International Civil Aviation Organization
CAR/SAM Regional Planning and Implementation Group (GREPECAS)

INFORMATION PAPER

GREPECAS/21 — WP/52
02/11/23

Twenty-first Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/21)
Santo Domingo, Dominican Republic, 15 to 17 November 2023

Agenda Item 6: Other Business

USE OF REMOTE SENSING OF IMAGES OBTAINED BY REMOTELY PILOTED AIRCRAFT (RPA) APPLIED TO THE EVALUATION OF OBJECTS PROJECTED IN AIRSPACE ACCORDING TO ANNEX 14 - OBSTACLE LIMITATION SURFACES (OLS)

(Presented by Brazil)

EXECUTIVE SUMMARY

The use of drones in the acquisition of aerial photogrammetric restitution and images emerges as a technology for obtaining cartographic information in three-dimensional format, aiming at the verification of objects projected in the airspace, which may cause adverse effects on the safety or regularity of air operations at a particular aerodrome or heliport. With the geoprocessing of the images coming from drones it is possible to build digital terrain models and elevation, in addition to obtaining accurate planialtimetric coordinates to verify and validate processes of analysis of Objects Projected in the Airspace, under the Air Force Command (COMAER).

Action:	Suggested actions will be presented in Section 4.
Strategic Objectives:	• Air navigation safety; • Determination of obstacles in aerodrome protection zones; • Determination of aeronautical information of an aerodrome.
References:	• Annex 4 – Aeronautical Charts; • Annex 19 – Safety Management; • LAR 77 – Reglamento Aeronáutico Latinoamericano.

1 Introduction

1.1 The analysis of objects projected in airspace in the vicinity of aerodromes and helipads is of paramount importance to verify and mitigate risks to aviation in general.

1.2 The Annex 14 Obstacle Limitation Surface (OLS) establishes general parameters for limitation surfaces of different natures in aerodromes, such as approach, takeoff, and transitional. From this concept, Brazil created the nomenclature Basic Plan of Aerodrome Protection Zone (PBZPA), disseminated in other Latin American countries (CAR/SAM region), comprising a set of different types of OLS. This Basic Plan establishes airspace surfaces exclusively for aircraft flight, restricting, for example, the construction of buildings at heights that may endanger occupants or impact flight safety. By observing these plans, it is possible to visualize, in a tridimensional map over the airport, the limits for the distance and heights of buildings in the vicinity.

1.3 Therefore, the use of remotely piloted aircraft in the acquisition of cartographic information of regions with large population density around airports will promote faster actions in covering large territorial swathes, safety in projects of urban expansion located within protection zones, and modelling of main problems that may have severe consequences to airmen, in approach and takeoff maneuvers of aircraft.

1.4 By analyzing altimetric information of raster images, possible obstacles could be identified, arising from OPEA in the delimiting surfaces of the airport with the use of existing Geographical Information Systems computational tools. These analyses must follow reliability parameters and minimum acceptance requirements, according to the foreseen in Brazilian standards on aeronautical data and information requirements. Therefore, it would be necessary to predict the quality of cartographic bases used in the study to provide reliability and metadata structures for the matrix operations between the pixels. The use of Geographical Information Systems as a multicriteria analysis tool is widespread and accepted by several professionals who wish to know better the studied environment, other than studies on the management of obstacles that have an adverse effect in several important stages in the field of air procedures.

1.5 Therefore, the use of drones to map the implementations provides agility in the acquisition of images that could be translated into numerous cartographic information. With orthophotos, the users could extract accurate and relevant information, from geoprocessing and data manipulation in geographical information systems, to obtain Digital Surface Models (DSM) and Digital Terrain Models (DTM). The use of geoprocessing to build orthophotos and digital surface models in airports is recurrent and presents satisfactory results of planialtimetric information of features such as vegetation, transmission lines, buildings and others.

