BE CIVIL ENGINEERING

PROJECT REPORT

EARTHWORK VOLUMETRICS USING UAV TECHNIQUE

SUBMITTED TO

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DEDICATION:

We would want to thank the MCE, our parents, and all our instructors for their unending encouragement and support during our academic careers.

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List of Abbreviations:

UAV: Unmanned Aerial Vehicle

GPS: Global Positioning System

GIS: Geographic Information System

DEM: Digital Elevation Model

GCP: Ground Control Point

DSM: Digital Surface Model

DSM: Digital Terrain Model

SFM: Structure from Motion

GNSS: Global Navigation Satellite System

RMSE: Root Mean Square Error

RTK: Real-Time Kinematic

CAD: Computer-Aided Design

3D: Three-Dimensional

BIM: Building Information Modeling

LiDAR: Light Detection and Ranging

AEC: Architecture, Engineering, and Construction

PPK: Post-Processed Kinematic

LOS: Line of Sight

DSM: Digital Surface Model

DTM: Digital Terrain Model

UAVSAR: Unmanned Aerial Vehicle Synthetic Aperture Radar

UAS: Unmanned Aircraft System

TLS: Terrestrial Laser Scanning

GCP: Ground Control Point

LiDAR: Light Detection and Ranging

DEM: Digital Elevation Model

ABSTRACT

This research offers a comparative examination of the conventional and unmanned aerial vehicle (UAV) methodologies for land surveying. The objective of our study is to evaluate the precision, efficiency, economic viability, transparency, workforce demands, and other pertinent considerations linked to the utilization of these two survey techniques. Our study employed a research methodology that entailed carrying out land surveys in diverse locations using both conventional and unmanned aerial vehicle (UAV) techniques. The data was obtained from Sector A2 of DHA Quetta via conventional ground-based measurements and aerial imagery acquired by unmanned aerial vehicles (UAVs) that were equipped with photogrammetric capabilities. After data collection, suitable software tools such as AgiSoft were employed to process and analyses the data, resulting in precise measurements and volumetric computations. Several significant discoveries surfaced from the examination of the research data. The results indicates that utilization of unmanned aerial vehicles (UAVs), specifically photogrammetry, presents notable benefits compared to the conventional approach in various aspects such as precision, efficiency, affordability, transparency, workforce productivity, and feasibility in difficult topographies. The findings of this investigation augment the existing corpus of knowledge pertaining to surveying methodologies and have the potential to inform the decision-making procedures of practitioners operating within this domain.

Key Words:

Surveying, mapping, unmanned aerial vehicle (UAV), drone, photogrammetry, volumetric analysis, conventional surveying, Sector A2, DHA Quetta, accuracy, timesaving, cost-saving, transparency, labor, data acquisition, data processing, AgiSoft, ArcMap, comparative analysis, strengths, limitations, decision-making, surveying techniques, efficiency, cost-effectiveness, emerging technologies, data accuracy, urban planning, land management, construction projects.

CHAPTER 1

INTRODUCTION:

1.1 Research Background

Minerals are abundant in Pakistan; yet, adequate steps have not been done to discover and exploit the country's natural resources, which impedes the company's ability to make progress economically. It is a crucial process at a mining site to assess and monitor the minerals being mined, as this is what defines the number of resources and money that will be required. In the last few decades, the Conventional serving method that is thought to be involved in covering global navigation satellite real-time kinematics for computing the number of stocks has been utilized. (Carrera-Hernandez, et al., 2020). The Conventional approaches take a significant amount of time, and there is also a significant risk of making mistakes while using them. In terms of the amount of time required and the amount of physical strain involved, the modern surveying approach is an excellent alternative to these Conventional serving ways.

Our thesis makes a proposal for the use of two different mapping techniques for the purpose of computing the volume of a specific target site. Following the comparison of the results to determine the accuracy of the results, images would be captured by UAV and then processed in AgiSoft Metashape to produce a digital elevation model, 3D dense point cloud, orthomosaic, and 3D model of the mining site. The results of the volume computation would then be evaluated. (Yucel & Turan, 2016).

1.2 Unmanned aerial vehicle (UAV) technology:

Recent developments in unmanned aerial vehicle (UAV) technology have completely altered the method in which we collect data about our environment. Due to their capacity to capture high-resolution data quickly and cheaply, UAVs have gained popularity in recent years for use in surveying and mapping. The aim of our research is to compare the volumetric results of digital (UAV-based photogrammetric) survey Vs the conventional surveying method being utilized in the field. The testing ground for our experimental comparison is a residential area in Sector A2 of DHA Quetta which is in the stages of development thus providing ideal testing incubator to the research. Comparison between Conventional surveying and UAV-based photogrammetry for volumetric analysis of a residential area in Sector A2 of DHA Quetta is the primary goal of our research.

By comparing the findings from Conventional and UAV-based photogrammetry methodologies, the study assesses the following (Fahlstrom, et al., 2022): -

a. Accuracy,
b. Efficiency
c. Cost-effectiveness
d. Time saving
e. Transparency
f. Accessibility and Terrain challenges

The study research framework consists of unmanned aerial vehicle (UAV) data collection, photogrammetric software processing of that data, and statistical and graphical techniques analysis of the results. Applications ranging from land management and urban planning to building projects all depend on accurate and efficient volumetric analysis. For such assessments, the time-consuming manual measurement and fieldwork of Conventional surveying has traditionally been used (Bristeau, et al., 2011). In contrast, photogrammetric approaches have arisen as a possible alternative with the development of UAV technology, allowing for quicker data collecting and analysis. The major aim of our study is to compare the Conventional surveying approach with UAV-based photogrammetry in terms of accuracy, time savings potential, cost-effectiveness, transparency, and labor needs. Drone imagery of Sector A2 at DHA Quetta is used in the study, processed with commercial tools like AgiSoft and ArcMap.

1.3 Problem statement

Despite advances in remote sensing, traditional methods for measuring and calculating earthwork volumes in construction and mining projects are laborious, time-consuming, and error prone. These issues may cause volumetric assessments, resource allocation, and project planning errors. Existing methods also struggle with complicated terrains, inaccessible places, and regular measurements needed for project management. This hinders progress monitoring, problem identification, and resource optimisation.

Thus, a complete approach that integrates Unmanned Aerial Vehicles (UAVs) to improve earthwork volumetrics accuracy, efficiency, and cost is needed. This technology should expedite data gathering, processing, and analysis, overcoming conventional surveying methods and enabling real-time monitoring, exact volumetric calculations, and informed decision-making in building and mining operations. Fixing these issues will enhance volumetric assessments, project planning, resource management, and cost estimates. The suggested technology integrates UAVs and laser scanning to revolutionized earthwork volumetrics and enable data-driven choices for project optimisation.

1.4 Research questions

The following are some questions that arise from this research:

1. How accurate and precise are conventional surveying methods and photogrammetry?
2. What is the time-saving potential of using UAV photogrammetry compared to conventional survey methods.
3. How does the cost of surveying use UAV photogrammetry differ vis a vis to conventional survey methods?
4. What is the level of transparency achieved in the surveying process using UAV photogrammetry compared to conventional survey methods?

1.5 Research Objectives

Our research seeks to assist in the development and comprehension of remote sensing techniques that would be beneficial in servicing a particular area that may have difficult terrain. Specifically, the research will focus on the development of these approaches.

The purpose of our research is to compare and analyze.

1. To evaluate the accuracy and precision of conventional surveying methods and photogrammetry to determine their reliability and level of detail.
2. To quantify the time-saving potential of UAV photogrammetry compared to conventional survey methods.
3. Analyze and compare cost effectiveness of both methods.
4. Present increased transparency achieved by photogrammetry.

CHAPTER 2.

LITERATURE REVIEW

2.1 Discrepancies in Previous Works:

Our research has identified and discussed the discrepancies or gaps in the previous works related to UAV photogrammetry and conventional survey methods. In the present era of technology, it is imperative to select appropriate surveying technique for capturing accurate and reliable survey data in urban environments. This includes the challenges faced in traditional surveying methods and the potential of UAV photogrammetry to overcome these challenges (AL Zahrani, et al., 2020). Many academic articles, studies, and industry reports on using following strategies in metropolitan settings or comparable circumstances have been materialized. Which are discussed in subsequent paragraphs.

2.2 New Work:

The research outlines the new contributions and advancements that our research aims to make. It would emphasize the specific aspects of UAV photogrammetry and conventional survey methods that will be evaluated, such as accuracy assessment, time-saving potential, cost-effectiveness, transparency, and labor requirements. The review would highlight the novelty and significance of our research in filling the existing gaps and providing a comprehensive analysis of the surveying techniques in Sector A2, DHA Quetta.

2.3 Surveying methods

2.3.1 Conventional surveying methods

In the past few decades there has been prominent development in technology that is used for surveying Conventional serving methods undergoes linear measurement for a building or leveling. they comprise of manual digital aided measurements (Soni, et al., 2015). These conventional techniques produce analog results, and they give manual input.

1. Dumpy level (Ruffell, et al., 2014)
2. Measuring wheel
3. Theodolites

2.3.2 Modern surveying methods:

This method incorporates digital devices in the GPS system that allows engineers to calculate the range of measurements such as levels, angles, and distances. Tools such as drone and UAVs are used to read inaccessible areas (Oludare, et al., 2016).They provide a viewpoint that are difficult to discover by Conventional methods. this includes,

1. laser scanners
2. total stations
3. drones
4. GPS equipment

2.4 Difference between modern and Conventional surveying methods:

The emerging technique of solving method enables the researchers and engineers to experience high levels of detail and reference points. It also allows to utilize the resulting data in a variety of ways that can be tailored to each task or project. Modern surveying techniques possess the ability to record large amount of data that can foresee potential risks and avoid costly mistakes, it cannot be discovered through a basic surveying approach (Beretta, et al., 2018).

2.4.1 Accuracy and precision

Modern surveying technique allows to the creation of accurate and detailed reports for land or building, it can be used to create drawings, elevations, and 3D point clouds (Ogundare, 2015).

