Report

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UAV

- Unmanned Aerial Vehicle, popularly known as Drone, is an aircraft without a human pilot on board.
- The flight of UAVs may operate with various degrees of autonomy: either under remote control by a human operator or autonomously by on board computers.
- UAVs are a component of an unmanned aircraft system (UAs); which include a UAV, a ground based controller and a system of communications between the two.

Types of UAV

1. **Rotary Wing/Multi-Rotor**
    - 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.

    - Multi-rotor, they comes with 3, 4, 6, 8 rotors. They are used for most common applications like aerial photography, aerial video surveillance etc.

Advantages:

- VTOL
- Surveillance or Surveying
- Cheaper to buy

Disadvantages:

- Shorter battery life
- Multiple points of failure

2. **Fixed Wing**

    They use a ‘wing’ like the normal airplanes out there. 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. 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 cannot be used for aerial photography where the drone needs to be kept still on the air for a period of time.

Advantages:

- Longer Battery life
- Better for large areas

Disadvantages:

- May need launcher device
- Needs open area for take-off and landing
- Higher costs and skill training required.

3. **Hybrid VTOL**

   A hybrid version has the benefits of fixed wing models (higher flying time) with that of rotor based models (hover). 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. The most popular one is drone used in Amazon commercials for its Prime delivery service.

GIS

- Graphical Information System is the technology to collect, manages, analyse and display data.
- GIS refers to information about positions on the earth surface also known as spatial data, e.g.: home address from space.
- At its most basic level, GIS data is perfect for creating maps. Cartographic data in map form displays the location of natural features such as roads, rivers, forests and valleys, or manmade features like farms or towns.
- This information can be gathered from photographs, satellites and other sources.
- There are mainly 5 components of GIS: People, Data, Methods, Hardware and Software.
- There can be aspatial data, which cannot be known from the space, e.g.: the colour of the house or ownership.

Some of the uses of GIS:

- **Business:** for market research and site selection, etc.
- **Defence and intelligence:** military operations such as troop deployments, mission, planning using real-time information, etc.
- **Education:** archaeological research, historic documents
- **Government:** land use classification, elections and planning for rural or urban development, etc.

Photogrammetry

- Photogrammetry is the process of deriving metric information about an object through measurement made on the photograph of the object.

- Photogrammetry is the science of making measurements from photographs. Photogrammetry means the measuring of features on a photograph.
- It determines the relative positions of points- distance, angles, elevation.
- The output of photogrammetry is typically a map, drawing, measurement, or a 3D model of some real-world object or scene. Many of the maps we use today are created with photogrammetry and photographs taken from aircraft.

Branches of Photogrammetry

1. **Aerial Photogrammetry:** The camera is mounted in an aircraft and is usually pointed vertically towards the ground. Aerial photographs are taken from the air by special camera mounted in an aircraft flying over the area with the camera axis vertical or nearly so.

Types of Aerial Photogrammetry

a. **Vertical Photograph:** Photos are taken with the camera axis as nearly as possible and do not have tilt more than 1 degree.

b. **Tilted Photograph:** Due to unavoidable aircraft tilts the camera axis is unintentionally tilted from the vertical. Then the resulting photograph is called tilted photograph. The camera axis is between 1 to 3 degrees.

c. **Oblique:** It has purposely given the tilt up to 30 degrees to the forward direction. Tilted photographs are classified with respect to appearance of apparent horizon. In high oblique, image of the horizon is included whereas in low oblique, horizon is not seen.

2. **Terrestrial Photogrammetry:** It is that branch of photogrammetry where photographs are taken from a fixed, and usually known, position on or near the ground and with the camera axis horizontal or nearly so. The position and orientation of the camera are often measured directly at the time of exposure. The instrument used for exposing such photograph is called photo theodolite.

3. **Space Photogrammetry:** The space photogrammetry embraces all aspects of extra-terrestrial photography and subsequent measurement wherein the camera may be fixed on earth, contained in an artificial satellite, or positioned on the moon or a planet.

Types of Photogrammetry

1. **Interpretative Photogrammetry**
   Photo interpretation is the study of photographic images. These images created from satellite imagery which senses energy in wavelengths

2. **Metric Photogrammetry**

It is used in making precise measurements on photos and other information to find the relative locations of points. The most commonly use of Metric Photogrammetry includes plain-metric mapping and topographical mapping.

Advantages:

- High speed of coverage of an area.
- Relatively low cost, as compared to other survey.
- Ease of obtaining topographic details, especially in inaccessible areas.
- Preparing maps.

Disadvantages:

- Cannot handle visuals hindrance like weather problems or tree shade
- Cannot be done in low light.
- Security concerns.
- Measurement accuracy disturbance on some height.

Remote Sensing

Remote sensing refers to getting information about objects or areas by using electromagnetic radiation or light without being in direct contact with the object or area. It is day-to-day business for people.

Elements of Remote Sensing:

- **Energy Source:** The first requirement for remote sensing is to have an energy source which provides electromagnetic energy to the target of interest.
- **Radiation and the Atmosphere:** As the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.
- **Interaction with the Target:** Once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.
- **Recording of Energy by the Sensor:** After the energy has been scattered by, or emitted from the target, we require a sensor to collect and record the electromagnetic radiation.
- **Transmission, Reception, and Processing:** The energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image.
- **Interpretation and Analysis:** The processed image is interpreted, visually, digitally or electronically, to extract information about the target which was illuminated.
- **Application:** The final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.

