Novel Concept for the Security Architecture of Airports Involving Holistic Interpretation via Artificial Intelligence

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Abstract. The Airport security touches a core value of society: Moving freely without fear, since at any time an airport can be the target of an attack. A constant evolution of airport security lies at the heart of defending such a core value. The attackers' approaches and technological devices changed, as did those of aviation security, in response to each attack. Digitalization and automatization offer the possibility to counter the attackers' approaches. An enhancement based on the combination of digitalization and automatization comprise Artificial Intelligence which is nowadays broadly used in airport security. An analysis of the existing areas of application of AI at the airport security revealed a lack in information exchange leading to the necessity of collecting and construing of security-related data to derive an overview of the overall security situation at the airport. In this paper, we describe a concept that centrally interprets and adequately acts on security-relevant information with the help of AI. Since an overall interpreting security system based on AI needs to be adapted to on airports security infrastructure, we present a way to perform this adaption.

Keywords: Airports · Security · Automation · Artificial Intelligence

1 Introduction

Since the beginning, commercial aviation has been the target of criminal and terrorist operations. Both, aircrafts and airports are affected, where aircrafts were even used as weapons. During this time, the attackers' approaches and technological means changed, as did those of aviation security, in response to attacks.

In the field of aviation security, the following methods are increasingly used, namely video recognition and analysis as well as profiling. In addition, these methods are extended by using Artificial Intelligence (AI) potentially offering added value for the operation enhancement of airport security.

Nowadays, Artificial Intelligence is broadly used in airport security, ranging from intelligent video surveillance through border control to monitoring of high-security areas. An analysis of the existing areas of application of AI at the airport security revealed a lack in information exchange. Therefore, a timely and adequate overview of the holistic

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airport security situation may be a difficult task. This leads to a time-delayed response in the event of a security-related incident such as identifying an unattended baggage and its originator, and initiating the appropriate measures. The centrally interpreting AI described in this paper overcomes this drawback.

2 Automatization of Security Processes

In this section, we examine the automatization level of the various types of security processes present at the airport (see Fig. 1). Our examination starts from passenger processes through baggage processes to security processes of room surveillance.

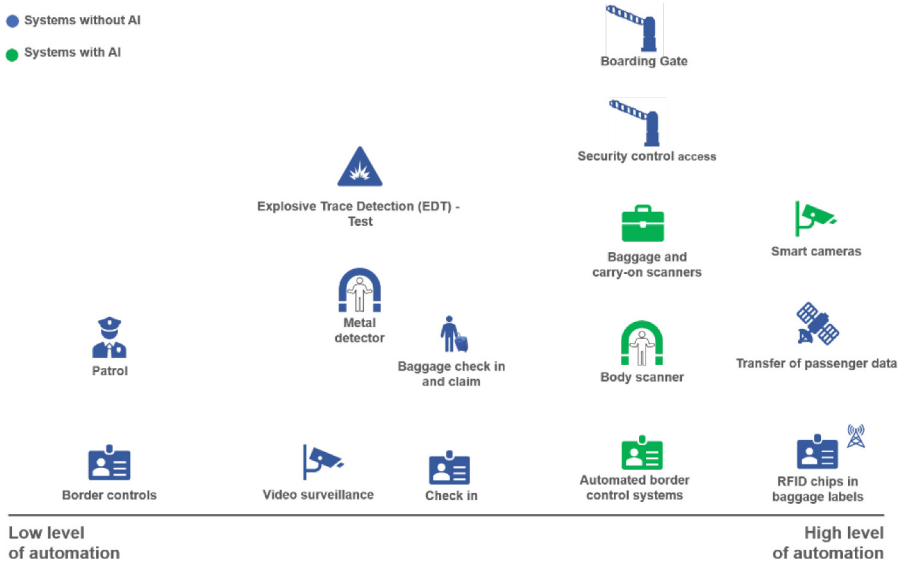

Fig. 1. Assessing the level of automation of security processes at airports based on current market offerings rather than system deployment

