ANAC AGÊNCIA NACIONAL DE AVIAÇÃO CIVIL

SMS | 10 ANOS

SAFETY MANAGEMENT SUMMIT BRAZIL

2025

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Soluções tecnológicas, equipamentos e procedimentos em Runway Safety

Torre Digital – D-TWR SC


ICAO
SAFETY
Runway Safety Programme –
Global Runway Safety Action Plan
Second Edition, February 2024

Prioridades Globais para a Segurança de Pista

- Abnormal Runway Contact
- Ground Collision
- Runway Excursion
- Runway Incursion
- Loss of Control on the Ground
- Collision with Obstacle(s)
- Undershoot / Overshoot

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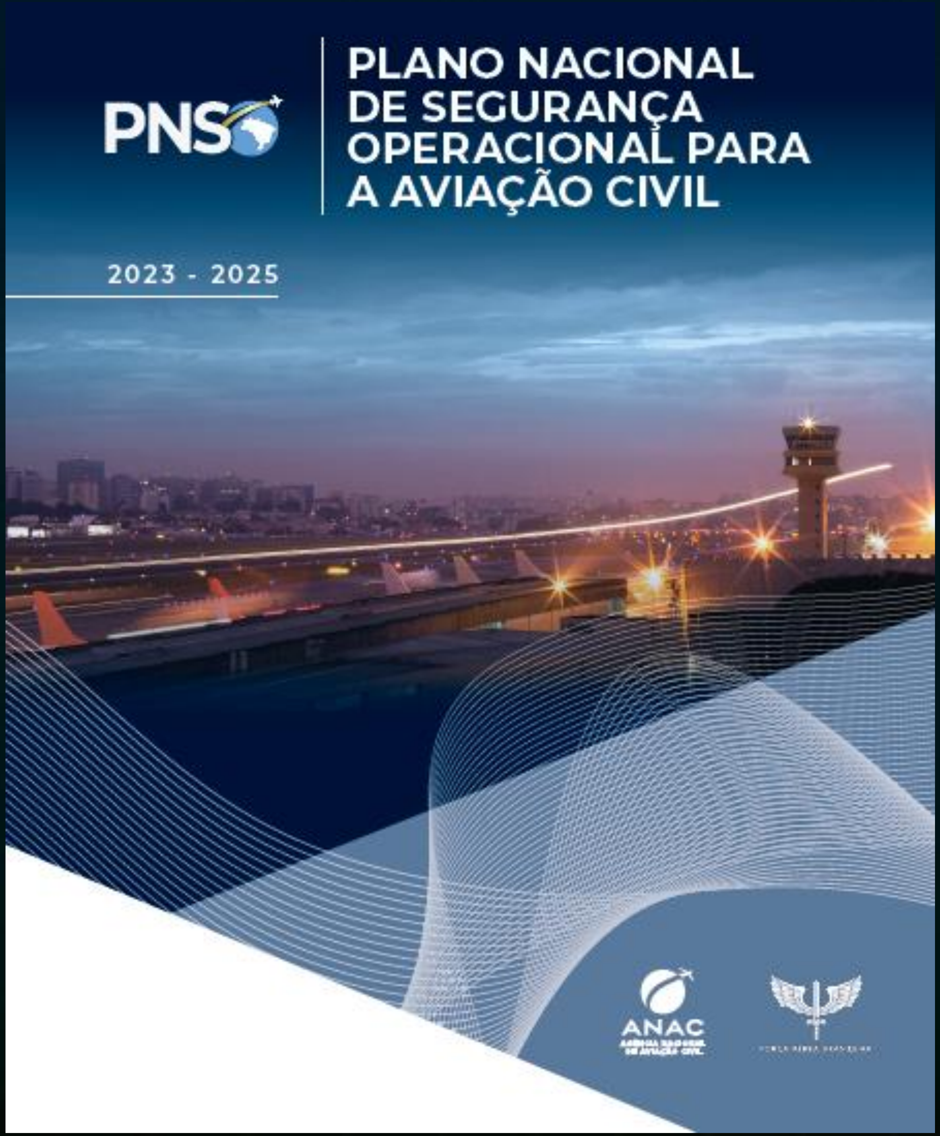
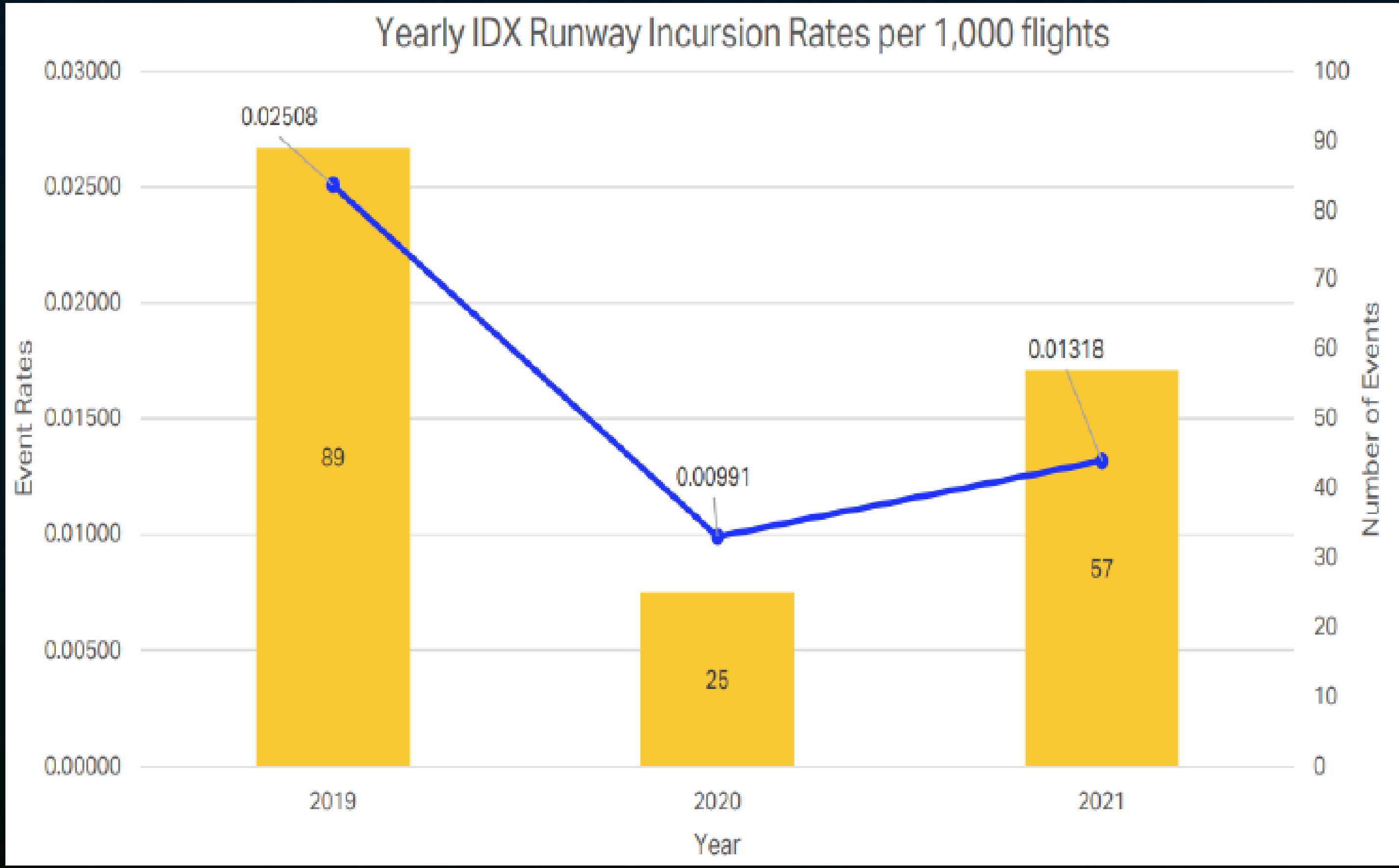