2 Discussion

2.1 This Information Note presents a case study, in which cartographic products and their respective analysis are presented, using digital image processing techniques and remote sensing. Thus, digital image processing software applications were used, namely Pix4D, ArcGIS, Global Mapper and AutoCAD, to work with supplementary techniques of remote sensing, by using the remotely piloted aircraft Phantom 4 RTK, marketed by the company DJI (Da-Jiang Innovations Science and Technology).

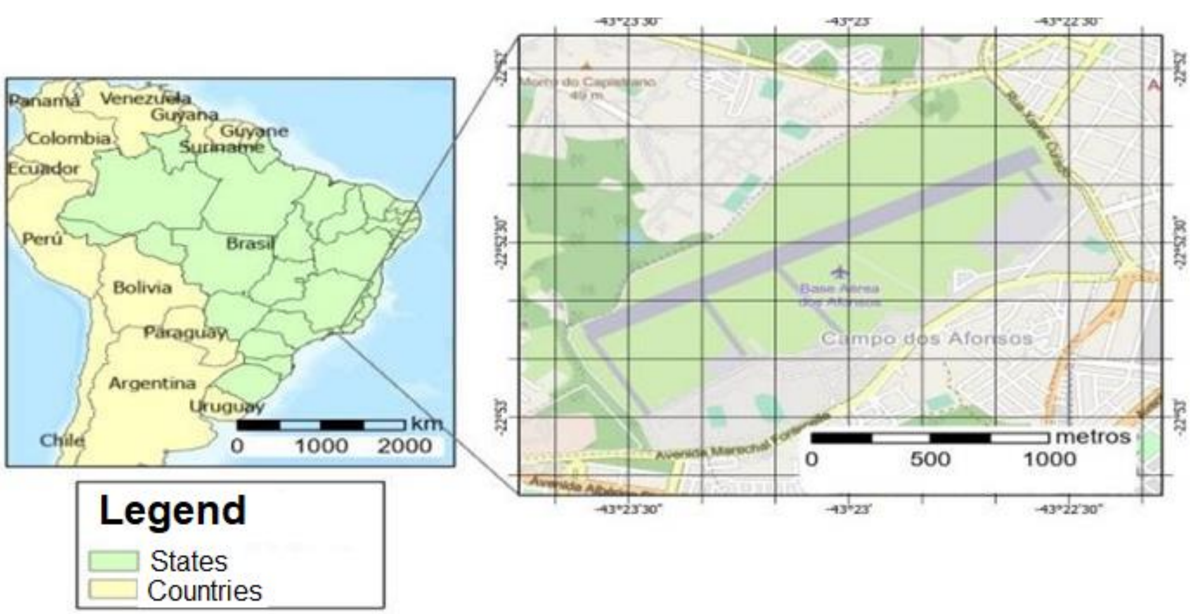

Figure 1 Map of the study area

2.2 The development of field work began with the creation of lines of drone flight plan, request of permission from regulatory bodies and aerodrome administrators, and planning of the acquisition of support points through GNSS/RTK receptors. Next, an aerial photogrammetric flight of the study area was performed, by using the drone Phantom 4 RTK, which uses a GNSS/RTK base for real-time correction of the distortions from photos taken. With the Pix4D software, images restitution and orientation were performed with the purpose of forming stereoscopic pairs. Therefore, for reliable cartographic analyses, it is necessary to correct the images and proceed to the orthorectification to enable each pixel to be relocated in its geometric position, as vertically as possible. In this way, it is possible to correct distortion effects and influences of relief. All the stages of the process can be seen in Figure 2, presenting the methodology flowchart:

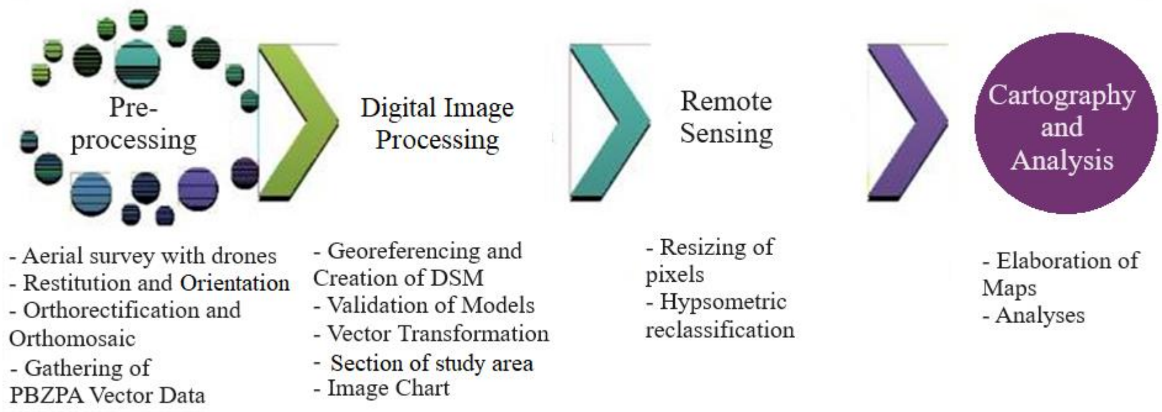

Figure 2 – Methodology flowchart

2.3 Next, the Basic Plans, based on Annex 14 Obstacle Limitation Surface (OLS), were obtained, via DECEA AGA Portal, in a planimetric vector format. In this study, the focus will be on the approach and takeoff surfaces that serve threshold 26 of the landing and takeoff runways (LTR), since they are the most critical zones for aerodrome air operations. In the stage of digital image processing, the georeferencing of digital surface model was performed for the study area. For that, the Universal Transverse Cartographic Projection System of Mercator (UTM), time zone 23, embedded in the Brazilian Geodesic System, SIRGAS 2000, was assigned to the model. Based on the support points in the field, obtained via the GNSS positioning system, the accuracy of the Digital Surface Model was validated, as generated by the aerial survey with drones, by using specific software and analysis based on Pix4D processing quality reports.

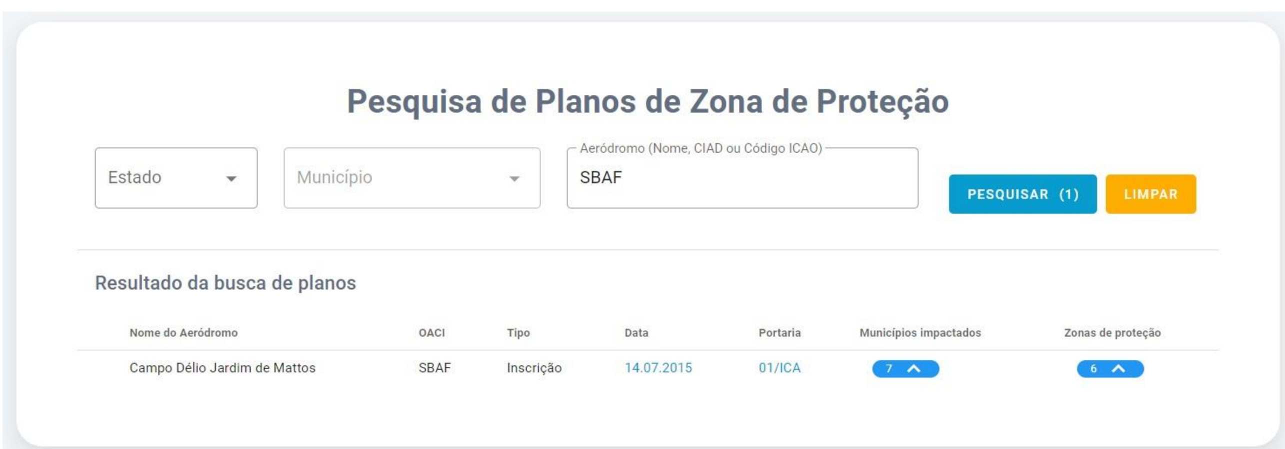

Figure 3 – DECEA AGA Portal

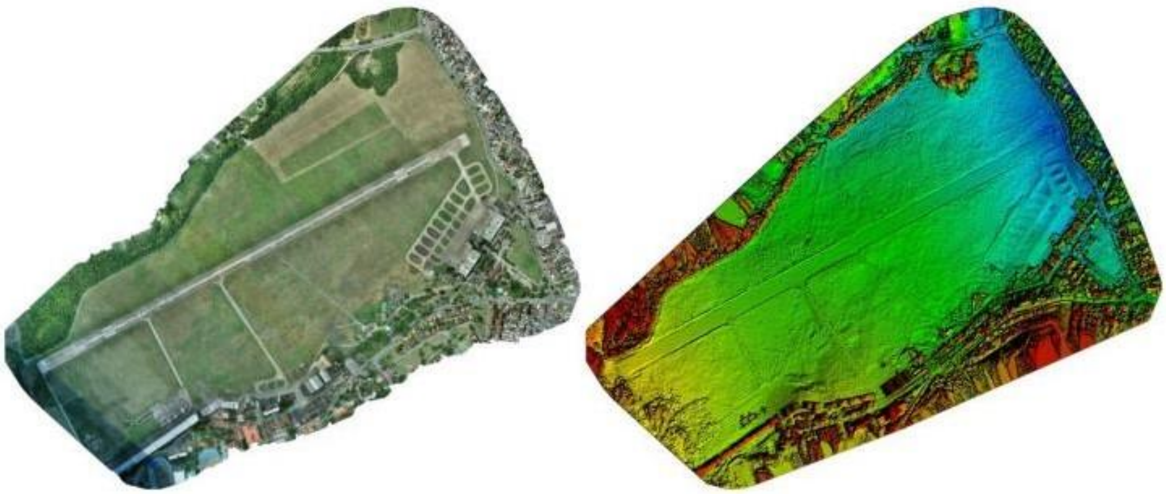

Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Figure 4: Orthomosaic and Digital Surface Model

2.4 With PBZPA data in vector format, it was necessary to transform line features to the pixel format, thus generating a new raster image. This new image will provide guidance on the matrix operations by using the ArcGIS Raster Calculator tool, and will delimit the maximum height of objects projected in the airspace of this location. With the PBZPA delimiting polygons referring to the Landing and Takeoff Zones, in vector format (.dwg), it would be necessary to perform transformation operations, so as to have approach slopes defined in pixel, i.e., also in raster format. For that, the ArcGIS Tin to Raster tool was used.

