3D Modelling Underwater Scenes For Operation Wallacea

Teaching Guide
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GitHub Repository:
https://github.com/gracecalvertyoung/Underwater-Photogrammetry-Teaching-Material

Dive Planning / Data Collection

PRE-DIVE CHECKS
☐ Is the GoPro charged and with enough free space?
☐ Is the quadrat ready to go?
☐ Is the transect tape ready to go?
☐ Does each diver have a HAS score sheet?
☐ Does each diver have a dive slate with enough free space?
☐ Are divers clear on their roles in the dive protocol?

DIVE BRIEFING/PROTOCOL
Prior to the dive, all divers should know how to measure a HAS score and how they'll layout notes on their dive slates. The dive plan is:

1. Lay-out transect 5 m deep (2 divers).
2. Place quadrat at 5 m along transect. (2 divers). Then,
   (a) Film quadrat for 3D (1 diver).
   (b) HAS-score quadrat (all divers).
   (c) Observe fish for 10 min (all divers).
3. Repeat (2) for next quadrat(s) (placed 5 m ahead of previous on transect).
4. At end of dive, retrieve all materials.

IMMEDIATE POST-DIVE CHECKS
☐ Have images from the GoPro been...
   ☐ downloaded,
   ☐ labelled,
   ☐ backed-up,
   ☐ deleted from the GoPro?
☐ Is the GoPro on charge, ready to go for the next dive?
☐ Has all data from slates been transferred to an Excel sheet?
☐ Have unidentified invertibrets and fish been identified with an expert?

Some things to decide with team prior to dives:

- *What should a diver do if s/he can't ID an invertebrate or fish? E.g.,* Draw a picture of the fish, note relevant features, photograph if possible, and ask for ID as soon as reach the surface.
- *In what cases should data be thrown out? E.g.,* Throw-out data, if someone swims over the quadrat while we are IDing fish.

Learning The Software

Session No. 01
First Exposure to PhotoScan Software

PRE-MEETING
☑Each student has confirmed that they've PhotoScan Pro loaded and activated on their personal laptop. Instructor has a second laptop in case one student's isn't working.
☑ Remind everyone to bring their (charged) laptop and a USB to the meeting.
☑ Have USB ready with ☑ PhotoScan Pro user's manual ☑ set of test images that will render in less than 5 minutes ☑ set of test images that will render in about an hour, plus final rendered file in case someone's laptop is slow.

MEETING (30 minutes)
Has anyone used PhotoScan before? Explain what the software does. Have students figure out how to accomplish the following skills on their own, while instructor is there to offer guidance. The best and least-boring way to learn software is to just play around with it and figure out yourself what all the buttons do. Instructor has laptop connected to the projector. Skills are, in the following order:

☑ Load first set of test images (about 20 images; suggested images in folder of GitHub repository linked on page 1 `.../PhotoScanPractice/scene_trafficcone_quick/`). Have students see what the images are and guess what they expect the 3D model to look like.
☑ Align, Build Dense Point Cloud, Build Mesh, and Build Texture of. Leave all default settings, except set accuracy to **Low**. *Does the model look as you might expect?*
☑ Practice manipulating model, zooming, rotating, and using different views.
☑ Delete unwanted edges of the model.
☑ Do the above steps, except using Batch Process and in a new Chunk.
☑ Export model as .obj file.
☑ Start rendering more complex scene using Batch Process. Check after dinner. Suggested images on GitHub repository linked on page 1 in folder `.../PhotoScanPractice/scene_quadbike/`.

POST-MEETING
No action items.

Session No. 02
First Exposure to Rhino 3D Software

PRE-MEETING
Each students should bring a (charged) laptop and a USB stick or hard drive to transfer files. The files we'll be working from are `scean_quadbike.obj`, and its associated `.mtl` and `.jpg` files. These are available in the GitHub repository linked on page 1 in folder `.../RhinoPractice/Quadrat3DM/`.

MEETING (40–60 minutes)
Has anyone used Rhino or a 3D modelling program before (like Google Sketch-Up, Inventor, SolidWorks, *etc.*)? After this meeting, students should be able to complete the Pre-Checks listed in Section 0 of the 3D modelling manual (GitHub repository linked on page 1, root folder `Manual_13Oct2016.pdf`). Skills are, in the following order:

☐ Open new file in Rhino.
☐ Import `.obj` file.
☐ Select and un-select the model.
I found that if didn't do this skill first, students accidentally highlight or select the model and then are really confused.
☐ Set view to "Rendered."
If the colors aren't showing, i.e., the model looks all grey, you'll need to edit the material of the object and load the correct image file with the colors; it's not exactly intuitive; instructions are on the blog `www.graceunderthesea.com`.
☐ Zoom, rotate, and pan the model. Get use to the four views.
☐ `Move` command. Get use to entering commands and following the command prompts.
☐ `Scale` command. Explain differences between `Scale` and `Scale1D` *etc.*
☐ `Rotate` command. Also use guidance features including "Ortho" and "Grid-Snap."
☐ `Point` command. Notice that if you aren't restricting selection locations, the point might look like it's in the right position in one view port, but look in a different location in another view port. To correct for this and make your job easier, see selection constraints including "On mesh."
☐ `Dim` and `DimAligned` command. But what are the units?
☐ Set document units to meters (File → Settings → Units...)
☐ `Rotate` the model so that one of the quadrat bars is parallel with the x-axis.
☐ Scale the object so that the quadrat bar is the desired length (*e.g.,* 2 m). Check your work by re-measuring the length of the bar after scaling. Show slide from 3D modelling manual with a non-obvious error in scaling. Can they spot the mistake?
☐ Move the object so that it's in the first quadrant (all positive axes).

POST-MEETING
Assure students this'll get easier with time and it's a really good software to know.

Session No. 03
Using Rhino to Measure Rugosity

PRE-MEETING
Each student should bring his/her (charged) laptop and a USB stick or hard drive to transfer files. The files we'll be working from are `Session_03.3dm` (plus `Session_03.jpg`), `rugosity_helper.3dm`, and `rugosity.py`. `Session_03.3dm` and `Session_03.jpg` are available in the GitHub repository linked on page 1, folder `.../RhinoPractice/Quadrat3DM_FirstExample/`. `rugosity_helper.3dm`, and `rugosity.py` can be found at `https://github.com/gracecalvertyoung/Rhino-Python-3D-Coral-Reefs`.

Give them the already-scaled/rotated model in Session_03.3dm; if they run through the below the steps fast, then ask them to import `Session_03.obj` *into Rhino and perform the pre-checks on it. If they don't have time, we'll do this in the fourth session.*

MEETING (40–60 minutes)
☐ Go over "What is rugosity?" slides in 3D modelling manual (GitHub repository linked on page 1, root folder `Manual_13Oct2016.pdf`).
☐ Run-through steps 1–9 in the manual for how to run the rugosity code (GitHub repository linked on page 1, root folder `Manual_13Oct2016.pdf`).
☐ Individually click on lines so you can check them. Don't batch-select or you might get some line pieces you don't expect.
☐ Go over cases when line isn't right: `Explode`, `Join`, `Line` commands, and box-select. For this task, use the file `.../RhinoPractice/rugositymesseduplinespractice.3dm` in the GitHub repository linked on page 1.

POST-MEETING
Again assure students that this will get easier over time.

Session No. 04
Using Rhino to Measure Fractal Dimension & Vector Dispersion

PRE-MEETING
Each student should bring his/her (charged) laptop and a USB stick or hard drive to transfer files. The files we'll be working from are `Session_04.3dm` (plus `Session_04.jpg`), `FD.py`, `k.py`, and `k_helper.3dm`. `Session_04.3dm` and `Session_04.jpg` are in the GitHub repository linked on page 1 in the folder `.../RhinoPractice/Quadrat_SecondExample/`. `FD.py`, `k.py` and `k_helper.3dm` can be found at `https://github.com/gracecalvertyoung/Rhino-Python-3D-Coral-Reefs`.

MEETING (30–40 minutes)
☐ Go over Fractal Dimension and Vector Dispersion slides in 3D modelling manual (GitHub repository linked on page 1, root folder `Manual_13Oct2016.pdf`).
☐ Run-through steps in the manual for how to run `FD.py` and `k.py` (GitHub repository linked on page 1, root folder `Manual_13Oct2016.pdf`).
☐ What numbers do you get? Are they the same as your neighbour's? Slight differences in the numbers could be from slightly different placements or orientations of the quadrats.
☐ Show how results from Rhino can be copy-and-pasted into Excel.

POST-MEETING
Practice all skills individually. Ask neighbour if need help.

Session No. 05
Data Management & Back-Up System

PRE-MEETING
NA

MEETING (10 minutes)

☐ What is your back-up system?
Assume no internet, depending on location.
Think worst-case scenarios; e.g., harddrive stolen, harddrive dropped in water, drunkard overwrites everything . . . What will you do?
Share data-loss horror stories. No consolation prize.
☐ How will you label files?
Consistency is key. Coordinate with spreadsheet.
Avoid confusion between computers/versions.
☐ Do your harddrives work between computers/operating systems?
Format as ExFat. Check before relying on harddrive.

POST-MEETING

Students write-out back-up plan: