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CONSTRUCTION AND TYPES OF DRONES USED IN PHOTOGRAMMETRIC MEASUREMENT

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Abstract. *This paper analyzes the construction and performance of two representative types of drones used in modern photogrammetric measurements: DJI Mavic 3 RTK and senseFly eBee X. These aerial platforms integrate advanced positioning and image capture technologies, allowing the acquisition of high-precision geospatial data, with applicability in topography, cadastre, precision agriculture and environmental monitoring. DJI Mavic 3 RTK, a multirotor drone, stands out for its maneuverability and high precision at a local scale, being equipped with a 20 MP Hasselblad L2D-20c camera and integrated RTK system, which ensures a positional error of less than 3 cm. In contrast, senseFly eBee X, a fixed-wing drone, uses 24 MP cameras and RTK/PPK technology, offering an autonomy of up to 90 minutes and the possibility of mapping areas of over 500 ha in a single flight. The research results show that the choice of photogrammetric platform depends on the purpose of the project: Mavic 3 RTK is ideal for detailed work and small areas, and eBee X for large-scale mapping. Both drones contribute to streamlining measurement processes and increasing the accuracy of modern geospatial products. In addition, the integration of these systems into geospatial workflows helps optimize data processing time, reduce operational costs, and improve accuracy in applied mapping projects.*

Keywords*: Photogrammetry,Drone,Geospatial precision,DJI Mavic 3 RTK,SenseFly eBee X,Aerial mapping.*

INTRODUCTION

In the last decade, drones have become indispensable tools in the field of photogrammetric measurements, bringing a revolution in the way geospatial data is collected and processed. Technological evolution has allowed the development of autonomous aerial platforms, capable of providing accurate, fast and cost-effective results. In this context, professional drones equipped with RTK (Real-Time Kinematic) systems and high-resolution cameras play an essential role in applications in topography, cadastre, precision agriculture, architecture and environmental monitoring.

Two of the most representative models used in the field of modern photogrammetry are the DJI Mavic 3 RTK and the senseFly eBee X. These drones illustrate two different design concepts: the DJI Mavic 3 RTK drone is a multirotor model, compact and versatile, ideal for missions in confined areas, requiring high maneuverability and centimeter precision. In contrast, the senseFly eBee X is a fixed-wing drone designed for large-scale coverage, known for its long-range autonomy of up to 90 minutes and its ability to map hundreds of hectares in a single flight. The comparative analysis of these two platforms highlights the differences in design, performance and practical applications. The aim of the paper is to evaluate how the choice of drone type influences measurement accuracy, operational efficiency and the quality of photogrammetric products, thus contributing to the optimization of modern mapping and geospatial analysis processes.

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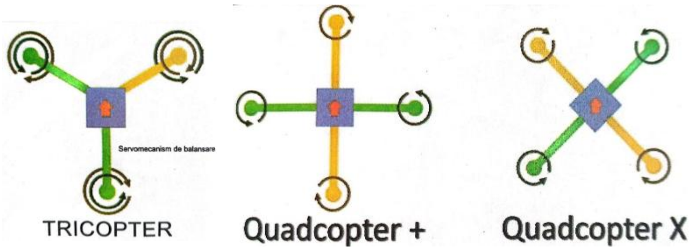

Figure 1. Ticopter, Quadcopter+, Quadcopter X

The tricopter is a type of drone with 3 engines, it has one engine in the back and two in the front, arranged in a triangle. The engines are arranged at 120°, providing stability and a good angle for filming

However, the construction of tricopters proves to be more complex, due to the mechanism for deflecting the direction of travel that must balance the rear engine, which has the least advantage of guaranteeing a smooth flight, something beneficial for situations in which we use the drone for filming.

Quadcopters are drones with 4 engines arranged symmetrically, easy to build and control, and the 'X' and '+' configuration is the most used due to better visibility. Of the 4 engines, 2 rotate clockwise and the other 2 rotate counterclockwise.