Categorias de Alto Risco para o TPR

- Controlled Flight Into or Toward Terrain
- Loss of Control in Flight
- Airprox / TCAS Alert / Loss of Separation / Near Midair Collisions / Mid-Air Collisions
- Runway Excursion
- Runway Incursion
- In-Flight Turbulence Encounter

Estatísticas de Incursão em Pista – IATA

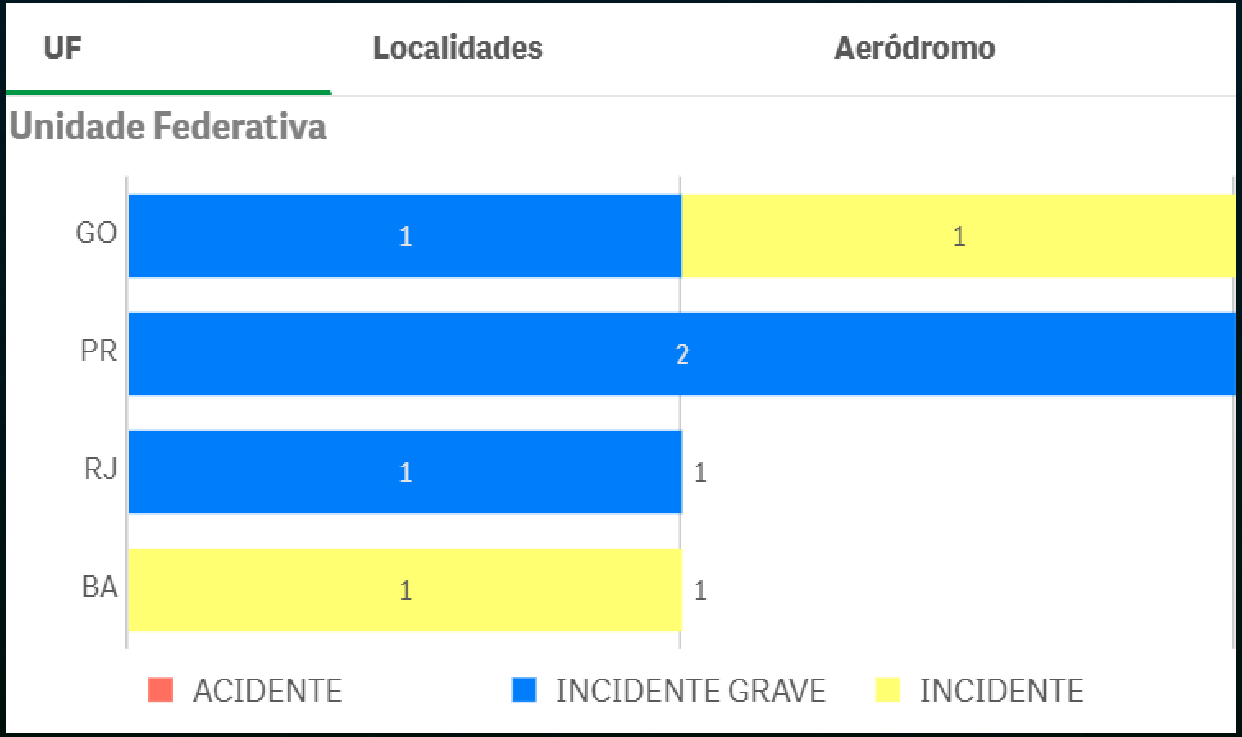


Estatísticas de Incursão em Pista - FAA

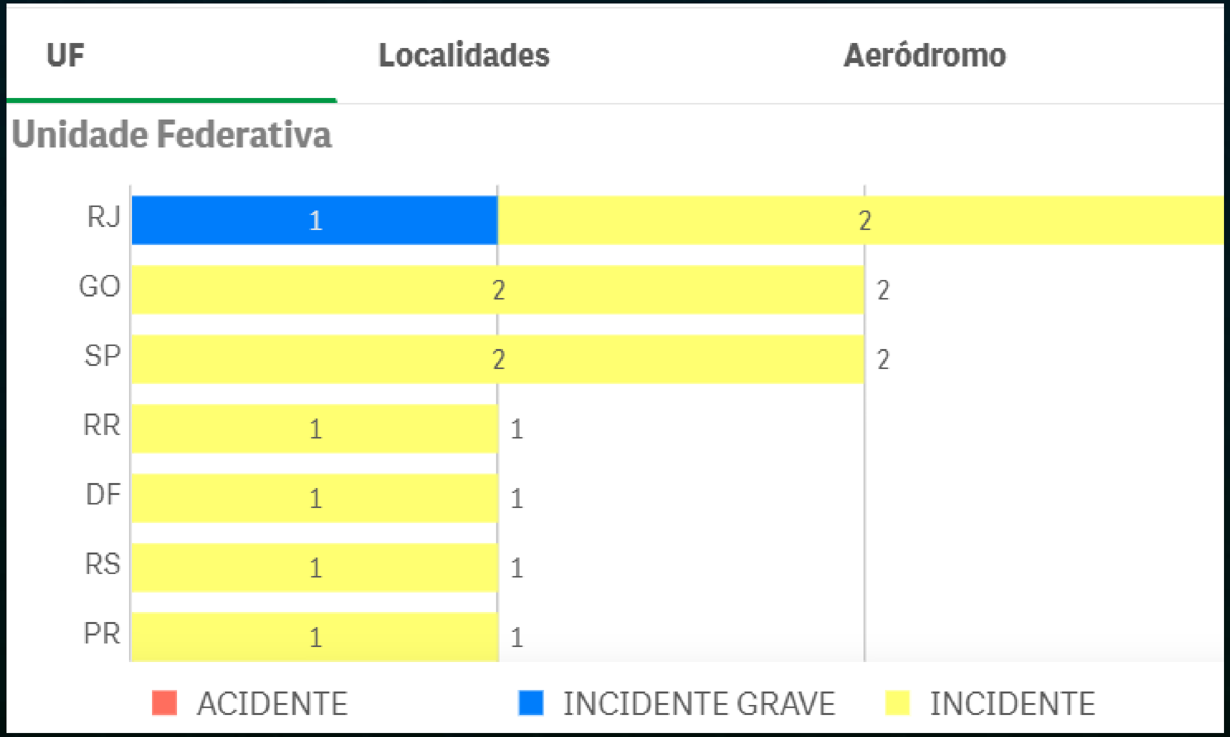
Regional Runway Incursion Totals for FY2025

