A 3d View from a Drone: Make a 3d model from your photos

Student worksheet

Introduction

Drones can take photos that you can analyze later. By planning ahead to have enough overlap between photos, you take those individual photos and make a 3-dimensional image!

When walking on a hike or around the schoolyard, sometimes you see something that is high up on a rock outcrop or on a hill that catches your interest. For instance, a previous forest fire might have left a hillside bare of vegetation to hold the soil in place. How is the hillside starting to shift after rainstorms or snows? Monitoring an area over many months can lead to discoveries about how the erosional processes happen and also provide homeowners, park rangers, planners, and others valuable information to take action to stabilize areas to prevent landslides.

The Challenge: Design and conduct an experiment to take enough photos to make a 3-dimensional image of an outcrop or landform. then analyze the image and interpret the resulting 3-d image

Taking photos from multiple viewpoints can yield better 3d models, so using a drone with a camera onboard, from the ground, a balloon and/or from a tall pole might be useful for the study.

Suggested materials:

- Drone with a camera or a long pole to attach a camera
- Extra batteries
- One-meter circle or square laid on the ground (cloth or tarp) and long tape measure
- Software that will make a 3D image from photos:
    - Autodesk Recap: https://recap360.autodesk.com/
    - SketchFab: show off your models! https://sketchfab.com/
    - App to scan using an iphone: Trnio: a smartphone 3d scanning application http://www.trnio.com/
    - App to scan using an Android device: Scann3d: http://scann3d.smartmobilevision.com/

Instructions

Write a draft question you want to answer: What are you trying to discover by making the 3-dimensional image?

Make a plan

- With your teammates, to develop your plan, you need to know how large the area is you want to photograph and field of view of the camera(s)?
- Who is needed for the team? Identify who will be the pilot? The photographer? The spotter? (If you use a camera that sends its image to a screen or phone, designate a photographer to take the photos)
- What hazards are there to be avoided?

Sketch a map showing planned route for your drone to fly and from which directions. Show where the pilot, photographer, and spotters will stand. Think about the order & from angles will you take the photos.

Sketch a drawing of where the photos will be taken. How far from the outcrop will the drone need to fly and get enough detail for your project? How many photos will you need to take to have 70% overlap?

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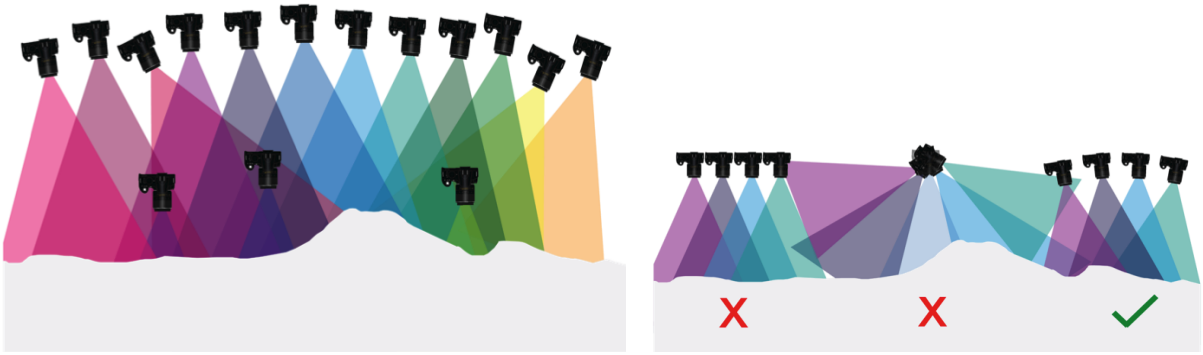
Where: how high, from how far away, how many? When during the day, during the year, after an event? Each photo should overlap the previous photo by 60% - 80%. If multiple rows of photos are taken, remember to overlap the rows by 60% - 80%. (left image). Less effective scans result from only taking photos straight on or in a divergent pattern (as in taking the photos while standing in one spot and turning the camera) (right image).

If possible, do a test run to take and process a portion of your outrop – a small-scale scan can provide hands-on experience for refining your procedures.



(Image credit: Kate Shervais, UNAVCO)

Think about:

- How does the angle of camera on the drone impact the photos? Are circles still circles in the photograph?
- What environmental or drone-based variables could interfere with your photographs?
- What other information should be in your sketch?
- How you will measure the size of objects and the height of your drone? (Hint: cut a tarp into a circle or square, one-meter across – other methods?)

Plan for Safety**:** Is it safe to fly a drone? If the study area is near the road, are you and your team safely off the road?

Field work: Take the photos and measurements

Carry out your investigation and collect your data:

1. Add information about your photos in a table to record data about each session and flight. Take measurements to calculate the object and heights.
2. Take a few photos of the full area you are investigating – later you can show the outlines of the individual images from each flight to calculate area and overlap.
3. Make a table similar to the one shown below to record your data...
4. After the investigation, show locations of your photos on map & site photo. What new questions did you think of while conducting your investigation?

Flight Number:	Test circle	1	2	3	4	5
Name of pilot, photographer, spotter(s)						
Date + Beginning & ending time of flight						
Filenames of photos (range)						
Height above ground, distance from the outcrop & area covered of each photo. Direction of image collection (panorama, walk, spin - around, zig-zag, etc)						
General description of images*						
After each flight, sketch the path on your map.						

* Consider describing: Are there trees, bushes, grasses in front of the outcrop? Lighting – cloudy/sunny? How far do roots go into the rock? How is the rock where there are roots different than other areas? Color, consistency, staining, etc.

Create the 3d model(s)

Using a online software such as Autodesk Recap to stitch the photos together to make a 3D image. Two smart device applications are Trnio (Apple ios) and Scann3d (Android). SketchFab is an online site for showing off your models!

Recap is currently free and allows 50 photos in a model. A single 'row' of photos with lots of overlap (think zig-zag up and down) works well for this application. An alternative is to take the photos with the drone (or other camera) then import them into a 3d model application on a smart device, such as Trnio or Scann3D. There are many applications that will create 3D models, such as Agisoft, that are not free.

Analyze & interpret the model(s)

How do the models contribute to answering your questions? What can you learn by reviewing the locations that photos were captured vs the end model?

Measure the objects in your photos. Are circles actually circles? This can provide information about the distortion of the objects in your images and models. Generate statistics from your data.

Describe what have you learned from data and the project.

Compile flight log, hypothesis, images, data chart, conclusion and any additional project pictures and results into a short report (or powerpoint) for a classroom presentation or science fair exhibit.

How would you have changed your investigation design? What modifications, sensors, and/or instruments would have helped with your project? Take a look at the engineering design loop for ideas.

Brainstorm additional projects you can do with the camera on your drone; what other 3D projects could you do; how could printing the 3D image help with your analysis, communication etc.