USING MODERN TECHNIQUES THROUGH AERIAL SCANNING

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Abstract. *Real estate 3D modeling has revolutionized the fields of architecture, engineering, and construction by providing an advanced and accurate method for designing, visualizing, and managing buildings and other structures. This technology involves the use of specialized software to create detailed three-dimensional digital representations of buildings that can be interactively analyzed and modified. In the contemporary digital age, modern measurement technologies have become indispensable in the process of building modernization, playing a very important role in ensuring the accuracy, efficiency and sustainability of construction and renovation projects. Technologies such as global positioning systems, total stations, laser scanning, digital photogrammetry and building information modeling have revolutionized the way real estate surveying and planning is done. These technologies enable fast and accurate data collection, providing detailed information on land topography, building structure and urban infrastructure, thus facilitating informed decision-making and optimizing construction processes.Building modernization involves not only adapting to current safety and comfort standards but also integrating innovative solutions to meet energy efficiency and sustainability requirements. Advanced measurement technologies play a key role in this context, enabling accurate assessment of the existing condition of buildings and real-time monitoring of the progress of renovation works. Thus, errors are much lower and resources are used more efficiently, helping to reduce costs and execution time. This topic was chosen due to the significant impact that modern measurement technologies have on the construction industry and the need to understand and capitalize on these technologies in the current context of building modernization.*

Keywords*: 3D Modeling, Agisoft Metashape, Lidar, Pix4D .*

INTRODUCTION

3D modeling has revolutionized the way we perceive and interact with the digital environment, providing the ability to create extremely detailed virtual representations of objects, buildings and even people. This technology enables the construction of accurate and realistic three-dimensional models used in a wide range of industries, from design and architecture, video games, movies, and augmented and virtual reality applications. In recent decades, advances in 3D modeling have facilitated the development of innovative techniques that have significantly reduced the time and costs involved in creating these models.

New technologies such as photogrammetry, 3D laser scanning, artificial intelligence (AI) and machine learning contribute to the accuracy and efficiency of 3D modeling. Photogrammetry, for example, allows the creation of detailed models by combining images captured from different angles, and 3D laser scanning provides an impressive level of detail by capturing surface points at a micrometric level. Artificial intelligence and machine learning are also increasingly integrated into workflows, providing automation in object recognition and classification and optimization of details. These innovations have made 3D models more accessible, more accurate and more realistic, thus supporting their use in new industries such as telemedicine, vocational training and planning.

MATERIAL AND METHODS

1.1. MATERIAL -HARDWARE

In order to create the 3D model of the buildings, it is essential to use an appropriate equipment for capturing images, a photogrammetric processing software and a set of specific techniques to ensure the precision and detail of the final model. DJI Phantom 4 is an advanced, popular aerial and photography drone due to its innovative film, performance and technologies. Launched by DJI, a leader in the drone industry, the Phantom 4 is recognized for its stability, high-quality cameras and automatic flight functions. Equipped with a 4K Ultra HD camera, the drone captures clear images and videos, even in windy conditions or in fast flight.

Among the Phantom 4's advanced features are obstacle avoidance, "Follow Me" mode that allows the drone to follow a subject automatically, and "TapFly," a feature that allows you to control the direction of the drone with a simple tap on your phone's screen. The drone also has a flight range of approximately 28 minutes and can reach a maximum speed of 72 km/h, making it suitable for various applications from professional filming to recreational hobbies. During a photogrammetry flight, the drone uses automatic flight algorithms to cover the entire area of interest. These are precisely planned through the DJI Pilot app or other photogrammetry software that can be integrated with the drone. Agisoft Metashape was used for image processing.

Figure 1. DJI Phantome 4 drone

1.2. MATERIAL –SOFTWARE

Pix4D Capture was used to acquire the photos and Agisoft Metashape was used to process the photos obtained from the results.

Pix4Dcapture Pro is a mobile application used to capture images and create 3D maps or terrain models using drones. This is an advanced version of Pix4Dcapture that includes additional functionality for professional or advanced users. The application allows users to plan automatons, control flight parameters and capture images in an efficient way for various applications such as mapping, terrain analysis or industrial inspections.

Figure 2. Capturing photos with the PIX4D

Agisoft was founded in 2006 by a specialized team in the field of photogrammetry, image processing and georeferencing technologies. Their main goal was to provide access software for users in various industries. Agiisoft metashape is the successor to Agisoft PhotoScan software, which was first released in 2010 and renamed in 2019. Metashape has continued to improve existing photogrammetry technologies, providing more accurate and versatile tools for creating 3D models and geospatial data processing.

