| 3D Scanning and Surface Area Measurements | |
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| Prepared by: | Bahr Marine Ecology Lab |
| Last Updated: | December 2022 |
| Pre-requisite SOP: Coral Airbrushing Protocol | |
| Safety Precautions: | |
| * **Required PPE – Enclosed shoes, gloves** | |
| Purpose: | |
| * The surface area of the corals will be measured using 3D scanner (EinScan-SE). More recent work has shown that 3D scanned images of the coral provide a more accurate surface area measurement which is needed to standardize physiological measurements. * Calculation of Surface Area * One measurement of calcification * Adapted from the Dr. Sarah Davies Lab at Boston University (thank you!) | |
| Materials: | |
| * Einscan-SE 3D Scanner * Einscan-S software * Scanner manual (can be found [here](https://www.einscan.com/support/download/manual/?scan_model=einscan-se&download_option=manual)) * Calibration object * Manilla file folder * Pedestal for coral branch | |
| Scanner Set-up: | |
| * Ensure that all the power and computer connection cables are plugged in (scanner power, cable from scanner to computer and cable from scanner base to scanner camera). * Turn the scanner on by touching the power button (it’s touch-sensitive) * Turn off overhead lights in the scanner area * Put up a manilla filing folder behind the scanner base and make sure that the scanner is pointed squarely at the wall. | |
| Running Software and Getting the Scan: | |
| * Open the Einscan-S software. If you do not have this installed it can be downloaded here: <https://www.einscan.com/support/download/software/?scan_model=einscan-se> * Click on Einscan-SE (left logo) * The scanner in the lab should already be calibrated but if you want to redo the calibration just to make sure (or if it’s been a while since it’s been used):   + Calibration object is in the drawer to the left of the scanner/computer (it looks like the logo on the screen of the program).   + Note: If the scanner has been relocated then DEFINITELY RECALIBRATE.   + Follow directions on the screen * Click on Fixed scan. * Click on New Project (if you open the program before turning on the scanner you may not be able to click on new project, quit the program and re-open). * Select Texture scan * It will ask you if you want to restart white balance.   + It is recommended re-doing white balance whenever you open the program for the first scan, for subsequent scans in the same day, with the same lighting you do not have to re-do it.   + To do the white balance hold up a white sheet of paper in between the scanner base and the scanner camera (the program also shows you a diagram). * Place your coral on the scanner base. * You should then select the shade from the slider such that the object you want to scan (i.e., the coral) is highlighted in red in the camera preview. Do not worry that the background is also highlighted. Just make sure you select the option that highlights your entire subject. * **TURN ON THE HDR OPTION with the slider button.** This is important for scanning corals otherwise you get unusable scans. * Select with turntable   + The default number of steps is 12. I find this to be sufficient. * Double check that HDR is on and make sure your coral is balanced and will not fall. * Click Start Scan   + You will see the scans start appearing on the screen. It will turn the object and scan 12 times (or however many steps you specified). Once the set of scans is done you will have the option to edit the scan. For instance, you can select certain part and delete them. **Do not do this yet.**   + If things look good, then click on the green check mark. * Rotate your object slightly on the turntable (but keep it in the same location) and start another set of scans. Repeat this twice for a total of three scan sessions per coral. | |
| Editing the Final Scan: | |
| * You may have had to place your coral on a pedestal to scan it (especially if it's something that couldn’t stand on its own like a branch). * You can now delete the scans of the pedestal and any extra parts that are not useful. To do so:   + You can select the areas in the scan by holding down the shift button and making a circle with your mouse:   + This will select a region of the scan.   + Then you can delete the region by clicking on the delete button in the edit tools area | |
| Saving and Exporting Final Scan: | |
| * Once you’re satisfied with your scan click on Mesh in the right-hand size of the screen * Select watertight model * Select high detail (or the level of detail you require, for most corals we’ll want high). * Click apply (decide whether you want to smooth/sharpen, in most cases you won’t) * Then click Save your scan. * When saving also select the “.ply” option | |
| Calculating Surface Areas Using Meshlab | |
| * Open the “.ply” (or .stl file also work) using MeshLab. * Use the appropriate method for selected the surfaces that you want to measure the area of:   + **If your coral nubs were essentially all live tissue:** then then easiest route may be to calculate the surface area of the entire scan and then subtract the surface area of any spots that were not coral (e.g., the bottom of the nubbin/branch)     - Select the entire scan surface using the “Selected connected components in a region” button and dragging across the whole scan to select everything. (Selected areas appear pink)     - Calculate surface area of selection. Menu path: Filters -> Quality measures and computers -> Compute Area/perimeter of selection     - The computed area will appear in the dialog box in the lower right-hand side. **The units are in square millimeters.**     - Deselect everything by pressing shift-D when the selection tool is engaged.     - Click on the Selected connected components in a region button again to deactivate the tool.     - Then use the z-painting tool to select the areas that you need to subtract. Menu path: Edit->z-painting tool. Then click on the red paintbrush icon. Increase hardness to 100 and adjust the size of the bubble as needed.     - You can then toggle between using the paintbrush and rotating the scan by pressing the escape button.     - Paint the areas that you want to calculate the area for:     - Once you have selected all the areas you want then compute the area/perimeter of selection again (step ii above).     - Then subtract the numbers as needed to get your final surface areas   + **If your nubs are patchy live/dead areas**: Proceed directly to just using the z-painting tool to select the areas of the nub that were live, and you want surface area for. Make sure to rotate the scan and ensure that the polyp valleys are well selected. E.g., avoid this:      - * Rotate and paint until everything is well selected:       * Then compute area of selection (see above) | |
| Quality Assurance and Control: | |
| *Proper Training*  Proper protocols and training must be implemented to ensure the quality of data generated in the laboratory. Researchers must ensure that all equipment is accurately calibrated, inspected, and maintained according to the manufacturer’s instructions.  *Data Review*  All laboratory data will be reviewed for completeness and transfer errors. Data will be reviewed by a second individual after entry into Excel spreadsheets by comparing the entered, electronic data to the original records (e.g., hand-written datasheets or laboratory notebooks). Data will be summarized as descriptive statistics and in tabular and graphical form to allow visual inspection and verification, and comparison to expected or target values.    *Data Verification*  Data will be checked for compliance with the procedures outlined in the SOPs. Any deviations from those procedures and the impact on the quality of the data will be assessed and discussed with Task Members. Any laboratory data outliers will be flagged.    *Data Validation*  Once the data has been reviewed and verified, it will be assessed to determine the overall acceptability of the objectives of the project. Blank samples, such as water quality testing, will be used to determine any biases or instrument calibration issues during the sample collection and analysis processes. Control samples will be used to determine the condition of the experimental test specimens in the absence of experimental treatments or exposures. Any errors in datasets detected will be discussed with lab members and project leads to determine the impact on the data and its use for the project. If there are any limitations to the data, they will be disclosed as part of the published literature.  *Procedure Specific QA/QC Methods*  Three dimensional scanner is calibrated according to calibration procedures described in the instrument manuals. | |