2.4.2 Information gathering

Combination of different methods provides a deeper understanding and reveals such information that is not easy to discover by conventional techniques.

2.4.3 Speed

Manual equipment is used in the Conventional serving technique which can be cumbersome and slow. Modern surveying technique allows digital methods that enhance the speed (Srivastava, et al., 2021).

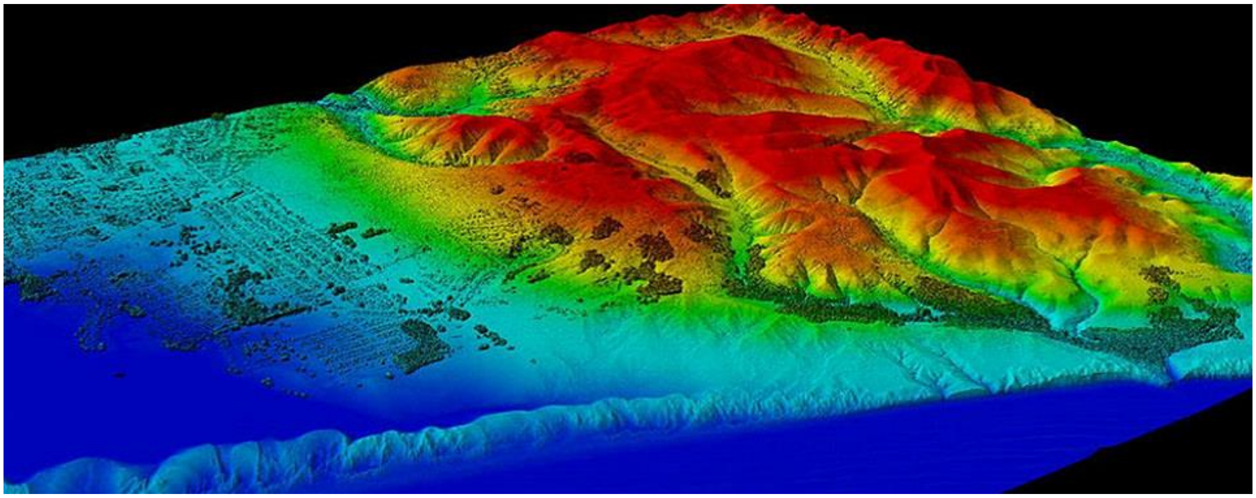
2.4.4. Cost

The nature and requirements of the survey define the cost of the project Conventional methods are suitable for the level of detail required and can be caused affected as they are more budget friendly. Whereas modern surveying techniques require a high cost and more budget (Chiang, et al., 2019).

2.5 Monitoring techniques

2.5.1 Remote sensing

Remote sensing allows monitoring and detecting the physical characteristics of an area through a satellite or an aircraft by measuring the emitted radiation from a distance. Special cameras from the satellite or aircraft collects the sensed images. So that system on chips is useful for creating images of the ocean floor but not having to travel at the bottom of the ocean (Gupta, 2017). Remotely sensed images also allow to track the growth of a particular area over decades, it also allows to discover and map rugged topography, for example, deep canyons call mom and huge mountain ranges on the ocean floor.



A <u>*Lidar*</u> *(Light Detection and Ranging) image created with data collected by NOAA's National Geodetic Survey* Figure 1

Remote sensors allow data collecting by detecting the energy is reflected from the earth, the more chances can be active or passive. Passive sensors respond to external stimuli whereas active sensors use internal stimuli for data collection. The sensor enables to sense of different objects from the earth's surface and provides spatial data which cannot be collected by physical inspection of art (Aggarwal, 2004). Remote sensing technology is vital in every field such as material engineering, art surface monitoring, water bodies, intelligence cases, and military and material engineering. A practical example of remote sensing includes.

1. Remote sensing technology is crucial and widely used in science fiction movies through lasers and radars.
2. It also assists farmers to explore the nature of soil for better cultivation and crop growth.
3. Remote sensing satellites allow volumetric calculation with the support of before and after sensing images.
4. Remote sensing technology it's helpful for gas and oil resources, and planning regarding the laying of water pipes and gas pipes through spatial data it's convenient with the help of this technology (Khorram, et al., 2012).
5. The geographic information system is practiced for contouring and analyzing hilly areas and mountains. GIS and remote sensing work together for capturing the data and processing it into spatial data for visualizing geographic positions on earth.

2.6 Limitation of remote sensing:

While practicing this technology, remote sensing objects do not work properly in such areas that have strong radiation. Furthermore, remote sensing is practiced by humans and there are chances of human error (Khanal, et al., 2020).

2.6.1 GIS:

Geographic information systems create, analyze, manage, and maps all sorts of data. It is connected to a map that integrates location with database. It provides foundation for analysis and mapping in almost every industry. it provides information regarding certain objects and their location and solves as a foundation for mapping, it also improves efficiency and communication (Nex & Remondino, 2014).

2.6.2 Working of GIS

Geographic information system stores information that can be linked together by geography. Its working is summarized as geographic references and location, relating information from different sources call mom data integration, data capture data structures data modeling and projection and registration (Malczewski, 2004). GIS pauses the ability to relate information and assist in management and planning of natural resources. It is also used for converting existing information that cannot be map into forms. For example, digital satellites images are analyzed to create a thematic layer of critical information (Weng, 2009).

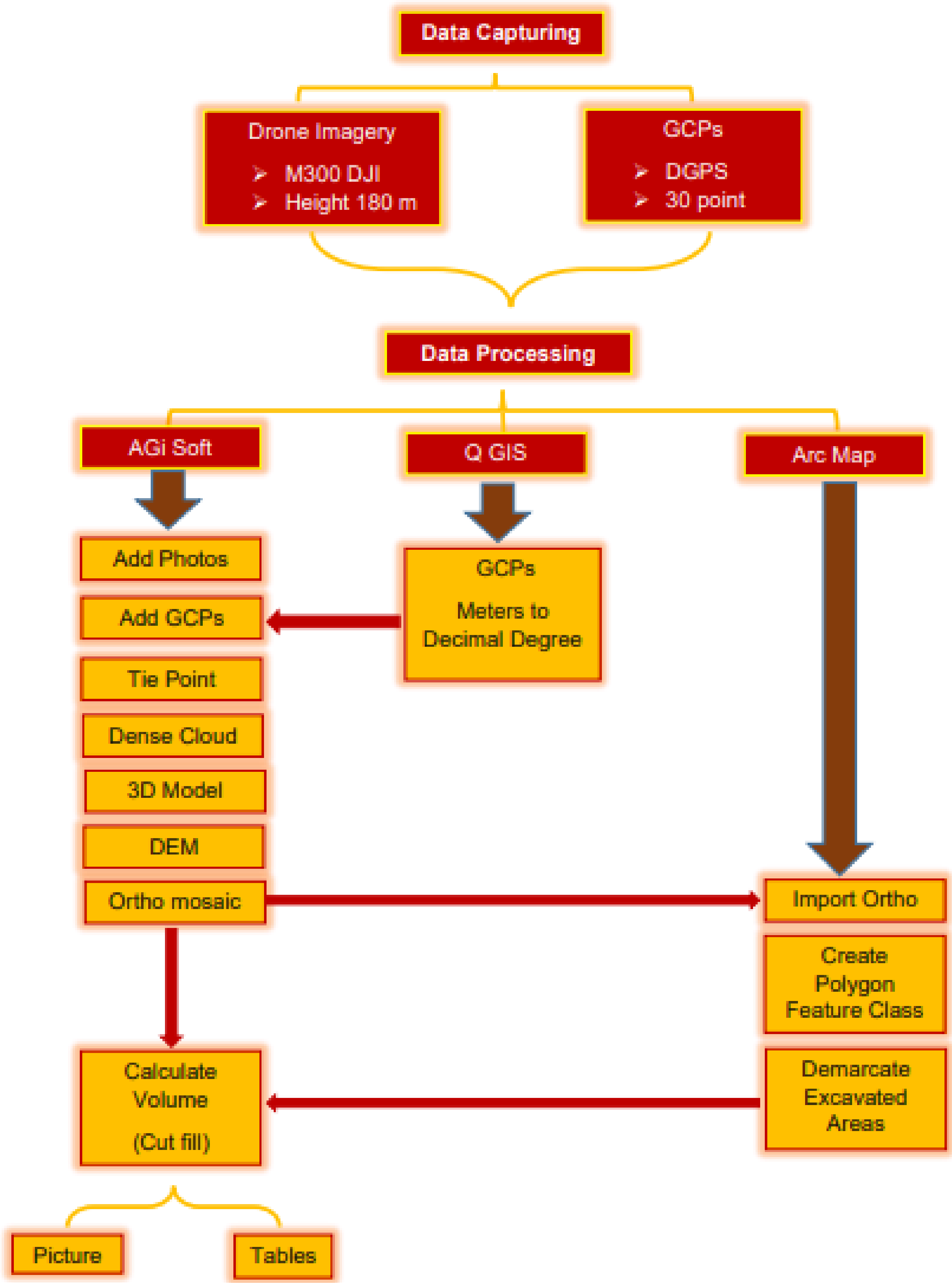
Geographic references

Georeferencing a map, picture, or dataset assigns spatial coordinates. It requires aligning the item to a latitude-longitude or projected coordinate system. To precisely place the object and include it with other geographic data, georeferencing must first construct a spatial reference framework for it. Giving an item a set of coordinates allows it to be used in mapping applications like a geographic information system (GIS) for spatial analysis and visualization.

Since a lot of studies have been caried on said subject but the variations in accuracy, time consumption, cost implications, transparency, labor requirements, or any other relevant factors were not focused on all reports specifically to barren and hilly terrain of Baluchistan.

CHAPTER 3

RESEARCH METHODOLOGY



3.1 ORIENTATIONS OF TERMS and AREAS USED in analysis.

3.2 GCPs:

GCPs are points with known coordinates that can easily be identified in images. When one marks GCPs on images, one links the images with points measured in the ground, which helps geo-reference the project and enhance the accuracy of the results. For this purpose, some points must be marked on the ground that would be clear enough to be visible to the UAV camera head (Mueller, et al., 2016) Secondly, the elevation, latitude, and longitude of these points should be known. The elevation and along are usually taken by the operation of RTK using DGPS.

3.3 Aircraft Specifications

Following are the specifications of a Mavic 2 drone that was used in our study.

Flight Distance	18km
Takeoff Weight	Mavic 2 Pro: 907 g
Dimensions	Folded: 214×91×84 mm (length×width×height)
	Unfolded: 322×242×84 mm (length×width×height)
Max Speed (near sea level, no wind)	72 kph
Maximum Takeoff Altitude	6000 m
Max Flight Time (no wind)	31 minutes (at a consistent 25 kph)
Max Hovering Time (no wind)	29 minutes
Operating Temperature Range	-10°C to 40°C
Operating Frequency	2.400 - 2.483 GHz
	5.725 - 5.850 GHz
Internal Storage	8 GB
Input	100-240 V, 50/60 Hz, 1.8A
Output	Main: 17.6 V ⎓ 3.41 A
	or 17.0 V ⎓ 3.53 A USB: 5 V⎓2 A
Battery	3850 mAh

Figure 2 Specifications of a Mavic 2 drone

3.4 Camera Specification.

The specifications of a Mavic 2 Pro Camera used in our study are as follows.

Lens	FOV: about 77°
	35 mm Format Equivalent: 28 mm
	Aperture: f/2.8–f/11
	Shooting Range: 1 m to ∞
Still Image Size	5472×3648
Video Resolution	4K: 3840×2160 24/25/30p
	2.7K: 2688x1512 24/25/30/48/50/60p
	FHD: 1920×1080 24/25/30/48/50/60/120p
Photo Format	JPEG / DNG (RAW)
Video Format	MP4 / MOV (MPEG-4 AVC/H.264, HEVC/H.265)

Figure 3 Mavic 2 Pro Camera

3.5 Data capturing

We require elevation data from UAV photogrammetry, in our case using a Mavic 2 drone, in the form of a point cloud which can then be converted into DEM. for the said purpose initially mavic 2 drone would be used for image capturing in following way.

3.6 Flight

A flight plan has to be set having a certain overlap so that the images may be formed clearly. The more the overlap the greater the precision of the model. In our case 75% overlap was maintained in all flights. Planning consists of setting up a flight map that shows the route of the drone inside the area and its perimeters, along which aerial photographs are to be captured, the specific requirements such as aerial camera and film requirements, scale, flying height, end lap, tilt, and swing round tolerances, etc. which are set up using Drone-Deploy.

Parameters for selection of flight plan are as follows.

3.6.1 Takeoff and landing point:

First, a point near to a GCP is selected for takeoff. This point should usually lye at a place from where maximum data from the area of interest could be captured.

3.6.2 Assigning Route:

A path must be assigned to the drone. It may be a single lateral path or may be in the form of a mesh depending on the amount of accuracy involved. A mesh provides greater accuracy due to the presence of multiple views of the same area.

3.6.3 Altitude:

Based on the weather and obstructions present in the route a particular altitude is set. The altitude remains constant throughout the flight unless altered manually.

3.6.4 Battery Timings:

The battery timing of the drone plays a vital role in the flight plan. Planning should be done beforehand to cover the area before the charge in the drone runs out. Owing to modern technology, the drone can return to its landing point automatically way before the batteries run out.

3.7 Data processing software

For data processing, used software’s are explained as follows.

3.7.1 AgiSoft.

The software is popular amongst many professionals due to its ease of use in photogrammetry and processing of 3D models. The data in the form of JPEG images that is obtained from the UAV flight is used as an input for the software. The Digital Elevation Model and 3D Model of the area is the output. The volumetric analysis is also carried out by the software that is helpful in predicting the amount of material present in the area.

3.7.1.1 Tie points.

Tie points in AgiSoft refer to identifiable points or features that are marked on overlapping images during the photogrammetric process. These points are used to align and merge multiple images into a single 3D model or orthomosaic.

3.7.1.2 Dense cloud.

In photogrammetry, a dense cloud is a point cloud that represents the 3D coordinates of the points on the surface of an object or a scene. In AgiSoft, a dense cloud is generated using the matching algorithms and depth maps that are created from the overlapping images of the object or scene.

3.7.1.3 DEM

DEM stands for Digital Elevation Model, which is a digital representation of the elevation or height of the Earth's surface. A DEM is typically represented as a grid of elevation values, where each cell in the grid corresponds to a specific location on the Earth's surface.

3.7.1.4 ORTHOMOSAIC

An orthomosaic is a high-resolution image made by stitching together overlapping aerial or ground-level photographs of an area, which have been corrected to remove the perspective distortion, such as the effects of camera tilt, lens distortion, and topographic relief. The resulting image has uniform scale and is geometrically corrected, so that the features on the ground are represented in their true planimetric location without the distortion caused by perspective.

3.8 QGIS:

QGIS (formerly known as Quantum GIS) is a free and open-source Geographic Information System (GIS) software application that is used for creating, editing, visualizing, and analyzing geospatial data. We will use to convert GCPs from meters to degrees.

3.9 ArcMap.

ArcMap is a desktop geographic information system (GIS) software application developed by Esri, which allows users to create, edit, analyze, and visualize geospatial data. It is a part of the ArcGIS suite of GIS software products, which is widely used in various fields such as geography, environmental science, urban planning, and natural resource management.

CHAPTER 4.

PROCEDURE

4.1 Setting Ground Control Points

The first step of the project was establishing ground control points (GCP) to create a Geo-referenced and improved relative orientation of the image. The following equipment was required for the laying of GCPs.

1. Colored spray paints
2. Paper tape
3. Marker
4. Differential GPS
5. Measuring tape

The following steps were taken to establish the required GCPs.

1. A relatively flat and natural spot is selected for the GCPs. For the purpose a reconnaissance of the complete area must be carried out.
2. Once the spot is selected, paper tape was used to make a 1ft x 1ft box that eventually forms a cross in the middle. These square boxes of 6" x 6" size give us a point in the center that is geo-referenced and is also visible to the camera fitted into the drone.
3. A big label indicating the number 1 is marked on the ground near to the GCP. It should also be large enough to be visible from the camera.
4. Similar method was used to create 15 GCPs at places that are at a different elevation from one another and are at such a distance that they may not accumulate errors in the model.

Figure 4 GCP no.2 having dimension 1ft x 1ft at the target site.

5. The next step is to assign a specific elevation and Lat/Long to the ground control points. For this purpose, a DGPS was used.

Figure 5 RTK Base Station placed at DHA Quetta

6. A reference base station is placed at suitable location. After the requisite settings the station takes sometimes, and its own location coordinates and altitude is calculated.
7. Next, the Rover station is placed on the marked GCPs which gives the latitude and longitude along with the elevation of the GCPs. The station automatically saves the location and altitude readings that may later go directly into the software for processing.

4.2 UAV Flight

The below-mentioned procedure was followed to map and carry out the drone flight of the site.

1. First a reconnaissance of the area was carried out. A total of 3.5-hectare area was decided for carrying out the requisite flights.
2. One flight of 30 minutes time could cover an area of approx. 9 hectares. Thus, our area was covered comfortably in one flight.
3. A suitable location was chosen for the flight having a certain elevation so that most of the area and GCPs are visible.

Figure 6 GCP number 4 is also the takeoff point for the UAV.

4. Drones deploy is a mobile phone software that was used to define the area that would be covered in a flight. A2-sector area had to be covered. For this purpose, a netted pathway was provided on the app to have an increased accuracy of the readings.
5. After assigning the area to the software the mobile phone was connected to the drone remote controller.

Figure 7 Flight Plan of the DHA Quetta opened on Drone-Deploy mobile app covering complete area.

6. The drone was assembled according to the instructions given along. The batteries were crossed checked. The altitude was set to 210 ft.
7. The drone was then placed on one of the GCP no 4. The wings were cross-checked so that they may not be intercepted somehow.
8. Now the drone was ready for takeoff. The launch button was pressed on the remote controller and the drone took off.

Figure 8 DJI Mavic 2 Drone depicting size with the reference to hand.

9. The drone moves itself to the starting point and starts to take its images according to the plan on the software automatically.
10. A certain percentage of lateral and longitudinal overlap of the images is already set. It should be more than 75%. In our case, we set it to the minimum requirement i.e., 75%. The overlap of images gives a clearer and more precise model.

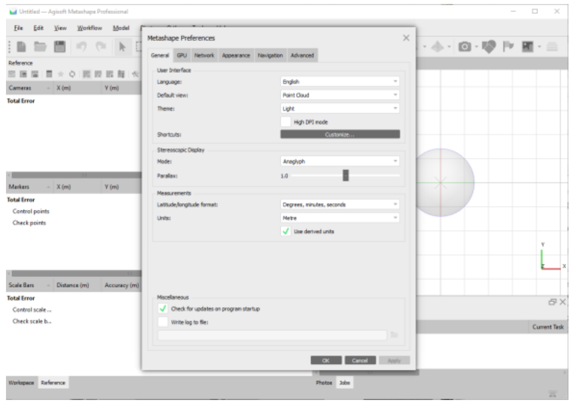
Figure 9 First Flight Landing at DHA Quetta after completing the depicted flight plan.

