SUMMER INTERNSHIP REPORT

A report submitted in fulfillment of the requirements for the summer internship program.

SUBMITTED BY:

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UNDER SUPERVISION OF:

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Indian Institute of Technology (BHU) Varanasi.

Duration: 20/ 05 / 24 - 12/ 07/ 24.

DEPARTMENT OF CIVIL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY (BHU) VARANASI.

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CERTIFICATE

This is to certify that the "**Internship report"** submitted by Rajesh Lodhi (22CEB0A40) represents their diligent work undertaken during the 2023–2024 academic year. This report is presented in partial fulfillment of the requirements for the summer internship program in the **Department of Civil Engineering** at the **Indian Institute of Technology (BHU) Varanasi.**

College Internship Coordinators

Arvind (M-tech student)

Department Internship Coordinator

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Civil Engineering.

Head of The Department

Prof. Sasankasekhar Mandal

Department of Civil Engineering.

ACKNOWLEDGEMENT

First and foremost, I would like to express my deepest gratitude to Dr. Shishir Gaur (Assistant Professor) for providing me with the invaluable opportunity to undertake this internship within the organization.

My sincere thanks also go to the college internship coordinators, Arvind (M-Tech student), for his support and valuable advice, which were crucial in the successful completion of our internship at IIT BHU.

Finally, I'm express my deepest appreciation to the staff members of our department, whose assistance and encouragement were pivotal in the successful completion of this internship.

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Drone Survey

Drone surveying, also known as unmanned aerial vehicle (UAV) surveying, uses drones to capture aerial data for site surveys. Drones are equipped with cameras and other sensors that face downward, such as RGB or multispectral cameras, and LiDAR payloads. During a survey, the drone takes multiple photos of the ground from different angles, and the images are geotagged. The data is then transmitted to ground equipment and processed into a digital representation of the site, such as an interactive 3D map.

Drones are continually proving to be powerful commercial tools, simultaneously providing adopters with leaps in efficiency and safety. The surveying and mapping industry is no exception.

With their ability to capture data from above, drones have been successfully integrated into surveying workflows to perform land surveys, photogrammetry, 3D mapping, topographic surveying, and more.

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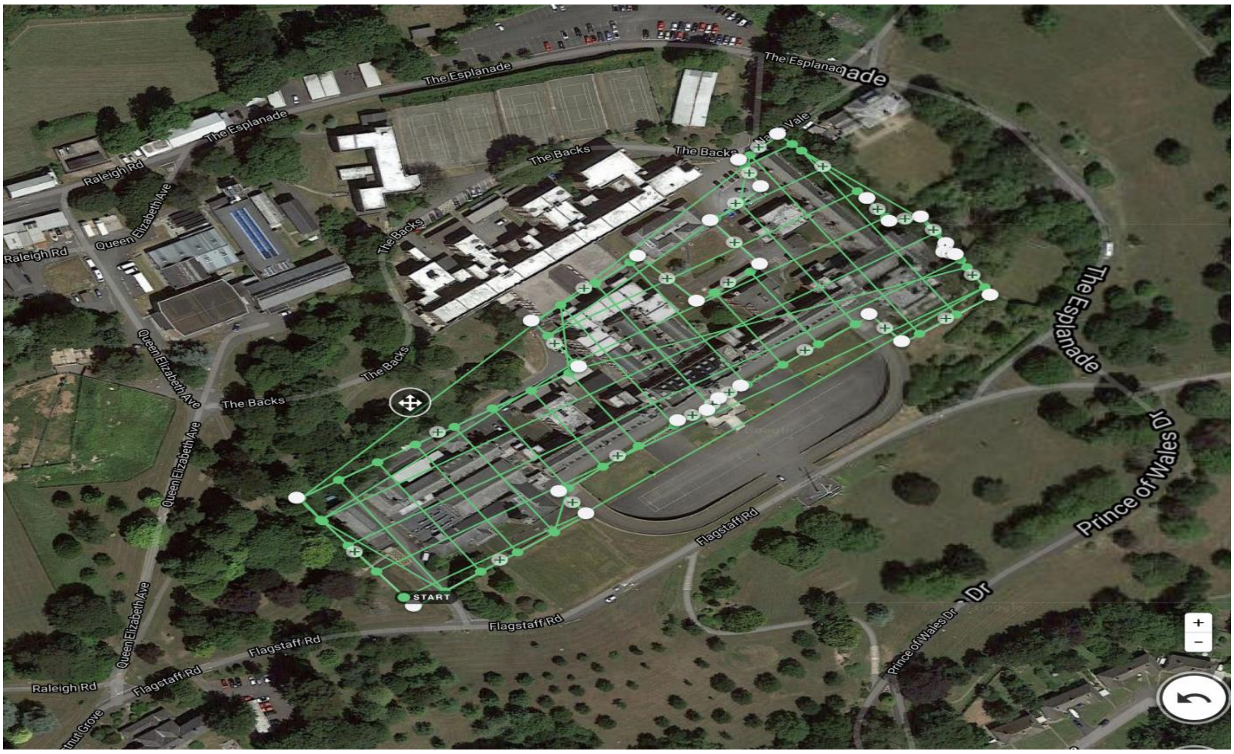
3D Mapping Drones :-

Drone Photography Services specialise in photogrammetry 3D mapping. Our drone (UAV) pilots are industry experienced in land surveying and construction. To improve the detail of our 3D mapping we take oblique aerial images at 30° and 45 ° angles flying around objects at different altitudes, in addition to flying the normal overlapping lawnmower path regular grid pattern. As all the images are geo-referenced, these additional oblique images add depth and detail to the final 3D rendered model when the images are draped over the wire frame mesh.

The 3D textured wire framed mesh is a representation of the shape of the model that consists of vertices, edges and faces together with the texture which is projected to it.This sparse and dense point cloud is triangulated to create a wire frame mesh model which can be saved as a file and imported into most GIS, CAD compatible software for further analysis.

Drone Photography Services' commercial drones can fly an average of 60-80 acres in around 20 minutes without the need to land to change a battery. We carry spare pre-charged batteries on each shoot. It only takes a few minutes to change the battery and get back in air. So, we are able to fly all day with very little disruption. Our cloud-based 3D mapping software uses powerful servers to plot and construct the 3D model. It identifies millions of key points in the overlapping high resolution aerial images and calculates a 3D point cloud which is a set of points defined by the X, Y and Z coordinates as well as colour.



What kinds of deliverables can we achieve with drone surveying?

Depending on choice of data sensors and surveying software, drone surveying can produce a variety of deliverables with use cases in many industries.

- High quality 2D Orthomosaic maps
- 3D orthomosaic map
- 3D models
- Point cloud
- DTM
- DSM
- Contours and Elevations
- Stream Flow

kinematics (PPK) capabilities. When paired with a few GCPs, survey-level accuracy can be achieved.

3D point cloud :-

A 3D point cloud is a collection of data points in space, each having precise coordinates (X, Y, and Z) that represent the external surface of objects within the surveyed area. In drone surveying, 3D point clouds are generated using data captured by drone-mounted sensors such as cameras or LiDAR systems. **File formats: .las, .Laz, .ply, .xyz.**

Orthomosaic maps :-

Orthomosaic maps are high-resolution, geometrically corrected images that accurately represent the Earth's surface, created by stitching together multiple aerial or satellite images. They are used in various fields, including agriculture, forestry, construction, and urban planning. distortion and stitched together during post-processing to create a highly-accurate orthomosaic map. Each pixel contains 2D geo-information (X, Y) and can directly procure accurate measurements, such as horizontal distances and surfaces.
File formats: geoTIFF (.tiff), .jpg, .png, Google tiles (.kml, .html)

Digital surface models (DSM):-

Digital Elevation Models, or DEMs, represent the elevation of the earth’s surface. DEMs can be either a DSM or DTM. The resulting model shows the elevation of the earth’s surface. The DEM is essentially a superset of the DSM and DTM.

DEMs are a 3D grid of terrain elevations collected from an area with satellite imagery or LiDAR technology. DEMs are useful for visualizing landscape changes over time, creating simulations of natural phenomena like landslides and floods, and measuring land use changes over time — as well as many other applications. They can also be combined with other models to create more detailed representations of the earth’s surface.

File formats: GeoTiff (.tif), .xyz, .las, .laz

Digital terrain model (DTM):-

Digital Terrain Models, or DTMs, represent the bare earth surface without any features such as buildings or vegetation. DTMs are created using methods similar to DSMs, such as LiDAR or photogrammetry, but require additional processing to remove objects above the ground. This process is known as “bare-earth extraction.

A digital terrain model has three main components:

- The surface itself
- The elevation at each point on the surface
- The slope at each point on the surface

This model is similar to DSM, but it represents only the highest points on the surface of the terrain instead of every point on its surface as DSM does. DTMs can be used to create contour lines. This is useful for building roads or railroad tracks because they allow you to see if there are any obstacles such as trees or rocks in your way before you start building them.

DTMs are particularly useful for terrain analysis, such as slope and aspect calculations, hydrological modelling and geological applications.