Region	FY2025				
	Operational Incident	Other	Pilot Deviation	Vehicle/ Pedestrian Deviation	Total
Alaska (AAL)	3		20	11	**34**
Central (ACE)	2		45	10	**57**
Eastern (AEA)	28	4	83	32	**147**
Great Lakes (AGL)	33	10	107	47	**197**
New England (ANE)	13	2	31		**46**
Northwest Mountain (ANM)	35	4	101	23	**163**
Southern (ASO)	47	10	167	33	**257**
Southwest (ASW)	42	1	99	48	**190**
Western Pacific (AWP)	89	7	256	37	**389**
Total geral	**292**	**38**	**909**	**241**	**1.480**

Estatísticas de Incursão em Pista - CENIPA

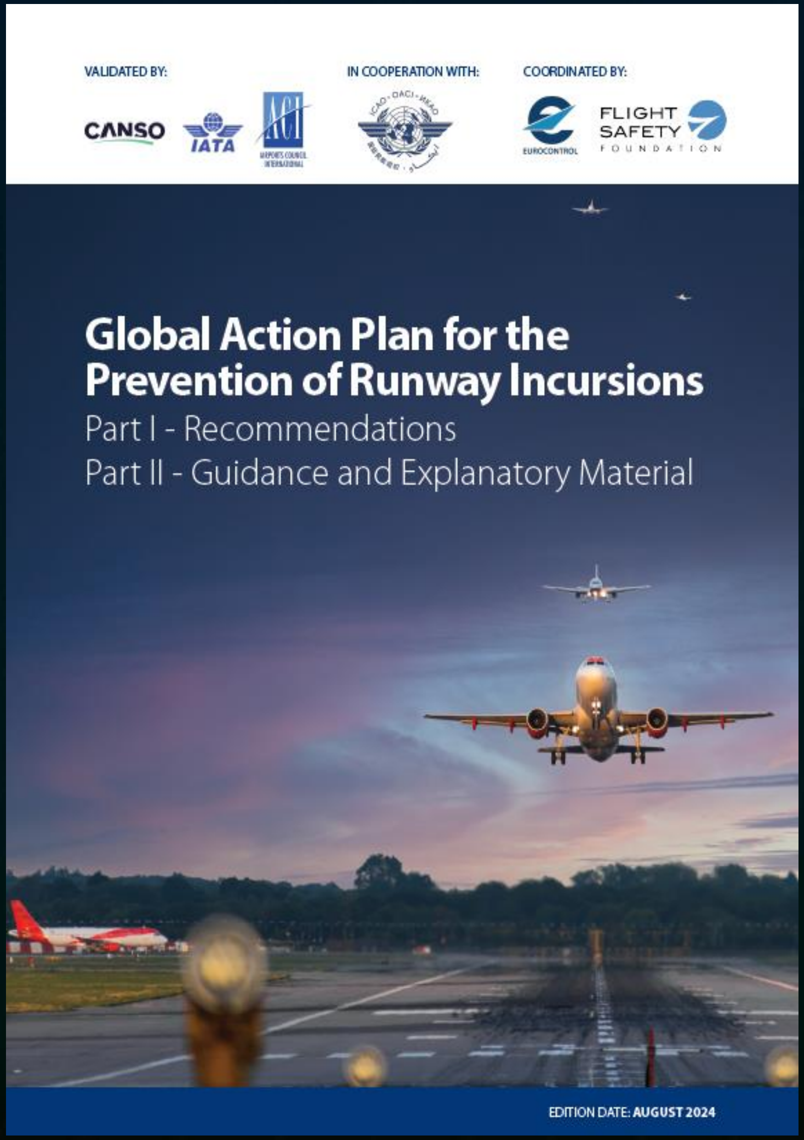


Total 2024: 6



Total 2025: 11

Plano de Ação Global para a Prevenção de Incursões de Pista



RECOMMENDATIONS TO AIR NAVIGATION SERVICE PROVIDERS

REF	Recommendation
	SAFETY MANAGEMENT AND SUPPORT FOR RUNWAY SAFETY TEAMS
ANSP1	Support the regulator to periodically assess the effectiveness of aerodrome local runway safety teams (LRSTs), including the existence and implementation of runway safety action plans. Annually assess own contribution to the effectiveness of the aerodrome LRSTs. Promote the creation and support the work of a national runway safety team.
ANSP2	Ensure harmonised awareness of runway incursion risk management procedures, practices and issues among the front-line operators (pilots, air traffic controllers and manoeuvring area vehicle drivers). Support aerodrome operators to develop aerodrome-specific educational materials to familiarise pilots and vehicle drivers with hot spots and other aerodrome-specific safety information in the aerodrome environment.
ANSP3	Annually assess, and update as necessary, how runway incursion risk management is included within initial and refresher/recurrent training of operational staff.
ANSP4	Ensure that information is provided to, and requested from, all participating parties in an incident, so that a complete picture of causal and contributory factors can be built, lessons learned and actions taken.
ANSP5	Share at local, national and international level the lessons learned and salient safety information from occurrence investigation reports and runway safety analyses.
ANSP6	Ensure that arrangements are in place to coordinate changes to manoeuvring area procedures, including work in progress, with stakeholders operating on the manoeuvring area of the aerodrome. Periodically assess the effectiveness of the arrangements and update as necessary.
ANSP7	Periodically (initially and upon change) review runway capacity–enhancing procedures when used either individually or in combination (intersection departures, multiple line-ups, conditional clearances etc.) to identify any potential hazards and, if necessary, develop appropriate mitigation strategies.
ANSP8	Annually assess the consistency of runway safety procedures for operation on the manoeuvring area of the aerodrome internally and at LRST meetings. The assessment should include coordination and communication procedures and practices between ATC work positions and between ATC and the other parties operating on the manoeuvring area.
ANSP9	In coordination with the aerodrome operators, periodically review the procedures for runway inspections and other runway works. This should include: a. Carrying out routine runway inspections in the opposite direction of runway movements with illuminated vehicle lights regardless of time of day. b. Informing flight crew of the runway inspection in progress in case of aircraft on final approach or approaching the runway holding position. c. Implementing procedures to increase overall situational awareness when vehicles occupy a runway (to be decided locally, e.g., technology, 'vehicle operation normal' calls or other means). d. Implement standard routes and timings for routine runway inspections. e. Wherever practicable, approval for a planned runway inspection should be given when there is sufficient time for the inspection to be carried out without any interruption. f. New procedures and technologies (e.g., unmanned aircraft systems) for runway inspection should be assessed for future implementation.
	SAFE RUNWAY OPERATIONS COMMUNICATIONS
ANSP10	Develop and implement a phased plan for use of one frequency and English language for all communication associated with the operation of a runway. The phased plan should aim at improving the shared situational awareness of all front-line operators and should include realistic and practicable measures that provide an adequate level of safety for each of its phases.

