

The Impact of Artificial Intelligence Technology on Border Surveillance: A Comprehensive Analysis

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Abstract

The study highlights a crucial factor in border studies; this factor has the potential to shift power balance especially amidst the current developments within the international system. Artificial Intelligence notably plays a pivotal role in border surveillance, enhancing national security and addressing security threats. This technology relies on simulating human intelligence through the use of data and advanced analysis methods. The techniques of Artificial Intelligence (AI), including the use of smart systems for intrusion detection and automatic analysis of images and videos, have been adopted in border monitoring in many countries. However, these technologies face challenges such as privacy. While in Algeria, geographical and natural conditions may pose additional challenges.

Keywords: Artificial Intelligence, Border Surveillance, Hybrid threats, National Security.

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1. INTRODUCTION

In the era of globalization and rapid technological advancement, border surveillance ranks among the top priorities of nations to ensure their security and protection from external threats. Borders have been considered the first line of strategic defence for states since their establishment, and their security is closely linked to the existence and continuity of the state. With increasing security challenges and complexities in the current geopolitical landscape, artificial intelligence (AI) plays a prominent role in enhancing the efficiency and effectiveness of border surveillance operations.

Modern developments in AI offer innovative tools and techniques that enable states to play their role as significant actors in their environment, alongside effectively protecting their borders. Thanks to AI's ability to analyze big data in a short time and machine learning capabilities, it's possible to monitor unauthorized activities at border crossings. However, this creates a challenge for nations concerning privacy issues and human rights, especially regarding their citizens. Therefore, the main problem around which the study revolves is: What is the role of artificial intelligence technology in enhancing border surveillance amid new security threats? And what are the challenges resulting from that?

To answer these questions, the study is divided into three axes:

1. **The Conceptual Framework of Artificial Intelligence**

Technology; focuses on the nature of AI from its concept and historical development of the technology to the most important fields adopting AI techniques.

2. **Prominent International Models Using AI for border Security**

Enhancement; these are realistic examples and research projects adopted by a group of countries (models, not exhaustive) to monitor their borders. The study chose the United States, China, and the European Union as they are at the forefront of AI research and innovation in border surveillance.

3. Challenges in Implementing Artificial Intelligence for Border Surveillance: The case of Algeria; and for the research need and self-reasons, we chose the Algerian model to understand the challenges that countries may face when they want to ride the wave of artificial intelligence in monitoring their borders, with an attempt to provide possible solutions to address these challenges. But before that, we went through the threats facing the Algerian borders to understand why the Algerian state should use this AI technique, then we mentioned the benefits it will achieve as a result of its use of AI, till we reach the challenges.

2. The Conceptual Framework of Artificial Intelligence Technology

2.1 Definition of Artificial Intelligence:

Before delving into defining AI and its significant aspects, it is necessary first to delineate the concept of natural intelligence, often referred to as human intelligence. This entails the capacity for learning, reasoning, and problem-solving through various means, along with the ability to interact with and comprehend the surrounding environment. Human intelligence encompasses cognitive abilities such as memory, planning, creativity, critical thinking, emotional expression, and effective communication with others. It constitutes a complex array of mental capabilities enabling individuals to adapt to diverse circumstances and achieve success across various domains of life, (Copeland, 2024)

Artificial Intelligence, on the other hand, is generally defined as the ability of machines to simulate the human mind and its workings, such as its capacity for reasoning and exploration. With the significant advancements in AI technologies, computers and software can now perform tasks of greater complexity that were once solely by humans. This includes tasks such as exploring and proving complex mathematical sequences and functions, as well as playing chess with high proficiency. The essential characteristic of this type of intelligence is its ability to accomplish tasks with high precision at great speed. It is characterized by a vast storage capacity for data and images.