To build one, you need to create a cross-shaped frame and mount the 4 motors each at the end of the arms, without any sophisticated mechanisms or other connecting elements.

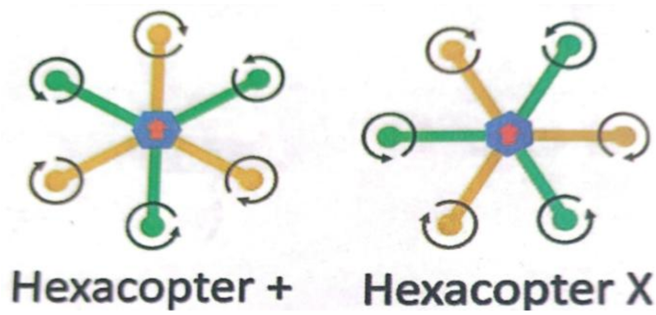

Figure 2. Hexacopter+, Hexacopter X

Hexacopters have 6 motors, an added benefit is that because the motors are spaced closer together around the center, if one motor fails, the hexacopter can usually remain stable. For this reason, you will see many drones used for professional aerial photography have a hexacopter or octocopter configuration, since 4 motors offer more safety and can carry more weight.

The Y6 configuration is a mix of a tricopter and a hexacopter. It has 6 motors on 3 arms, arranged exactly like a tricopter, with 2 arms in the front spaced 120° apart and a single arm in the back. However, because Y6 copters have 6 motors, they are considered hexacopters. Y6 configurations have several advantages over regular hexacopters. Since they only have a 3-arm assembly, assembly is easier and the frames can weigh less.

The X8 configuration is actually an 8-motor quadcopter frame, a combination of a quadcopter and an octocopter. The X8 frames have 4 arms with 2 rotors each, one facing up and the other facing down. The X8 copters have the same advantages as the octocopters, their main feature being the ability to lift heavy payloads. Just like the Y6 configuration, the X8 also has the advantage of having 2 motors placed along the same thrust axis, so it is even more stable in case one motor fails during flight.

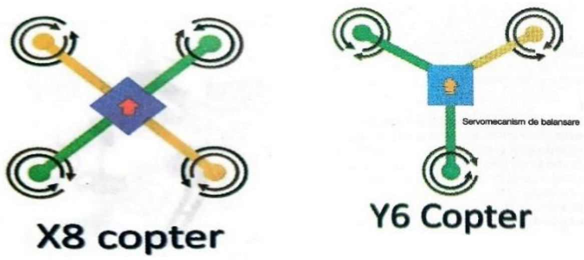

Figure 3. X8 Copter, Y6 Copter

MATERIALS AND METHODS

Materials used DJI Mavic 3 RTK

The DJI Mavic 3 RTK drone represents a combination of advanced engineering and the strategic use of lightweight materials, designed to provide performance, stability and durability in various flight conditions. Its construction is based on the integration of composite materials, lightweight metals and high-precision electronic components, all of which contribute to reducing weight and increasing energy efficiency.

These provide rigidity and protection to internal components, without compromising mobility and flight time, contribute to flight stability and protection of integrated sensors. The Hasselblad camera housing is made of CNC-machined aluminum alloy, providing dimensional accuracy and effective protection of the lens and image sensor.

By combining materials — aluminum, magnesium, titanium, and carbon fiber — the DJI Mavic 3 RTK manages to achieve an optimal balance between weight, strength, and performance, solidifying its position as one of the most advanced platforms for professional photogrammetric applications.

Figure 4. DJI Mavic 3 RTK Agriculture and Photogrammetry

Its use in photogrammetry and agriculture DJI Mavic 3 RTK

The DJI Mavic 3 RTK drone is an advanced technological solution widely used in the fields of photogrammetry and precision agriculture, thanks to the combination of the high accuracy of the RTK (Real-Time Kinematic) positioning system and the performance of the integrated camera. This aerial platform allows the acquisition of extremely accurate geospatial data,

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essential for the creation of 3D modeling, orthophotomaps and high-resolution topographic analyses.

