CE 103: SURVEYING
LECTURE 17: DRONE SURVEY

Course Teacher: Saurav Barua

Dept. of CE

Daffodil International University

Contact No: +8801715334075

Email: saurav.ce@diu.edu.bd

OUTLINE

- Applications of drone survey
- Land data survey
- Mapping and survey application
- The way drone survey works

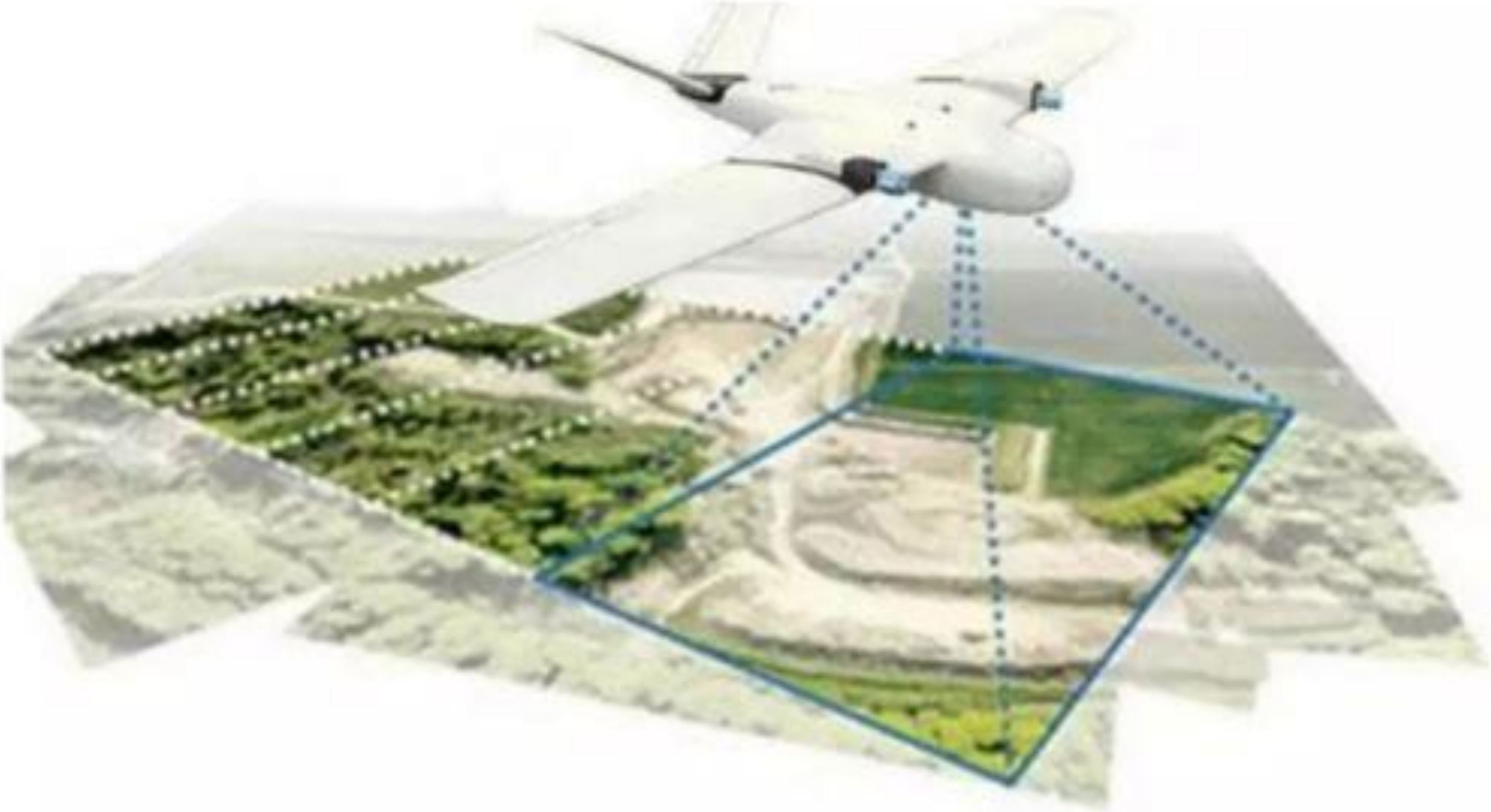
INTRODUCTION TO DRONE SURVEY

Introduction

Drone surveys are a faster, safer and more cost-efficient way to survey at height. Sometimes referred to as aerial surveys, UAS (Unmanned Aerial System) surveys, or UAV (Unmanned Aerial Vehicle) surveys, drone surveys are an increasingly popular method of surveying form the air.

An unmanned aerial vehicle (UAV), commonly known as a drone, as an unmanned aircraft system (UAS), or by several other names, is an aircraft without a human pilot aboard. The flight of UAVs may operate with various degrees of autonomy; either under remote control by a human operator, or fly autonomously based on pre-programmed flight plans.

INTRODUCTION TO DRONE SURVEY



INTRODUCTION TO DRONE SURVEY

APPLICATIONS

Surveying and GIS

Surveyors and GIS professionals are using drone mapping to achieve tremendous time and cost savings on surveying and mapping projects. Time spent collecting accurate data is vastly reduced. By acquiring raster data from the sky – in the form of geo-referenced digital aerial images – surveyors can gather millions of data points in one short flight.

Less time spent on the ground also means staff safety is improved by minimising risk to surveying teams when out measuring locations such as construction sites, unstable slopes or busy transport routes.

APPLICATIONS

Construction

The applications here are similar to those of surveying, but with the addition of an aerial monitoring capability. Consequently, this is one of the fastest growing areas for drone adoption. There's a lot to keep track of on a job site—project progress, the location of equipment, the volume of materials left—and the ability to quickly get an aerial view or 3D model makes it all a lot easier.

APPLICATIONS

DRONE - SURVEYING

LANDDATA SURVEYS

- Clients requiring detail and contour surveys
- Seek to reduce costs
