GIS - AI

Types of Drones – Explore the Different Models of UAV's

- A "**Drone**" is basically an Unmanned Aerial Vehicle(UAV) – an aircraft without a human pilot aboard. We will explore the different types of drones out there in the market – some of which are just concepts, while most others are already in action.

- "**Drones**" can be classified on a different basis – say based on '***usage***' like Drones for Photography, Drones for aerial Mapping, Drones for Surveillance etc. However, the best classification of 'Drones' can be made on the basis of aerial platforms. Based on the type of aerial platform used, there are 4 major types of drones.

- Multi Rotor Drones
- Fixed Wing Drones
- Single Rotor Helicopter
- Fixed Wing Hybrid VTOL

Multi Rotor Drones

- Multi Rotor drones are the most common types of drones which are used by professionals and hobbyists alike. They are used for most common applications like aerial photography, aerial video surveillance etc. Different types of products are available in this segment in the market – say multi-rotor drones for professional uses like aerial photography (whose price may range from 500USD to 3K USD) and there are lots of variants for hobby purposes like amateur drone racing, or leisure flying (price range from 50USD to 400USD). Out of all the 4 drone types (based on aerial platform), multi-rotor drones are the easiest to manufacture and they are the cheapest option available as well.

- Multi-rotor drones can be further classified based on the number of rotors on the platform. They are
- **Tricopter** (3 rotors),
- **Quadcopter** (4 rotors),
- **Hexacopter** (6 rotors),
- **Octocopter** (8 rotors).
- Out of these, Quadcopters are the most popular and widely used variant.

Fixed Wing Drones

- Fixed Wing drones are entirely different in design and build to multi-rotor type drones. They use a ‘wing’ like the normal airplanes out there. Unlike multi-rotor drones, fixed wing type models never utilize energy to stay afloat on air (fixed wing types can’t stand still on the air) fighting gravity. Instead, they move forward on their set course or as set by the guide control (possibly a remote unit operated by a human) as long as their energy source permits.

- Most fixed wing drones have an average flying time of a couple of hours. Gas engine powered drones can fly up to 16 hours or higher. Owing to their higher flying time and fuel efficiency, fixed wing drones are ideal for long distance operations (be it mapping or surveillance). But they can not be used for aerial photography where the drone needs to be kept still on the air for a period of time.

Single Rotor Dones

- Single rotor drones look very similar in design & structure to actual helicopters. Unlike a multi rotor drone, a single rotor model has just one big sized rotor plus a small sized one on the tail of the drone to control its heading. Single rotor drones are much efficient than multi rotor versions. They have higher flying times and can even be powered by gas engines. In aerodynamics, the lower the count of rotors the lesser will be the spin of the object. And that's the big reason why quadcopters are more stable than octocopters. In that sense, single rotor drones are much efficient than multi-rotor drones.

- However, these machines comes with much higher complexity and operational risks. Their costs are also on the higher side. The large sized rotor blades often pose a risk (fatal injuries have been recorded from helicopter accidents) if the drone is mishandled or involves in an accident. Multi-rotor drones, often owing to their small rotor blades have never been involved in fatal accidents (though a scar on human body is likely). They also demand special training to fly them on air properly (though they may not need a runway or a catapult launcher to put them on air).

Hybrid VTOL

- These are hybrid versions combining the benefits of Fixed wing models (higher flying time) with that of rotor based models (hover). This concept has been tested from around 1960's without much success. However, with the advent of new generation sensors (gyros and accelerometers), this concept has got some new life and direction.

- Hybrid VTOL's are a play of automation and manual gliding. A vertical lift is used to lift the drone up into the air from the ground. Gyros and accelerometers work in automated mode (autopilot concept) to keep the drone stabilized in the air. Remote based (or even programmed) manual control is used to guide the drone on the desired course.
- There are some versions of this hybrid fixed wing models available in the market. However, the most popular one is drone used in Amazon commercials (for its Prime delivery service).

Surveying & Mapping

Surveying with a drone offers enormous potential. With a drone, it is possible to carry out topographic surveys of the same quality as the highly accurate measurements collected by traditional mathods , but in a fraction of time.

This subsantitally reduces the cost of a site survey and the worklaod of specialists in the field.

What is meant by drone survey ?

- A drone survey refers to the use of a drone , or unnamed aerial vehicle (UAV) to capture data with downward facing sensors, such as RGB or multispectral cameras, and LIDAR Analysis.
- During a drone survey with an RGB camera , the ground is photographed several times from different angles, and each image is tagged with coordinates.
- From this data, a photogrammetry software can create geo referenced orthomosaics , elevation models or 3D models to project area
- Unlike manned aircraft or satellite imagery ,drones can fly at much lower altitude , make the generation of high – resolution , high – accuracy data , much faster, less expensive and independent of atmospheric conditions such as cloud over.

Data received from doing drone surveying

1) Orthomosaic Maps

An orthomosaic is like Google Earth, but way sharper. It is a large, map-quality image with high detail and resolution made by combining many smaller images called orthophotos.

File Formats : geoTIFF(.tiff), .jpg,.png

Advantage & Disadvantage

- 1) Drones can fly
- 2) Used as logistic
- 3) Saves Time
- 4) Drones Require less effort
- 5) Live Streaming

- 1) Shorter Lifespan
- 2) Vulnerable to wild animal attack
- 3) Easily Hacked
- 4) Spying
- 5) Risk of Atrocites

Listing Some of its uses :

1) Get Updated Views of Large Land Areas :

One of the main use cases for an orthomosaic is simply to get an updated view of a large area of land. Google Earth is helpful, but often the imagery is outdated. Your new development project could be finished, new construction projects could be underway, or the landscape could have changed from natural disasters. Real estate agents may also want an updated view of property to see if it is a good fit for their needs. Whatever the reason is, orthomosaics are the best way to combine aerial images for an updated view of your land.

2) Use Orthomosaics for Accurate Measurements :

Construction firms also find orthomosaics particularly useful. They can get updated views of their construction sites on a regular basis, and they can leverage the accuracy of the orthomosaics for precise measurements. Software programs such as DroneDeploy allow users to measure distance, area, and volume. Construction firms can use these tools to calculate the volume of stockpiles, estimate material costs, and collect other valuable data without actually having to be at the construction site. Software programs can also use the raw data from the aerial photos to construct 3D models, which is another powerful tool for construction firms.

3) Perform Inspections

Along with inspecting crops, orthomosaics are great for performing aerial inspections of equipment and other facilities. They can be used for inspecting rooftops, solar installations, buildings that are falling apart, and more.

3D Point Cloud

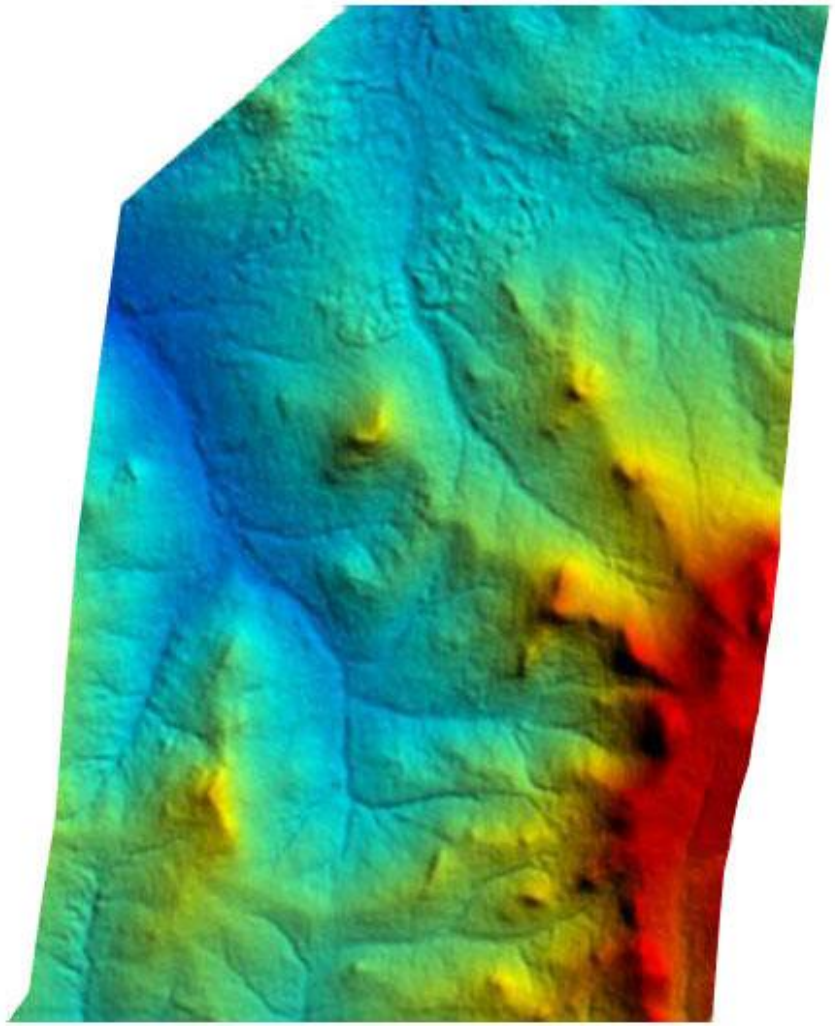
- A densified point cloud can be generated from drone images. Each point contains geospatial(X,Y,Z) and color information. It provides a very accurate model for distance (slant and horizontal) , area and volume measurements.