The Hasselblad L2D-20c camera, with a 4/3” CMOS sensor and 20 MP resolution, offers superior image quality, characterized by clarity, chromatic fidelity and a low level of distortion. In combination with the RTK system, which corrects the drone’s geographical position in real time, results with centimeter precision are obtained, significantly reducing the need to use a large number of ground control points (GCPs).

Within the photogrammetric process, the drone is programmed to perform automatic flights according to a predefined mission plan, created using the DJI Pilot 2 or Pix4Dcapture applications. During the flight, it captures a sequence of overlapping images, which are subsequently processed in specialized programs (such as Pix4Dmapper, Agisoft Metashape or DroneDeploy). Through these applications, point clouds, digital terrain models (DEMs), three-dimensional (3D) models and georeferenced orthophotoplanes are generated, used in mapping, topography or territorial planning.

In agriculture, the DJI Mavic 3 RTK is used to monitor crop health, assess seeding uniformity, and identify areas affected by pests or nutritional deficiencies. By capturing multispectral or RGB images, the drone allows the analysis of vegetation indices, such as NDVI (Normalized Difference Vegetation Index), which helps determine the health of plants. The collected data can be integrated into GIS (Geographic Information System) platforms to create thematic agricultural maps, facilitating decision-making regarding irrigation, fertilization, and phytosanitary treatments.

By integrating RTK technology, a high-performance camera, and automatic flight planning systems, the DJI Mavic 3 RTK offers a complete and efficient solution for modern photogrammetric and agricultural projects. This technological combination helps optimize work time, reduce operational costs, and increase the accuracy of results, strengthening the role of drones as an indispensable tool in the digitalization and automation of land monitoring processes.

Figure 5. Establishing a flight area

Materials used senseFly eBee X

The senseFly eBee X drone is a fixed-wing aerial system designed for professional photogrammetric missions and characterized by a lightweight yet extremely durable construction. The choice of materials used in its manufacture plays a key role in ensuring aerodynamic efficiency, extended autonomy and durability in various operating conditions. The main structure of the drone is made of composite materials based on carbon fiber and EPP (Expanded Polypropylene) foam. Carbon fiber is used in load-bearing elements and in areas subject to mechanical stress, due to its excellent weight-to-strength ratio, as well as its ability to dampen vibrations during flight. EPP foam, a light and flexible material, provides effective protection against mechanical shocks and vibrations, helping to maintain the overall low weight of the drone.

The mounting elements and internal structural components are made of aluminum alloys and high-density engineering plastics, used to securely fix the electronic modules and the camera. This combination optimizes both structural strength and in-flight maneuverability. By using modern composite materials, the eBee X manages to achieve low weight, an autonomy of up to 90 minutes and superior aerodynamic efficiency, making it ideal for high-precision, extended-coverage photogrammetric missions.

Figure 6. senseFly eBee X

Using it in photogrammetry senseFly eBee X

The senseFly eBee X drone is one of the most advanced fixed-wing aerial platforms used in professional photogrammetry for the rapid and accurate collection of geospatial data. Designed to cover large areas in a short time, the eBee X is ideal for mapping, surveying, cadastre, precision agriculture and environmental monitoring projects.
Equipped with interchangeable high-resolution cameras, such as the S.O.D.A. 3D, Aeria X or Duet T, the drone offers flexibility depending on the mission requirements. Its RTK/PPK (Real-Time Kinematic/Post-Processing Kinematic) system ensures centimeter-level accuracy without the need to place a large number of ground control points (GCP). This technology allows the acquisition of orthophotomaps and digital terrain models (DEM) with high accuracy, suitable for detailed geospatial analysis.
Flight planning is carried out using eMotion 3 software, which optimizes the trajectory based on wind conditions, altitude and image overlap. The captured images are then processed in photogrammetric applications such as Agisoft Metashape or Pix4Dmapper, where point clouds, three-dimensional models and georeferenced orthophotomaps are generated.
Due to its high autonomy, positioning accuracy and aerodynamic stability, the eBee X drone is an ideal solution for large-scale photogrammetric projects, contributing to increasing efficiency and achieving high-quality results in modern spatial analysis.