The passenger security process starts by purchasing the ticket [1]. The passenger name is sent to authority and compared with several databases [1]. Transmitting the data is highly automated [1]. The various types of check in (online, self-service and counter) are culminated by taking the arithmetic mean yielding a medium level. The security check solely by metal detector features a lower level than medium. Besides the metal detector, an explosives trace detection is conducted by personal using a wiping test. In the case of a manual check, due to e.g. an alarm, the level is low. An example for the application of AI is the body scanner [2]. Such AI-driven types of the security are displayed in Fig. 1 by a green icon. Checking the carry-on baggage is conducted by CT-scanners using AI to detect dissembled forbidden items [3]. Access to security check and gate is granted by scanning the boarding pass. In some cases, this procedure is not fully automatic leading to a high level of automation. The border control is undertaken by biometric scanners

and automatic door [4]. The presence of the security officer is mandatory and therefore the level is high. The automation level of baggage check is comparable to the passenger check in. Transportation and routing of baggage is fully automatic employing barcode or RFID [5, 6]. Checking baggage is comparable to the checking of carry-on baggage. The room surveillance is realized by security officer patrol and cameras [1, 7]. Additionally, cameras can be equipped with intelligent analytic software interpreting e. g. the behavior of persons using AI [7].

3 The Usage of Artificial Intelligence Within Airport Security

The processes described above are complex, involve human resources and need to be able to adapt to changing threat situations in the future. At the same time, quality, convenience and efficiency need to be increased at a high security level. Due to the high cost pressure, the design of the processes needs to make economic sense.

The use of AI offers an approach to address these challenges. Unlike humans, AI can make faster decisions, solve problems with less uncertainty in less time, and is constantly available [8]. In addition, human decision making is subject to errors. These errors can be reduced by using AI [9]. A disadvantage is the lack of flexibility under changing conditions.

Currently, AI is used independently in certain areas. One of these is intelligent video surveillance interpreted by AI. Here, the system independently learns to detect and report irregularities in the security area [10]. The project iBorderCtrl as another example represents an AI-based system for psychological profiling. This involves the automatic detection of deception in real time by analyzing people's nonverbal micro-expressions [11].

Another AI-based system is the monitoring of high-security areas accessible only to authorized personnel. This system uses electronic gates in conjunction with motion sensors and various types of cameras [12].

These and the previously described examples act independently of each other and thus represent stand-alone solutions. There is no exchange of information between the individual AI systems. Thus, no overall picture of the security situation can be created. To overcome this drawback, an AI solution is proposed below that has access to all security-relevant systems.

4 Holistic Interpretation via Artificial Intelligence

Figure 2 shows a scheme of the AI information flow. Different areas of the airport are shown with sensors (in blue) and actuators (in green). In the upper half are the above-mentioned security processes. By including safety (in the lower half), the AI is able to detect mutual ramifications.

Safety (accident prevention) and security (crime prevention) are by definition two separate areas. However, safety can have an impact on security and vice versa. For this reason, an overall concept is needed that covers both areas in the context of management—Especially of critical infrastructures such as an airport. Our proposal for such a