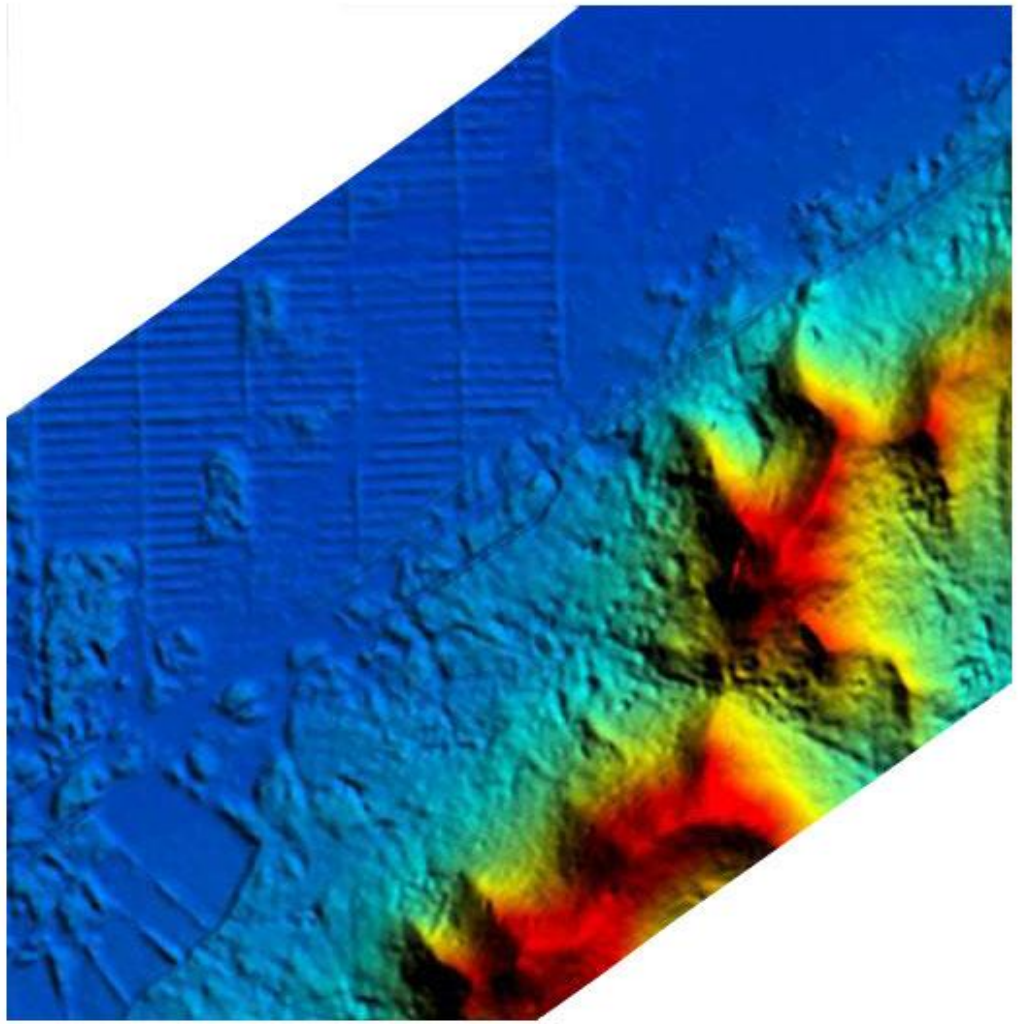
- File Formats : .las , .laz , .ply , .xyz