AI is used in various practical applications in the modern era. Among these Applications are: (Copeland, 2024)

- Robotics; AI is employed in the development of robots that possess the ability to learn, adapt to their surroundings, and perform tasks autonomously.
- Image recognition; AI is utilized in these applications, such as facial recognition, object detection, pattern recognition, and types of fingerprints...
- Speech recognition; AI is used in speech recognition applications, including automatic translation and voice command recognition.
- Machine learning and deep learning: AI is applied in machine learning and deep learning applications, such as predictions, classifications and clustering

2.2 A historical overview of artificial intelligence:

The history of AI is rich with dreams and aspirations, stretching back to ancient times with references like Homer's mechanical tripods (Stephen Cave, 2020). However, it's only in the past fifty years that the AI community has been able to materialize these dreams into experimental machines, allowing us to explore the mechanisms of thought and intelligent behaviour that were once purely theoretical concepts; (Alan, 2010, p. 03)

-1950s: computer scientist John McCarthy introduced the term "artificial intelligence" at the Dartmouth Conference in 1956, marking the field's inception.

-1950s-1970s: Early AI research focused on symbolic or rule-based approaches, programming computers with explicit rules and logical reasoning. Notable achievements include the development of the Logic Theorist by Allen Newell and Herbert A. Simon, capable of providing mathematical theorems. This period called the golden years of AI or "AI spring" (Wipo technology Trends, 2010)

-1970s -1980s: AI faced challenges during the "AI winter" periods, marked by funding cuts and doubt in the AI's capabilities.

-1990s –present: During this period, significant developments occurred in the field of AI, as interest in it was revived due to the advancements in machine learning, alongside the emergence of neural networks as a key technology inspired by the structure of the human brain, leading to improvements in pattern recognition and decision-making based on data. We also experienced the emergence of other techniques; Support Vector Machines (SVM) and Decisions Trees, contributing to developments in data classification and

predictive capabilities. Additionally, the concept of ‘big data’ emerged, with providing a qualitative leap for the field as machine learning algorithms became suitable for analyzing vast amounts of data, extracting valuable and useful patterns. (Mohanna, 2023)

And the field remains open to further exciting innovations and developments as technological progress continues in this science, it is expected that future technologies will witness remarkable developments in multiple areas.

2.3 Application Areas of Artificial Intelligence

AI is increasingly vital in contemporary society, offering efficient solutions to complex problems across numerous sectors like healthcare, finance, education, agriculture-The discussion about smart agriculture has become prevalent -commerce, automobile industry and security; and for research necessity, the focus will be on the last field:

AI is utilized by countries to develop security technologies, enhancing intelligence analysis, predicting threats, and swiftly responding to security incidents. It can analyze vast amounts of data from various sources; including videos, social media, platforms, and intelligence analytics, to identify unusual patterns and suspicious activities. Moreover, machine learning, which has seen significant advancement in surveillance, can analyse user behaviour and detect anomalous activities within networks and information systems without the need for human intervention.

The application areas in security are numerous and diverse due to the paramount importance it holds for countries. These areas can’t fully cover in a single article; however, we can highlight some of the most prominent ones.

-AI in cyber security: The emergence of cyber attacks in various forms and types, especially electronic crimes, cyber terrorism, and cyber conflicts between states, has greatly reduced international confidence. With the emergence of AI, one of the latest technologies used to enhance cyber security, many countries have rushed to benefit from these technologies in pre-emptive detection and discovery of potential threats before causing harm to individuals or devices(دحماني، 2023، صفحة 607). Thanks to automation-the application of machines to tasks previously performed by human such as robots- efficiency has increased, and the rate of human errors has decreased. Automation also helps in shortening response times by quickly identifying

the source and extent of the breach, allowing teams to act quickly and mitigate potential damage, thus always creating an opportunity to advance for the benefit of security agents. Indeed, AI also provides a robust system for protecting sensitive data and information.

-AI in urban security: some companies leverage AI technologies to bolster security in transportation. For instance, smart systems are employed to analyze traffic data and identify areas needing traffic improvement, such as activating smart traffic signals(منصور، 2020، صفحة 13). AI can also fortify security in self-driving cars and autonomous aircraft. To improve security in urban areas, cameras and intelligent image analysis systems are utilized to monitor unusual activities and identify potential crimes. Consequently, the security level in cities can be elevated, enhancing the quality of life for residents.