Agisoft Metashape uses advanced image processing algorithms to reconstruct 3D models from sets of images captured from different angles. It can create dense point clouds, which are meant to represent the geometry of an object or terrain in three-dimensional space. One of Metashape's strengths is its ability to georeference 3D models by integrating GNSS data or ground control points (GCPs), allowing it to be used in high-precision mapping projects. The software can also create orthophotoplanes, which are accurate georeferenced images.

An outstanding feature of Metashape is its ability to create high-precision 3D models from images obtained from different angles and more recently, to integrate data from high-performance cameras, including multispectral and thermal cameras. This makes it a valuable tool not only for creating detailed visual models, but also for applications involved in environmental analysis. Another advantage of Metashape is the fast data processing, which allows users to get accurate results in a very short time. In addition, integration with drones has completely transformed the way aerial data is collected and processed. Drones capture images from angles that are hard to reach or dangerous to film from another way, and Agisoft Metashape can process these images to create three-dimensional representations.

Metashape allows users to convert this point cloud into a polygon model. The individual points become the faces of a 3D model, and this model can be used for a variety of applications, from analyzing the topography of a piece of land to the detailed reconstruction of buildings or heritage structures. Depending on the complexity of the image set and the required accuracy, the density of the point cloud can vary, thus providing additional detail in areas of interest. Another significant advantage of Agisoft Metashape is its flexibility in integrating with various data sources. In addition to traditional imagery, the software also supports data from LiDAR systems, which are often used to collect accurate information about terrain and structures. LiDAR (Light Detection and Ranging) can be used to obtain very accurate data in the area where traditional photogrammetry is less effective, such as in dense forests or mountainous areas.

2.3.METHODS

The method will be carried out in several distinct stages, designed to ensure the precise collection of data, their correct processing and the generation of a faithful 3D model. It is based on advanced photogrammetry techniques, especially on capturing high-resolution aerial images and processing them to build a precise model.

2.3.1. CAPTURE OF DRONE IMAGES

Capturing drone images is a crucial step in obtaining accurate and high-quality 3D models. Flight planning, camera settings and shooting methods greatly influence the final result in applications such as photogrammetry and 3D modeling.

2.3.2. INSERTING PHOTOS IN THE AGISOFT METASHAPE PROGRAM

To start inserting the 277 photos, I created a new project and uploaded **the desired photos (Workflow > Add Photos).**

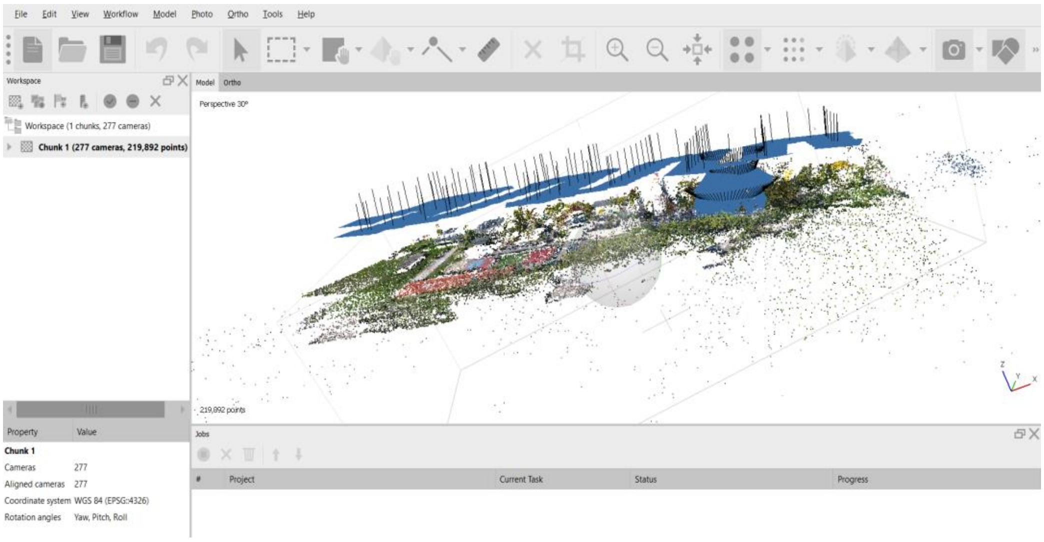

Figure 3. Inserting photos in the Agisoft Metashape program

2.3.3 ALIGNMENT OF PICTURES

Aligning photos in Agisoft Metashape is an essential step to building an accurate 3D model. This involves identifying common points in overlapping images so that the software can determine photo positions and the basic structure of the scene. To align the photos, select **Workflow > Align Photos, at medium density.**