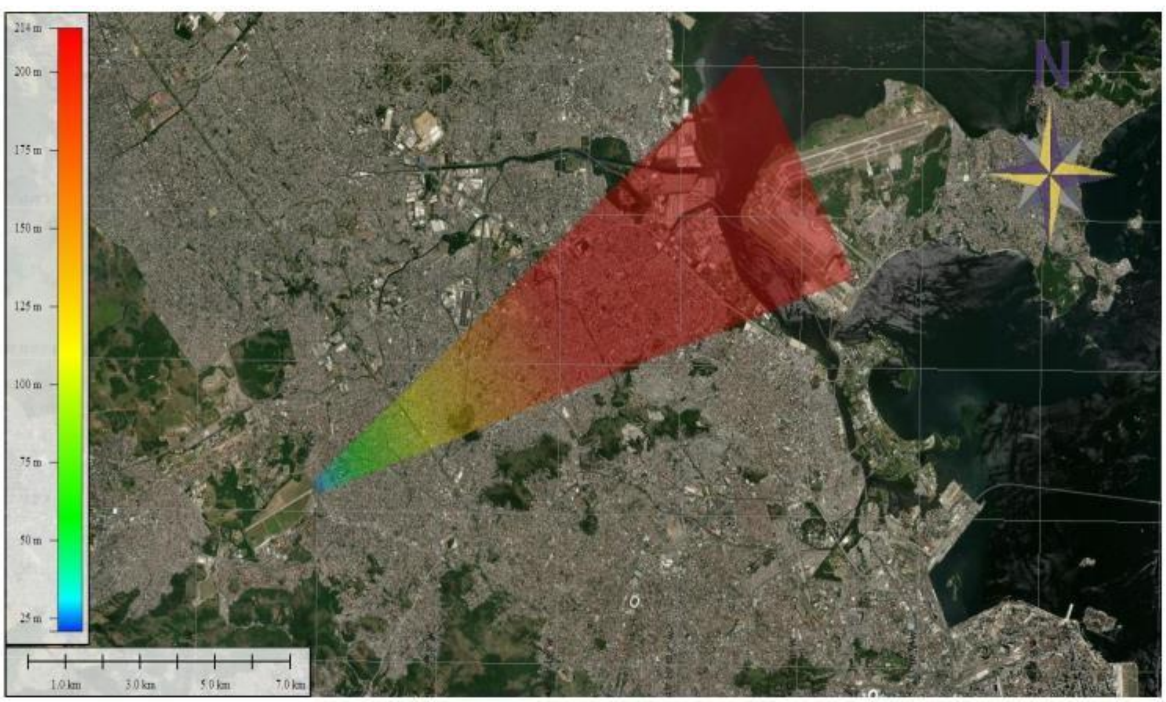

Figure 5: Approach and Takeoff Ramp in raster format

2.5 Subsequently, the raster images obtained by the drone and the PBZPA were edited, limiting only the study area of influence of OPEA, to enable faster computational processing. Pixel resampling was performed to obtain smaller cells. The smaller the cell size, the more accurate the model analysis by geographic information systems. The image chart contains the PBZPA obstacle limitation plans and the altitudes obtained in the digital elevation model of buildings close to the aerodrome operational area.

Figure 6: Map of the digital surface model close to the runway threshold

2.6 With the use of aerial photogrammetry techniques with drones it is possible to provide the user with the most diversified cartographic products containing highly accurate planialtimetric information, for example radiometric maps; digital elevation, terrain and surface models; matrix of errors; overlay maps; among other relevant products in the geoprocessing of digital images.