-AI in military security: AI plays a crucial role in modern military operations, enhancing various aspects of defence and security. AI technologies are used for tasks such as autonomous vehicles, predictive maintenance of equipment, logistics optimization, and intelligence analysis. Its ability to process large amounts of data and quickly adapt to changing situations makes it a valuable asset for modern military operations. (Das, 2023)

-AI in border security: AI technologies focus on border security in various forms, including assessing travellers' subtle and imperceptible emotional expressions, biometric analysis of fingerprints and facial recognition, and scanner programs capable of distinguishing between humans and other entities in remote areas. Additionally, aerial imaging is used to detect illegal activities such as drug trafficking and illegal migration. (Tylar, 2022)

3. Prominent International Models Using AI for border Security Enhancement

Due to the complexities of the border landscape and the shift from political borders to smart borders on one hand, and the changing types and nature of threats on the other hand, it has become imperative for nations to enhance their borders monitoring methods by incorporating AI to improve surveillance and detection techniques of illegal activities.

Here are some of the countries that have taken the lead in a rapidly evolving global race:

3.1 United States of America:

Since 2011, the US has been harnessing AI to protect its national borders, underscoring the increasing importance of adopting technology to enhance national security. With technical surveillance enhancements along both its northern and southern borders, the Department of Homeland Security has received over 780 million dollars for technology and border surveillance in fiscal year 2021 (Tylar, 2022), underscoring the importance of investing in technology to fortify border protection and ensure national security.

The journey of AI in monitoring the American borders began with researchers of Arizona pioneering the effort, in collaboration with the U.S Customs and Border Protection agency, The Automated Virtual Agent for Truth Assessment in Real Time (AVATAR)-innovated by Aaron Elkins-was developed. It was based on machine learning principles and computer vision, in addition to natural language processing. Thus it combines AI with high-precision sensors and vital measurements aimed at identifying dishonest individuals or potential threats based on eye movements, changes in voice, posture, and facial expressions (physiological changes). The experiment proved that the AVATAR project can detect lies and deception with an accuracy ranging from 60 to 75%, and in some cases up to 80%, while the average human accuracy in such tasks ranges from 54 to 60% at best (Science, 2018). By questioning travellers at border crossings: airports, ports..., and after distinguishing whether there is any unusual movements at the crossing, AVATAR sends light signals to the connected computer inside, which is monitored by human agents. These ones interpret the signals as requiring intervention and further investigation by officials. Thus, AVATAR achieves its goal of alleviating the pressure felt by security devices due to increasing border flows and the continuous threat of terrorist attacks, (Daniels, 2018) especially since the U.S. Border Security System oversees the monitoring and inspection of over 300 land, air, and sea ports (Muhammad, 2024).

Following the 2012 testing of AVATAR along the US-Mexico border, the project drew the interest of Frontex, the EU's border control agency. Field

trials were conducted at Bucharest Airport in Romania, during which AVATAR was deployed to monitor travellers in their native language and evaluate their behaviour (Muhammad, 2024).

AVATAR faced criticism by experts in the field, describing it as ‘immature’, especially since it took minutes instead of taking just seconds to issue a judgement of doubt (Science, 2018); as a result, AVATAR kiosks have not been fully deployed in the US so far, as it undergoes further research and development.

In the realm of advancing lie detection technologies, the U.S has also adopted another technique known as Facial Biometric Comparison technology, this one aimed at bolstering comprehensive biometric entry and exit procedures in aerial, maritime, and terrestrial environment. (GAO, 2022) U.S Customs and Border Protection (CBP) has effectively integrated facial biometrics into entry procedures across all international airports through Simplified Arrival, and into exit procedures at 49 airports sites. Additionally, it has extended facial biometrics to 38 seaports and all pedestrian lanes at both South Border and Northern Border entry ports. So far, CBP has used this technology to process over 300 million travellers and thwarted over 1900 imposters from gaining to the US. (CBP, 2024)

The process involves travellers encountering a camera linked to CBP’s cloud –based facial matching service. This camera compares live images with stored photo templates from passenger travel documents. If a quality image matches historical templates, the traveller proceeds to inspection for admissibility or exits the U.S. under CBP supervision. (CBP, 2024)

Homeland security proposes a “virtual wall”, encompassing an extensive network of drones, sensors, and related technologies spanning the nation’s borders. This proposed system is posited to offer significant utility in monitoring remote and insufficiently monitored areas situated between official ports of entry. The idea has had bipartisan support and has gained traction across successive presidential administrations, primarily premised on the belief that it would afford heightened efficacy, cost-efficiency, and reduced disruption compared to traditional physical barriers. (Tylar, 2022)