Digital Surface models(DSM)

- A **DSM** (Digital Surface Model) captures both the natural and built/artificial features of the environment, as shown below;

- **DSM** is suitable for a **3D modelling** for telecommunications, city planning and aviation. Since the objects are removed from the ground surface, the following projects will be good examples.
- *Runway Approach Zone Execution*: In aviation, DSMs can identify runway obstacles in the approach zone.
- *Vegetation Management*: Throughout a transmission line, DSMs can see where vegetation occupies the line and how much of the line is occupied.
- *Field of View Inference*: Urban planners use DSM to control how a proposed building will affect the visibility of residents and businesses.
-





Digital Terrain Model

- A **DTM** (Digital Terrain Model) typically augments a DEM, by including vector features of the natural terrain, such as rivers and ridges. A DTM may be interpolated to generate a DEM, but not vice versa.

- In some countries, a DTM is actually synonymous with a DEM. **In other countries such as the United States and Turkey has a different meaning to the DTM**. DTM is a vector data set consisting of dots at regular intervals and natural features such as mountain ridge and breaking lines (a line in the model showing a marked cut in the slope of a surface, such as a road or a stream). **DTM** strengthens **DEM** by adding linear properties to bare soil terrain.

-

Digital Evaluation Model

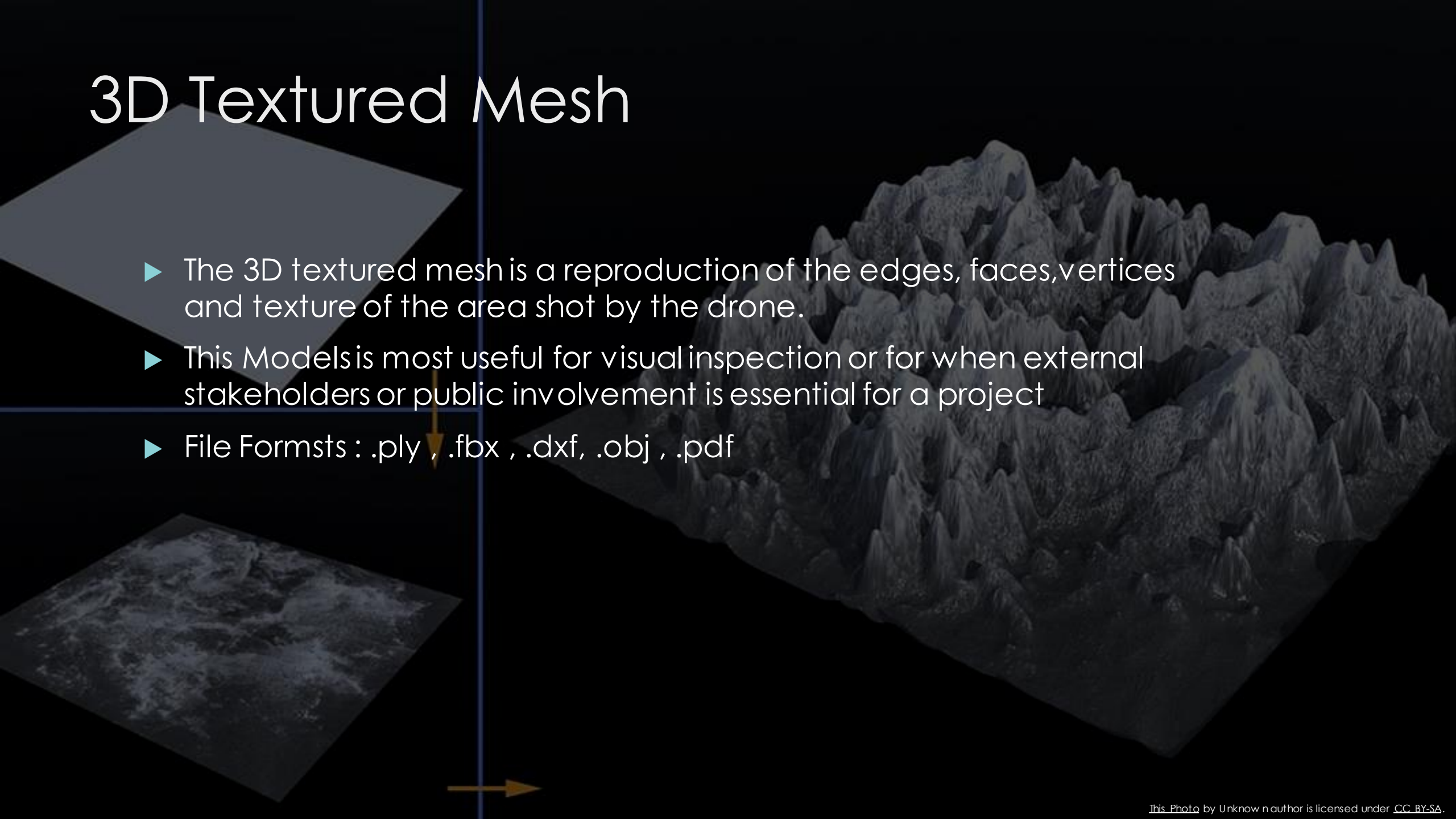
- – A **DEM** (Digital Elevation Model) Represents the bare-Earth surface, removing all natural and built features;

- **Artificial** (power lines, buildings and towers) and **natural** (trees and other types of vegetation) elements are **not** included in a DEM. When you filter out off-land spots such as bridges and roads, you override artificial formations and vegetation, you get a **smooth DEM**.