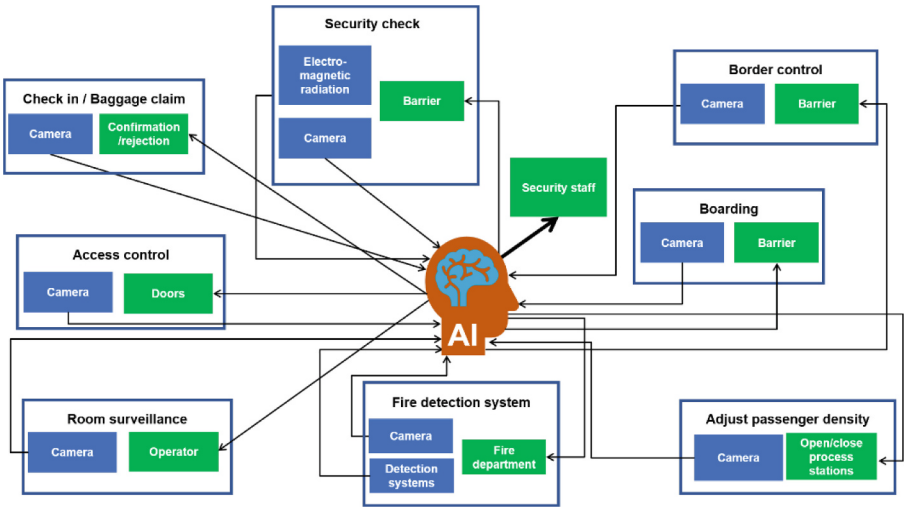

Fig. 2. Schema for the use of AI in different areas of security and safety

concept consists of a centrally managing and interpreting AI system. In contrast to existing AI systems, such an overall interpreting AI system is able to detect the intertwining of safety and security.

An example of the need to include safety is the false activation of a fire alarm with subsequent evacuation to an area at risk from attackers.

Smoke detectors offer the possibility to react to traces of fire in the air by means of laser sensors, temperature measurement and cameras or video technology. This automatically opens emergency exit doors and smoke vents in the event of a fire, closes key doors, and deploys emergency lighting [13].

However, the sensors can trigger a false alarm, for example, if the sunshine is at an unfavorable angle [14].

Thus, the possibility exists for terrorists to trigger an alarm by manipulating these sensors and exploit the response for an attack. This exploitation may consist, for example, of the deliberate placement of an explosive device—Disguised as an unattended item—Along the evacuation route of passengers. An AI having that has access to information from the smoke detectors can detect possible tampering by matching data from various sensors. In addition, such an AI can detect a coincidence in time between the occurrence of a fire alarm and an unattended item in the evacuation route by accessing information from the room monitoring system. Based on this detection, the responsible authorities are alerted with recommendations for action.

Another advantage of this overall system is the correlation of different security aspects. For example, the AI-enriched room monitoring can relate an unattended item in the terminal to the behavior of the originator. The originator is detected by the system using room monitoring, and at the same time, the AI detects suspicious behavior of the originator. The central AI system detects a critical situation and per-forms face recognition of the originator. With the help of the data determined by the face recognition, similarities are searched for in available databases. An image of the causer together with

the results serves as the basis for the action recommendation for the actuators, in this case the security personnel.

Such an overall system must be tailored to each airport, since each airport is individually designed, e.g., in terms of layout and security architecture. Those responsible for the security of an airport can thus realize an overall system by centralizing both the evaluation and the control. In order to obtain a system that takes care of the interpretation of the data, we propose an AI system adapted to the security architecture. In order for this AI system to detect and adequately respond to any threats, a learning process is necessary. This can be done, for example, with the help of scenarios. The German Aerospace Center (DLR) project E^2S^2AI (Evaluation and Evolution of Safety and Security with Simulation Based Artificial Intelligence) employs a different approach. The AI system learns by performing different factions within the security architecture. Feedback to the AI system on the success or failure of the action enables it to learn. To realize the potential of this learning method, it is beneficial to establish symmetry so that the system can compete against itself. For this reason, another system is introduced to test the weaknesses of the first's response. Both systems learn by responding to the other's action (see Fig. 3). Because both AI systems are adapted to an airport's security architecture, they can provide valuable advice on how to improve an airport's safety and security.

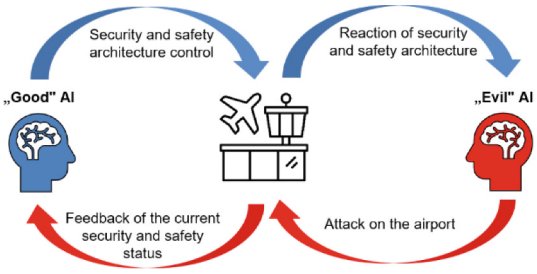

Fig. 3. E^2S^2AI method, two AI systems compete against each other to improve security at the airport

5 Conclusion and Outlook

The analysis of security processes shows an advanced level of automation and widespread use of AI in many areas. However, these are isolated solutions for specific tasks, such as facial recognition. The systems used do not provide for any exchange of information between the individual AI applications.