4.3 Image Processing in AgiSoft

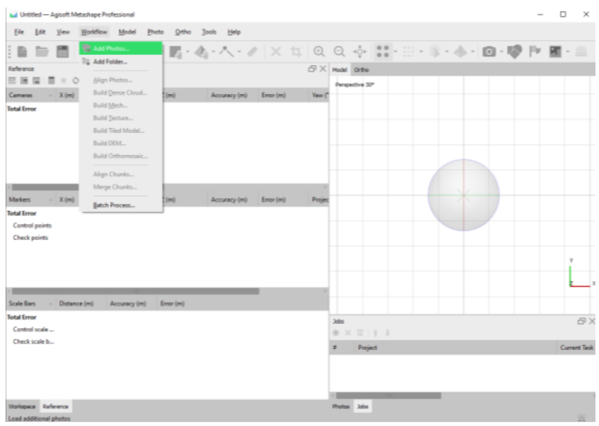
Launch Agisoft Metashape and modify the software's preferences. Navigate to the "Tools" menu. Regarding preferences in Metashape Pro on a Mac operating system, there are various options available for customization (Tinkham & Swayze, 2021).

4.3.1 Preferences

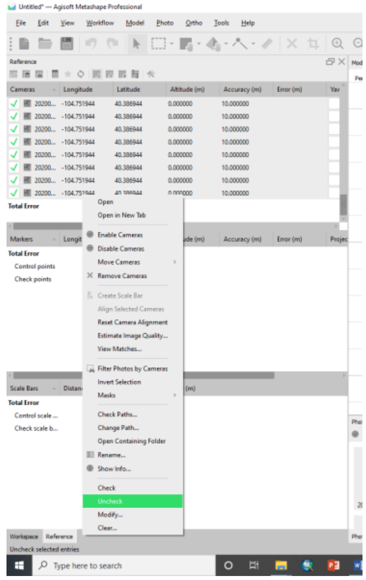
Alter the default display setting to exhibit a "Point Cloud" view and ensure that the units of measurement are set to "Metre."



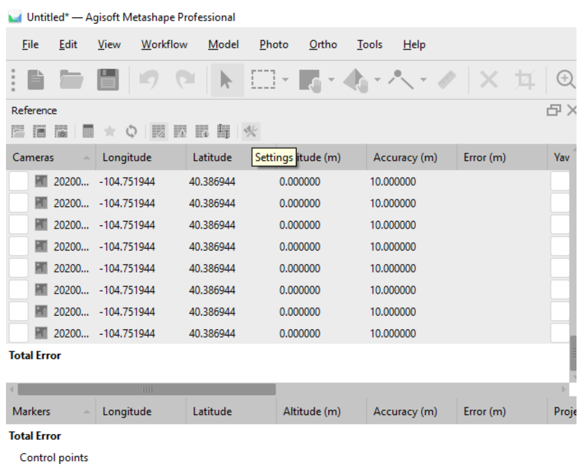
1. Add photo Workflow >> Add Photos



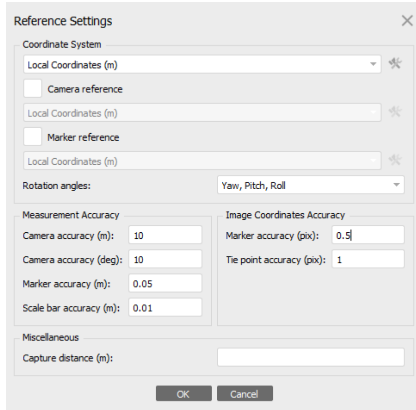
It should be noted that in cases where photos captured by a camera or a phone have imprecise GPS coordinates, it is advisable to deselect the Cameras option. The term "cameras" is used to refer to photos in this context. To deselect all photos simultaneously, one may click on the reference pane, choose all the photographs, and then right-click. Uncheck



2. Make sure to save your project. File >> Save As
3. In the reference pane, go to Settings.

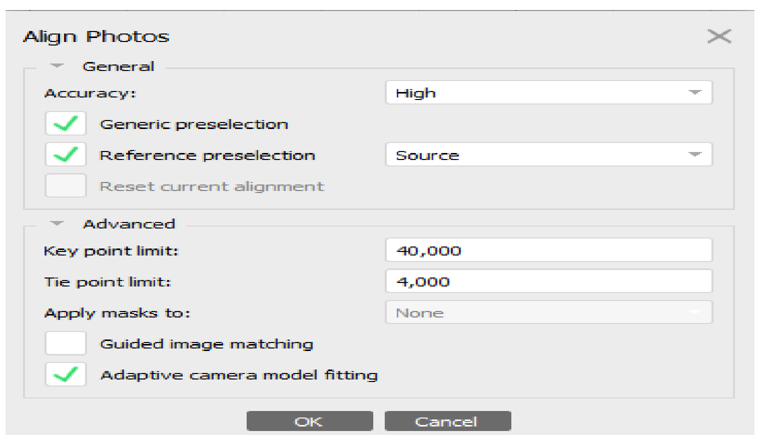


In the event of necessity, it is advisable to alter the coordinate system that is intended for use in your project and provide specifications for both the camera (if applicable) and/or ground control (Marker Reference). The appropriate terminology for this scenario would be "The designation should solely read as 'Local Coordinates (m)'."



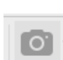
provide information regarding the precision and accuracy of your camera and markers used as ground control points. The marker accuracy in the illustration is approximately 0.05 m or 5 cm, as it was manually obtained using a tape measure.

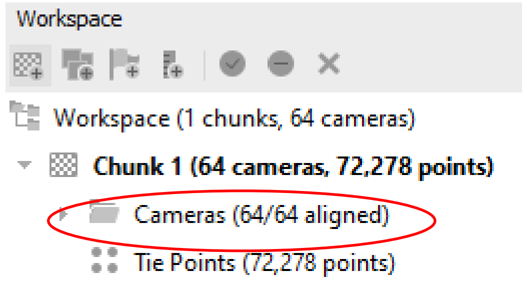
4. Align-Photos

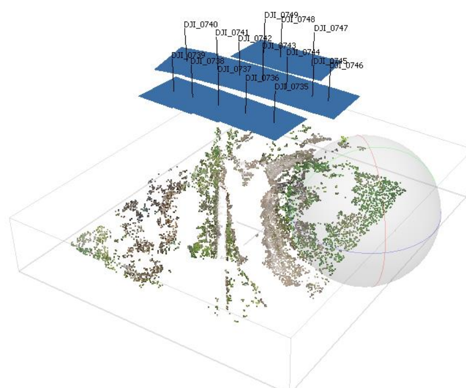


Workflow >> Align Photos

Check alignment by looking in the Workspace. You may have to check in the camera icon.

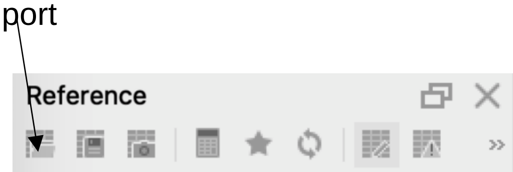






5. In the Reference screen, import the coordinates of the targets (also called ground control points [GCP])

Import



The format for the ground control (GC) coordinates ought to be in .txt format, as exemplified below, with tab delimiters. It is important to select the suitable coordinate system at the outset. To establish a local coordinate system, opt for the "Local Coordinates (m)" option. Select the suitable columns to ensure the proper importation of the text.

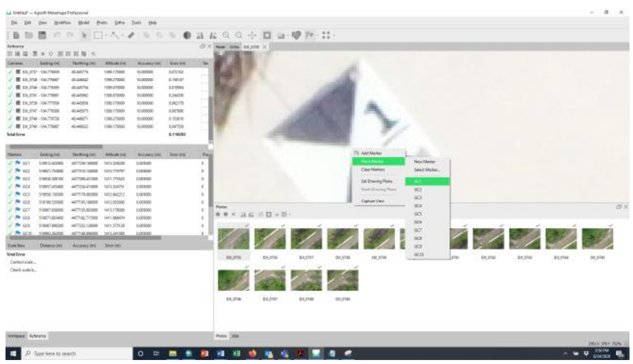
Targets - Notepad

File Edit Format View Help

ID	X	Y	Z
71	-3.6	9.4	2.6
53	-1.75	9.9	2.7
72	0.3	8.6	1.2

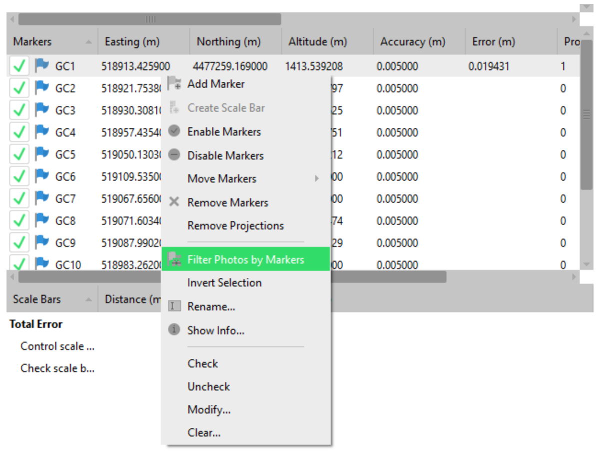
A dialog box will appear with the message “Can’t find match…”—just say “Yes to All” Cannot locate a match for "1" and choose "Yes to All."

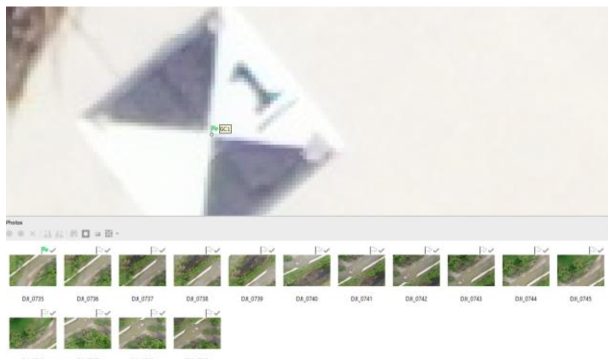
With GCP, double-click on each picture. The picture will show up in a new window. Focus on each GCP/target. Assign coordinates by right-clicking on the center of each target, selecting "Place Marker," and then selecting the correct target from the list of imported ones.