- This model is used extensively in hydrology, land and land use planning.
- *Hydrological Modeling*: Hydrologists use DEMs to clean basins and calculate flow accumulation and flow direction.
- *Balancing Land Destruction*: The areas prone to screaming are high sloping areas with sparse vegetation. This application is useful in planning the motorway or residential subdivision.
- *Soil Mapping*: DEMs help mapping soils (such as geology, time, and **climate**), a height function.

To Obtain Elevation Models Data

- *IDAR*: As a result of the light coming out of the device hitting the ground, the reflected surface is returned to the sensor to measure the height of the ground surface.
- *Satellite Interaction*: Synthetic aperture radars, such as Shuttle Radar Topography Mission, use two radar images simultaneously captured antennas to create a DEM.
- *Photogrammetry*: Aerial photography uses photographs taken from at least two different points with photogrammetry. Similar to the operation of vision in humans, it can obtain depth and perspective due to separate perspectives.

3D Textured Mesh



- The 3D textured mesh is a reproduction of the edges, faces, vertices and texture of the area shot by the drone.
- This Models is most useful for visual inspection or for when external stakeholders or public involvement is essential for a project
- File Formsts : .ply , .fbx , .dxf, .obj , .pdf

Contour Lines

- Depending on the project requirements , either the DDTM or DTS model , wiith custom contour intervals, can be used to create a contour lines map, giving you a better understanding of the surface of the area shot by the drone.
- Files Format : .shp , .dxf , .pdf

Some of available software for aerial survey and mapping

- Pix4D Mapper photogrammetry
- Maps Made Easy orthophoto and 3D models
- 3DF Zephyr photogrammetry software
- Open Drone Map photogrammetry
- ESRI Drone2Map for ArcGIS