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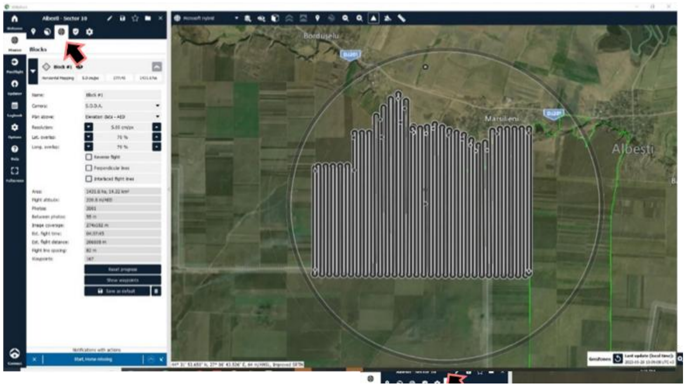
Figure 7. Orientation of flight lines

RESULTS AND DISCUSSIONS
Advantages and disadvantages of DJI Mavic 3 RTK

The DJI Mavic 3 RTK is a professional multirotor drone designed for photogrammetry, surveying and technical inspection applications. It stands out for its compact size, ease of use and the integration of the RTK system, which allows obtaining geospatial positions with centimeter accuracy, without the extensive use of ground control points.
The Hasselblad L2D-20C camera, with a 4/3" CMOS sensor and 20 MP resolution, offers high-quality images and chromatic fidelity, making it suitable for 3D modeling and cadastral applications. At an altitude of 100 m, the drone provides a GSD resolution of approximately 2.7 cm/pixel, sufficient for detailed work.
Control is carried out through the DJI Pilot 2 application, which allows automatic flight planning and real-time monitoring. The autonomy of approximately 45 minutes offers a balance between precision and efficiency, although territorial coverage is limited compared to fixed-wing drones.
Main advantages: high precision thanks to the RTK system, high-performance Hasselblad camera, excellent maneuverability and advanced obstacle avoidance system.Disadvantages: short autonomy, sensitivity to weather conditions and high costs of auxiliary equipment


Figure.8 Image created with DJI Mavic 3 RTK

Advantages and disadvantages of senseFly eBee X

DJI Mavic 3 RTK is a professional multirotor drone used in photogrammetry, topography and technical inspection applications. Thanks to its compact size and integrated RTK system, it provides geospatial positioning with centimeter accuracy, without requiring numerous ground control points.

The Hasselblad L2D-20C camera with a 4/3" CMOS sensor and 20 MP resolution provides high-quality images, suitable for 3D modeling and cadastral work, reaching a GSD resolution of approximately 2.7 cm/pixel at an altitude of 100 m.

The flight autonomy is approximately 45 minutes, which offers a good compromise between accuracy and operational efficiency.

Advantages: high accuracy, high-performance camera, excellent maneuverability, advanced obstacle avoidance system.

Disadvantages: limited autonomy, sensitivity to weather conditions, high cost of batteries and accessories.

Figure 9. Orthophotoplan with senseFly eBee X

Technical comparison between DJI Mavic 3 RTK and senseFly eBee X

The comparative analysis between the DJI Mavic 3 RTK and senseFly eBee X drones highlighted notable differences from a technical, operational and photogrammetric point of view, both platforms being successfully used in the field of modern aerial mapping.

