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The Future of Defense: Artificial intelligence Supported Detection and Recognition of Targets

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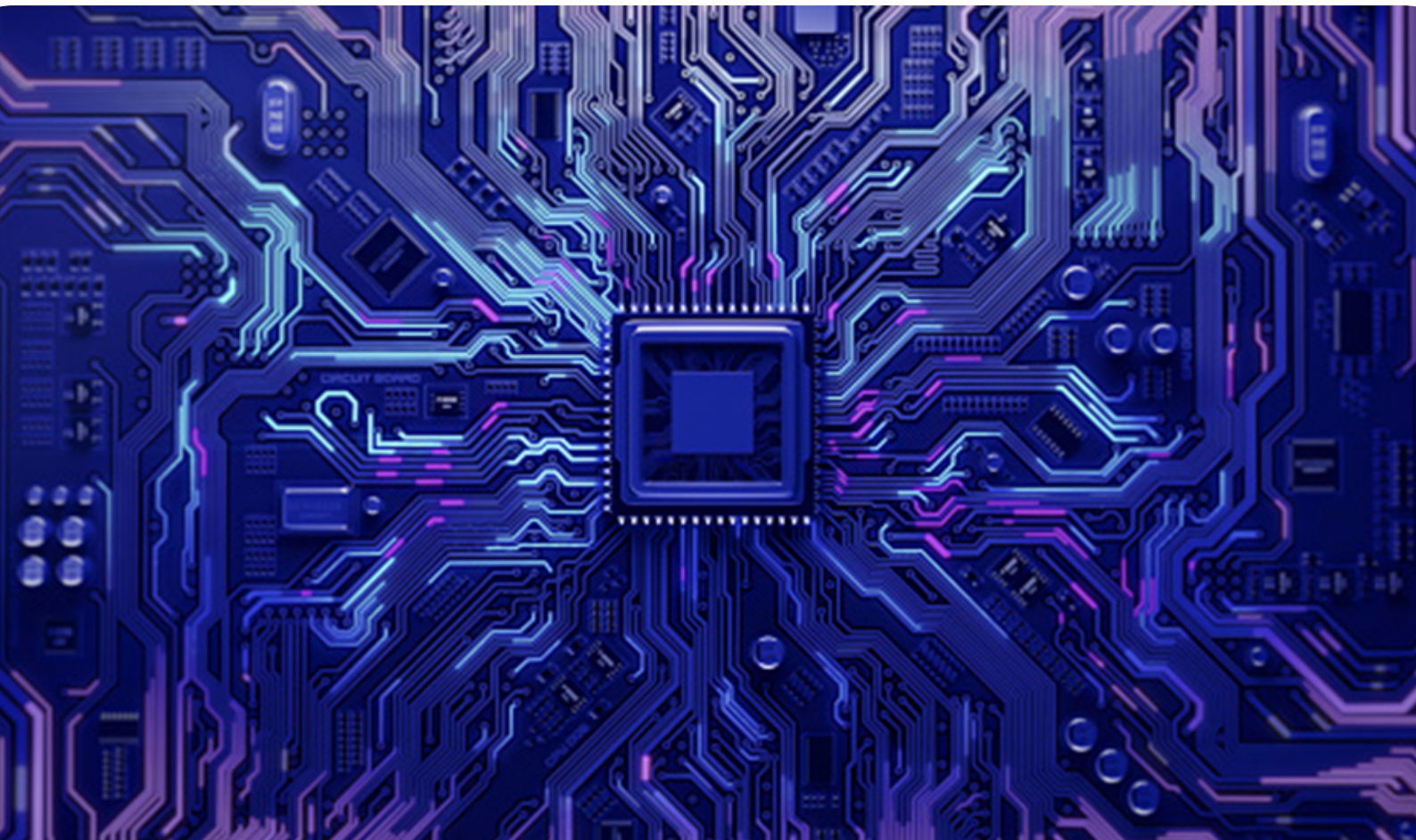

Introduction

New technologies are transforming the security and defence sectors at a faster pace than ever before. Digital technologies, in particular, are affecting established balances of power within the global security landscape. Therefore, it is essential to ensure that Europe's security and defence sectors remain at the cutting edge of technological development.

The use of Artificial Intelligence (AI) in our society has grown exponentially in all areas, from political and social life to the military. In the latter area, it has been demonstrated that artificial intelligence is capable of optimising and automating many military missions. The implemented software systems have been demonstrated to help increase soldiers' safety, and are effective in the search and rescue of people, and are capable of preventing enemy attacks, among many other operations.

The national defence strategies of the great powers use these technologies for and by the armies. For several years now, cybersecurity and AI have been the subject of dedicated national strategies.

The use of autonomy and AI will play an increasingly vital role in military operations. Indeed, small targets coming from different directions and new intelligent and sophisticated weapons operating in complex scenarios nowadays represent the new threats.

New techniques based on artificial intelligence using deep learning and machine learning, seem particularly useful for image processing of high-resolution cameras, when operating with a wide field of view for the detection of difficult targets (low contrast, small size, operating in degraded visual environments). Moreover, AI could help applications on camera mounted on unmanned air vehicles, where full images cannot be streamed to the ground station. AI can provide benefits on data fusion, particularly from imaging radar and cameras, for a better situational awareness picture, and on the implementation of aid decision making tools and missions planning.

European Defense Agency (EDA) study

EDA has accomplished a two-year study (2020-2021), called ARTINDET, to understand how AI applications can be used to improve the automatic detection, recognition, identification and tracking of small, fast-moving targets in a complex battlefield environment. In other words, the principal objective of this study is to analyse the most promising AI-based techniques for Automatic Detection Recognition Identification and Tracking (A-DRIT), at least in the following operative conditions: spatially distributed small targets in strong background, high-resolution imaging systems with a wide field of view, multidimensional imagery, and multiple cooperating platforms.

In such a hostile context, high-performance electro-optical imaging systems and spatial resolution radars seem to be the best solution to efficiently detect and attenuate these new threats.
High resolution multidimensional electro-optical sensors are designed to have enough diversity for improving detection, recognition, identification and tracking of difficult targets. The main challenge stems from the considerable quantity of data produced. Therefore, automatic processing would be helpful with a drastic reduction of reaction time for a decision, often crucial in military missions.

The study developed and analysed new image processing techniques of imaging systems relying on AI. For that purpose, images captured by high-resolution cameras and synthetic aperture radar operating with a wide field of view fed the different algorithms tested. The various techniques implemented and tested are designed for an unmanned aerial vehicle. ARTINDET examined all the needed steps for the deployment of this kind of system.

The study used two scenarios for object identification: one in an urban area (mainly critical building identification) and one focused on ship detection and recognition in open sea. Two data sets were created for each scenario, composed of both electro-optical and radar images, and two artificial intelligence algorithms were developed: one for the segmentation in urban scenario (mainly critical building identification) and one for the detection of ships.

One of the main conclusions of the study is that artificial intelligence significantly enhances the performance of those two technologies related to image pre-processing, fusion and inference.

The study revealed that the use of the new artificial intelligence-based algorithms leads to a considerable improvement of the identification and detection performances, also due to the automatic and “intelligent” choice of the images supported by machine learning and neural networks.

The study also highlights the necessity of additional work such as creating a European military image database for artificial intelligence-based system training and testing, furthering algorithm developments, certificating and validating of artificial intelligence algorithms, implementing hardware architecture, and extending measurement campaigns for artificial intelligence procession performance analysis and validation. Therefore, additional research efforts should be put into these promising technologies, which can make a difference in defence capabilities.

The Agency has proposed to EU member states to launch a dedicated project called AIDRIT, which, if accepted, could start in 2022. It would look into the additional work highlighted in the ARTINDET study. There is also a real possibility that this topic could be the subject of one of the next proposals under the European Defence Fund.

The United States Defence Department's AI projects

The United States wants to increase the use of AI in the military sector. On the contrary, most European countries have not made this issue a priority in the years to come. The United States has a military AI strategy before having a national AI strategy, whereas Europe seeks to adopt general regulations before addressing the specific case of the use of AI for military purposes.

In the United States, several sectors of its armed forces have AI in information analysis, decision-making, vehicle autonomy, logistics and armament. In this regard, the armed forces employ this type of advanced technology in the most common tasks, as well as in the use of drones. The Defense Department considers AI as a modernisation priority. Indeed, the United States Department of Defense juggles more than 685 AI projects, including some associated with major weapon systems, such as the MQ-9 Unmanned Aerial Vehicle and the Joint Light Tactical Vehicle.

"We can take large pieces of terrain and rapidly identify hundreds of targets, prioritise them based on a high priority target list that determines which ones we should strike with the resources that we have. And then that goes back into our firing solutions. That happens in seconds versus what would take hours normally, or sometimes even days to be able to develop these targets. And it's doing it in real time at the edge in our command posts and not being tied just back into a garrison computing environment.", said Lt. Gen. Michael E. Kurilla, commander of the XVIII Airborne Corps. Artificial intelligence would offer massive capabilities for counterterrorism in the Middle East, for example, where the United States forces no longer have a significant military presence.

Thus, the Pentagon focused on AI abilities that aid target recognition, battlefield analysis, and autonomy on uncrewed systems for combatpurposes.

NATO response

Allied Defence Ministers adopted an AI Strategy for NATO at their Octobre 2021 meeting. With this formal adoption, Allies have committed to the necessary cooperation and collaboration to meet these challenges in both defence and security. The aim of NATO's AI Strategy is to accelerate AI adoption by enhancing key AI enablers and adapting policy, including by adopting Principles of Responsible Use for AI and by safeguarding against threats from malicious use of AI by state and non-state actors.

NATO' Allies commit to ensuring that the AI applications they develop will be in accordance with the following six principles: lawfulness (AI applications will be developed and used in accordance with national and international law), responsibility and accountability (AI applications will be developed and used with appropriate levels of judgment and care), explainability and traceability (AI applications will be appropriately understandable and transparent), reliability (AI applications will have explicit, well-defined use cases), governability (AI applications will be developed and used according to their intended functions), and bias mitigation (proactive steps will be taken to minimise any unintended bias in the development and use of AI applications).

For NATO, the common commitment to these principles has practical advantages, providing a coherent common basis, while supporting interoperability goals.

Difficulties faced

Despite its effectiveness and its multiple advantages, it is notorious and at the same time a weakness that anyone who knows how the algorithm works can disable it or even turn it against its owners. A Chinese laboratory demonstrated this in March 2019, which managed to deceive the sophisticated AI algorithms of Tesla cars.

In addition, there is the moral dilemma that military weapons are not subject to human orders. In this regard, the European Union has already taken a position on the issue by issuing a guideline declaring that “lethal autonomous systems must be subject to human control”.

Also, integrating the software-centric tech into weapons and networks not initially designed for it will be challenging. “Officials from the military labs told us that the department is likely to face difficulties with transitioning these capabilities to the end-user that are similar to those experienced with other emerging technologies”, the United States Government Accountability Office said.

Moreover, there are no cohesive goals across the military branches, and there is no way of knowing whether each service has enough people with the right skills. It should be established artificial intelligence specific goals for cultivating technical talent, make it easier for all personnel to learn about AI and put it to use.

Conclusion

Last year we saw policymakers pitch their visions about how to regulate AI. This year they will have to get concrete as debates around AI rules heat up on both sides of the Atlantic. AI Act negotiations could take long. Indeed, it has taken eight months for the European Parliament and European countries to understand the regulation and start negotiations, and it will possibly take until at least next fall before European institutions begin negotiating a final text.

Moreover, EU Strategic Compass for security and defence, to be adopted by the Member States in March 2022, will set out a common strategic vision for the next decade and outline how the EU will enhance its capacity to act and respond to various crises and challenges by investing and innovating to develop the necessary capabilities and technologies needed.

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