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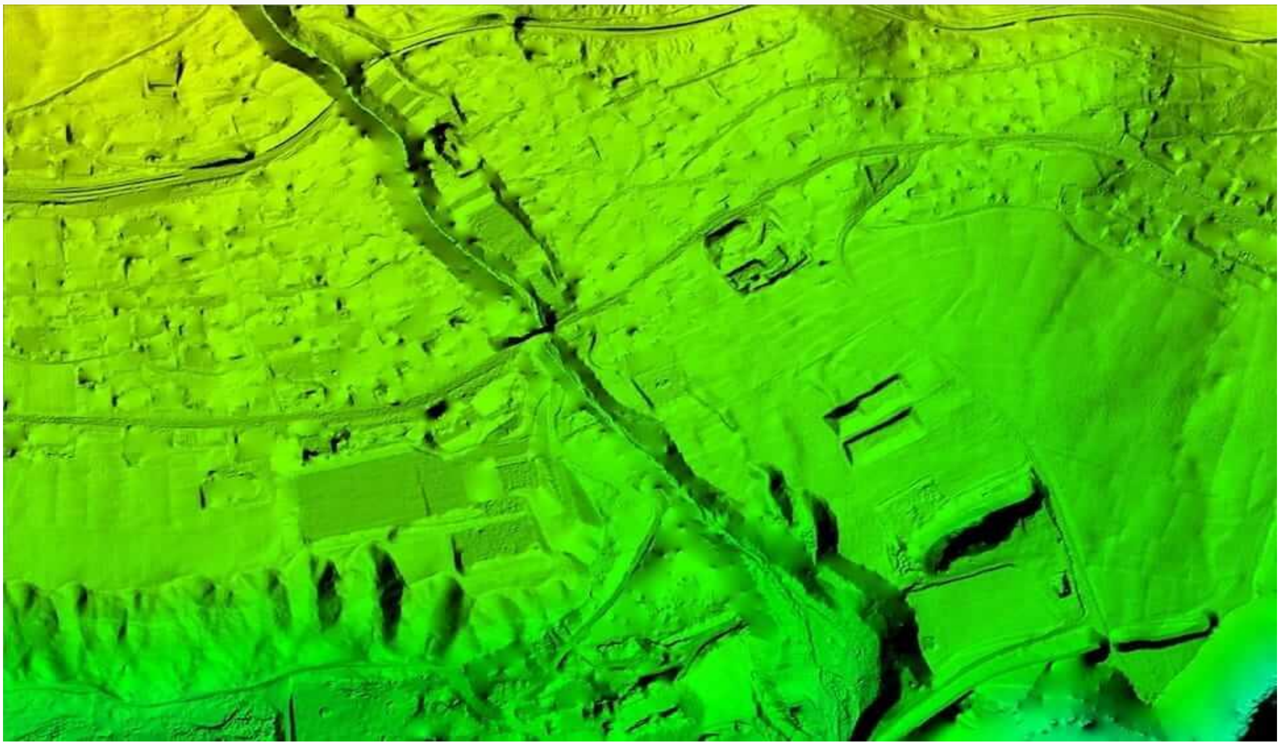
File formats: GeoTiff (.tif)

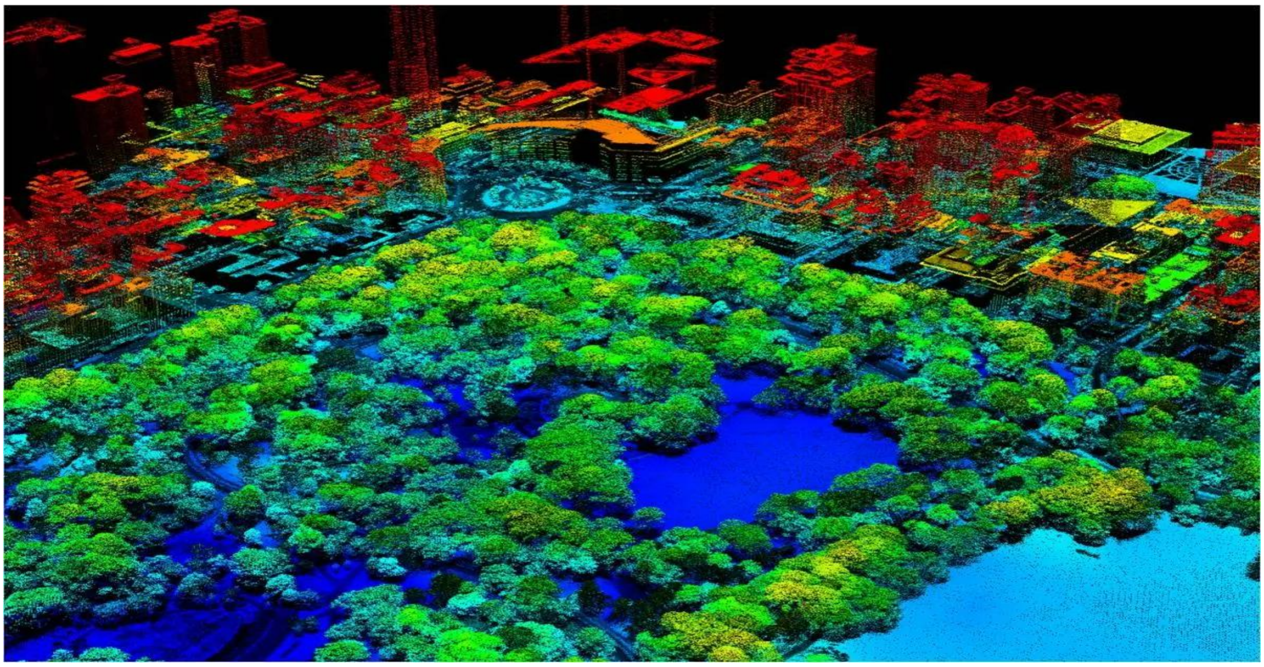


Digital Surface Models (DSMs):-

Digital Surface Models, or DSMs, represent the topography of the earth's surface, including all objects on it, such as trees, buildings, and other features. DSMs are created using aerial data capture methods, like LiDAR (Light Detection and Ranging) or photogrammetry. LiDAR uses laser beams to measure the distance between the

sensor and the ground, while photogrammetry uses aerial photographs to create 3D models.
There are many benefits of DSMs. For one, they accurately represent the earth's surface, allowing users to accurately measure features and make decisions based on that information. 3D visualization of the Earth's surface allows users to see the surface and features in a more realistic and immersive way. This is particularly useful in applications such as urban planning and design where visualizing the impact of planned developments on the existing landscape is critical.

Digital surface models offer several advantages over traditional topographic mapping. Because DSMs are typically created using LiDAR or photogrammetry, they provide high-resolution data. This means that DSMs can capture much more detail than traditional topographic maps, often based on field surveys, and may not accurately capture all features. The high-res data also provides highly accurate elevation measurements. This allows for more precise calculations of slope, aspect and other terrain characteristics, essential for industries that model water flow and drainage.



3D textured mesh:-

A 3D textured mesh surface model is a digital representation of an object's surface in three dimensions that uses a collection of polygons, edges, and vertices to define its shape and structure. 3D textured mesh models can be textured and lit to create realistic images, and can be optimized and deformed to create complex animations. They are used in a variety of applications that require realistic 3D models, including animation, virtual reality, medical imaging, and industrial design.

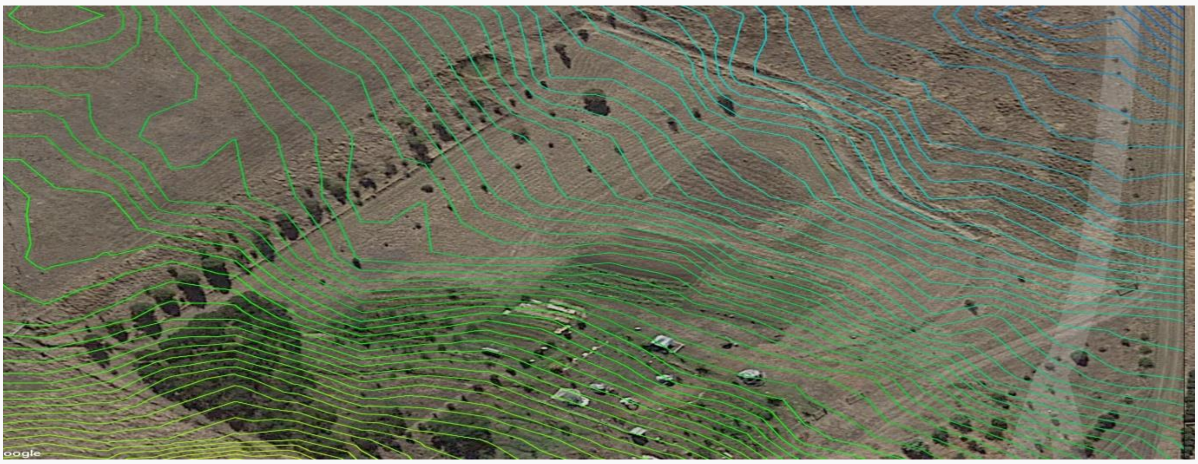
File formats: .ply, .fbx, .dxf, .obj, .pdf.

Contour lines :-

In a drone survey, contour lines are lines drawn on a topographic map to show ground elevation or depression relative to a certain point. They are also known as level curves or isolines. Contour lines are made up of lines instead of pixels and are represented in vector file format.