REF	Recommendation
ANSP11	Periodically evaluate radio telephony practices, assessing elements such as frequency loading and use of ICAO-compliant phraseology. Promote wherever practical ATC teamwork in crosschecking communication messages and read backs.
ANSP12	Ensure that ATC communication messages are not overly long or complex in order to assist pilots and vehicle drivers to maintain good situational awareness whilst taxiing or during critical stages of operations.
ANSP13	Ensure that, whenever practicable, en route clearances are passed prior to taxi, and, in order to avoid flight crew distractions during taxi, consider passing any revision to the en route clearance whilst the aircraft is stopped.
ANSP14	Ensure that air traffic controllers always use the phrase: "HOLD POSITION" when passing a revised clearance to an aircraft that is at a holding position or on the runway.
ANSP15	In cooperation with aerodrome operators, implement procedures for airside vehicle drivers, including standard phrases for: a. Radio checks and readability scale. b. Radio communication failures (transmitting blind). c. The use of predefined and process-specific discrete call signs for manoeuvring area vehicles. d. When a driver becomes lost or uncertain of a vehicle's position in the manoeuvring area. e. Position reporting. f. Runway access and runway crossing requests
ANSP16	In relation to conditional clearances: a. The procedures should eliminate or mitigate the risk of the operational use of conditional clearances. b. If conditional clearances are used, ensure a policy and procedures are developed and implemented in accordance with ICAO provisions. c. Ensure that air traffic control officers (ATCOs) are aware of potential threats and errors when using conditional clearances.
	AERONAUTICAL INFORMATION
ANSP17	In relation to aeronautical information: a. In coordination with aerodrome operators, implement procedures to ensure that significant and up-to-date aerodrome information which may affect operations on the runway is provided to manoeuvring area drivers and pilots (e.g., by notices to airmen (NOTAMS), ATIS, R/T, maps, new digital technology or other means). b. Information on temporary changes to operating conditions at the aerodrome should be optimised to increase the situational awareness of the most critical changes. When needed, an AIP supplement with graphics and charts should be published.
	SUPPORTING PILOT WORKLOAD AND PRESSURES MANAGEMENT
ANSP18	In relation to standard taxi routes: a. Assess the risk potential of taxiing traffic confusion on or near the runway and mitigate it by implementing, whenever practicable, the use of standard taxi routes. b. If standard taxi routes are implemented, they should be published with clear designators. c. To reduce complexity during taxi operations, the number of published standard taxi routes should be restricted to only the routes with potential risk of taxiing traffic confusion.
ANSP19	When planning a runway assignment change for departing or arriving traffic, consider the time the flight crew will need to prepare/rebrief. As far as practicable, changing the runway assignment for an aircraft taxiing for departure should be avoided.

REF	Recommendation
ANSP20	To prevent pilots from taking the wrong intersection, a line-up and/or take-off or crossing clearance should be issued only when the aircraft is at or approaching the runway holding position and there are no intersections on the taxiway ahead of the aircraft.
ANSP21	Line-up clearance should not be issued if: a. The pilot has reported the aircraft is not ready to depart. b. The aircraft is expected to wait on the runway for more than 90 seconds for the take-off clearance. If the aircraft holds on the runway for longer than 90 seconds, an updated instruction should be provided to the pilot.
ANSP22	If the take-off clearance is not issued together with the line-up clearance, the phrase "line-up and wait" should be used.
ANSP23	Ensure that when an aircraft is instructed to line up and wait due to a reason other than usual runway traffic spacing, the aerodrome controller provides the reasons for waiting (e.g., provides information about traffic to cross the runway).
ANSP24	Issuance of a premature or late landing clearance should be avoided. Criteria should be decided locally (e.g., not before the final approach fix/final approach point (FAF/FAP), not below 1,000 ft above ground level).
ANSP25	Assess the policy, procedures and practices related to the use of "immediate departure" to avoid, as far as practicable, its use or mitigate the associated runway incursion risks.
ANSP26	Assess the policy, procedures and practices related to the use of line-up clearance while runway inspection is in progress to avoid, as far as practicable, its use or mitigate the associated runway incursion risks.
	ENHANCED PROCEDURES FOR SAFE RUNWAY OPERATIONS
ANSP27	Assess the current procedures and practices regarding runway occupancy status and ensure the use of memory aids, considering also the availability of new/emerging technologies.
ANSP28	a. In cooperation with aerodrome operators, implement H24 stop bars or other lighting systems (e.g., ARIWS) at all active runway holding positions to provide a level of safety commensurate with the level and complexity of operations and the potential risk of runway incursion. b. Ensure that stop bars at runway holding positions are controlled by the controller in charge of the runway operations on that runway (aerodrome controller). c. In cooperation with aerodrome operators, implement procedures, in line with the applicable regulations to be followed in case of stop bar unserviceability.
ANSP29	Assess the sight lines from the tower visual control room (VCR) and existing visibility restrictions which have a potential impact on the controllers' ability to see the runway and: a. Implement appropriate short-term mitigations, and b. Identify longer-term improvement measures.
ANSP30	Review controllers' tasks, the operational environment and operating procedures to ensure optimal "heads-up" time for aerodrome controllers.
ANSP31	Ensure that operating procedures include monitoring of aircraft vacating runways, in particular where the exit taxiway may lead directly to another runway (crossing).
	ENHANCED TECHNOLOGY FOR SAFE RUNWAY OPERATIONS
ANSP32	Consider the implementation of runway safety nets and emerging technologies that can improve the situational awareness of front-line operators.
ANSP33	Improve situational awareness by adopting the use of technologies that enable location identification of traffic on the manoeuvring area (e.g., via GPS with transponder, Mode S squitter).