In this paper, we present a concept that centrally interprets and adequately acts on security-relevant information with the help of an AI. Such a system combined with adequate devices has the potential to speed up the reaction time to security incidents. In contrast to currently deployed AI systems, our concept presented in this paper is capable of detecting coordinated attacks and responding adequately. AI-enhanced room monitoring, for example, can establish a link between an unattended item in the terminal and the behavior of the originator. The identified information and corresponding recommendations for actions are immediately made available to the responsible parties.

The German Aerospace Center (DLR) project E^2S^2AI is investigating the methodological basis for this concept and its feasibility. In the process, an AI system is being developed that is intended to increase safety and security at the airport. This system consists of two components challenging each other. This approach leads to learning unforeseen types of attacks and the appropriate response. Subsequently, the aim is to test the method developed in E^2S^2AI with a real-world airport's security landscape. In addition, the data protection and acceptance of such a system will be evaluated.

References

1. TSA: Security Screening, (2023). https://www.tsa.gov/travel/security-screening Accessed 31 Aug 2023
2. European Commission: Communication from the Commission to the European Parliament and the Council on the Use of Security Scanners at EU Airports, (2023). https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52010DC0311. Accessed 31 Aug 2023
3. Airport Munich, Security Screening and Passport Control, (2023). https://www.munich-airport.com/security-screening-and-passport-control-3949908. Accessed 31 Aug 2023
4. German Federal Police: EasyPASS-RTP, (2023). https://www.easypass.de/EasyPass/EN/What_is_EasyPASS/home_node.html;jsessionid=B371E625806C60D9557D31553D6449D4.1_cid289. Accessed 31 Aug 2023
5. SICK Sensor Intelligence Detecting, (2021). https://www.sick.com/de/en/products-by-tasks/detecting/c/g304757. Accessed 31 Aug 2023
6. IATA: Baggage Tracking, (2023). https://www.iata.org/en/programs/ops-infra/baggage/baggage-tracking. Accessed 31 Aug 2023
7. Bonn International Center for Conversion: Innovationen zum Schutz deutscher Flughäfen vor Anschlägen. Bonn International Center for Conversion, Bonn (2008)
8. Kikuchi, S.: Artificial intelligence Applications to Critical Transportation Issues. Transp. Res. Board Natl. Acad. (2023) http://onlinepubs.trb.org/onlinepubs/circulars/ec168.pdf. Accessed 31 Aug 2023
9. Mezher, T., Asem, M., Maarouf, B.: Embedding Critics in Decision-Making Environments to Reduce Human Errors. Knowledge-Based Systems, Beirut (1998)
10. Donadio, F., Frejaville, J., Larnier, S. and Vetault, S.: Artificial intelligence and collaborative robot to improve airport operations, in M. E. Auer and D. G. Zutin, Online Engineering & Internet of Things Switzerland (2018)
11. Jupe, L.M., Keatley, D.A.: Airport artificial intelligence can detect deception: Or am I lying? Secur. J. **33**, 622–635 (2019)
12. Koroniotis, N., Nour, M., Schiliro, F., Gauravaram, P., Janicke, H.: A holistic review of cybersecurity and reliability perspectives in smart airports. IEEE Access. **8**, 209802–209834 (2020)
13. IKZ Haustechnik: Umfassende Brandschutzlösungen für Flughäfen, (2023). https://www.ikz.de/uploads/media/IKZF_200810_1775_Reportage.pdf. Accessed 31 Aug 2023
14. Berliner Morgenpost: Feueralarm am Flughafen BER—Bei ungünstigem Sonnenschein, (2023). https://www.morgenpost.de/flughafen-BER/article231725619/Brandmelder-fuehrten-zu-Fehlalarm-am-BER.html. Accessed 31 Aug 2023