Contour lines connect places that are the same height above sea level or a given level, such as mean sea level. Numbers on the lines indicate the height in feet. Lines that are drawn close together indicate a steep slope, while lines that are widely spaced indicate flatter land. The difference in elevation between two consecutive contour lines is called the contour interval. The contour interval can be chosen based on the terrain, with a higher interval for areas with large variations in elevation, such as hills and ponds, and a smaller interval for flatter terrain. A collection of contour lines projected onto a plane is called a contour map or contour plot. Contour maps can show valleys, hills, and the steepness of slopes.

File formats: .shp, .dxf, .pdf

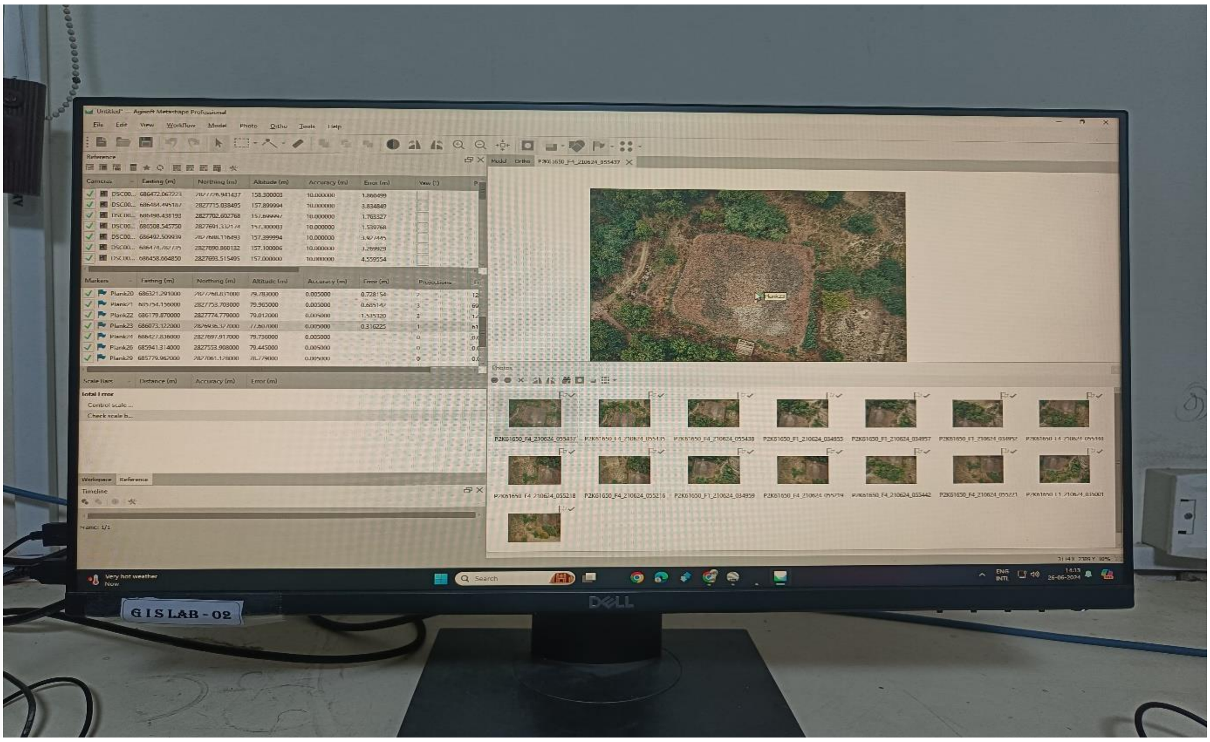


Drone Image Processing

Drone image processing involves the use of specialized software to convert raw aerial images captured by drones into useful, actionable data. This process includes several key steps:

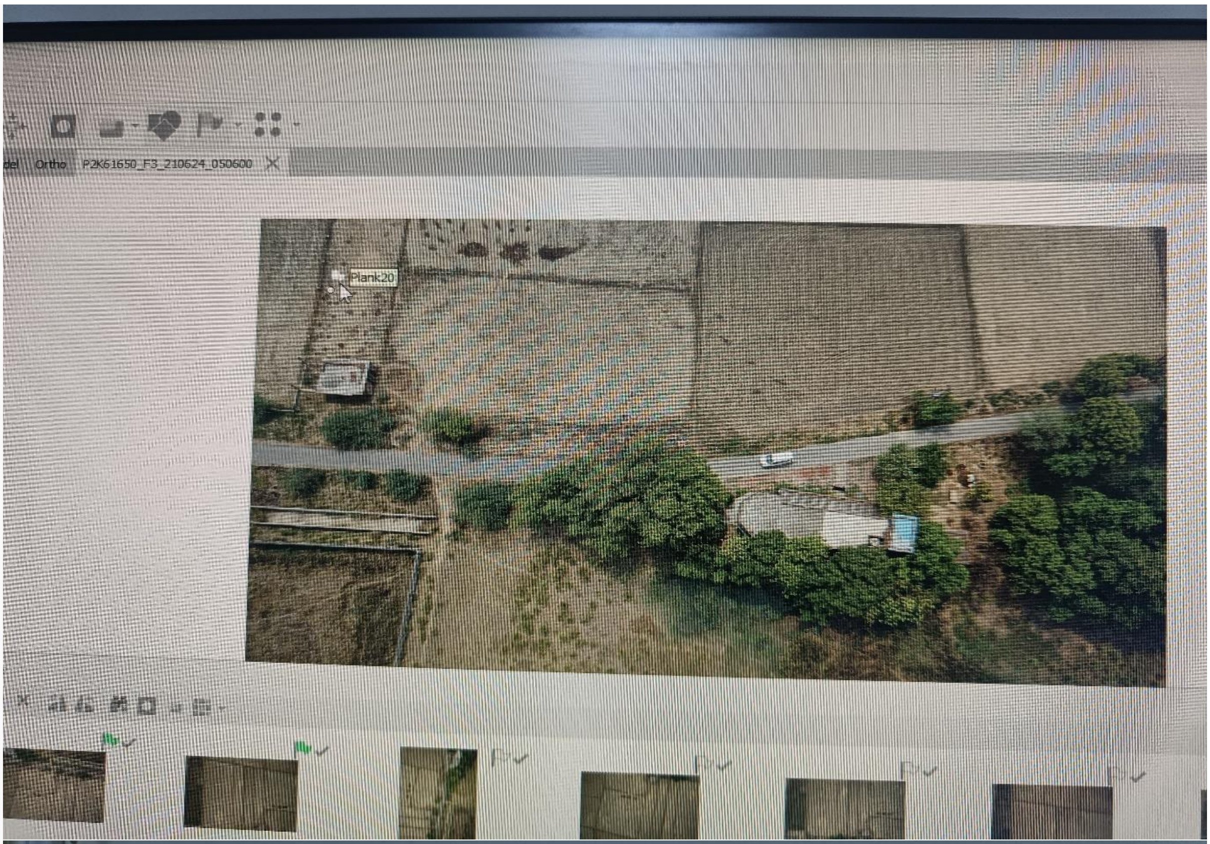
1. **Image Capture:** - Drones equipped with high-resolution cameras take multiple overlapping photos of the survey area from different angles.

2. **Data Upload:-** The captured images are transferred to a computer or cloud-based processing platform.



3. **Image Alignment:-** The software aligns and stitches together the overlapping images using algorithms that detect common points in the photos. This process is known as photogrammetry.

4. **Georeferencing:-** Images are georeferenced using GPS data embedded in the images and ground control points (GCPs) to ensure spatial accuracy.