Another alternative is to first place the markers by right clicking on the image and choosing “Add Marker.” Choose the correct marker. Then in the Reference Pane, you can rename it by double clicking on the name in the Markers pane and import the text file afterward. Make sure the name matches your text file.

Once you have placed a marker, you can filter the photos by that marker to get Metashape’s best guess as to matching photos. In the Reference Pane, right click on the marker and click “Filter Photos by Marker.” The associated photos Metashape has found will show up in the photo viewer. You will get white flags for guesses. You will need to go through ALL the photos with the marker and reposition them in the correct location or confirm they are correct by dragging the flag to the correct place. You can always right-click >> Remove Marker if you make a mistake.





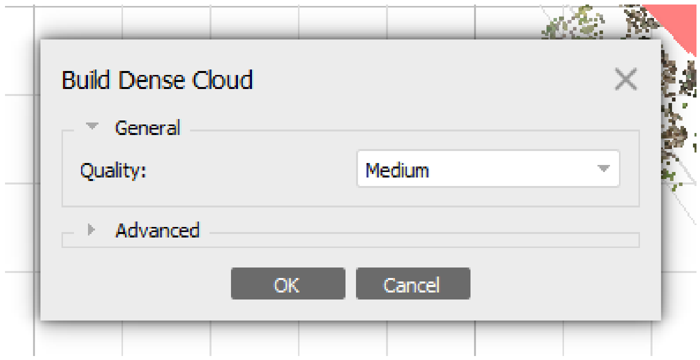
Work your way through the photos assigning or correcting the GCP in each photo. Click the Update button in the Reference pane to roughly georeferenced the model based on these points. This will speed up placing the remaining GCPs.

To optimize the camera alignment and generate a camera calibration based on the GCPs, click the Optimize Cameras button in the Reference pane toolbar. Accept the default settings.

6. Errors
    1. It is advisable to review and verify any errors at this point. There exist multiple factors that may contribute to inaccuracies and inconsistencies.
    2. The control points exhibit measurements of Error (m) and Error (pix).
    3. The term "Error (m)" refers to the residual error that occurs either per coordinate or in 3D space. The aforementioned pertains to the spatial separation existing between the input (source) and the approximated locations of the marker.

4. The error, expressed in pixels, is the root mean square reprojection error of the marker. This value is computed across all photographs in which the marker is visible.
5. It is advisable to periodically save your project in the .psx format to prevent the loss of any work.

Build dense cloud Workflow >> Build Dense Cloud Choose “Medium.”

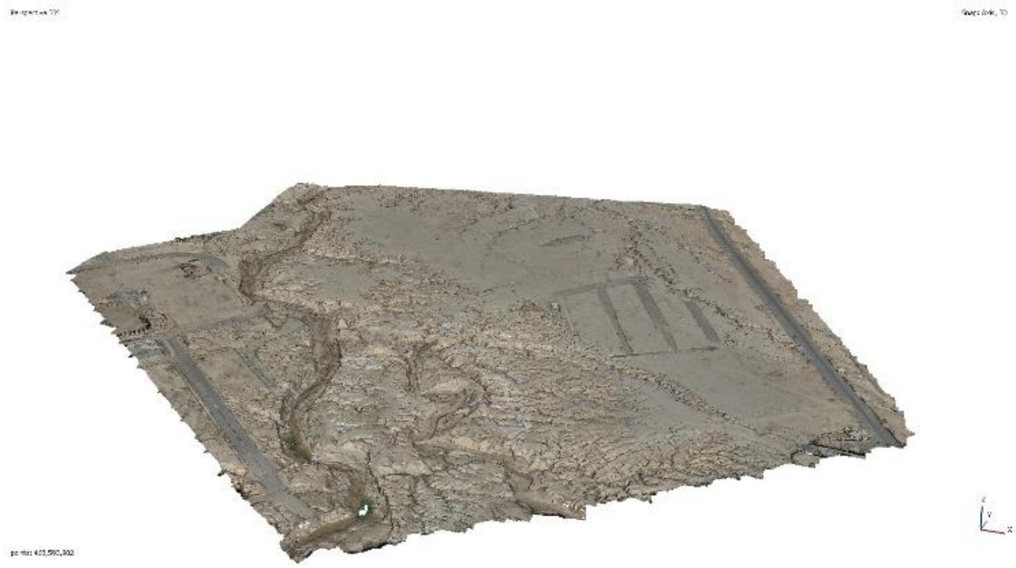


View dense cloud   Model >> View Mode >> Dense Cloud OR click the dense cloud icon.


<

7. After the dense cloud is created, the points may need to be edited. Some portions of the model may be inaccurate, or just outside of the region of interest. This is an appropriate time to remove these points. Select points to delete by using one of the selection tools.

Build MESH Workflow >> Build MESH Choose “face count>>Medium.”

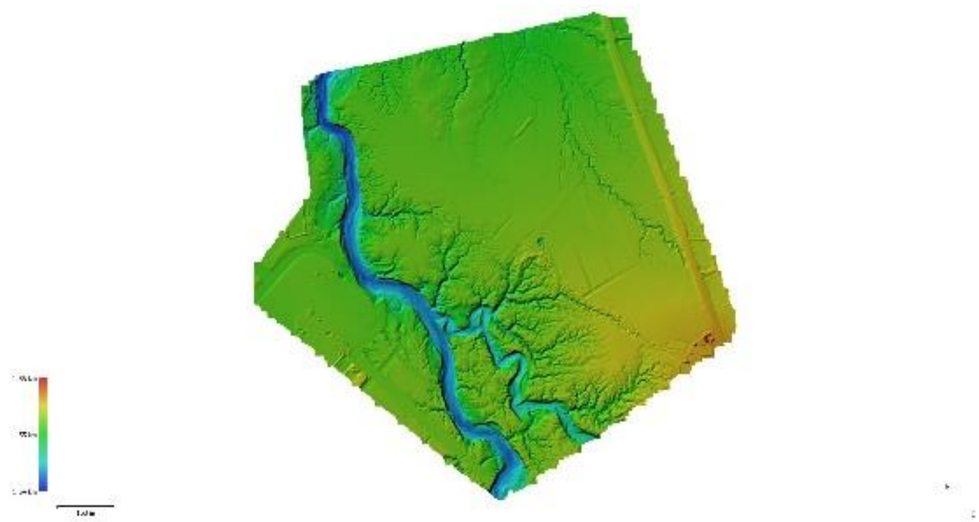


8. Build TEXTURE

   Workflow >> Build TEXTURE

9. Build DEM

   Workflow >> Build DEM



(A screenshot from AgiSoft)

10. Build ORTHOMOSAIC

    Workflow >> Build orthomosaic

11. Save your project again and then export. To export point cloud: File >> Export >> Export orthomosaic >> Ok
12. Now use ARCmap for polygon features.
13. Import ortho in Arcmap

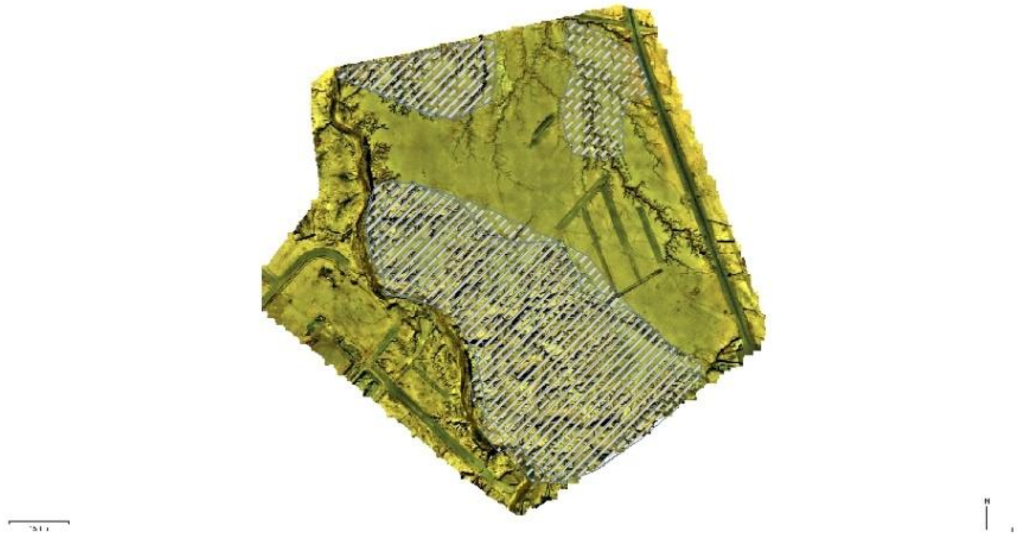
    Catalogue>>connect folder>>slect folder>>ok
14. Create database.

    >>select your folder>>rt click>>file geo database>>rename it>>
15. Create feature class.

    Rt click database>>new>>feature class>>name it>> select polygon feature>>ok.
16. Create shape.

    Editor>>start editing>>create feature>>

    Start making required number shapes on your orthomosaic and save this activity.

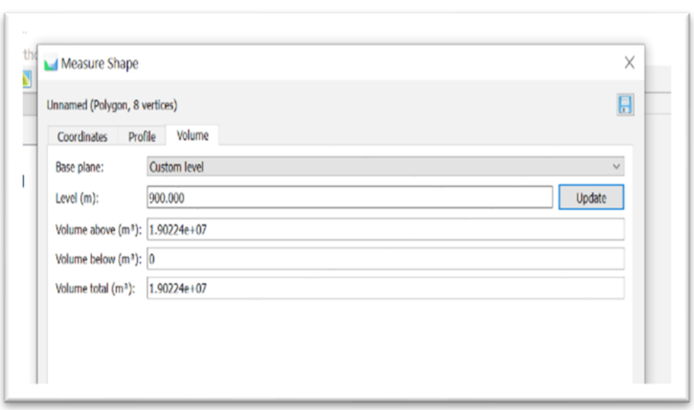


17. Import shape in AgiSoft.

    File>>import>>import shapes>> select ArcMap shape>>ok.