In the same context, the Border Security Administration has deployed independent towers (a Watchful Eye) along the U.S –Mexico border. These towers utilize high-precision AI technology, consisting of a combination radars and surveillance cameras with the capability to cover an area with a diameter of 4.8km and a height of 10m. They are characterised by ease of transportation and setup, requiring only a few hours, in addition to their use of solar energy for operation. (Davis, 2022)

The towers can communicate with each other to track objects beyond their range, thus providing complete coverage of the operation. The AI system has been trained to distinguish between grass, humans, vehicles, and animals, enabling precise scanning of remote border areas and identifying the source of any detected activity. In the event of positive results, the AI sends immediate alerts directly to field agents' phones without the need for continuous video monitoring. The system was tested in 2020 with the deployment of 60 towers, and after registering numerous successes in thwarting drug smuggling and illegal immigration attempts, it was expended to 200 towers. (Davis, 2022)

On the northern border with Canada, U.S. employs similar AI technology; the Northern Border Remote Video Surveillance System (NBRVSS) to monitor and detect ships along the Canadian coast, kilometres away, distinguishing suspicious from normal activity through radar systems, surveillance devices, and high-resolution cameras utilizing AI. This technology successfully tracked suspicious ship; enabling border guards to intercept it after identifying its number of people onboard using NBRVSS. (Kosck, 2022)

The United States has made significant strides in innovating and developing artificial intelligence technologies to enhance and reinforce border surveillance. However, it may face challenges alongside privacy and human rights concerns. Harsh or rainy weather conditions can affect the quality of images and reduce the ability of facial recognition systems to accurately distinguish individuals.

Additionally, volatile weather conditions like fog can interfere and decrease the effectiveness of smart systems, thus these technologies may require

additional improvements or alternative techniques to adapt to any climatic conditions.

3.2 China

China has also extensively utilized AI systems to enhance its border security at border crossings. It has developed smart surveillance systems based on data analysis and facial recognition to identify suspicious or wanted individuals. Additionally, it has employed biometric technologies such as fingerprint recognition and facial scanning to increase the accuracy of verifying individuals' identities, thereby aiding in border security, crime prevention, and combating smuggling of illicit goods.

Here some technologies used by China to secure its border:

Let's begin with the cornerstone of surveillance in China: its extensive network of cameras. China boasts the largest surveillance camera network globally, outfitted with advanced AI and optical devices for video monitoring and recording. These systems possess the capability to store and analyze images of individuals passing by, allowing for recognition and tracking based on archived data. According to The New York Times, over half of the world's surveillance cameras, totalling around one billion units, are situated in China. (Times, 2022).

China has developed a massive data analysis platform, the first of its kind, in such a way that each Chinese citizen receives a personal electronic file containing all personal, natural, professional, educational, and other relevant information. This technology is called "One person-One file". It facilitates the provision of accurate and up-to-date information about individuals, allowing relevant authorities and border security to access it quickly and easily to verify travellers' identities and provide positive or negative assessments of their border-crossing eligibility. China asserts that this technology improves the efficiency of border inspection and surveillance operations, especially in busy border areas such as airports, saving time and facilitating smooth traffic flow without issues. (Tylar, 2022)

China has extended its development of databases beyond mere personal information. It has collaborated with companies like Huawei to gather various types of personal data from mobile devices, phone applications,

social communications, and online activities. Additionally, China collects biological and genetic data, marking the pinnacles of its “One person-One file”, database technology. The Chinese government has been collecting voiceprints, iris scans, and DNA samples from its citizens -arguing that facial features and voices may change over time-. The government asserts that this use is in favour of preserving national security and stability, enabling authorities to track criminals and terrorists with minimal margin for error. This genetic tracking can even be used to index entire generations. (Times, 2022). China defends this technology, especially against accusations from human rights organisations alleging that it violates its citizens’ privacy, likening its use of such data to criminal investigations worldwide, which often rely on genetic information. Therefore, China uses this data to predict criminal behaviour in advance and take precautions when individuals enter or leave the country.

Through the analysis of data collected using the “one person-one file” technology, based on AI, China adopts a Comprehensive Surveillance technique over the lives of its citizens, despite applying stricter controls on certain minority groups, such as Tibetans and Uyghur, whom it perceives as a threat (Tylar, 2022). Human rights activists, like HRW have accused China of unfairly targeting specific ethnic and minority groups. Consequently, numerous human rights organizations have petitioned for the suspension of the program, but China has not responded to any of them.