Advantages:

- Provides data of large areas
- Provides data of very remote and inaccessible regions
- Easy and rapid collection of data
- Rapid production of maps for interpretation

Disadvantages:

- Needs cross verification with field survey data
- Data from multiple sources may create confusion
- Objects can be misclassified or confused
- Distortions may occur in an image due to the relative motion of sensor and source

Drone Survey

- Surveying is the precise science of determining the positions of, and the distances between, points in 2D and 3D space.
- A drone survey is simply a survey conducted from overhead using a drone. Sensors such as such as RGB or multispectral cameras are used in it.
- A drone survey with an RGB camera, the ground is photographed several times from different angles, and each image is tagged with coordinates.

Processing the drone survey data-

- Data outputs from the drone
- Importing into a photogrammetry software

What are drones used for in surveying-

- Land surveying
- Land management and development
- Precise measurements
- Slope monitoring
- Urban planning

Advantages:

- Reduce field time and survey costs
- Maps the inaccessible areas
- Provide accurate and exhaustive data

Output-

It depends on the camera or sensor and the software we are using for post-processing. Some of the examples are Orthomosaic maps, 3D point cloud, etc.

1. **Orthomosiac:**

An orthomosaic map is a detailed, accurate photo representation of an area, created out of many photos that have been stitched together and geometrically corrected ("orthorectified"). Each pixel contains 2D geo-information (X, Y) and can directly procure accurate measurements, such as horizontal distances and surfaces. so that it is as accurate as a map.

2. **DSM**
   A Digital Surface Model is a digital representation of the earth's surface within a set of predefined coordinates, and all objects elevated above the ground like trees and buildings. Drone images are used to create DSM models of the area. Each pixel contains 2D information (X, Y) and the altitude (Z value) of the highest point for this position.

3. **DTM**
   A Digital Terrain Model (or DTM) does not include any structures or objects and only represents the surface of the earth. Both utilize RGB data to represent differences in elevation. After filtering objects such as buildings, the drone images are used to create DTMs with each pixel containing 2.5D information (X, Y, and Z value of the highest altitude).

4. **Point Cloud**
   Point clouds are datasets that represent objects or space. A densified point cloud can be generated from drone images. Each point contains geospatial (X, Y, Z) and colour information. It provides a very accurate model for distance (slant and horizontal), area and volume measurements. The main advantages are precision, efficiency and savings.

5. **3d textured mesh**
   Edges, faces, vertices, and texture of the drone data are reproduced and then created in a 3D textured mesh. Some file formats for storing 3D textured mesh are .pdf, .dxf, .obj, etc. This model is most useful for visual inspection or for when external stakeholders or public involvement is essential for a project.

6. **Contours**
   Often simply referred to as 'Contours' or 'Topographic Maps' is a 2-D maps, where the lines on the map join points of equal elevation. These lines reveal peaks and valleys as well as the steepness of the slope. Depending on the project requirements, either the DTM or DSM model, with custom contour intervals, can be used to create a contour lines map, giving us a better understanding of the surface of the area shot by the drone.

Advantages of aerial survey

- **Improving safety:** One of the most important advantages of using drones is the removal of people from unsafe and dangerous environments. Instead of requiring

people to enter high risk environments, such as towers, cliffs and other tall structures, a drone can be used to inspect and survey these environments remotely in a far safer and lowered risk capacity.

- **Improved accessibility:** The size and weight of drones allow them to access places where you can't easily fly an aircraft or use a crane.
- **Investing in technology:** Professional and high-end drones, like any other piece of smart technology, can be expensive, but they are a smart investment for engineering teams. When integrated correctly, these tools enhance progress and inform better design solutions, adding deep value to the project.
- **Real-time progress monitoring:** Using drones, project teams can now conduct more frequent data capture and progress monitoring of construction and installations for a greater portion of the project.

Available tools/software for aerial survey and mapping

- **Pix4D:** As with Agisoft's Metashape, Pix4D Mapper has functionality for RGB, thermal and multi-spectral imaging. Pix4D Mapper allows you to automate both your drone flight and image data transfer and provides survey-grade results to sub-centimetre level.
- **Bentley Context-Capture:** Context-Capture is billed as a 'Reality Modelling' solution – enabling you to capture a real-life representation of a physical asset or assets. It doesn't just work with photogrammetric data either. You can also use LiDAR derived point clouds to create truly incredible 3D models and maps.
- **Global Mapper:** With support for 'virtually every known spatial data format', as well as access to common spatial databases. With tons of features and options such as cut and fill optimization, contour generation, volume measurements and line of sight modelling, Global Mapper can be used by almost anyone looking for a powerful tool to get the most out of drone data.
- **Agisoft Metashape-** Their roots lie in advanced photogrammetric algorithms which have more recently been adapted for the drone market. The Standard Edition provides plenty of features for the amateur and professional drone mapper, but you'll need the Professional version if you want to create geo-referenced elevation models and orthomosaics. The Professional version also allows the use of NIR, RGB, thermal and multispectral imaging.

Drawbacks of existing software/tools for aerial survey and mapping

- **Pix4D:** Because of the wealth of features, Pix4D software can be a little overwhelming. Despite the excellent support it can be difficult to know where to start if you've never used quality drone mapping software.
- **Bentley Context-Capture:** Bentley Context-Capture can appear to be over-engineered for many drone mapping applications. It's complex and the scope for data manipulation is huge.

- **Global Mapper-** Compared to the other options, the Global Mapper model, interface and support options are a little antiquated. Standard support is via a ticket system but only if you pay.
- **Agisoft Metashape-** Functionality is pretty limited unless we choose the professional edition.