18. Volume calculation

    Rt click polygon>>measure>>customize live>>enter level>>update>>volume is calculated.



CHAPTER 5

RESULTS AND ANALYSIS

5.1 Volume Estimation

For the calculations of volume in AgiSoft 9x points were chosen where unsuitable material was excavated. AgiSoft measures the volume based on the pile surface and a base surface created in AgiSoft. An ArcMap tool is used to make a boundary along the surface to compute volume. The measure dialogue gives the volume. Where the surface is above the base surface, cut is computed, where the surface falls below the boundary fill is computed. This dialogue also gives the total volume of the target surface.

The base surface was taken as mean reduce level of undisturbed soil of surrounding area.

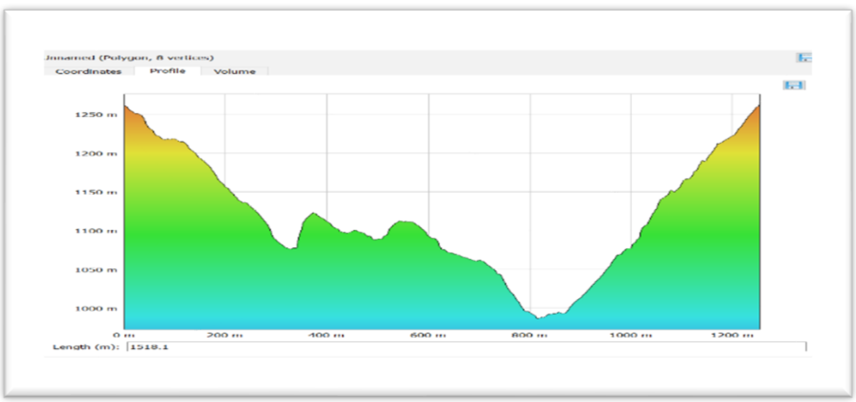


Figure 10 *<u>Volume Calculated by AgiSoft for One of The Plan</u>*

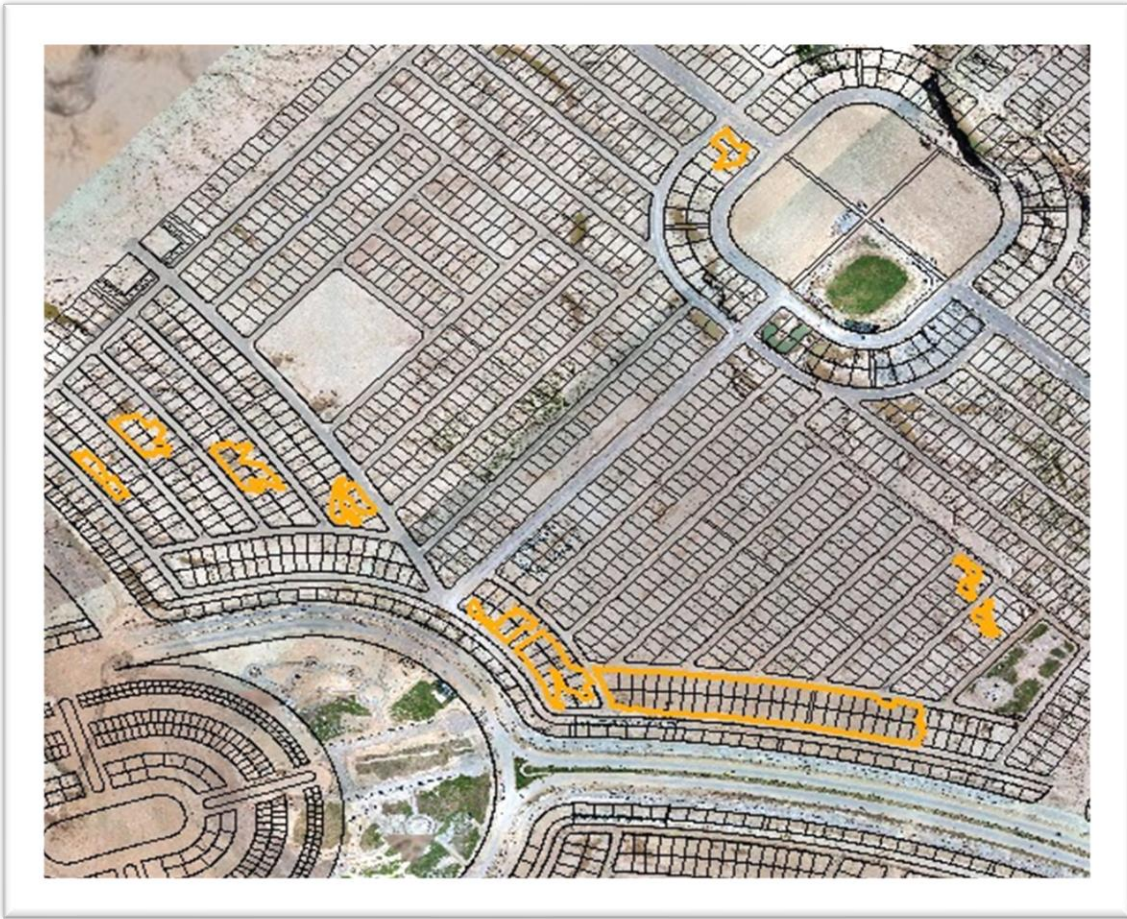


Figure 11 <u>*Unsuitable Material Excavation at Sector-A2 DHAQ*</u>

5.2 Results and Comparisons

5.3 Volume calculated by AgiSoft for all 9 points is as follows.

5.3.1. <u>**PLAN#**1</u>

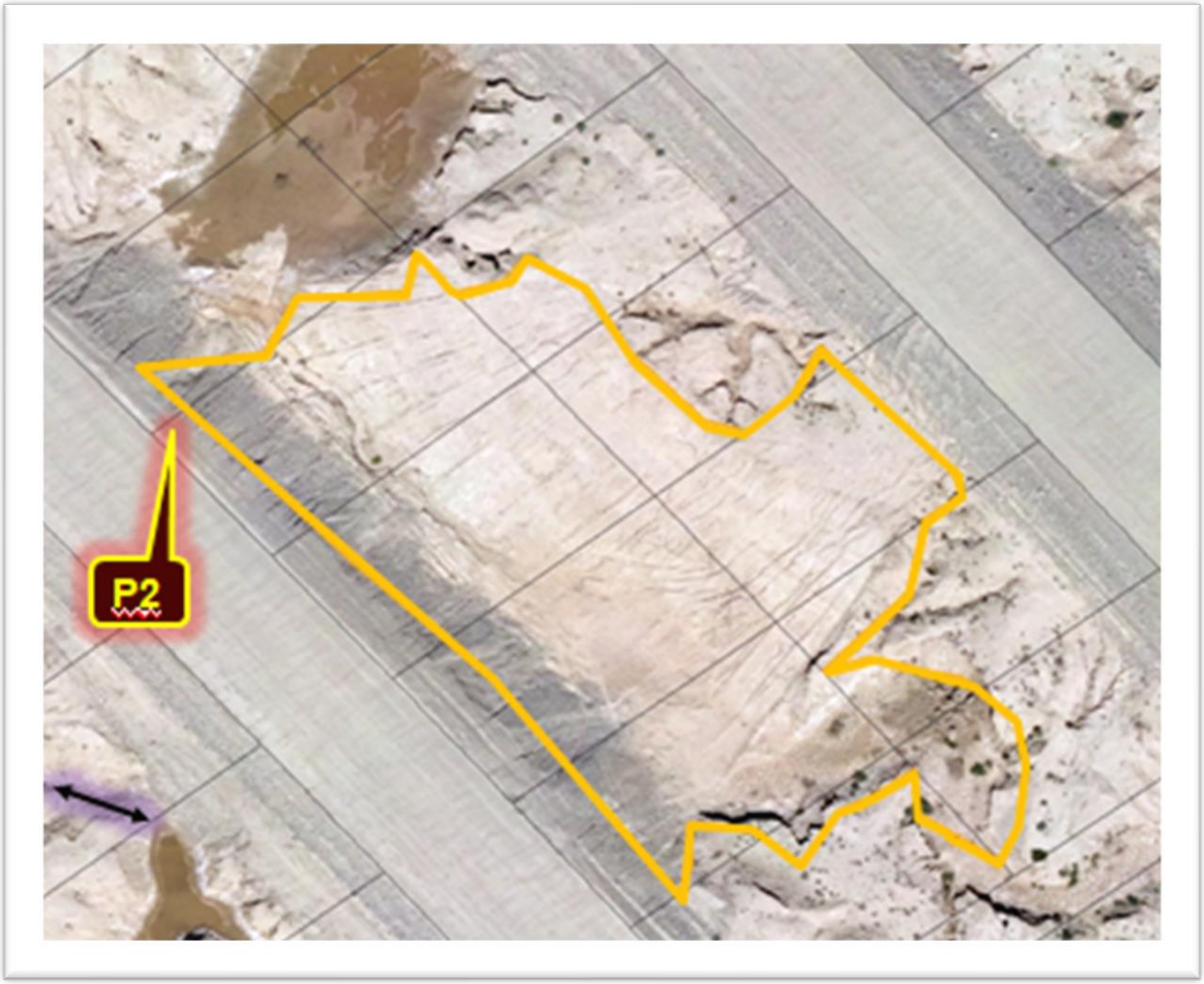
Table 1 Volume calculated by AgiSoft PLAN#1

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P1	1091	628.18	644.56

5.3.2. **PLAN#2**

Table 2 Volume calculated by AgiSoft & Conventional Method PLAN#2

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P2	2137.4	1809.5	1856.1



5.3.3. PLAN#3

Table 3 Volume calculated by AgiSoft & Conventional Method PLAN#3

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P3	2492.1	4434.1	4658.9

5.3.4. PLAN#4

Table 3 Volume calculated by AgiSoft & Conventional Method PLAN4

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P4	1526.9	2160.5	2218.5

5.3.5. PLAN#5

Table 4 Volume calculated by AgiSoft & Conventional Method PLAN#5

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P5	4053.9	607.9	620.3

5.3.6. PLAN#6

Table 5 Volume calculated by AgiSoft & Conventional Method PLAN#6

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P6	21808.1	17306.1	17878.3

5.3.7. PLAN#7

Table 6 Volume calculated by AgiSoft & Conventional Method Plan#7

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P7	662.2	1435.3	1445.9

5.3.8. PLAN#8

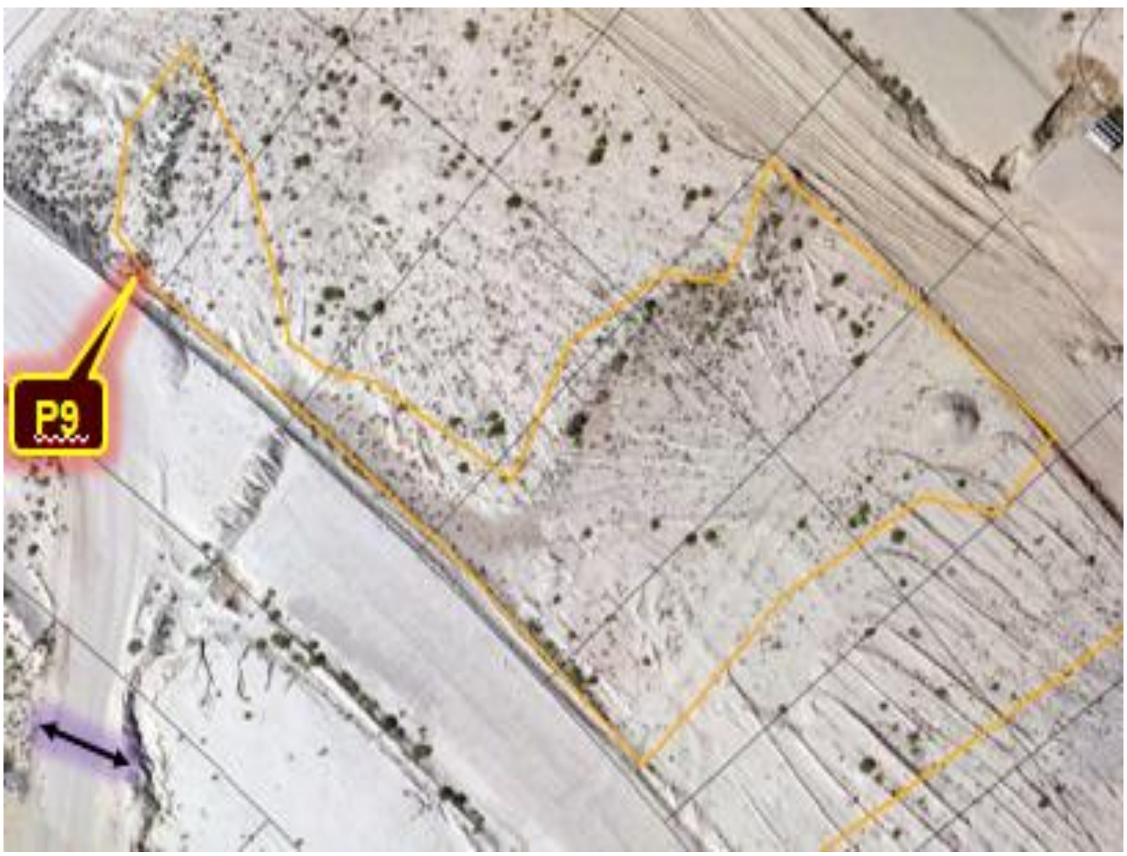
Table 7 Volume calculated by AgiSoft & Conventional Method Plan#8

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P8	543.04	1664.8	1682.4

5.3.9. PLAN#9

Table 8 Volume calculated by AgiSoft & Conventional Method Plan#9

Plan	Area m^2	Exc Vol m^3	Volume by conventional method
▪ P9	1514.49	1435.3	1446.1



5.4 Total volume calculated.

Table 10: _volume calculated by AgiSoft._

Description	Area m^2	Exc Vol m^3	Volume by conventional method
▪ Plan-1	1091	628.18	644.56
▪ Plan-2	2137.48	1809.5	1856.1
▪ Plan-3	2492.13	4434.1	4658.9
▪ Plan-4	1526.91	2160.5	2218.5
▪ Plan-5	4053.91	607.9	620.3
▪ Plan-6	21808.1	17306.1	17878.3
▪ Plan-7	662.2	1435.3	1445.9
▪ Plan-8	543.04	1664.8	1682.4
▪ Plan-9	1514.49	1435.3	1446.1
▪ Total	35829.21	31222.19	32451.06

5.5 Area - Time Ratio

From the estimated time consumed it is for sure that photogrammetry takes a lot more time to display results as compared to the other two methods, but the area covered by photogrammetry is immense. To compare the overall efficiency an Area to Time ratio has been calculated as under.

Survey Method	Total Time	Area (m^2)	Area-Time Ratio (m^2 /min)
Photogrammetry	130(mins)	198093.1	628.87
Conventional method	9 days	35829.21	2.68

Table 9 Area to Time ratio of different surveying methods

5.6 Comparison of Conventional vs UAV technique based on the research Data.

Criteria	Conventional Method	UAV	Logical Reasoning
Accuracy	Lower	Higher	UAV photogrammetry can cover a larger area and do volumetric calculations using specialist software, improving accuracy over conventional surveying methods.
Timesaving	Slower	Faster	UAV photogrammetry can survey a bigger region in less time than conventional approaches.
Cost-saving	Lower	Higher	UAV approach decreases manual labor, equipment setup, and survey time. Conventional methods are more labor-intensive and costly.
Transparency	Limited	Higher	UAVs can create open maps, shared photos, and 3D models. Conventional methods may not be as visual or shareable.
Labor	More required	Less required	Manual data collecting requires surveyors and assistance. UAVs capture aerial photographs, reducing personnel.
Coverage and Data Density	Limited	Higher	UAVs, especially photogrammetry, can cover bigger areas and take high-resolution aerial photos. This yields a more complete dataset than standard methods.
Accessibility and Terrain Challenges	Limited	Higher	UAVs are great at collecting data from inaccessible regions. Such terrains may limit conventional methods.

Data Processing and Analysis	Manual, slower	Automated, faster	UAV approaches, especially with AgiSoft, provide quicker and automated data processing and analysis. Manual calculations may delay conventional methods.
Repeatability and Monitoring	Limited	Possible and easier	UAV approaches may be replicated for continuing monitoring and comparison. Repeated surveys may take longer with conventional methods.
Safety and Risk Mitigation	Lower	Higher	UAVs eliminate the need for surveyors to visit dangerous or difficult places, guaranteeing safety. Surveyors risk more using conventional methods (Gupta, et al., 2015).

In terms of precision, effectiveness, cost-effectiveness, transparency, and labor, below is a comparison between the conventional approach (assuming Conventional surveying techniques) and the UAV (Unmanned Aerial Vehicle) method:

5.6.1 Accuracy:

Excavation was claimed by the DHA contractor, the same area was surveyed using drone technique. The result showed discrepancies. In response a new team was sent to DHA comprising both parties(consultant team and DHA contractor). The new data obtained by the consultant team matched the drone results. It depicts that accuracy was attained using the drone technique. Photogrammetry (UAV approach) covers a broader region and makes volumetric calculations with AgiSoft software, it may be deduced that it gives reliable findings (Abubakar, et al., 2023). The specifications provided by high-quality sensors are extremely precise, often within two millimeters (FlyGuys, 2021).

5.6.2 Timesaving:

The UAV method (photogrammetry) takes more time than the conventional method. According to the thesis, the complete area of 198,093.1 m2 may be covered by photogrammetry in 130 minutes, but the same amount using the conventional approach would take 9 days to cover. As a result, the UAV method speeds up gathering and analysing data.

5.6.3 Cost-saving:

There is a lack of concrete pricing information in the thesis. However, it is reasonable to assume that the UAV method will reduce expenses associated with manpower and tools. Manual labor, equipment setup, and extended survey times are commonplace in the Conventional approach, all of which add up to higher costs. By contrast, the UAV method facilitates quicker data gathering, which lessens the need for human labor and, subsequently, the project's overall cost.

5.6.4 Transparency:

Transparency is not addressed directly in the thesis as a criterion for evaluation. However, unmanned aerial vehicles (UAVs) and photogrammetry can render an open and understandable map of the mapped region. Transparency in project planning, monitoring, and reporting is improved by the ease with which the produced pictures and 3D models may be shared and discussed.

5.6.5 Labor:

Surveyors, helpers, and maybe even manual data collecting could be needed for the Conventional approach. Instead, the UAV method requires less manpower because to the UAVs' ability to take aerial photos on their own. However, professional workers may be needed for operating and analysing the acquired data using specialized software like AgiSoft, which might be a drawback to the UAV technology.

5.6.6 Coverage and Data Density

When compared to the Conventional method, the UAV technology, and photogrammetry in particular, enables for more thorough coverage of a greater region. This is clear from the thesis's discussion of the vast dissimilarity amongst the regions investigated. Capturing high-resolution aerial photography with the UAV method results in a richer dataset that can give more granular details about the studied region.

5.6.7 Accessibility and Terrain Challenges:

There are some places that may be inaccessible or difficult to reach via the conventional approach. Data gathering from regions that would be difficult or risky for conventional surveying methods is made possible by UAVs because to their versatility and portability.

Limitation:

Vegetation, steep slopes, and other obstacles can make it difficult to reach some depression sites. Drones may have trouble navigating and gathering useful data in such environments. Surveyors can nonetheless accomplish their work in these challenging environments using traditional surveying techniques, guaranteeing complete coverage and precise data collecting.