These models of technologies serve as effective tools in enhancing border security. Through the use of Comprehensive Surveillance technique at border crossing: airports, ports..., individuals and goods can be monitored and tracked accurately, facilitating the detection of suspicious activities and predicting potential threats before they occur. As for One person- One file technique, it provides a comprehensive database containing individuals’ information, enabling border authorities to identify them quickly and easily when crossing borders. However, this must be done in a balanced manner, respecting human rights and privacy and ensuring that individuals are not subjected to injustice or discrimination.

3.3 European Union

The European Union is actively working to develop AI-equipped technologies aimed at combating illegal migration-migration management- and bolstering European border security. One of the EU's primary challenges is pre-empting migration waves before they occur. Through the development of an application called "ITFlows"-IT tools methods for managing migratory flows-, the EU intends to collect and analyze data to create tools that can predict migration patterns and identify potential risks associated with the arrival of refugees at European borders (D'agostino, 2022). This includes:

- Forecasting migration movements, determining the countries of origin of migrants, and anticipating the routes they are likely to take; through using an AI system that analyze data on conflict and disruptive events around the world to predict migration trends.

- Pertaining to the reception and integration of refugees in European countries. (DW, 2022)

The application falls under the initiative "EU Horizon 2020" –the European Union's program for funding research and innovation for 2014 to2020, with a budget of 80 billion Euros- The European Commission has allocated 5 million Euros for this project, developed by TerraCam and various research institutes, alongside charitable organizations. ITFlows is scheduled to commence in 2023 and is intended to complement another technological system designed to monitor maritime border crossings, especially in Italy and Spain. (D'agostino, 2022)

As a part of the initiative, the "ROBORDER" project was developed, spanning nearly 4 years (2017-2021), with a budget allocation of 8 million Euros. Although there is some secrecy surrounding key details of its dedicated website, the project aimed to develop an autonomous border surveillance system using AI technologies through the use of robots capable of mobility, resembling land, aerial, maritime and underwater vehicles. These ones integrate sensors with adaptability to any environment, enabling early detection of criminal activities at borders such as irregular migration and smuggling, as well as monitoring coastal areas. Additionally, they possess the capability to detect environmental threats and subsequently notify border authorities about the situation in the surveyed area. (Roborder)

Europe has relatively recently adopted a new technology to enhance border monitoring. Researchers in the field will notice significant overlap between this technology and the “AVATAR” technology -mentioned above-, with the addition of some advanced technological components tailored to the nature of monitoring European borders.

The iBorder Ctrl project (Intelligent Portable Control System), is an initiative aimed at enhancing border control efficiency and security for individuals entering EU Members States. The project encompasses a variety of software and hardware technologies, such as portable readers, biometric verifications systems, automated deception detection, document authentication tools, and risk assessment capabilities (Digitalis, 2018). The iBorder Ctrl aims to streamline the external borders of the EU, by combining advanced technologies with the future vision of Schengen Border Management. It involves a two-stage process; the first one, travellers register before their journey, undergoing automated interviews and data correlation to enhance security checks. And the second is happening at the border, there will be security measures such as document verification and automated lie detection, this has been implemented at border-crossing points in Hungary, Greece and Latvia. The collected data is securely analyzed to provide automated decision support to border officers, ultimately reducing time and costs per traveller (CORDIS, 2022). Moreover, the system prioritized transparency and empowered travellers with ownership and control over their data, prioritizing fundamental rights and ensuring an improved border crossing experience (iBorderCtrl, 2023). Apart from a number of tests such as motion detection system are not yet in place at EU borders.

Technologies utilizing artificial intelligence for border surveillance in the EU face substantial criticism due to the potential infringement of human rights and privacy. Critics worry about potential discrimination and lack of transparency in data collection and surveillance operations. Advocates call for effective regulations to protect rights and privacy.