Recomendação ANSP13

Garantir que, sempre que praticável, as autorizações em rota sejam transmitidas antes do táxi e, para evitar distrações da tripulação durante o táxi, considerar transmitir qualquer revisão da autorização em rota enquanto a aeronave estiver parada.

Recomendação ANSP32

Considerar a implementação de redes de segurança de pista e tecnologias emergentes que possam melhorar a consciência situacional dos operadores.

e.g.: Advanced Surface Movement Guidance & Control System (A-SMGCS), Runway Monitoring Conflict Alert (RMCA), Conflicting ATC Clearance e Runway Status Lights (RWSL) ou Digital Towers

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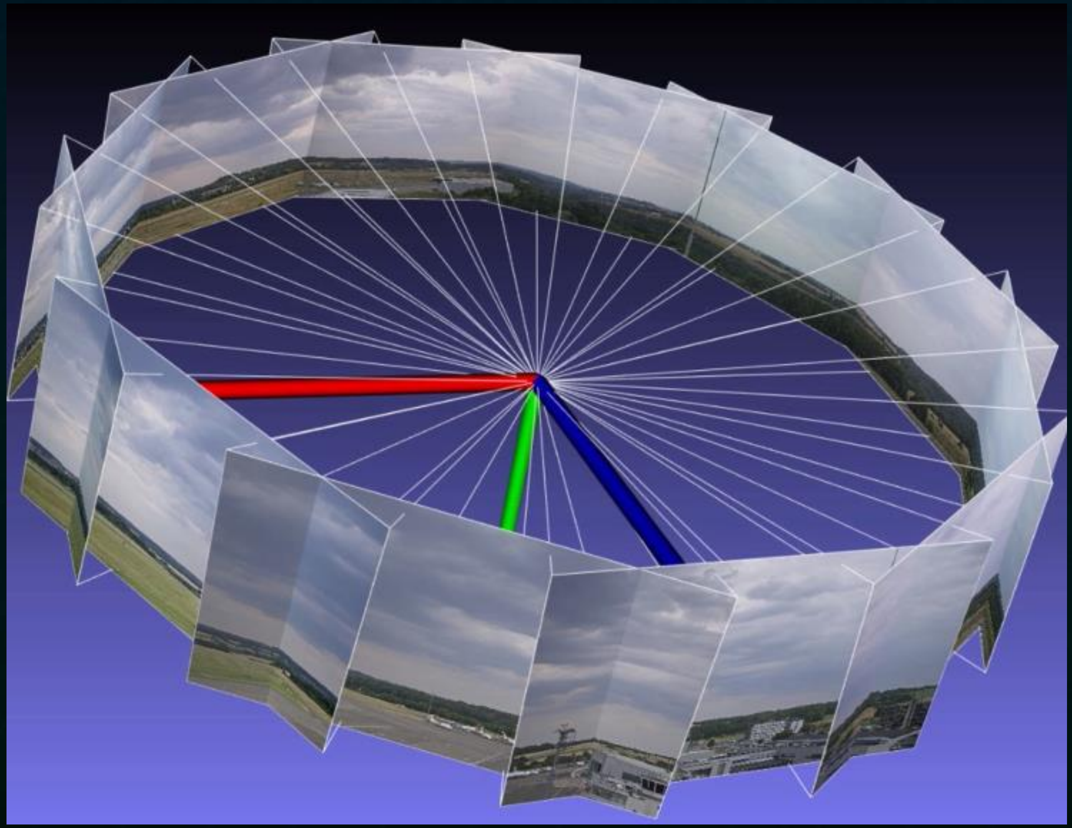
Torre Digital da Base Aérea de Santa Cruz

Sistema com 14 telas de 55 polegadas em resolução 4K.

Cobertura de 360 graus da área de movimento do aeródromo.

Câmeras Fixas e Móveis

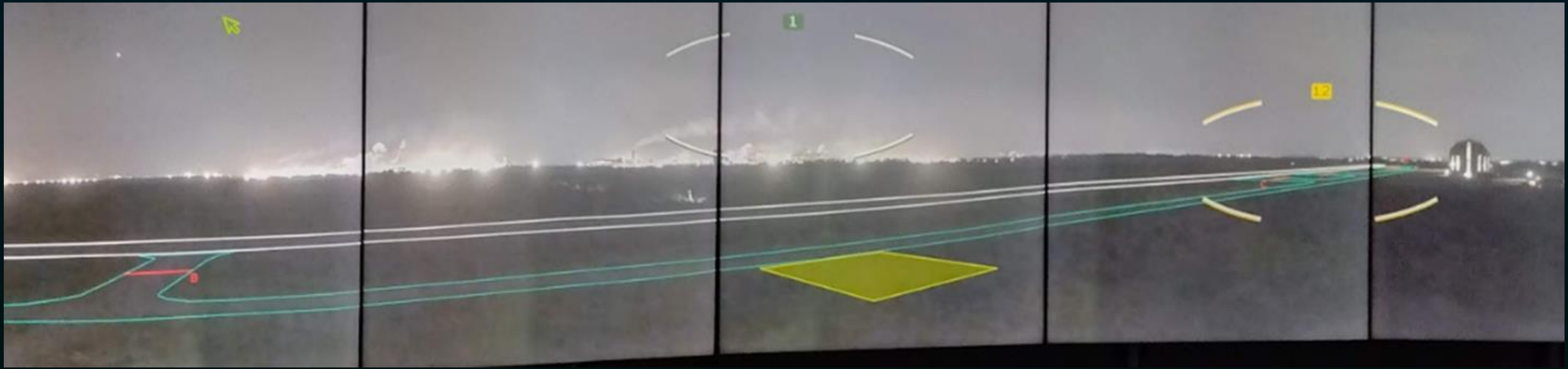
Telas Panorâmicas



Vantagens

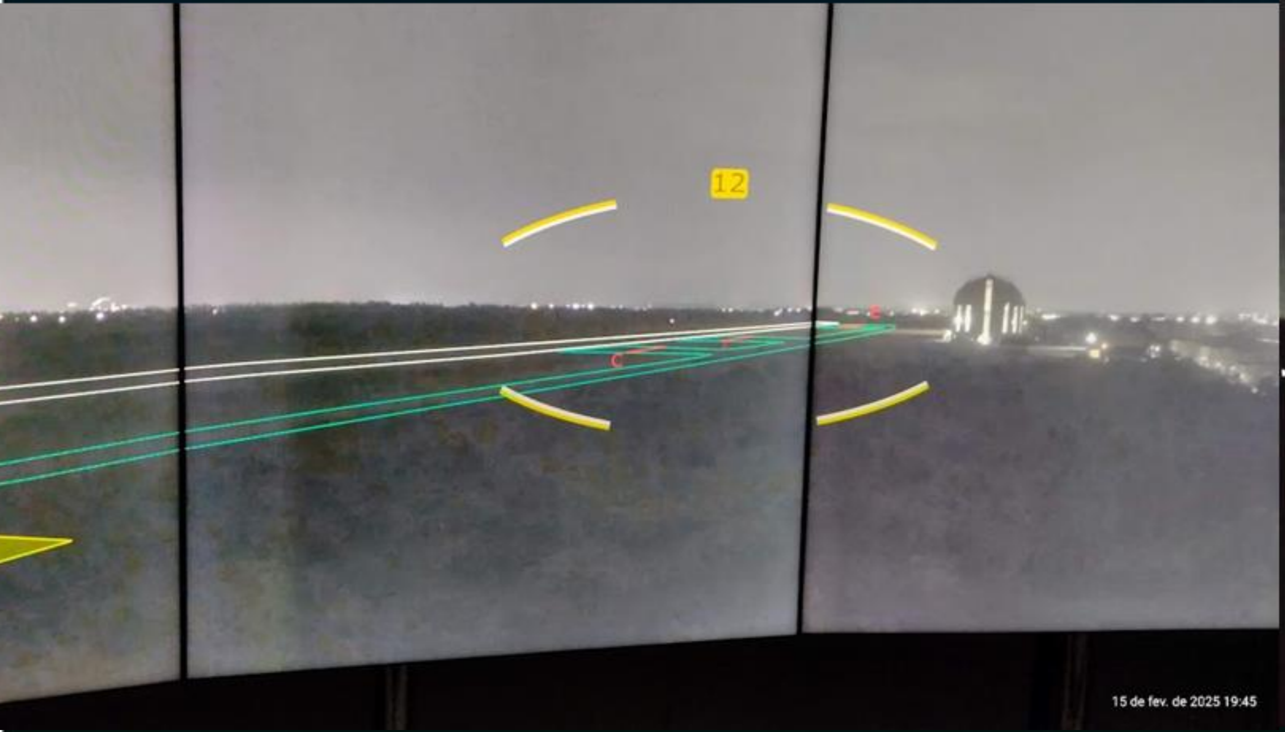
- Segurança e conforto para os operadores;
- Sistema de Visualização aumentado - zoom;
- Visualização noturna melhorada;
- Delimitação da área de manobras - overlay;
- Ganho da visualização dos pátios Norte e Oeste; e
- Etiqueta do tráfego na tela panorâmica (integração com o SAGITARIO).

Função Overlay



As elipses representam a direção e a quantidade de zoom das câmeras móveis

Visão noturna ampliada



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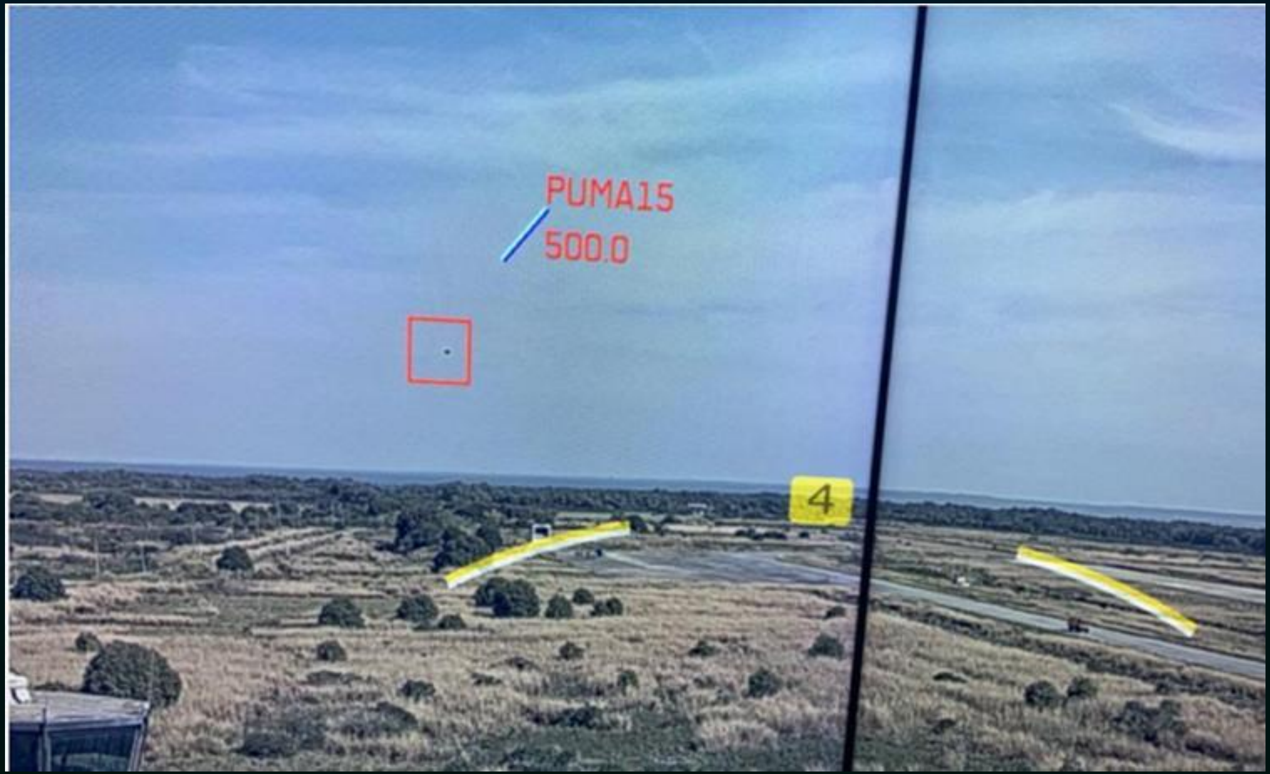
Função Bounding



Capacidade de detecção de movimentos superiores a 4 pixels.

Óbices

- Diminuição do tamanho real da imagem. Para aeronaves de pequeno porte a visualização fica deficiente;
- Perda da visão 3D (profundidade);
- Maior foco do controlador no tablet do que nas telas panorâmicas (Check farol e paraquedas);
- Maior probabilidade de degradação para AFIS do que nas TWR convencionais:
- Necessidade de manutenções corretivas na torre das câmeras (troca de sílicas, troca de vedação, house de câmeras, abelhas e ninho de aves); e
- Necessidade de Contrato de Suporte Logístico de manutenções específicas.