Ortho
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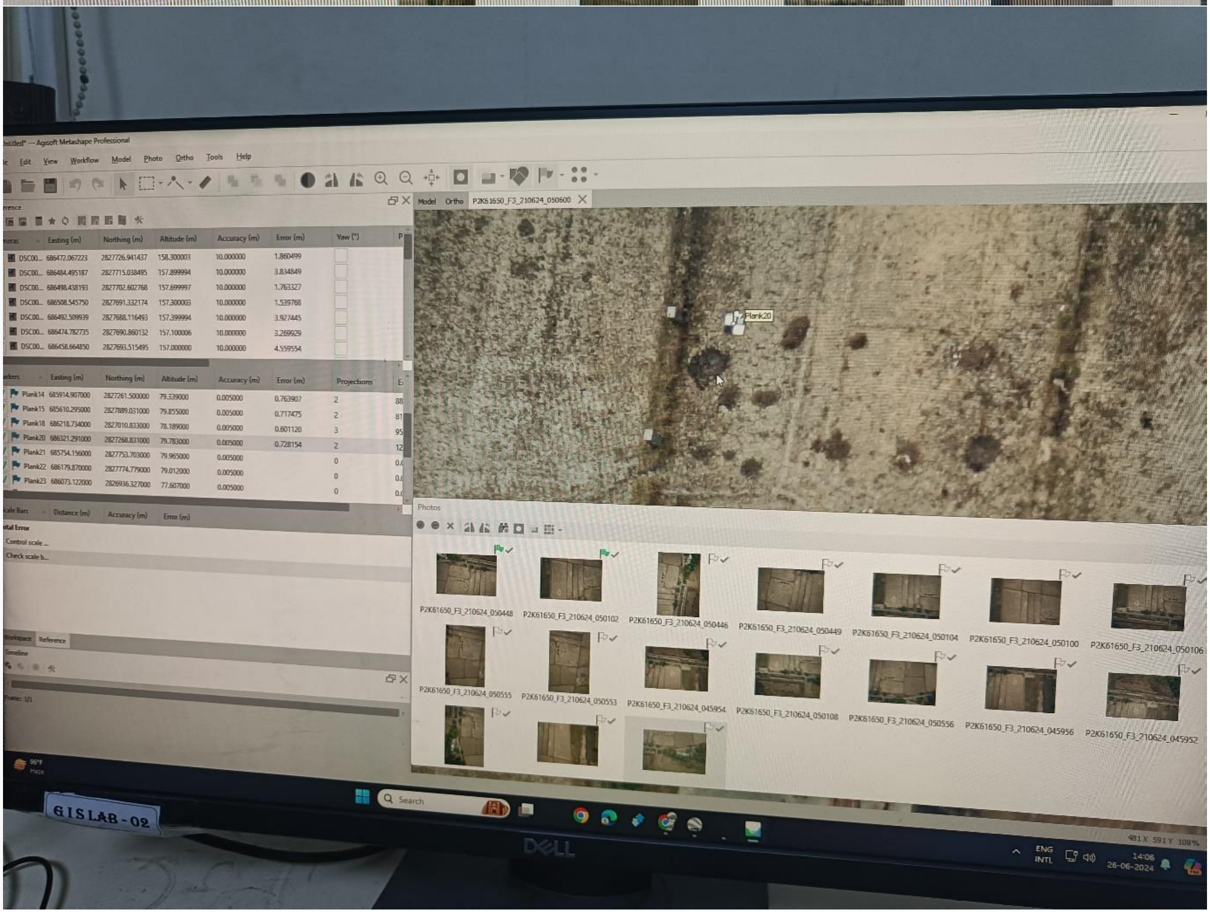
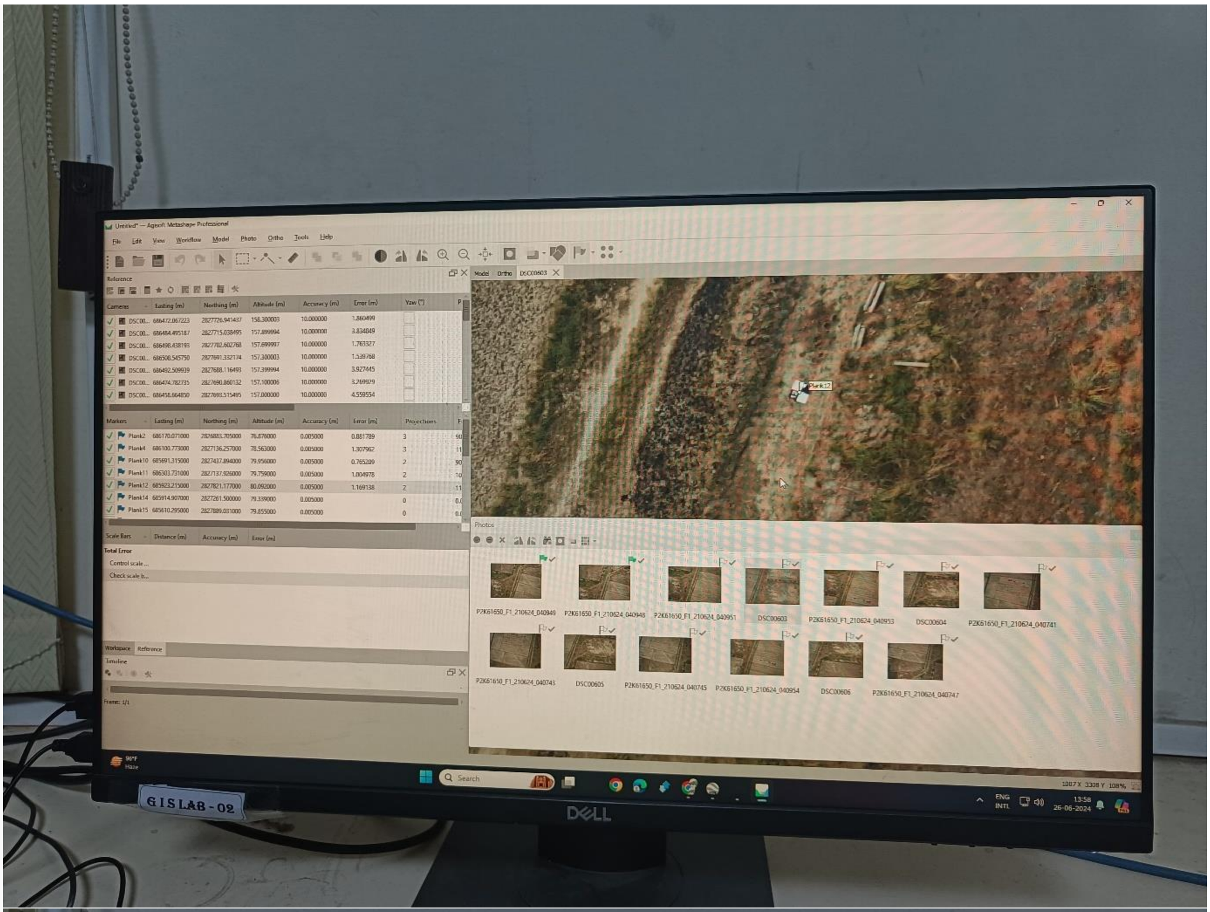
Plank20