4. Challenges in Implementing Artificial Intelligence for Border Surveillance: The case of Algeria

The 5th Industrial Revolution has imposed a new change on the international arena, which is artificial intelligence. We see a large number of governments

worldwide racing towards developing systems based on AI technologies, especially in the military and border security fields; where the lion's share of attention and resources is dedicated to harnessing AI technologies. However, it's not only governments that have embraced this AI wave; non-governmental entities have also entered the race, seeking to enhance their capabilities and efficiency to facilitate their criminal operations. These include terrorist groups and militias. A statistical study conducted in March 2020 on AI-powered drones revealed that more than 102 countries possess military drones, in addition to approximately 63 non-governmental organizations or entities (الحميد، 2023). This has raised the bar for countries in enhancing their border security. Algeria is one of the countries facing unique challenges due to its vast territory and the diversity of potential risks on its borders, in this context, artificial intelligence can play a crucial role in enhancing national security and border protection.

4.1 Algerian Border Threats

Algeria occupies the position of the largest Mediterranean country with an area estimated at 2.381.741 Km². Its strategic depth extends in the Sahel and Sahara. It oversees the protection of a border strip measuring approximately 6.343 Km, with a coastline spanning 1.640 Km. Its strategic location and extensive reach have made it a focal point for numerous hybrid threats, particularly due to the lack of security in most, if not all, surrounding countries, which often transitions to a complete absence of security, making them sources of various threats, including organized crime, terrorism, illicit trade, and illegal migration-Algeria has become a destination country for illegal immigrants after being a transit country towards Europe.

Reports from the UN have indicated that the Sahel serves as a transit zone for 30-40% of the drug trade, turning the area into a stronghold for terrorists and organized crime groups. Additionally, it's ranked as the second-largest black market for arms trade (بلختير، 2021، صفحة 353). This has placed Algeria on the verge of a volcano, necessitating constant and vigilant surveillance by its military to monitor and guard its borders. With 80% of its borders characterised by harsh desert terrain and rugged landscapes, and bordered by

fragile or failed states, it poses a significant challenge for the National Army to maintain control over the entire border.

Algeria has adopted the Smart Borders model along its entire border strip to enhance monitoring, improve efficiency, and enhance its technological capabilities in the field. This involves using advanced technological means to improve the ability to detect suspicious activities on the borders, such as using radar sensors and day-night cameras, in addition to drones to monitor smuggling and illegal migration across the borders. Algeria has been regularly able to arrest human traffickers, terrorist elements, and seize smuggled goods and weapons due to its possession of an advanced arsenal for border monitoring. However, threats still persist, especially as terrorist groups possess sophisticated that can breach national borders and disrupt security. Therefore, the changing security situation necessitates that Algeria, like other countries combine the Smart Borders model with AI algorithms to bolster its border security.

4.2 Benefits of Using AI Techniques in Monitoring the Algerian Borders

AI techniques are considered a powerful tool to enhance border monitoring efforts in Algeria, providing effective solutions to address its unstable security environment and the border risks that come from it. Here are some key benefits of using AI technology in the border monitoring process:

- Enhancing the efficiency and accuracy of Algerian border monitoring operations; this is achieved through the rapid analysis of vast volumes of stored data. From this analysis, valuable information are extracted, aiding in early and accurate threat detection. This accomplishment allows relevant authorities to take pre-emptive measures before situations escalate, particularly in closed and fixed border crossings such as airports, seaports, and land border check points...

- Improving the efficient use of human and data resources: this is evident through the capacity of AI techniques to identify areas requiring intensive monitoring based on the analysis of data and behavioural patterns of various criminal groups. AI algorithms analyze the movement data of terrorist groups, organised crime, smugglers, and other criminal activities, which are active in specific areas at specific times. Consequently, priority areas are identified to allocate necessary logistical equipment, thereby reducing the

pressure on border guards and military services on one hand, and minimizing excessive costs on the other. This is particularly crucial considering Algeria's prior readiness along its border strip, with significant investments in manpower and resources to secure borders amidst wars and crises affecting neighbouring countries.

-The capability to predict potential threats; AI can utilize historical data analysis, such as political events, security situations in neighbouring countries, social, geographical data, and tracking the paths of both illegal migrants and terrorist organizations over time, to predict potential threats and their sources. This enables authorities to take pre-empting steps to manage or address them effectively ex; when the AI system notices an increase in unusual vehicle movement in a specific area of the desert, after analyzing the data, it discovers that this sudden movement may indicate an attempt by a terrorist group to infiltrate across the border. Based on this prediction, the authorities take immediate action by increasing surveillance and enhancing inspection in the concerned area.