O futuro em Runway Safety

RESEARCH ARTICLE

An Overview on Computer Vision Analysis in the Airport Applications

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ABSTRACT This research serves a dual purpose: it aims to map the current landscape of knowledge in a field rich with technological challenges while simultaneously showcasing innovative techniques that demonstrate the transformative power of computer vision in airport applications. To achieve this, the study offers a thorough analysis of various object recognition and tracking methods, exploring their implications both in general contexts and specifically within airport environments. As airport operations become increasingly complex, the integration of advanced technologies such as computer vision and AI models is essential. This review examines a variety of object detection and tracking techniques, including deep learning models, traditional algorithms, and hybrid approaches, highlighting their effectiveness in addressing specific challenges to airport environments and detailing their performance under real-world conditions such as adverse weather, occlusion, low visibility, and data privacy concerns. A key insight is the superior capability of deep learning techniques, which, through multiscale feature extraction and region proposal strategies, provide enhanced detection accuracy and robustness in dynamic airport settings. In addition, emerging trends such as federated learning and hybrid sensor fusion are explored, emphasizing their potential to improve scalability and situational awareness by integrating data from various sources, including radar and optical sensors. The analysis also examines precise aircraft detection to optimize ground operations, real-time runway surveillance to ensure safe takeoffs and landings, and advanced passenger monitoring systems that improve security by identifying potential threats. These findings underscore the pivotal role of computer vision in improving operational efficiency and safety while laying the foundation for the future development of intelligent, integrated airport management systems.

INDEX TERMS Aeronautical applications, deep learning, computer vision, federated learning, object detection, object tracking, hybrid sensor.