Model
Ortho
P2K61650_F3_210624_050600
Plank20
Photos
GISLAB-02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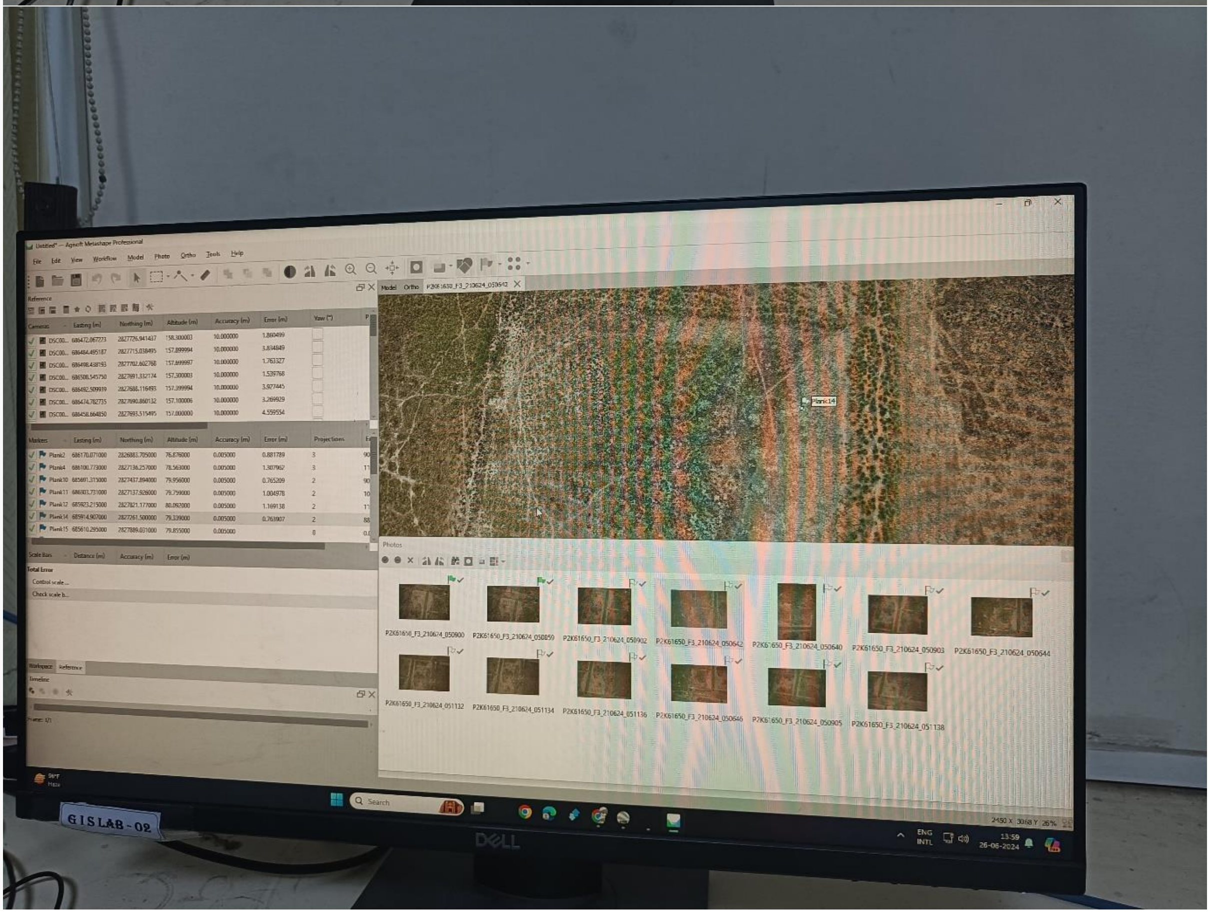
GIS LAB - 02
DELL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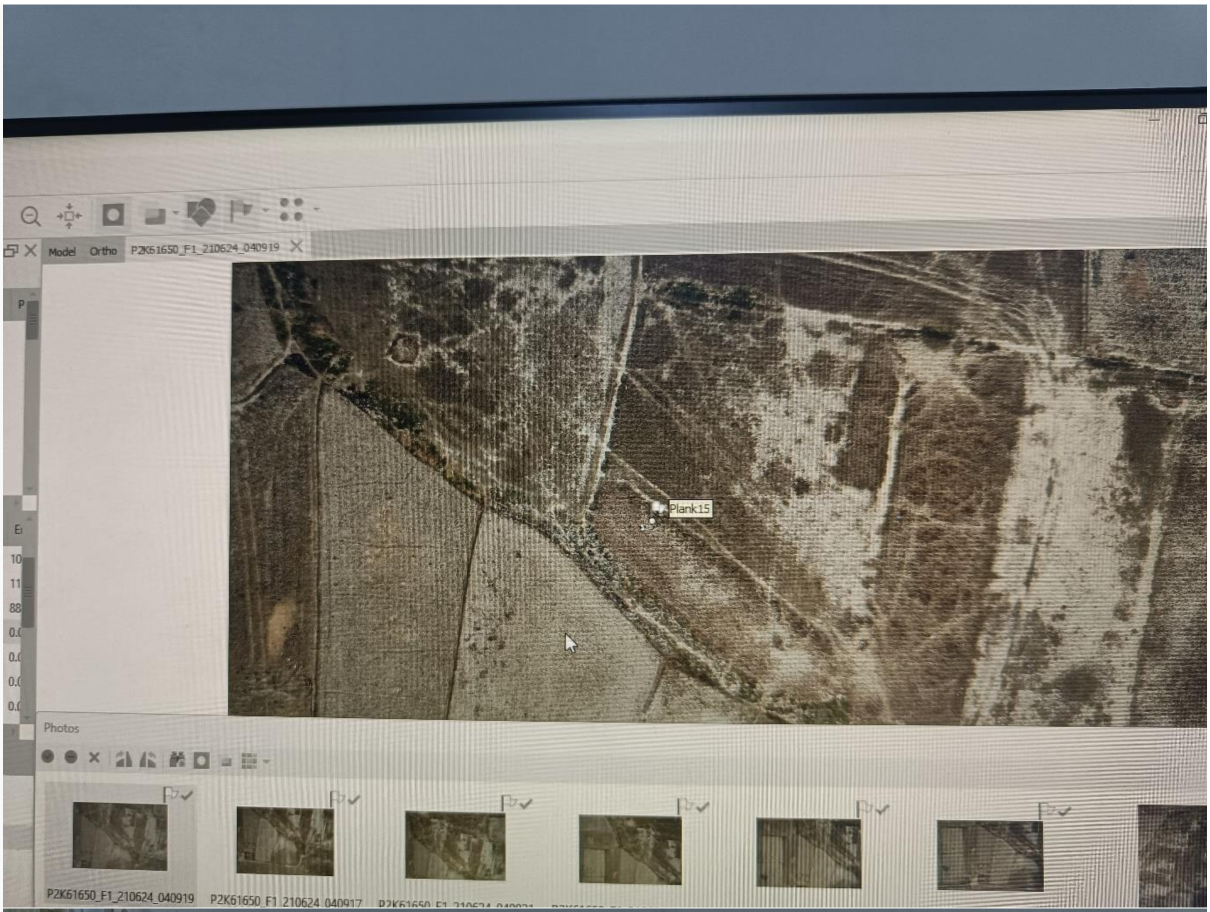
Model
Ortho
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Plank15
Photos
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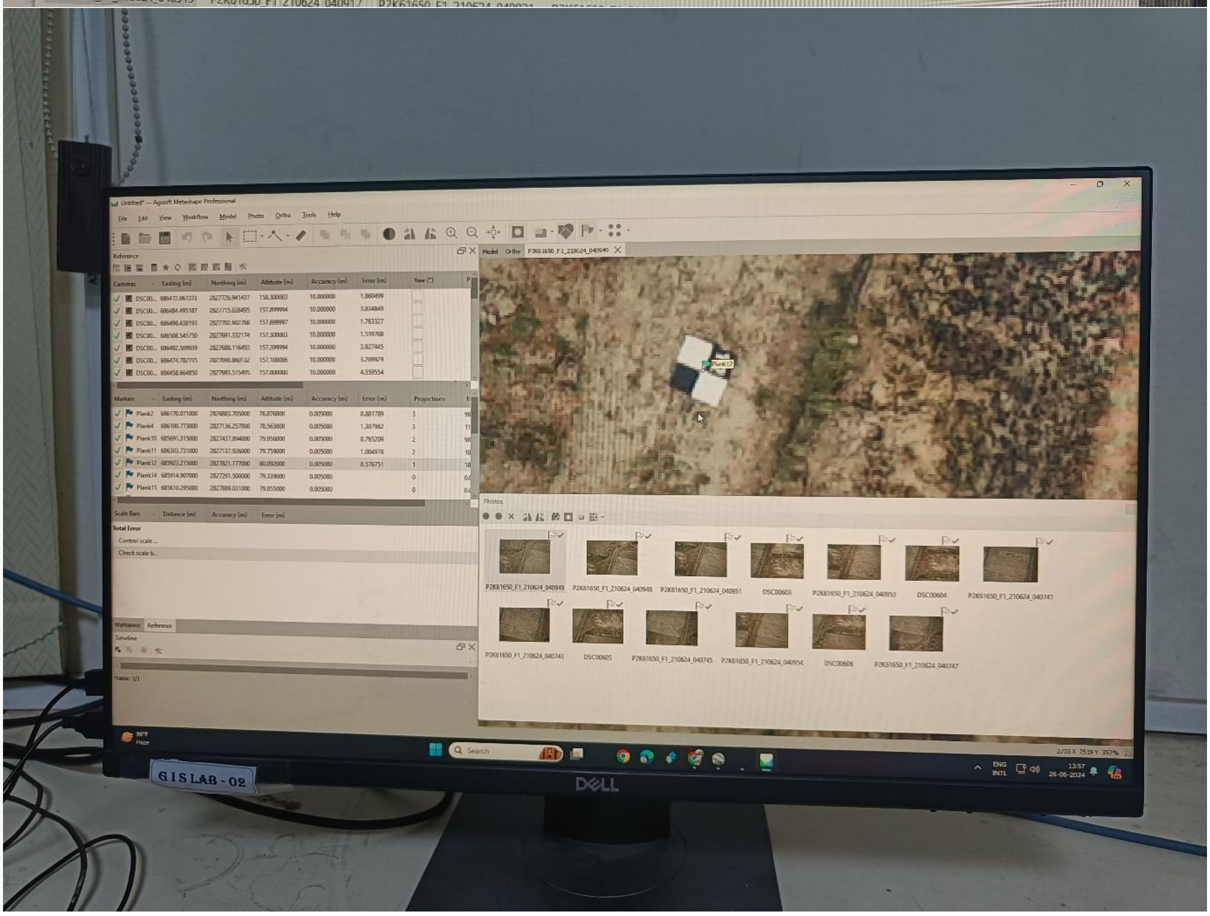