-The capacity of AI to learn from its mistakes; it has the ability to improve its performance and learn from its mistakes, which helps in developing its algorithms. Ex: if a new method of drug smuggling across borders is discovered and not captured by traditional surveillance system, AI can learn from this experience and adjust its models and techniques to enhance its efficiency in detecting this new type of threat in the future. This means that AI evolves flexibly and dynamically with the evolution of the threat type. Therefore, there is no need for reprogramming and investing in the development of technologies because programming becomes temporary based on the current situation.

-The reduction of human errors; is evident in the ability of AI to analyze data accurately and make decisions based on these analyses, ex: when humans monitor borders, they may experience fatigue or distraction, leading to overlooking unusual patterns or suspicious activities. However, with AI, the system can analyze radar and surveillance cameras data with high accuracy, continuously without feeling tired or distracted. Also, if unusual vehicle movements are detected in a specific area, the AI system may indicate

suspicious activity. This information is analyzed quickly and accurately, and an immediate alert is sent to the relevant security authorities for immediate investigation. This rapid and continuous response helps reduce the chances of human error and increases effectiveness in border monitoring and countering threats efficiency.

Now we come to the important part, which is that Algeria, like other countries can use AI technologies and adapt them to suit its border security environment. However, it may face challenges that could hinder its progress towards using technology and benefiting from it.

4.3 Challenges of using Artificial Intelligence in Monitoring Algerian Borders

There are several challenges facing the Algerian state in its use of AI for border monitoring, including:

- The digital and technological infrastructure; AI needs a high-speed communication networks and digital infrastructure “Data is the fuel for AI”.

Despite the recent improvements made by the Algerian government to develop the technological and digital infrastructure, particularly by enhancing both wired and wireless communication networks to provide broader coverage and higher transmission speeds, there are still challenges. The instability in the communication network persists in some areas, and in others, there is a complete absence of coverage. Additionally, frequent power outages, and altogether affect the provision of digital services to those areas.

- The legal and ethical aspects of using AI; Government around the world, without exception, face fear and hesitations from their populations regarding the use of AI. These concerns revolve around privacy, data protection, transparency, and in some countries even issues of justice and discrimination. To address this challenge, the Algerian government must strike a balance between the need of security and human rights while ensuring privacy protection. This can only be achieved through awareness campaigns to make people understand the necessity of using AI and collecting the necessary data about each individual to protect them and their properties.-creating a form of transparency between the state and the citizen will built trust in the government- Naturally, there should be a legal framework in place to protect the rights of citizens.

-The high costs of using AI for border monitoring; purchasing AI based devices, systems, and software for border monitoring, especially for Algerian borders, which requires hefty costs. These devices need maintenance, and operating them necessitates qualified and trained teams, which requires investment in their training to handle such sensitive and advanced equipment. Therefore, it is necessary to establish a sound financial strategy and open the door to private investment. By collaborating with private technology companies and establishing specialised research centres in the field, either under state control or within universities, the burden of costs can be reduced.

Of course, there are many other challenges that cannot be fully mentioned in this article, such as the harsh nature in the south Algerian borders and its impact on communication coverage, climate change, and natural phenomena like sandstorm that may affect surveillance systems, in addition to challenges in the field of cyber security protection.

However, these challenges can be addressed through the development of smart threat detection technologies and the adoption of advanced strategies to protect cyber systems. Measures can also be taken to enhance resistance to harsh weather conditions and develop communication technology to improve coverage in such harsh conditions.

5. CONCLUSION

In conclusion, artificial intelligence represents a revolution in border surveillance, contributing to enhancing national security and combating asymmetric security threats in innovative and effective ways. By developing smart sensing systems that continuously and accurately collect data on border activities, it enables relevant authorities to take immediate corrective actions upon detecting any threats or unauthorized activities.

However, the use of AI raises ethical and legal challenges and questions regarding data privacy. To address these concerns, countries are striving to establish legal frameworks to ensure the responsible and effective use of these technologies.

And all this lead us to say, that the success in implementing AI and border surveillance technology requires comprehensive strategic thinking that takes

into account all these challenges and works to address them in an integrated manner, under the framework of international cooperation.

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