Although drone surveys have many useful applications, traditional surveying methods still have some advantages on depression grounds, especially when it comes to accuracy, ground control, complicated terrain, restricted access, and adaptability to changing environmental conditions. Ultimately, the needs, limitations, and goals of the surveying project will determine which of the two approaches will be used.

5.6.8 Data Processing and Analysis:

When combined with photogrammetry software like AgiSoft, the UAV approach paves the way for very effective and automated data processing and analysis. The simplicity with which volumetric computations may be generated from the gathered aerial data is demonstrated by the thesis's reference of the calculation of volumes using AgiSoft software. Manual data processing and computations are possible in the Conventional approach, but they can slow down the process and introduce room for error. The Conventional approach typically use more conventional 2D representations, which may provide difficulties when attempting to provide such visuals (Ulvi, 2021).

5.6.9 Repeatability and Monitoring:

The UAV method has the benefit of being able to be repeated, allowing for ongoing monitoring and comparison of the same region. This may be helpful for keeping tabs on shifts, monitoring development, and spotting trouble spots. Surveying the same region several times by hand may be more time-consuming and labor-intensive when using the conventional approach.

5.6.10 Safety and Risk Mitigation:

Unmanned aerial vehicles (UAVs) can be used in place of humans in dangerous settings, decreasing the likelihood of harm to surveyors. It reduces the need for surveyors to physically enter hazardous or difficult areas, making data collecting safer.

The study employed drone technology as a means of data capture within Sector A2 of DHA Quetta. This suggests a contemporary and effective methodology for gathering data in contrast to conventional techniques.

The software tools employed for processing the captured data were AgiSoft and ArcMap. AgiSoft is recognized for its proficiency in photogrammetry, indicating that the investigation utilized this methodology to produce three-dimensional models or maps. ArcMap is a software application that belongs to the class of Geographic Information Systems (GIS). It is designed to facilitate spatial analysis and visualization.

Conducting an evaluation of the precision of the generated models or maps in relation to established datasets or ground truth would yield advantageous results.

The research incorporates volume calculations conducted through the utilization of AgiSoft software. The present study involves a comparison between the volumes computed by AgiSoft and those obtained using Conventional techniques. The statement implies that the study was centered around evaluating the precision and expediency of volume computations utilizing photogrammetric techniques.

The research introduces an area-time ratio to evaluate the efficiency of photogrammetry in comparison to the conventional method. Photogrammetry is a technique that can cover a larger area, albeit at the cost of a longer processing time for the results, when compared to conventional methods. The discovery underscores the inherent compromise between the extent of coverage and the duration of processing.

CHAPTER 6

RECOMMENDATION:

It is recommended utilizing UAV (Unmanned Aerial Vehicle) survey for volume calculation due to its numerous advantages over conventional survey methods. Firstly, UAV survey offers remarkable time efficiency. With swift deployment and rapid data acquisition, it significantly reduces survey duration, allowing for quicker results and decision-making. Secondly, it proves to be cost-efficient as it eliminates the need for expensive manned aircraft or ground-based equipment. UAVs are more affordable, making surveys more accessible to a broader range of projects. Lastly, the processing period is greatly reduced thanks to advanced software and automation, enabling faster data analysis and volume calculations. Embracing UAV survey for volume calculation undoubtedly enhances efficiency, reduces costs, and expedites project timelines. Drawing from the dissertation titled "Earthwork Volumetrics Utilizing Unmanned Aerial Vehicles," the following suggestions can be posited for future academic inquiry:

1. Examine Various Unmanned Aerial Vehicle (UAV) Platforms: Evaluate and contrast the efficacy of diverse UAV platforms in the context of earthwork volumetrics. The study involves the utilization of drones with diverse functionalities, such as fixed-wing drones or larger-scale unmanned aerial vehicles (UAVs), to evaluate their efficacy in acquiring precise data for volume computations.
2. It is imperative to conduct a thorough examination of alternative software options that are specifically tailored for earthwork volumetrics, despite the widespread use of AgiSoft as a preferred data processing tool. Conduct a comparative analysis of various software solutions with respect to their performance, accuracy, and efficiency to ascertain the optimal choice for processing point cloud data.

3. Undertake field studies to verify the precision and dependability of the proposed methodology. approach will aid in the establishment of the methodology's credibility and offer valuable insights into potential limitations or challenges that may arise during its practical implementation.

4. Perform a cost analysis to assess the economic viability of utilizing unmanned aerial vehicles (UAVs) for the purpose of measuring earthwork volumes. It is important to consider the expenses related to equipment, software for data processing, training, and upkeep. Conduct a comparative analysis of the expenses associated with the proposed approach against those of conventional surveying techniques to ascertain the cost-benefit ratio of the former.
5. The limitations of remote sensing, such as adverse weather conditions or strong radiation, that may impact the accuracy and reliability of the data obtained should be identified and addressed. Examine methodologies to address these constraints and enhance the overall efficacy of the approach.
6. It is imperative to evaluate the potential influence of the proposed methodology on the environment, particularly in areas that are deemed sensitive or protected, by considering environmental factors. Assess the prospective advantages of diminished environmental disruption and resource consumption in contrast to conventional surveying techniques.
7. Engage in collaboration with industry experts, such as construction companies or mining organisations, to obtain valuable insights into their distinct needs and requirements pertaining to earthwork volumetrics. Integrate the feedback and suggestions provided by the stakeholders to enhance the methodology and guarantee its pragmatic feasibility.
8. Examine Automation and Artificial Intelligence: Assess the possible application of automation and artificial intelligence methodologies in the processing of gathered data, including but not limited to feature extraction, object recognition, and pattern analysis. The implementation of this approach has the potential to optimize the workflow of data processing, improve precision, and minimize the need for manual labor (Van, et al., 2020)

CHAPTER 7

FUTURE WORK:

Several possible future methods and accomplishments might be contemplated based on the data presented in the thesis: Photogrammetry is the examples of the cutting-edge surveying methods that the thesis suggests being used to calculate volumes at mining sites. Field tests and case studies might be part of a future programmed to verify the reliability and precision of these methods in actual mining operations.

Mining site monitoring and evaluation may benefit greatly from the use of remote sensing technology like satellite imaging and aerial drones. Integrating remote sensing data with surveying methods might be the subject of future research aimed at enhancing the speed and precision of volume calculation (Noor, 2018). Creating State-of-the-Art Algorithms for Processing Data The thesis discusses the usage of AgiSoft Metashape and FARO Scene to analyses the collected data and provide reports for volumetric analysis. The time and effort spent on volume computation may be reduced in the future because of developments in data processing algorithms that allow for more automated and efficient processes.

The research addresses flight planning for UAVs and the significance of taking photos with adequate overlap to optimize flight planning and data capture. Developing sophisticated flight planning algorithms that optimize the flight route, picture capture settings, and data gathering procedure may be a part of future protocols to increase the precision and consistency of the findings. AI/ML Could Improve Mining Operations Artificial intelligence (AI) and machine learning (ML) hold great promise for improving mining operations. Possible directions for further study include looking at how AI and ML algorithms might be used to automate data processing, spot abnormalities at mining sites, and improve overall volume computation efficiency.

More complete and precise knowledge of the mining site can be attained by fusing data from numerous sensors, such as LiDAR, photogrammetry, and GPS. To increase confidence in and accuracy of volume calculations, future protocols may look at ways to combine information from many sensors. Sustainability in Environmental Monitoring

Mining activities have profound effects on the natural environment. To better measure and monitor the environmental impacts of mining, future studies may investigate combining surveying methods with remote sensing technology. This has the potential to improve natural resource management and promote more environmentally responsible mining practices.

Creating standardized procedures and standards for using cutting-edge surveying methods in mining operations helps increase repeatability and reliability of findings. Guidelines and standards for the use of surveying and remote sensing technology in the mining industry might be the subject of future work. Advanced surveying methods, remote sensing technology, data processing algorithms, and environmental monitoring practices should all be integrated into future procedures and accomplishments in this sector to increase the efficiency, accuracy, and sustainability of mining operations.

CHAPTER 8

CONCLUSION

This thesis investigates the problems with conventional approaches to measuring and estimating earthwork volumes in construction and mining operations, and proposes a systematic approach to fixing them. To improve the precision, productivity, and economy of earthwork volumetrics, the combination of Unmanned Aerial Vehicles (UAVs) scanning methods offers a viable alternative.

Manual measurements and subjective interpretations hampered accurate volumetric assessments, leading to inefficient resource allocation and suboptimal project planning, as discussed in the aforementioned review of existing literature and discussions on the limitations of conventional surveying methods. It has become clear that there has to be a simplified mechanism in place that allows for constant monitoring in real time, accurate volumetric calculations, and data-driven decision making.

The construction and mining industries stand to benefit greatly from the creation and execution of an integrated approach to earthwork volumetrics leveraging UAVs methods. Professionals may increase project results, efficiency, and cost by going beyond the bounds of conventional procedures. This study lays the groundwork for more research and promotes the use of cutting-edge technology in the field of earthwork volumetrics.

When conducted with precision instruments and by skilled surveyors, conventional surveying can achieve high levels of accuracy, typically within a few millimeters or even sub-millimeter accuracy. Photogrammetry, on the other hand, relies on the analysis of imagery to extract measurements and create 3D models. The accuracy of photogrammetry depends on factors such as the quality of the imagery, the number and distribution of control points, the accuracy of the camera calibration, and the processing algorithms used.

Photogrammetry allows hard and inaccessible areas to be analyzed with good accuracy but conventional surveying have inherent difficulties due to handling of equipment and human error. Photogrammetry allows for the rapid collection of data over large areas. This can significantly reduce fieldwork time and overall project duration, which in cases of conventional surveying would have been otherwise. Photogrammetry can be employed for both small-scale and large-scale surveys, including topographic mapping, volumetric calculations, terrain modeling, and infrastructure monitoring. The same imagery can be used for multiple purposes, saving time and resources, though conventional surveying has also been used for multipurpose but have limited applications as compared to photogrammetry. Photogrammetry may not be suitable for real-time or dynamic measurements.

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