- Investigate innovative methods
- Various applications – different solutions
- Vast area
- Access difficulties
- Drone survey opportunities

DRONE SURVEY

http://www.dronemetrex.com/topodrones.html

- **Horizontal Accuracy 10mm and vertical accuracy of 25mm**
- Capture high resolution data using pre-programmed, autonomous flights;
- Equipped with IMU/GPS system which makes ground control points redundant;
- Control circuit board goes with IP software to plan fully autonomous missions, control the flights, and store high accurate data in secure format;
- Have "Active" Gimbal camera mount and software controlled for active counter-movement compensation of the drone airframe tip, tilt, yaw movements.
- TopoDrones carry latest-model metric and calibrated camera systems
- Our metric cameras can have 4-BAND digital sensors, which simultaneously capture a near infrared fourth band in addition to standard RGB, PAN, and CIR bands;
- Able to provide camera calibration databased on verified field calibration reports.

Mapping and Survey Applications

How Can Drones Help?

There's a lot of work important being done on sites today that could be made more efficient by the use of drones. Prospective sites ready to be developed need to be surveyed and terrain mapped. An understanding of the topology and geology are essential for initial planning and design.

Sites undergoing development and construction need careful management, including ongoing surveying, monitoring of work in progress, inventory and supply management, and optimisation of operations.

From a CAD and design perspective, there is reality capture: the ability to overlay digital models with the actual construction site for tasks like spacial planning and volumetric calculations.

For complete and finished structures, there's the need for ongoing inspections for regulatory and safety compliance. Especially for tall, hard-to-reach structures, such as cell phone towers (not many in Hong Kong), power and phone line pylons, bridges, and skyscrapers (a lot in Hong Kong!), inspections of this nature are always a challenge.

The way many of these tasks are carried out today can sometimes be a bit of a struggle.