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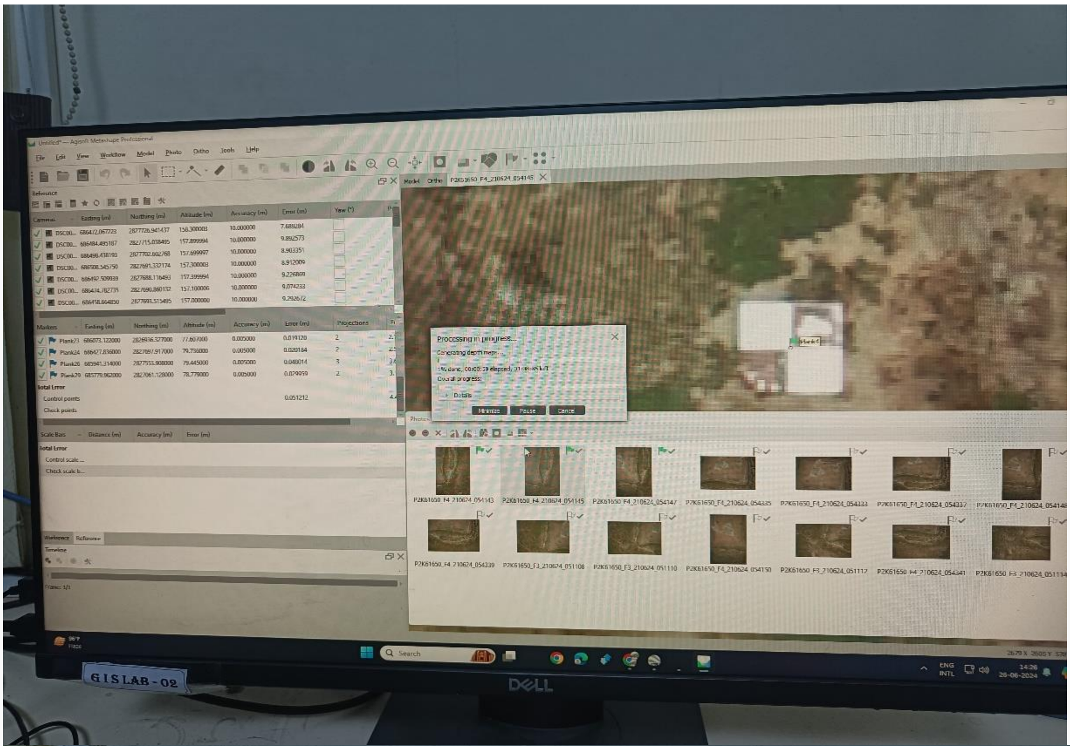
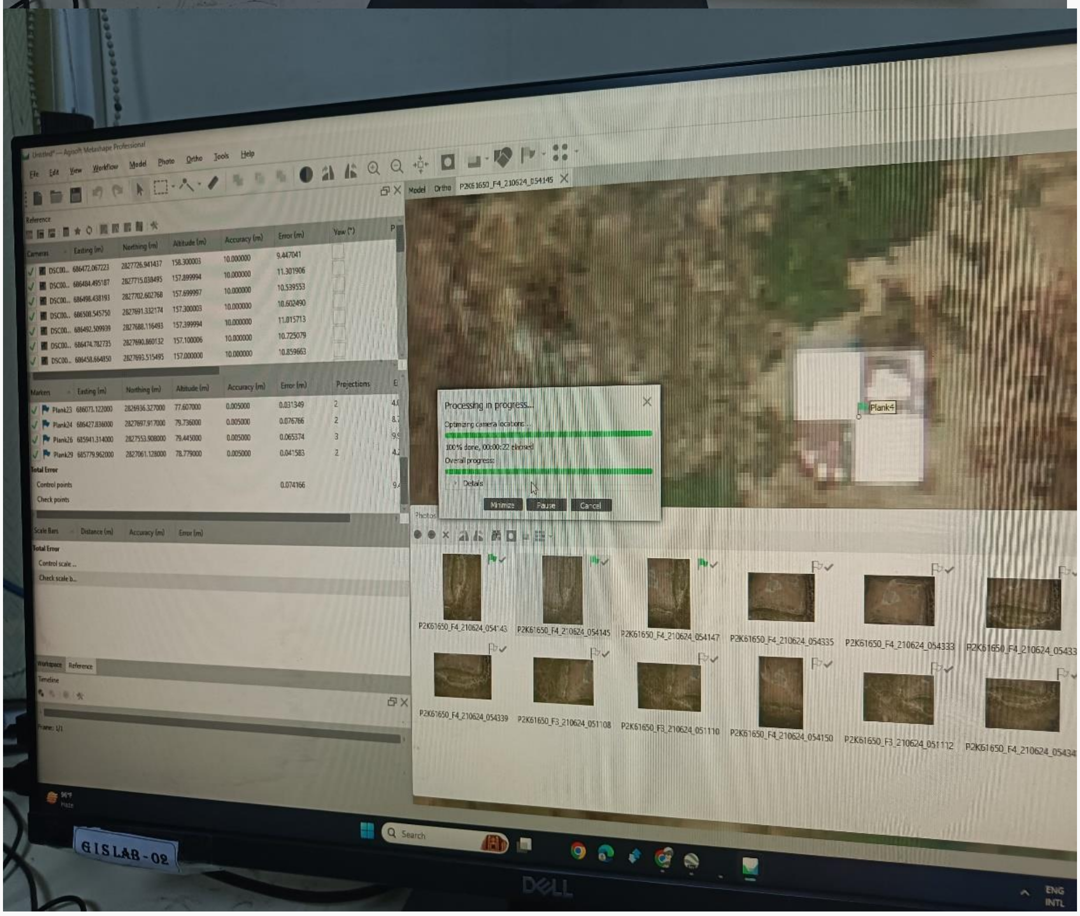
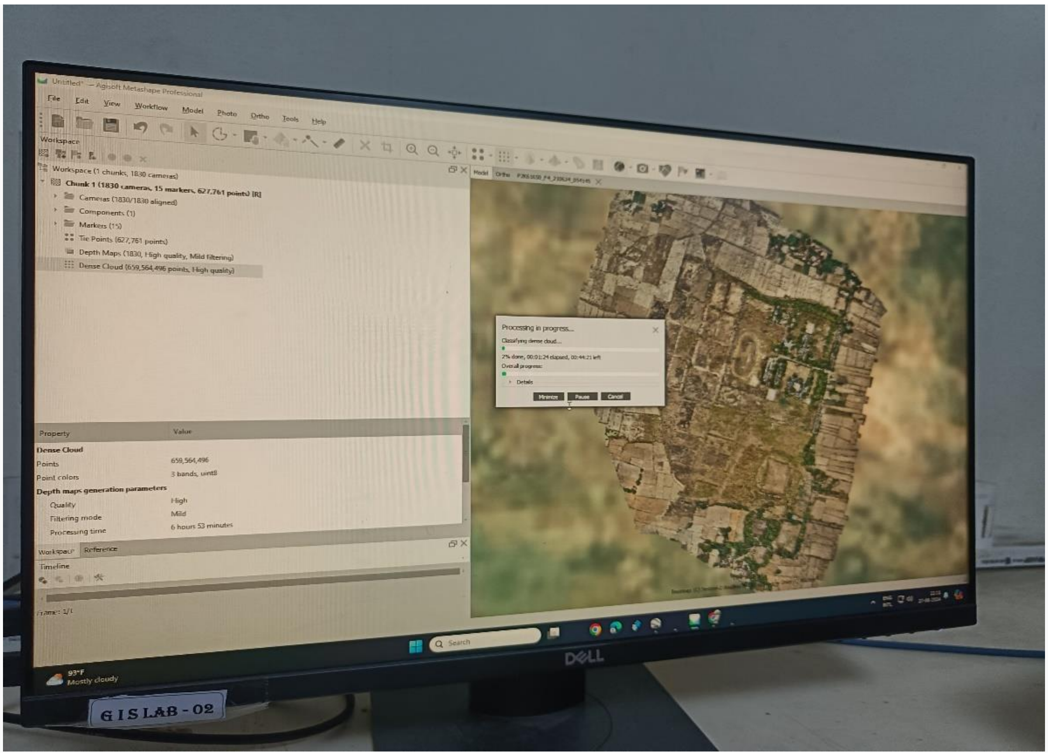
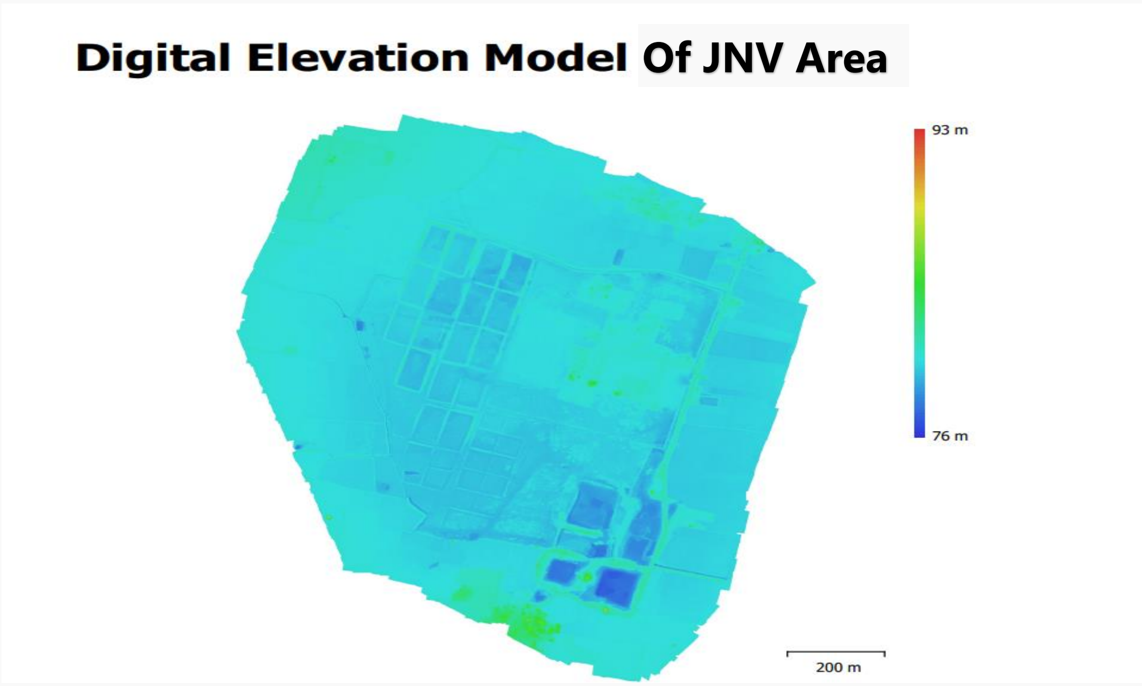
5. **Point Cloud Generation**:- From the aligned images, the software generates a 3D point cloud, a collection of data points representing the surface of the surveyed area.







6. **Digital Surface Model (DEM) and Digital Terrain Model (DTM):-** The point cloud is used to create DEMs, representing the earth's surface and objects on it, and DTMs, representing the bare ground surface.

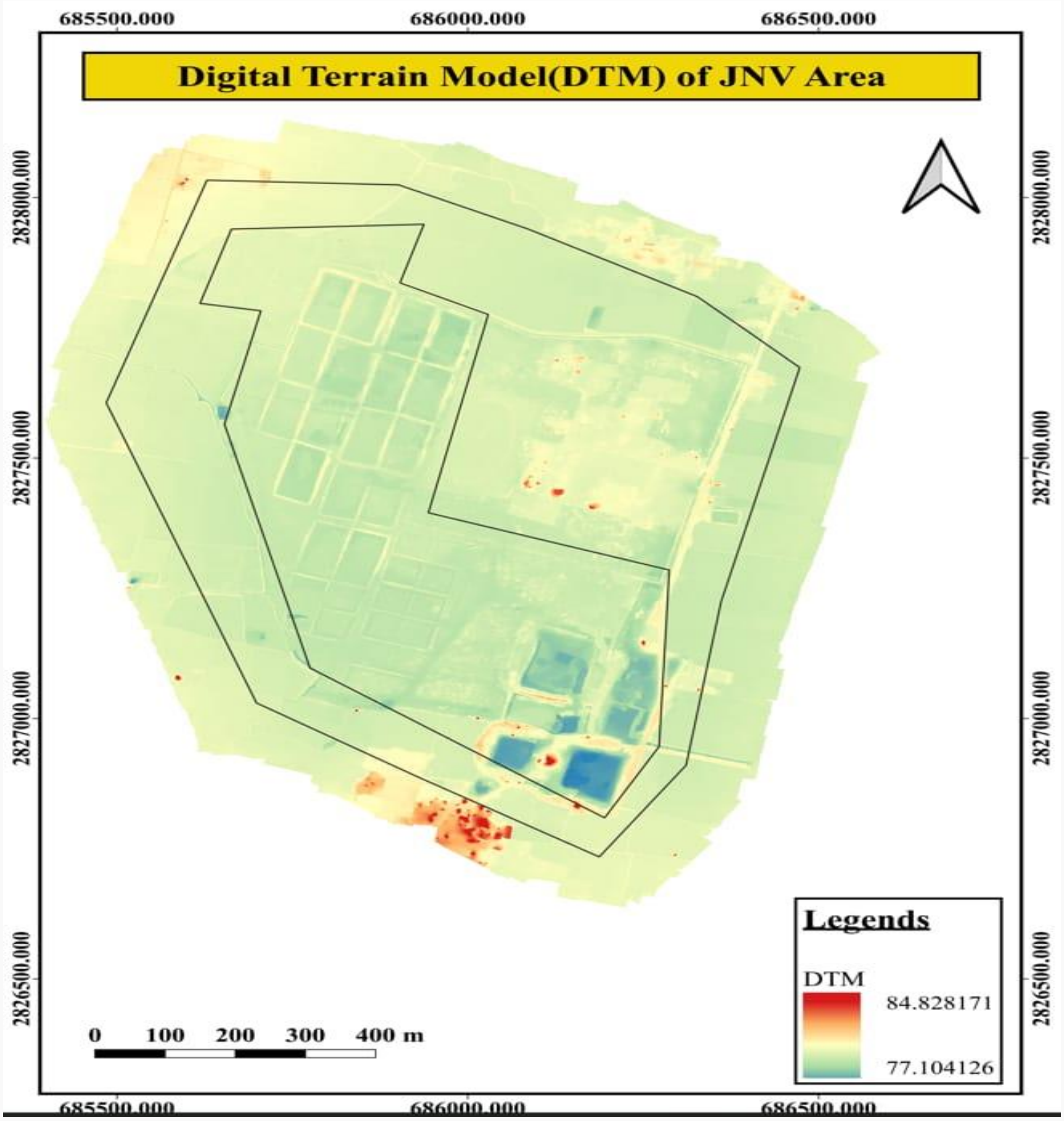


The DEM (Digital Surface Model) image of the Kathiraon study area uses different colours bands to represent elevation values

Blue areas: Represent the lowest elevations, around 76 meters.

Green areas: Represent mid-range elevations.

Red areas: Represent the highest elevations, around 93 meters.



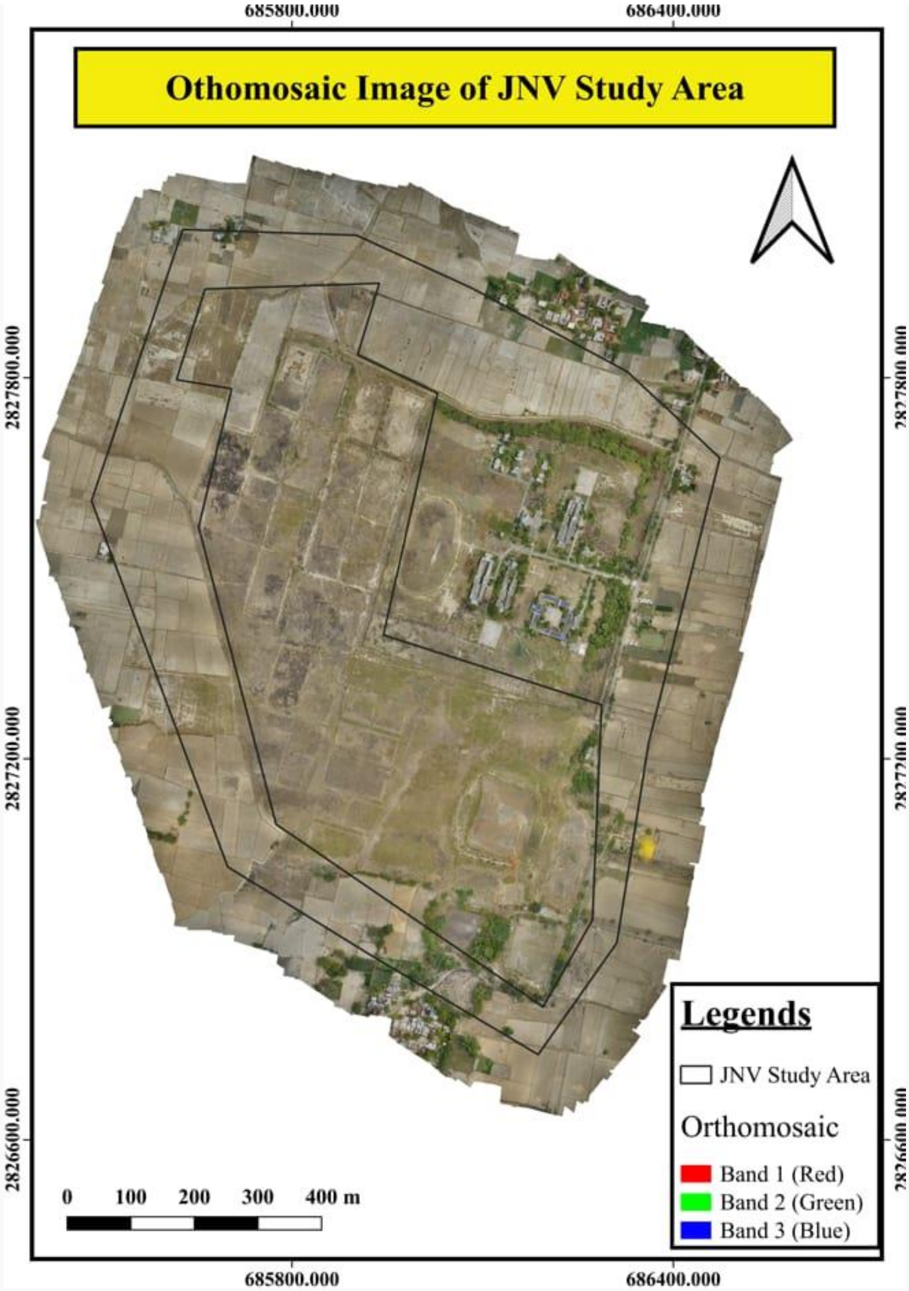
The DTM (Digital Surface Model) image of the Kathiraon study area uses different colours bands to represent elevation values

Red areas: Represent the highest elevations, with values around 84.828171 meters.

Green areas: Represent the lowest elevations, with values around 77.104126 meters.

Other colours (**yellow, light green,** etc.): Represent intermediate elevations between the highest and lowest points.

7. **Orthomosaic Creation:-** The images are stitched together to form a single, high-resolution, and geometrically corrected image called an orthomosaic. This image is free from distortions and can be used for precise measurements.



The different colour bands in the legend refer to the standard RGB colour channels used to create this true-colour representation:

Band 1 (Red): Represents the red wavelength of light. This band is useful for identifying vegetation and distinguishing between different types of soil and ground cover.

Band 2 (Green): Represents the green wavelength of light. This band is often used for general purpose viewing and can help in assessing plant health and Vigor.

Band 3 (Blue): Represents the blue wavelength of light. This band is useful for mapping water bodies and assessing water quality.

8. **Analysis and Interpretation:-** The processed data is analysed to extract meaningful information. This can include creating contour maps, calculating volumes, monitoring changes over time, and more.

