enhance-search-and-rescue-operations-in-canada.

14. **Operations**. Lethal Autonomous Weapons Systems (LAWS) are a widely contested and debated application of AI on operations, but Autonomous Weapons Systems are not the only operational use for AI.[39] Tesla's development of a self-driving car relies on their ability to capture and process real-life situations from every Tesla vehicle sold globally.[40] Capture and transmission of all video feeds from every vehicle would be too costly and bandwidth-intensive to be practical. The AI system onboard a Tesla analyses all video in real-time and compares it against the self-driving computers' predicted action. If the driver's reaction does not match the predicted action, the video is flagged as an exception and returned to Tesla for review. In a future military, where all soldiers and platforms record battlefield events as they unfold, it would not be practical to transmit all video feeds back to an HQ. Untether AI, a Canadian company, develops Application-Specific Integrated Circuits (ASIC), which integrate Neural Network (NN) engines with video processing accelerators, allowing sophisticated analysis of high-resolution video in near real-time.[41] Every camera system could have AI coprocessors embedded, allowing exceptions or critical events to be flagged and transmitted to the HQ for review. The vast amount of data captured by all sensors would be efficiently processed at its source, reducing the information sent to the HQ, and limiting information overload.

15. **Intelligence**. AI tools that process mass quantities of imagery and video, detect, and categorize their content are readily available. Application of these tools to the intelligence process would accelerate the processing of input data and focus the application of human expertise to higher-level analysis. Folio3, a Toronto-based company, provides an image processing engine used by major corporations such as Honda, Mercedes-Benz, and Colgate. The software can locate text within an image or video, detect the language, perform automated translation, and enter the text within a database.[42] In a military context, automated extraction and translation of all text and keyword-tagged images would significantly increase the volume and context of information available to Int Analysts.

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[39] Mary Wareham, "Report on Activities Convention on Conventional Weapons Group of Governmental Experts Meeting on Lethal Autonomous Weapons Systems United Nations Geneva," *Human Rights Watch* (2018), 8-9.

[40] "Tesla Customer Privacy Notice," last modified Aug 2021, accessed 20 Jan, 2022, https://www.tesla.com/legal/privacy.

[41] "Untether.Ai Products," accessed Jan 20, 2022, https://www.untether.ai/products1.

[42] "Folio3 AI Image Processing," accessed 20 Jan, 2022, https://www.folio3.ai/computer-vision/ai-image-processing/.

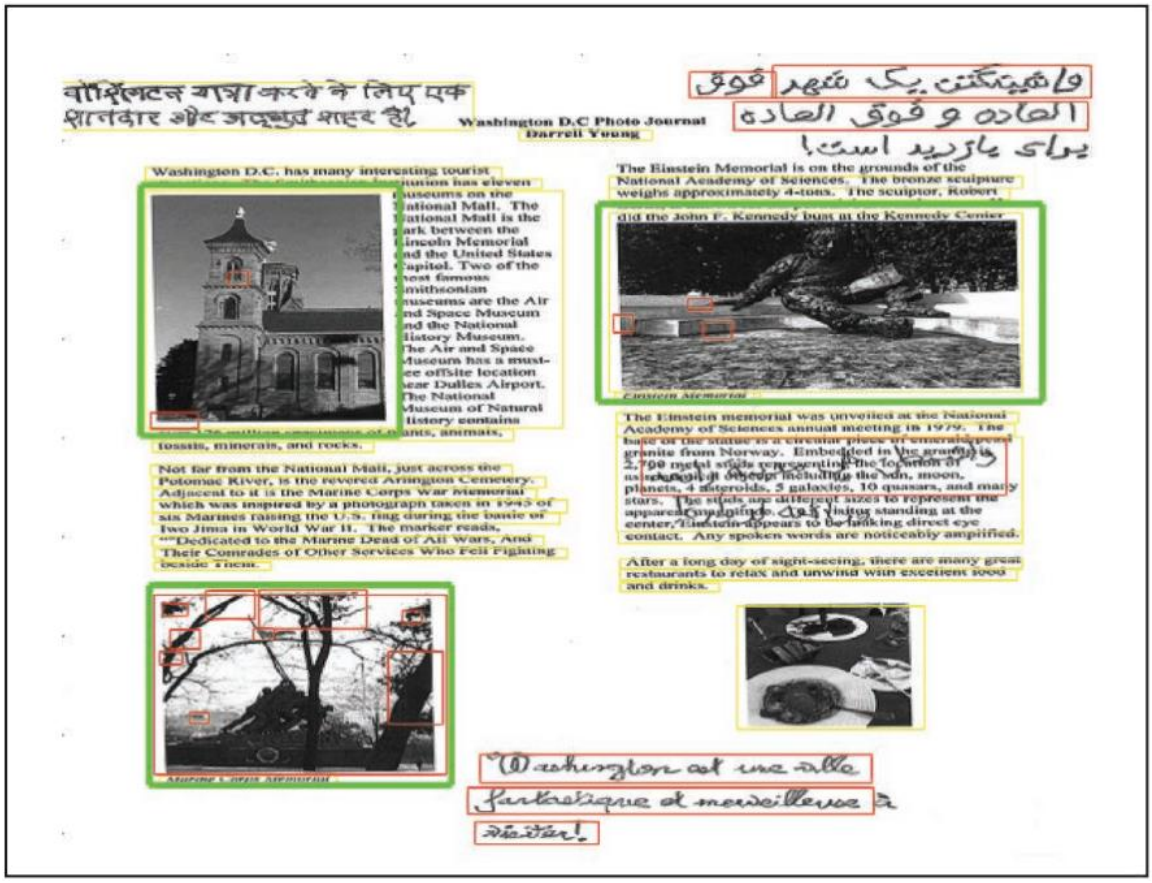

Figure 4 – Deep Learning Text Recognition
Young, *Classification of Handwriting*, 46.

16. AI can analyse vast quantities of still image or video data to detect minor variations. These changes could highlight pattern of life or track plans at a tactical level, disturbances in the environment at the operational level, or the location and speed of construction at a strategic level. Detection and visualisation of key information would expedite the refinement of data into actionable intelligence, enabling rapid decision-making.

Figure 5 – Stages of Pattern of Life Processing
San, *Build a Motion Heatmap Video Using OpenCV With Python*

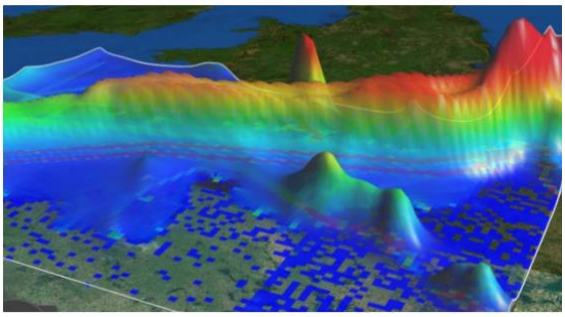

Figure 6 - Heat map of vessel frequency and density in the English Channel
Nezda, *Machine Learning for Patterns of Life*, 29.

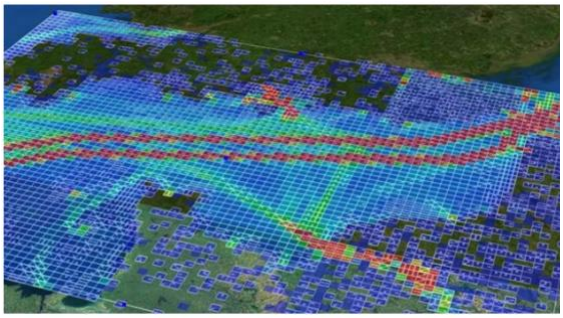

Figure 7 – Discovered routes and shipping lanes in the English Channel
Nezda, *Machine Learning for Patterns of Life*, 29.

17. **Logistics**. Globally, many multinationals have leveraged AI to manage and develop insights into their supply chain processes. Kinaxis is an Ottawa-based company that produces an AI-enabled supply chain manager used by Ford, Cisco, and Proctor & Gamble.[43] Multinationals use Kinaxis products to rapidly respond to changes in customer demand and react to supply chain disruptions. The CAF would immediately benefit from the use of a commercially successful product, with a proven ability to respond to supply chain disruptions, regardless of whether the interruption is caused by union labour action or a military strike on a supply vessel. Defence Resource Management Information System (DRMIS) is undergoing a lifecycle refresh, with a $250-500M (CAD) funding

[43] Kinaxis, *Kinaxis Annual Shareholder Report (2020)*, 2021, 74.

range.[44] Given that one of DRMIS' primary roles is business process and supply chain management, any efficiencies that can be gained would improve the speed and performance of the supply chain while reducing demands on stressed personnel resources.

CONCLUSION

18. The United States, United Kingdom, Australia and China are aggressively pursuing AI to enable military operations. Each of those countries have developed a strategic military plan to encourage and manage adoption of AI in future projects and programs. Despite a relative wealth of AI-focused corporations in Canada, DND has not yet developed the same strategic military plan to encourage and manage the adoption of AI. DND has the opportunity to leverage Canadian corporate AI expertise to augment military capabilities with proven commercial technologies.

RECOMMENDATIONS

19. DND can learn from foreign militaries' plans, successes, and failures when developing their own AI adoption plan. The availability of Government funds to encourage investment in Canadian companies provides a unique opportunity to expedite the adoption of AI within DND.

20. The following five recommendations are proposed to the Chief of Force Development:

a. **DND Plan for AI**. Augment the Government of Canada plan for AI with a strategic military plan for the use of AI. This plan should identify an OPR as the central point of coordination for AI within DND.

b. **AI Expertise Contract Vehicle**. Due to the competitive nature of AI as an emerging technology, AI expertise will not reside within the CAF. Projects will be required to rely on outsourced, contracted, or partnered resources. A contract, such as a Task-Based Informatics Professional Service (TBIPS) vehicle, should be created by the OPR to permit access to AI expertise on an as-needed basis.

c. **AI Considerations for New Projects**. Most lifecycle or new major capital projects could benefit from adoption of emerging technologies. Mandatory consideration of emerging technologies should be a requirement within the procurement process. The best people to determine what can and should be automated are intimately involved in the project, supported by subject

[44] "Defence Resource Management Information System," last modified Jan 09, 2020, accessed Jan 20, 2022, http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1912.

matter experts (SMEs) available through the contract created above.

d. **Innovation Funding**. Through programs like IDEaS and SARNIF, the Government is making funding available to support innovation and investment within Canada. L1s should continue to be encouraged to pursue these funding sources to modernise their department.

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