Satellite imagery can be used to as part of the planning and design process, buts it's often of low resolution, and not up to date. Many satellite images date quickly, especially urban areas in Hong Kong, and are not an accurate reflection of what's on the ground right now.

Aerial images via conventional aircraft can provide higher resolution, and more current. But the cost of aerial photography in Hong Kong is often prohibitive, and even if it isn't, access over most urban areas would not achieve great results. The minimum altitude for manned aircraft is 500 ft above water and the countryside, and 1000 ft over the urban area – often too high to capture anything in considerable detail.

Ground-based surveying tools can't always capture all the data required, and sometimes require portions of a site to be shut down, which of course adds to costs. Generally speaking, multiple methods often need to be employed to collect all the necessary data – and it can still be fragmented and incomplete.

Safety is always an issue on any construction site, so reducing the number of people that need to visit a site, and/or be on site to analyse progress, check inventory, and survey structures is always going to have a positive effect on safety.

In structural inspection, often the only access is to manually climb or rope-access tall structures for inspection, or utilise expensive and potentially dangerous helicopter flights.

The Drone Advantage

1. As mentioned, drones are being used increasingly by surveyors, project managers and GIS professionals around the world to save time and costs on surveying and mapping projects. In the field, time spent collecting accurate data is vastly reduced by using drones.
2. By acquiring raster data from the sky – in the form of geo-referenced, ortho-corrected digital images, with resolutions down to 1.5 cm / 0.6 in per pixel – millions of data points can be gathered in one short flight.
3. And this capability can be repeated over time, building an ongoing report and archive of construction and development in progress.
4. For inspection, the ability to get up close to almost all areas of a tall and generally inaccessible structure greatly speeds up assessment and analysis, enabling more efficient decision-making for follow up action.

How it Works

A set of digital images or photographs taken by the drone at a pre-set, consistent altitude over the site are digitally processed and stitched together into an orthomosaic. An orthomosaic is essentially a grid of photos, geometrically-corrected to accurately map the survey site being covered.

Orthomosaics

Because the drone is continually using GPS to maintain its flight path, position and general stability against wind and turbulence, the GPS data is also used to geo-tag each photo as its taken during the mission. These geo-tagged photos can then be reassembled by post processing software into the orthomosaic within the parameters of a known position on the Earth's surface.

Accurate orthomosaics require images be taken with a significant degree of overlap, usually at least a 70 percent overlap between one image and its adjoining images. Images also need to be of a reasonable resolution (12MP is a good starting point), and taken in reasonable light conditions (a bright but overcast day is ideal. Strong sunny days may have better colour rendition, but produce dark shadows that may lack detail).

Greater Accuracy

Most drone-collected geo-tagged images can produce orthomosaics with accuracies and detail down to 5 cm / 1.9 in per pixel, just based on the GPS data collected by the drone.

For more stringent survey requirements, additional accuracy can be achieved by establishing a Ground Control Point (GCP) before the flight commences. This GCP could simply be a fixed object, such as a post or the corner of a building, or a pre-determined latitude / longitude point set in Google Earth. This GCP can be uploaded into the drone's flight plan software before the flight, and is then used a reference point during photo taking and post processing.

Certain advanced survey drones can receive real-time in-flight data corrections during a mission, streamed from a fixed Virtual Reference Station (VRS) on site to achieve X, Y, and Z accuracy down to 3 cm / 1.2 in per pixel, without needing Ground Control Points.

Controlled Flight

With their in-built GPS and highly responsive flight control systems, today's drones are able to fly and maintain very specific, accurate zig-zag flight patterns, flying backwards and forwards across a site until the entire area is photographed and mapped with the degree of precision and overlap needed. They're able to fly slow enough to capture sharp, clear images without motion blur, and their powered gimbal systems ensure the camera is maintained at a stable, consistent nadir angle throughout the flight.