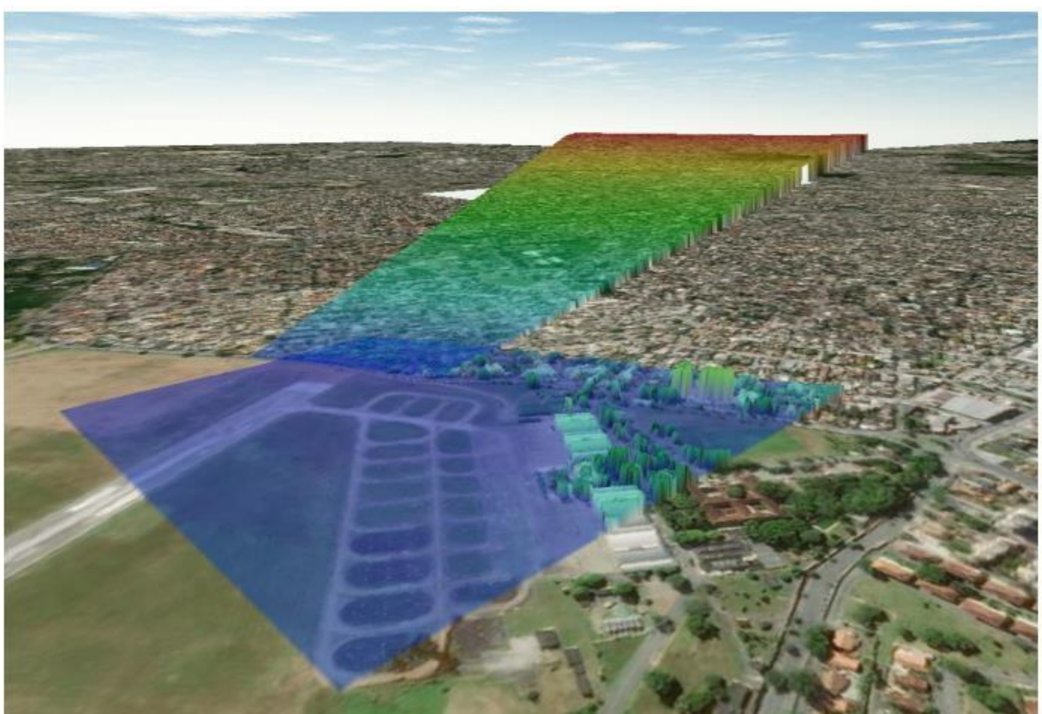

Figure 7: Digital surface model of buildings in the area of influence of the approach ramp and 3D takeoffs generated from the OLS and aerial survey with drone

2.7 After all stages of geoprocessing between the cartographic bases it can be stated that the proposed methodology is accurate and provides elements that are consistent with the study area. For this statement, the statistical quality of the digital surface model of the aerial survey was analyzed, and it has a mean square error of approximately 2 centimeters. The use of drones with embedded RTK correction system brings numerous advantages in the final quality of the product restituted. In addition, it reduces the need for topographic survey of support points in the field and provides faster processing in the office. The radio survey correction technology minimizes the effects of drag on image acquisition, providing greater accuracy in digital pre-processing.

Figure 8: Geoprocessing between raster images to check possible obstacles

2.8 Finally, it is necessary to individualize the pixels that violate the ramp, in this case, the positive values of the subtraction of the raster images. Then, having the raster resulting from this subtraction, the real altitudes of the pixels that became obstacles are calculated. For this, the Select by Mask tool of the ArcGIS software was used. Thus, using the subtraction raster as a mask, it is compared with the original digital surface model and it is possible to obtain the same obstacles, but with their real orthometric altitudes.

Figure 9: Digital surface model of obstacles located in the approach area of threshold 29 of the Campo Délio Jardim de Mattos (SBAF) aerodrome

3 Conclusion

3.1 The methodology used in this Note proved to be effective in assessing possible obstacles that violate the protection zones. The use of accurate cartographic bases allowed a thorough evaluation of the existing features near the aerodrome landing and take-off threshold. The use of geographic information system in the operations with raster images and 3D visualization allowed to quantify the intrusion area of these obstacles. The quality of the cartographic bases was paramount to the validation, since there was an average error of 17 centimeters, meeting the maximum allowed in DECEA standards, which establish a maximum error of 1 meter for altimetric evaluations in this type of work.

3.2 The analysis of objects projected in airspace from drone images provides airport administrators with more accurate and less costly cartographic solutions in the assessment of urban expansion around the airport. In large centers, sometimes it is difficult to evaluate new implementations due to the complexity of access for verification by conventional topography. In addition to high costs with topography, transportation, equipment and operator safety teams, the assessment of obstacles in the ground does not allow the covering of all area of influence of the protection surfaces.

3.3 Thus, the use of aerial photogrammetry with drones emerges as an effective method to reduce costs and it allows cartographic evaluation at any time. Finally, it is possible to use drones for individualized 3D mapping of each feature, enabling impact mitigation studies of a given obstacle, as the need for removal or demolition.

4 Suggested actions

4.1 The meeting is invited to:

a) Consider the use of onboard drones with LIDAR sensor to map PBZPA influence areas; and
b) Consider the use of drones with LIDAR in the assessment of obstacles in large urban centers and delimitation of protection zones of future Vertiports.

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