The DJI Mavic 3 RTK, a multirotor drone, stands out for its high maneuverability, portability and planimetric accuracy below 3 cm, thanks to the integrated RTK system. The 20 MP Hasselblad CMOS 4/3" camera allows for high-quality images with a ground resolution (GSD) of approximately 2.7 cm/pixel at an altitude of 100 m. This is ideal for urban areas, confined spaces, rugged terrain or construction sites, where vertical take-off and stable flight offer a significant advantage. The main limitations are the flight autonomy of up to 45 minutes and the reduced coverage area (60–70 ha per flight), which makes it more suitable for local projects and detailed inspections

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Characteristic	**DJI Mavic 3 RTK**	**senseFly eBee X**
Platform type	Multirotor	Fixed wing
Room sensor	Hasselblad CMOS 20 MP	S.O.D.A. 3D 24 MP
GSD Resolution	~2,7 cm/pixel	~2,0 cm/pixel
Planimetric accuracy	< 3 cm	< 3 cm
Flight autonomy	45 minutes	90 minutes
Area covered (one flight)	~70 ha	400–500 ha
RTK/PPK system	Integrated RTK	RTK/PPK optional
Launch/landing	vertically	Manual/automatic (with open space)
Areas of application	Cadastre, inspections, constructions	Extensive mapping, agriculture, environment
Main advantage	Maneuverability and local accuracy	Efficiency and high coverage
Main disadvantage	Limited autonomy	Requires launch/landing space

In contrast, the senseFly eBee X, a fixed-wing drone, is designed for large-scale missions, covering up to 400–500 ha in a single flight, with an autonomy of approximately 90 minutes. Equipped with the 24 MP S.O.D.A. 3D camera and compatible with additional sensors (Aeria X, multispectral, etc.), the eBee X offers a GSD resolution of approximately 2.0 cm/pixel, making it ideal for regional mapping, precision agriculture, large-scale surveying and environmental monitoring. However, launching and landing require open spaces, and the absence of hovering makes it less effective in areas with vertical obstacles or in detailed inspections. Comparatively, the DJI Mavic 3 RTK stands out for its versatility and local accuracy, being recommended for detail projects and precision mapping, while the senseFly eBee X excels in operational efficiency and extended coverage, being preferred for regional projects and large-area mapping. From an economic point of view, the Mavic 3 RTK has lower acquisition and operating costs, an important aspect for small and medium-sized surveying companies, while the eBee X offers superior long-term performance in complex applications and large-scale projects.

CONCLUSIONS

The rapid evolution of unmanned aerial technologies has led to a significant diversification of the platforms used in photogrammetry, adapted to different operational, topographic and economic requirements. Progress in the field of optical sensors, high-precision GNSS positioning systems and image processing algorithms has contributed to increasing the accuracy, efficiency and accessibility of these systems.

DJI Mavic 3 RTK, with its multirotor architecture, represents a compact, easy-to-operate and very precise solution, being ideal for local missions, rapid mapping and work carried out in dense urban environments or areas with difficult access. The integration of the RTK (Real-Time Kinematic) module allows the acquisition of geospatial data with centimeter precision, reducing the need for ground control points and considerably optimizing the workflow. Also, the high mobility and reduced flight preparation time make this system a preferred option in applications that require rapid interventions and operational flexibility.

In contrast, the senseFly eBee X, a fixed-wing platform, stands out for its high autonomy, superior energy efficiency and the ability to cover large areas in a short time. Thanks to its aerodynamic design and advanced navigation systems, the eBee X allows for long-duration flights, making it suitable for regional-scale applications such as agricultural land monitoring, environmental studies or large infrastructure projects. The high quality of the photogrammetric data obtained, combined with the possibility of integrating different types of sensors (RGB, multispectral, thermal), reinforces the versatility of this platform.

The comparative analysis between the two platforms highlights their complementarity within modern photogrammetric applications. The DJI Mavic 3 RTK excels in detail work, site surveys and high-precision 3D modeling, while the eBee X proves optimal for large-scale mapping, where autonomy and flight efficiency are essential factors. The choice of the appropriate platform therefore depends on the project purpose, the terrain conditions and the desired level of accuracy. In conclusion, the continuous development of UAV technologies and their integration into modern photogrammetry workflows significantly contribute to the transformation of the way geospatial data is collected and analyzed. Future trends, such as the integration of artificial intelligence, automated processing and 5G communications, will amplify the operational efficiency and accuracy of these platforms, strengthening the role of drones as indispensable tools in geospatial research and land management.

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