Pre-Programmed Flight

Because of this need to fly and maintain a very specific, accurate flight pattern, the site map and flight plan are pre-programmed, saved, and uploaded to the drone before the mission commences. This can be done either on site, or beforehand in an office, but requires an internet connection so the flight plan software can bring up a background satellite map of the location to be surveyed – usually Google Maps or Mapbox.

To set up a mission, the user simply marks out the area to be surveyed on the satellite map, adjusts the degree of photo overlap required, and the most efficient direction of the flight path (the optimal flight altitude is usually calculated by the software, but can be adjusted), and saves the flight plan ready for upload to the drone.

Once the drone is switched on and is deemed flight-ready, the flight plan is uploaded and the mission executed. The drone takes off, executes the flight plan and takes all photographs entirely automatically. If a problem or hazard is encountered, the drone operator has manual override via the flight transmitter / controller, which cancels the flight plan and gives immediate manual control back to the operator.

Most software solutions are also capable of resuming a flight plan from a cut-off point, should a manual override be necessary, or should the drone need to return for a battery.

Add in 3D

If a key requirement of the job is a 3D visualisation or model of the site being mapped, then post-processing is greatly enhanced if there is a set of oblique images taken around the site from different angles.

These images are acquired by flying a generally circular path around a site, capturing images at 30, 45 and 70 degree angles, looking inwards from the perimeter of the site. The post processing software then has a clear set of images of the sides of existing buildings and structures within the location, which in turn produce more realistic and accurate 3D renderings.

Generally, this oblique angle capture process cannot be executed as part of an automatic flight plan, and will need to be flown manually by a skilled operator, but the results are well worth the additional time spent to capture a good oblique image set.

Post Processing

Once the flight mission is complete and the site fully photographed and mapped, the photographs and the geo-data need to be processed into an usable orthomosaic map. This can be done with desktop software solutions, or increasingly, with cloud-based solutions, where the entire photo set is uploaded to a cloud service, and processed in a few hours, leveraging the power of distributed processing.

Desktop Solutions

A number of desktop systems are well established, with others appearing more recently.

Principal among these is German-based Pix4D, who offer a range of desktop processing packages aimed at different sectors, including structure and site surveying, agriculture, and 3D rendering.

ESRI's ArcGIS, arguably the world's most powerful GIS mapping software, is well established, and has a huge range of applications. ESRI has a new package, Drone2Map, currently in beta, which enables the creation of orthomosaics, 3D meshes and more inside ArcGIS from drone-captured still imagery.

Autodesk is offering ReCap 360 as a free download for most Autodesk suites, enabling the import, view, and conversion of point cloud data. However, you can do very little without upgrading to the ReCap 360 Pro version, which enables orthomosaic stitching and advanced editing and measurement tools. The Pro version also offers cloud-based storage.