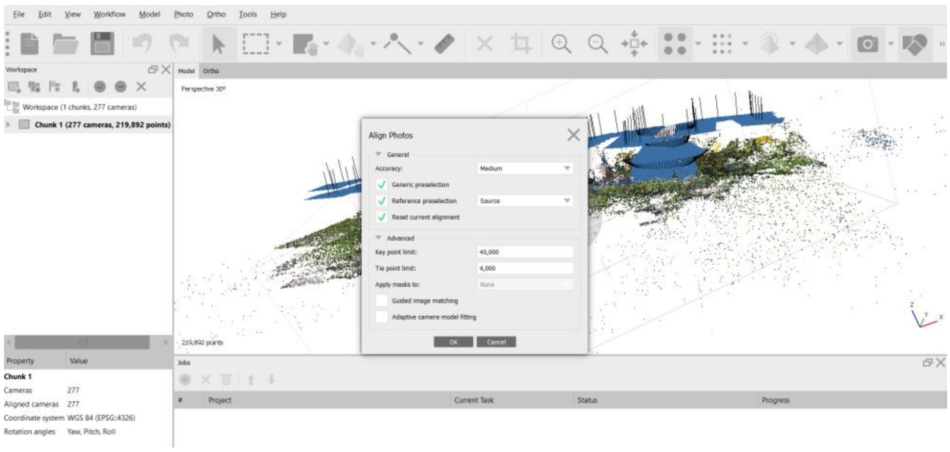

Figure4. Alignment of pictures

2.3.4. CREATION OF A DENSE CLOUD OF POINTS

To use Build Dense Cloud, the first step is to make sure the photos are aligned correctly. Aligning the photos is the basis for generating the dense point cloud. Accessing the Build Dense Cloud option I selected it from Workflow, choosing medium density.

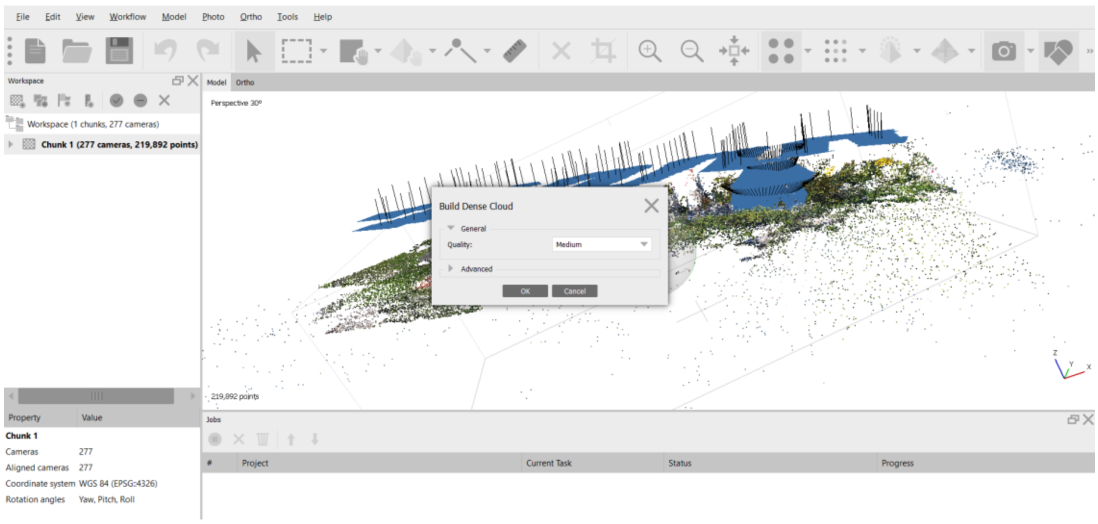

Figure 5. Creation of a dense cloud of points

2.3.5. USING THE BUILD MESH

In Agisoft (Metashape), "Build Mesh" is a process that generates a 3D mesh (mesh) from the dense point cloud of a photogrammetric model. This step is important to create a continuous 3D surface and provide details about the shape of the reconstructed object.