Survey Data

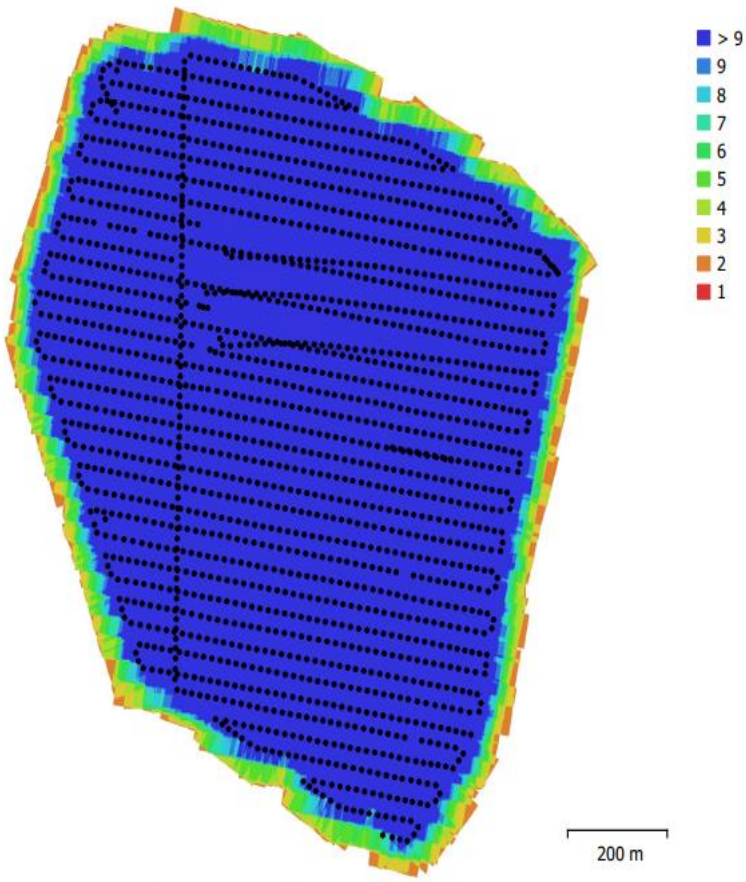


Fig. 1. Camera locations and image overlap.

Number of images:	1,830	Camera stations:	1,830
Flying altitude:	94.5 m	Tie points:	627,758
Ground resolution:	2.13 cm/pix	Projections:	4,842,364
Coverage area:	1.24 km²	Reprojection error:	0.702 pix

9. Visualization and Reporting:-

Ground Control Points

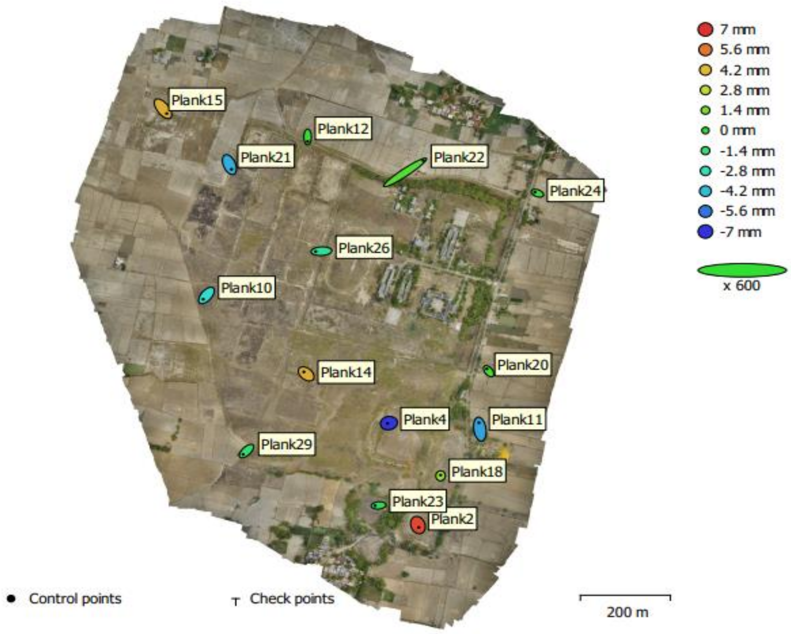


Fig. 5. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
15	3.97932	3.56261	0.359912	5.34109	5.3532

Table 5. Control points RMSE.
X - Easting, Y - Northing, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
Plank18	0.0799814	0.59024	0.205059	0.629944	0.913 (3)
Plank2	0.601612	-1.86317	0.648839	2.06261	1.699 (4)
Plank23	-2.56581	-0.268221	-0.0690082	2.58071	1.826 (3)
Plank4	-0.990905	-0.25527	-0.688695	1.23343	2.379 (3)
Plank14	-1.73369	1.65105	0.450788	2.43615	1.836 (3)
Plank29	-2.52483	-2.65347	-0.133986	3.66519	3.006 (3)
Plank10	-2.43368	-3.07362	-0.327529	3.93411	3.035 (3)
Plank26	-4.22978	-0.244149	-0.201083	4.24159	4.401 (2)
Plank21	1.5151	-3.75898	-0.450285	4.07777	2.241 (4)
Plank15	2.74504	-3.90922	0.448414	4.79774	2.960 (4)
Plank12	0.000239314	-3.65685	0.0145911	3.65688	3.972 (2)
Plank22	13.4419	9.65128	0.0695789	16.548	11.825 (3)
Plank24	-1.89441	0.80304	0.0204695	2.05769	2.258 (2)
Plank20	-1.34057	1.90325	0.0466144	2.32844	2.462 (2)
Plank11	-0.703517	5.19171	-0.469678	5.26017	3.696 (3)
Total	**3.97932**	**3.56261**	**0.359912**	**5.3532**	**4.029**

Table 6. Control points.
X - Easting, Y - Northing, Z - Altitude.

10. Applications of Drone image processing:-

- **Agriculture:** Crop health monitoring, irrigation planning, and field mapping.

- **Construction:** Site surveys, progress monitoring, and as-built documentation.

- **Environmental Monitoring:** Habitat mapping, forest surveys, and disaster assessment.

- **Urban Planning:** Infrastructure development, land use planning, and 3D city modelling.

- **Mining:** Volume calculations, pit mapping, and resource management.

❖ Advantages of Drone image processing:-

- **Efficiency**: Faster data collection and processing compared to traditional methods.

- **Accuracy:** High-resolution images and precise georeferencing ensure accurate results.

- **Cost-Effectiveness:** Reduces the need for extensive manual surveys and labour.

- **Safety:** Drones can access hazardous or hard-to-reach areas without putting surveyors at risk.

CONCLUSIONS :-

Drone image processing has revolutionized spatial data analysis, enabling the generation of highly detailed and accurate outputs such as Digital Terrain Models (DTMs), Digital Surface Models (DSMs), georeferenced data, 3D models, and orthomosaic maps. DTMs provide insights into the bare earth surface, essential for applications like flood modeling, landslide risk assessment, and construction site planning. DSMs, which include all surface objects, are crucial for urban planning, telecommunications, and forestry. Georeferencing ensures that drone data aligns accurately with geographical coordinates, facilitating precise mapping and spatial analysis. 3D models offer realistic representations of landscapes and structures, aiding architectural visualization, heritage conservation, and virtual reality applications. Orthomosaic maps, created by stitching multiple drone images into a geometrically corrected and distortion-free single image, are invaluable for land use planning, agriculture, and environmental monitoring.

Agisoft Metashape stands out as a leading software for photogrammetric processing, generating high-quality 3D spatial data and orthomosaic maps, making it indispensable for surveying, mining, agriculture, and cultural heritage documentation. By enhancing the accuracy and comprehensiveness of spatial data, drone image processing with tools like Agisoft Metashape addresses real-life problems such as disaster management, environmental monitoring, urban development, and efficient resource management, ultimately driving better decision-making and operational efficiency across various sectors**.**

AGISOFT METASHAPE SOFTWARE USES :-
https://youtu.be/_9fJL67YWIw?si=nHGnmSbypEfHkStA

REFERENCES :-

1.YouTube Channels: Various educational channels on YouTube that provide tutorials and explanations on drone image processing, photogrammetry, and the use of specific software like Agisoft Metashape.

https://youtu.be/je79gV8HsZI?si=U-VphvPx9FQ85xR5.

https://youtube.com/playlist?list=PL2UsAzNdeUas6e8FUh3Sjpqqcxf2Bzh81&si=s_QXNtgXGjlHgwjY

https://youtu.be/WjvEnVuhKFE?si=FWJkVLC6K6se98jh

2.Websites: Online resources, articles, and blogs from authoritative sites related to drone technology, GIS, and photogrammetry. Websites of software providers like Agisoft Metashape also offer extensive documentation and user guides.

https://wingtra.com/drone-mapping-applications/surveying-gis/

3.Site Visits: Practical experiences gained from visiting sites where drones are used for image capturing and data analysis. These visits provide hands-on knowledge of how drone image processing is applied in real-world scenarios.

4.Drone Usage: Direct experience using drones for image capturing. This involves understanding the setup, operation, and data collection process, as well as the subsequent processing of the captured images to generate various outputs like DTMs, DSMs, 3D models, and orthomosaic maps.