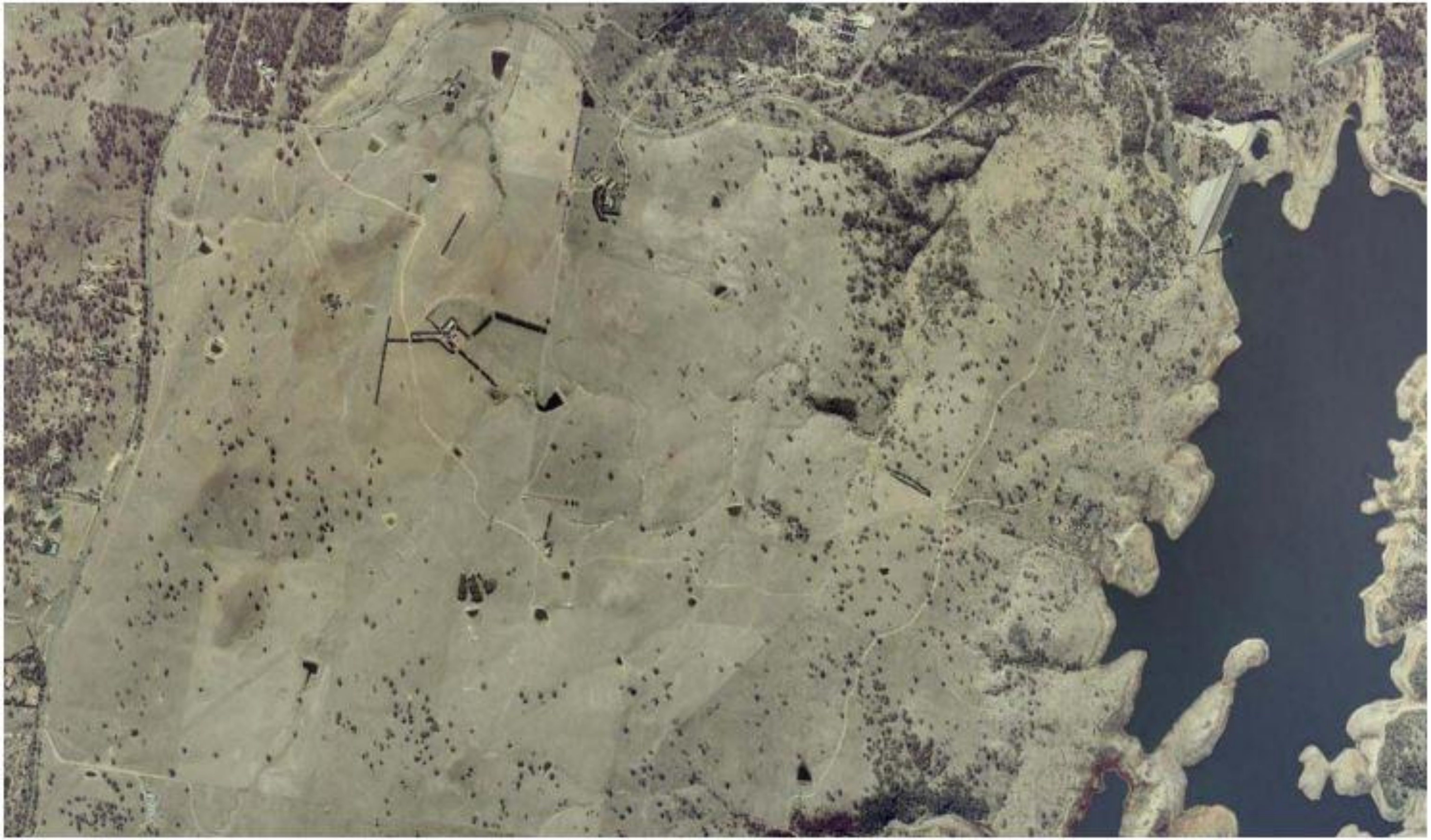
Agisoft PhotoScan is another stand-alone software product that performs photogrammetric processing of digital images and is able to generate 3D spatial data.