2.3.6. USING THE BUILD TEXTURE

In Agisoft Metashape, the "Build Texture" function allows adding a detailed texture to a 3D model, making it more realistic. After you have created the mesh, you can use the Workflow > Build Texture option for the Mapping Mode.

2.3.7. REALIZATION OF BUILD DEM

In Agisoft Metashape, Build DEM is a process that creates a digital terrain model (Digital Elevation Model) from photogrammetric data. It allows users to build a detailed representation of the terrain, useful in cartography, land management, archaeology, construction and other geospatial fields.

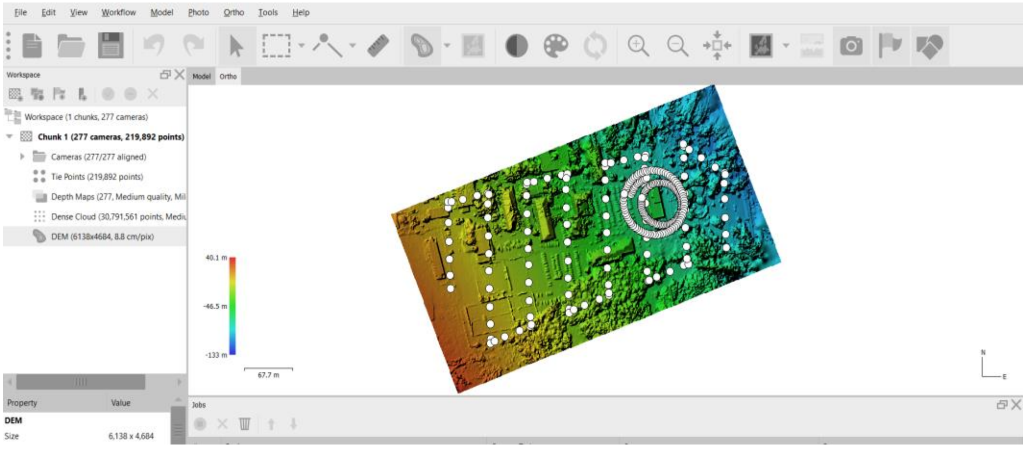

Figure 6. Build DEM

2.3.8. USING BUILD ORTHOMOSAIC

The Build Orthomosaic option in Agisoft Metashape is used to create an orthomosaic, a detailed, geometrically corrected image of a surface. Unlike a simple aerial image, orthomosaic eliminates distortions caused by camera tilt and terrain variations, providing a precise overhead view ideal for mapping, geospatial analysis and land management.

RESULTS AND DISCUSSIONS

Initially, the process starts with importing and aligning photos. In this step, Agisoft Metashape uses common points between images to establish camera positions and orientations, if available, geographic control points can be used to specify alignment accuracy. This step is essential to build or accurate base for the whole process.

The next step is to create the dense point cloud, which adds essential details to the 3D terrain model. After the initial alignment of the photographs, a dense 3D point cloud is created that captures information about terrain variability and surface features. These points constitute or detailed representation of the topography, essential to create a precise geometry of the area.

After obtaining the dense point cloud, the mesh, i.e. a 3D network of the terrain, can be constructed. The mesh is a three-dimensional model that describes the terrain surface, having a direct impact on the accuracy of orthorectification, especially in areas with steep slopes or complex landforms. Another crucial step is to create a digital terrain model (DEM). This is a 3D terrain elevation model, essential for correcting distortions caused by camera tilt and terrain elevation variations. The DEM allows accurate image correction to be performed to ensure each point on the land surface is correctly aligned to its actual elevation level.

Once these steps have been completed, one can proceed to the final step of constructing the orthophotoplane. In this phase, all images are orthorectified based on the digital terrain model (DEM) and the geometry obtained through the point cloud and mesh. Correcting geometric distortions ensures that every detail is accurately rendered and images are combined into a uniform mosaic. This final stage ensures that the resulting orthophotoplan will represent the terrain in a geographically correct manner, being usable for precision analysis and integration into the GIS application.

Figure. 7 Orthophotomap

CONCLUSIONS

In conclusion, each step, from photo alignment and dense point cloud creation, to mesh construction and digital terrain model (DEM) generation, contributes significantly to the accuracy and final detail of the orthophotoplane. Correcting distortions and integrating the images into a uniform mosaic ensures an accurate representation of the terrain, essential for applications as varied as urban planning, geospatial analysis, environmental monitoring or natural resource management. Thus, the orthophotoplane generated in Agisoft Metashape by a powerful and reliable tool, values in any project that needs to look detailed and prior.

BIBLIOGRAPHY

AUTOLISP REFERENCE GUIDE, AutoCAD 2012 for MAC, 2011 Autodesk, Inc. All Rights Reserved

BADEA GH., Cadastre, 2013, Conspress Publishing House, Bucharest

BOS N., IACOBESCU O., 2009, Cadastre and Land Book, C.H. Beck Publishing House, Bucharest

CASIAN, A., ȘMULEAC, A., & SIMON, M. (2019). Possibilities of using the UAV photogrammetry in the realization of the topo-cadastral documentation

CONSTANTIN CUCOȘ, 2023, Education and temporality, HTTPS://DOXOLOGIA.RO/EDUCATIE-TEMPORALITATE

DECREE-LAW NO. 115 OF APRIL 27, 1938 FOR THE UNIFICATION OF PROVISIONS REGARDING LAND BOOKS, PUBLISHED IN THE OFFICIAL GAZETTE NO. 95 OF APRIL 27, 1938, HTTPS://LEGISLATIE.JUST.RO/PUBLIC/DETALIIDOCUMENT/25

FAINITA GABRIELA, 2016, Land Registry Overview, HTTPS://PROJURISTA.RO/CARTEA-FUNCIARA-PREZENTARE-GENERALA/

GHERGAR ALISIA, MADĂRA RĂZVAN, POPESCU, GEORGE, DRAGOMIR LUCIAN, 2023, APLICATION OF MODERN MEASUREMENT TECHNOLOGIES IN THE PROCESS OF SISTEMATIC REGISTRATION OF REAL ESTATE, Research Journal of Agricultural Science

GREEN R., 2008, The AutoLisp Crash Course,Autodesk

HERBEI, M., & SALA, F. (2016). Classification of land and crops based on satellite images Landsat 8: case study SD Timisoara

HTTPS://CODE.VISUALSTUDIO.COM/, ACCESSED ON 13.04.2023

HTTPS://CODE.VISUALSTUDIO.COM/DOCS/EDITOR/INTELLISENSE, ACCESSED ON 01.04.2023

HTTPS://DOCS.MICROSOFT.COM/RO-RO/POWER-APPS/MAKER/PORTALS/VS-CODE-EXTENSION, ACCESSED ON 01.04.2023

HTTPS://SUPPORT.MICROSOFT.COM/RO-RO/, ACCESSED ON 01.04.2023

HTTPS://WWW.ITLEARNING.RO/CAPITOLUL-1-PREZENTARE-GENERALA-A-PROGRAMULUI-AUTOCAD/, ACCESSED ON 12.04.2023

MARGARET ROUSE, 2015, Intellisense. What Does Intellisense Mean?, HTTPS://WWW.TECHOPEDIA.COM/DEFINITION/24580/INTELLISENSE

OPREA LUCIANA ET AL., 2013, "Introduction of the general cadastre in an administrative territory", HTTP://PANGEEA.UAB.RO/UPLOAD/20_261_7_OPREA_-_INTRODUCEREA_CADASTRULUI.PDF

PLAN A PROJECT WITH A WORK BREAKDOWN STRUCTURE (PROJECT SERVICE), 2023, HTTPS://LEARN.MICROSOFT.COM/RO-RO/DYNAMICS365/PROJECT-OPERATIONS/PSA/SCHEDULE-PROJECT-WORK-BREAKDOWN-STRUCTURE

POPESCU, G., POPESCU, C. A., HERBEI, M., & SMULEAC, A. (2016). Measuring the parameters that influence the phenomenon of displacement and deformation of the ground at Mina Livezeni

SABĂU, N., CRAINIC, G., 2006, Applications of remote sensing in cadastre, University of Oradea Publishing House

SELF-DISCIPLINE AND MANAGEMENT OF THE MOST PRECIOUS RESOURCE – TIME, HTTPS://THEWOMAN.RO/AUTODISCIPLINA-SI-MANAGEMENTUL-CELEI-MAI-PRETIOASE-RESURSE-TIMPUL/

SMULEAC, A., HERBEI, M., & POPESCU, C. (2012). Creating the digital terrain model of the Usamvb Area using modern technology