Remote Sensing & GIS

- Photogrammetry is the science of making measurements from photographs, especially for recovering the exact positions of surface points. Moreover, it may be used to recover the motion pathways of designated reference points located on any moving object, on its components and in the immediately adjacent environment. Photogrammetry may employ highspeed imaging and remote sensing in order to detect, measure and record complex 2-D and 3-D motion fields. Photogrammetry feeds the measurements from remote sensing and the results of imagery analysis into computational models in an attempt to successively estimate, with increasing accuracy, the actual, 3-D relative motions within the researched field.

- Photogrammetry is as old as modern photography, can be dated to the mid-nineteenth century, and its detection component has been emerging from radiolocation, multilateration and radiometry while its 3-D positioning estimative component (based on modeling) employs methods related to triangulation, trilateration and multidimensional scaling. In the simplest example, the distance between two points that lie on a plane parallel to the photographic image plane can be determined by measuring their distance on the image, if the scale (s) of the image is known. This is done by multiplying the measured distance by 1/s. Algorithms for photogrammetry typically attempt to minimize the sum of the squares of errors over the coordinates and relative displacements of the reference points. This minimization is known as bundle adjustment and is often performed using the Levenberg–Marquardt algorithm.
- The photogrammetry has been derived from three Greek words:
- Photos: means light
- Gramma: means something drawn or written
- Metron: means to measure

Definition of photogrammetry includes two areas:

- (1) Metric: It involves making precise measurements from photos and other information source to determine, in general, relative location of points. Most common application: preparation of planning metric and topographic maps.

- (2) Interpretative: It involves recognition of objects and judging their significance through careful and systematic analysis. It includes photographic interpretation which is the study of photographic images. It also includes interpretation of images acquired in Remote sensing using photographic images, MSS, Infrared, TIR, SLAR etc.

Applications of Photogrammetry:

- 1)Geology: Structural geology, investigation of water resources, analysis of thermal patterns on earth's surface, geomorphological studies including investigations of shore features.
- 2) Forestry: Timber inventories, cover maps, acreage studies
- (3) Agriculture: Soil type, soil conservation, crop planting, crop disease, crop-acreage (4) Design and construction: Data needed for site and route studies specifically for alternate schemes for photogrammetry. Used in design and construction of dams, bridges, transmission lines.
- (5) Planning of cities and highways: New highway locations, detailed design of construction contracts, planning of civic improvements.

Contd...

- (6) Cadastre: Cadastral problems such as determination of land lines for assessment of taxes. Large scale cadastral maps are prepared for reapportionment of land.
- (7) Environmental Studies: Land-use studies.
- (8) Exploration: To identify and zero down to areas for various exploratory jobs such as oil or mineral exploration.
- (9) Military intelligence: Reconnaissance for deployment of forces, planning man oeuvres, assessing effects of operation, initiating problems related to topography, terrain conditions or works.
- (10) Medicine and surgery: Stereoscopic measurements on human body, X-ray photogrammetry in location of foreign material in body and location and examinations of fractures and grooves, biostereometrics

Classification of Photographs

- (1)On the basis of the alignment of optical axis
- (a) Vertical: If optical axis of the camera is held in a vertical or nearly vertical position.
- (b) Tilted : An unintentional and unavoidable inclination of the optical axis from vertical produces a tilted photograph.
- (c) Oblique : Photograph taken with the optical axis intentionally inclined to the vertical. Following are different types of oblique photographs:
- (i)High oblique: Oblique this contains the apparent horizon of the earth.
- (ii)Low oblique: Apparent horizon does not appear.
- (iii) Trimetrogon: Combination of a vertical and two oblique photographs in which the(central photo is vertical and side ones are oblique. Mainly used for reconnaissance.
- (iv) Convergent: A pair of low obliques taken in sequence along a flight line in such a manner that both the photographs cover essentially the same area with their axes tilted at a fixed inclination from the vertical in opposite directions in the direction of flight line so that the forward exposure of the first station forms a stereo-pair with the backward exposure of the next station