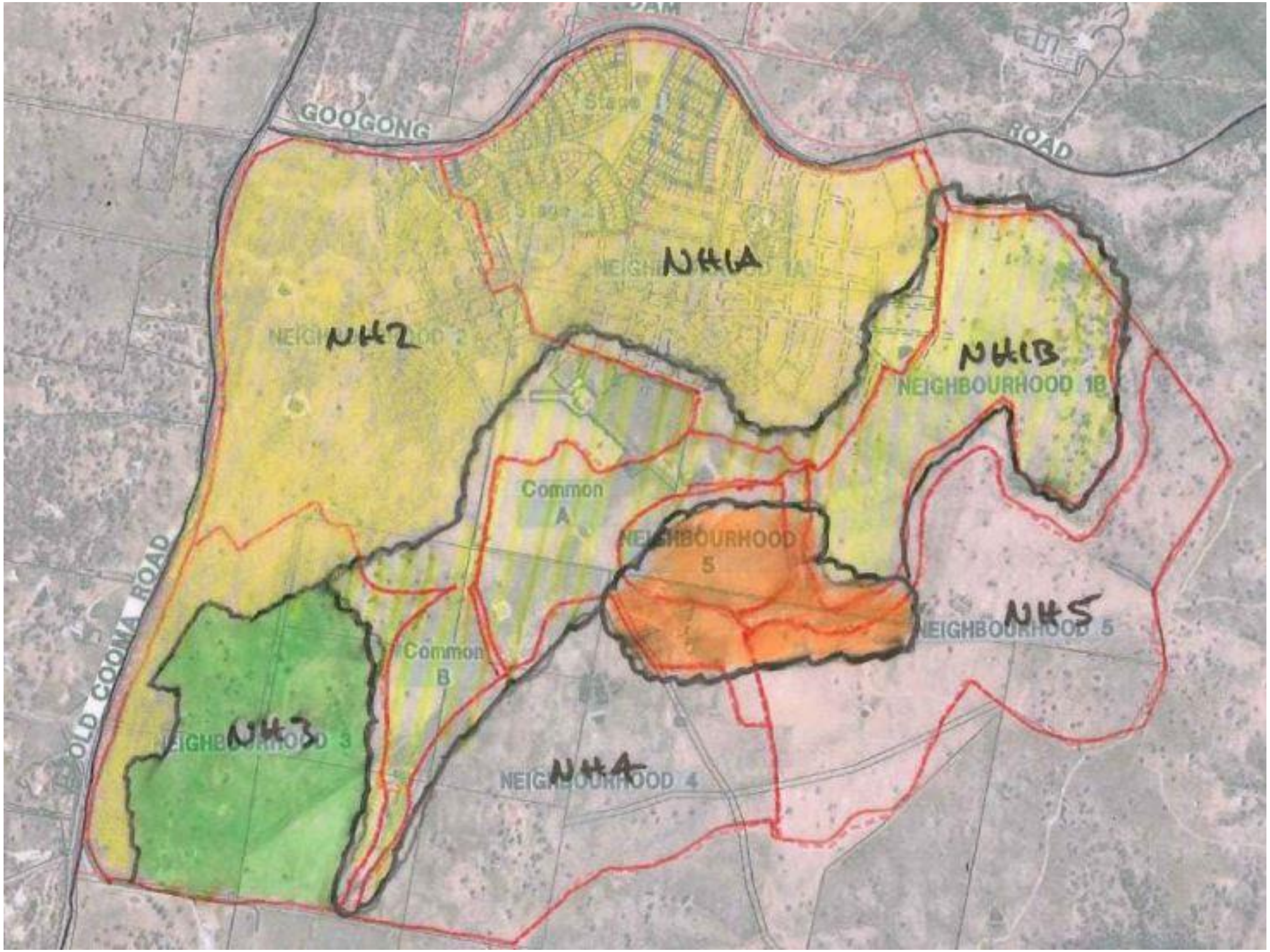
Bentley, another major player in the infrastructure space, offers ContextCapture which creates 3D models from simple photosets.

Cloud Solutions

Silicon Valley startup, DroneDeploy has rapidly carved itself a major share in the cloudbased orthomosaic processing arena since launching in 2015. Image sets are uploaded via a desktop computer, or can be uploaded in the field direct from the capture app (if an internet connection is available). Processed data sets include orthomosaics, terrain models, 3D models, and crop NVDI analysis images.

All orthomosaics and models can be viewed online, or downloaded for import and processing in other desktop software systems. In a similar vein, Maps Made Easy also offers cloud-based map processing, processing and producing orthomosaics, terrain models, 3D models, and crop NVDI analysis.





GOOGONG
ROAD
OLD COOMA ROAD
Stage
NH1A
NH2
NH1B
NEIGHBOURHOOD 1B
Common
A
NEIGHBOURHOOD
5
Common
B
NH5
NEIGHBOURHOOD 5
NH3
NH4
NEIGHBOURHOOD 4