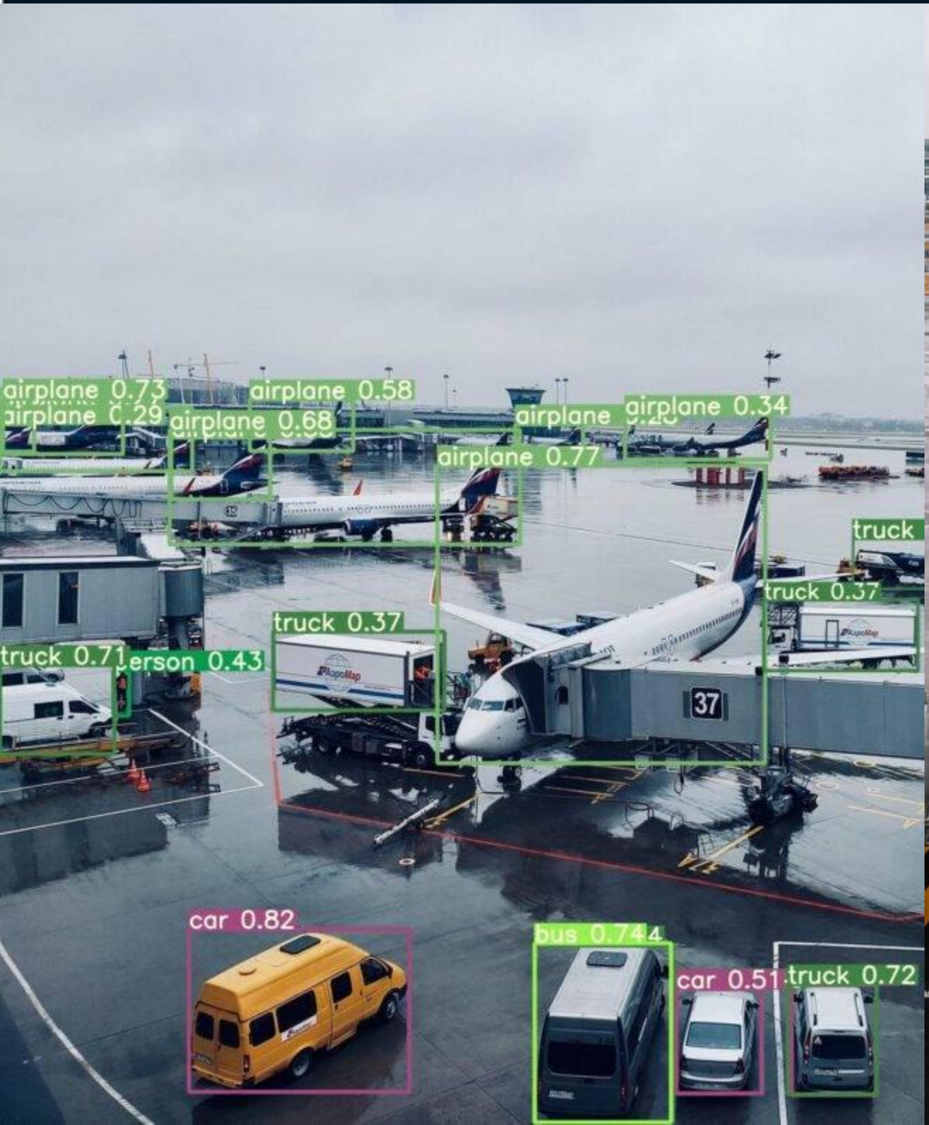
I. INTRODUCTION

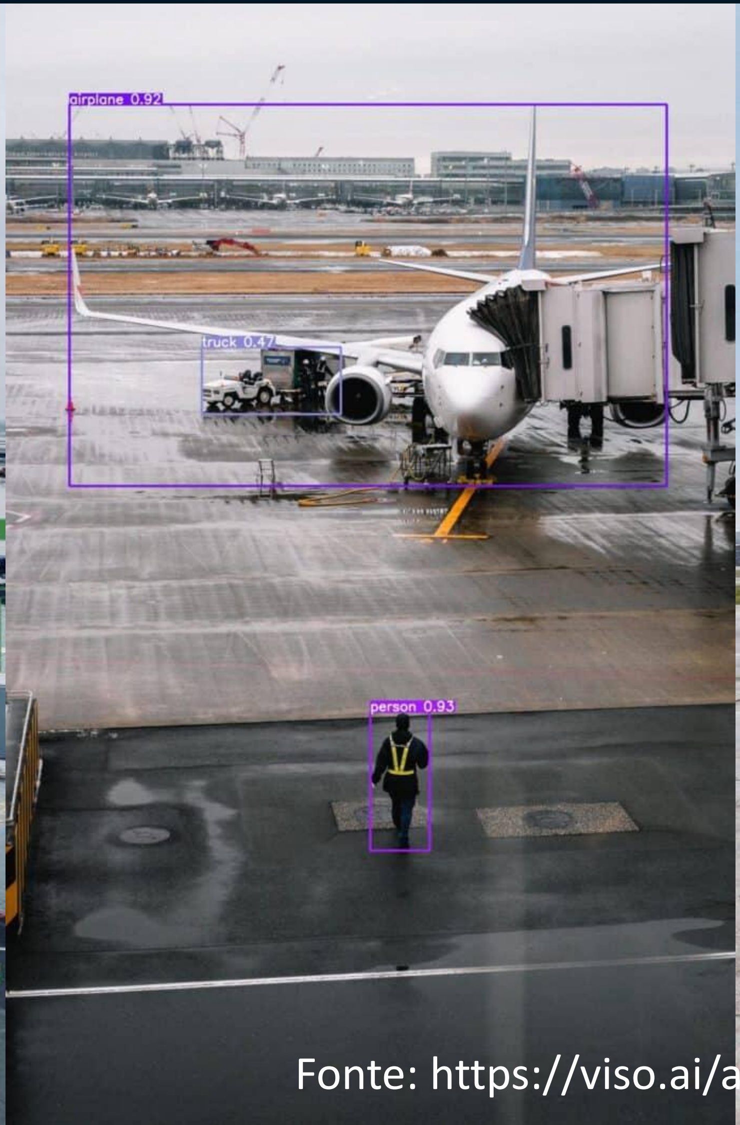
For several decades, the advancement of methods that allow computers to recognize and comprehend visual input has been a significant area of research [1]. This journey began in 1959 when neurophysiologists conducted experiments in cats to understand how visual stimuli affected brain responses. During the same time, the launch of an initial vision detector was unveiled, allowing computers to capture and digitize pictures. This marked a pivotal moment in the 1960s when academic interest in artificial intelligence (AI) surged, particularly with respect to its potential to solve challenges related to human vision. In 1974, the advent of optical character recognition (OCR) technology enabled machines to recognize printed text in various fonts and typefaces. Based on this framework, neural networks were used to analyze handwritten text for intelligent character recognition (ICR) [2]. Both OCR and ICR have found widespread application in numerous fields since their inception. The neuroscientist David Marr developed in 1982 a machine algorithm to identify fundamental visual elements such as edges, corners, and curves, based on the hierarchical nature

The associate editor coordinating the review of this manuscript and approving it for publication was Mohd Tariq.

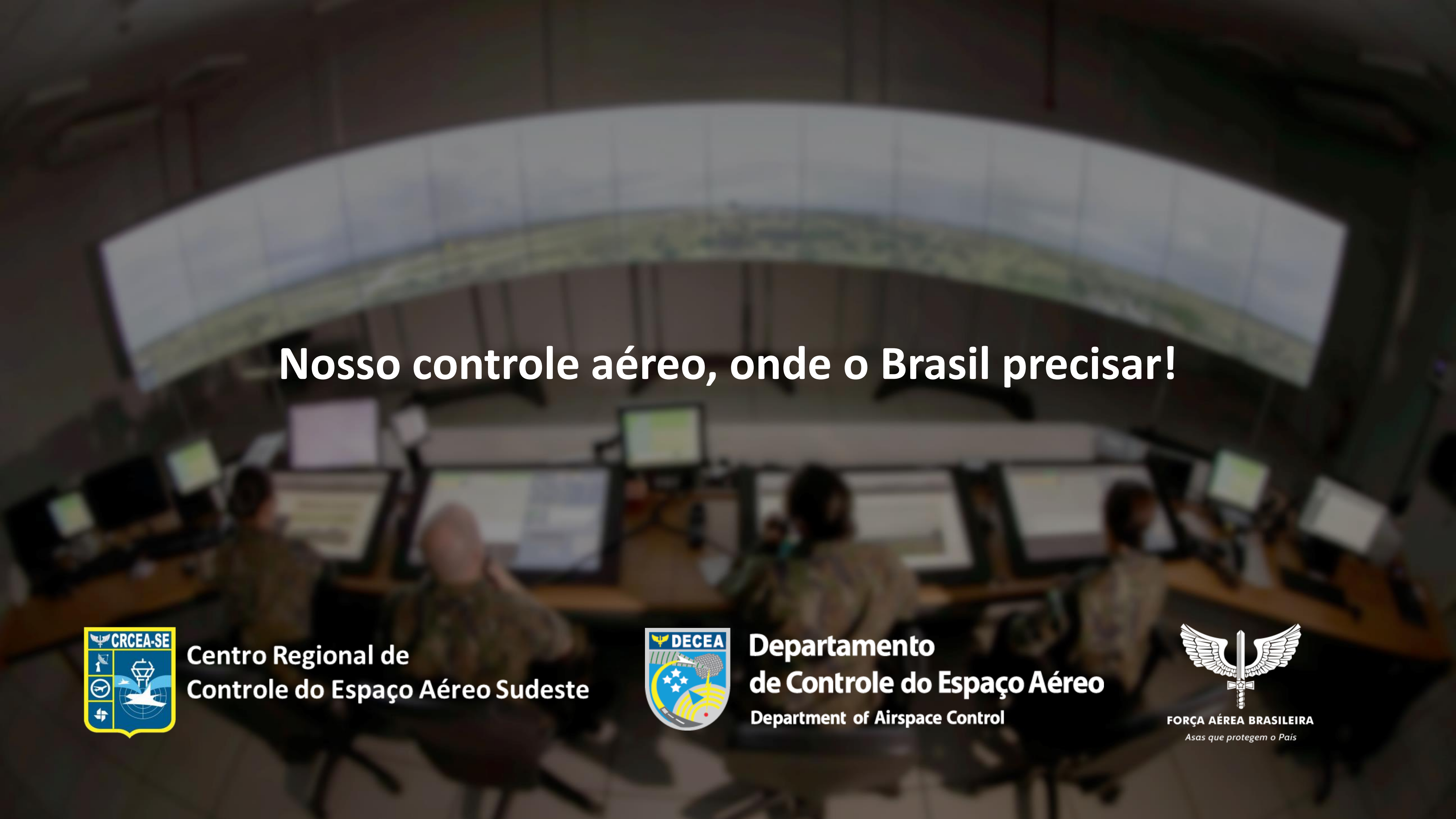
Esse estudo oferece a análise de vários métodos de reconhecimento e rastreamento de objetos, explorando suas implicações em ambientes aeroportuários.

Os achados destacam o papel da visão computacional, ao mesmo tempo que estabelecem as bases para o desenvolvimento futuro de sistemas inteligentes de gerenciamento aeroportuário.





Fonte: https://viso.ai/applications/computer-vision-in-aviation/



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