

3D Models Allow the Recovery of Information from Video Transects: A Case Study in Coral Reefs

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Image data acquisition is crucial for understanding long-term ecological processes. The video transect technique, developed in 1996 in Australia, has the main advantage of continuously visual recording the reef, allowing for the recovery of information that was previously unrecognized as relevant. With technological advances, the recovery of this information has reached a new level. Using photogrammetric techniques, it is possible to three-dimensionally reconstruct the filmed surface of reefs, enabling the collection of fundamental data on the structural complexity and population structure of corals and other benthic species. Structural complexity is the number of irregularities and indentations in the reef, indicating the amount of shelter it provides to marine fauna. Population structure describes the age distribution of species and is positively correlated with structural complexity. In this paper, we present the application of a 3D photogrammetry method to measure structural complexity in coral reefs using video transect images. The video transects used are 20 meters long by 48 centimeters wide, with an average duration of two to three minutes. To construct the models, 350 deinterlaced images were extracted from each video, ensuring a high overlap rate. The models were generated using Metashape 2.0.0 (Agisoft). The images were automatically aligned, followed by the generation of a mesh of overlapping points, which was then textured. A mosaic model was then produced. Spatial scale was calibrated using ten one-centimeter markings arranged along a 20-meter measuring tape. Structural complexity was estimated by the ratio between the number of points and vertices and the reconstructed area of the transect. To ensure comparability between models, it is essential to standardize the parameters used during processing to avoid bias. Changes in camera lens, resolution, and image quality can also affect the results. Despite these limitations, the technique offers a valuable opportunity to revisit the past of ecosystems recorded on video, allowing retrospective analyses with a high level of detail.

Keywords: Photogrammetry 3D. Structural Complexity. Marine Ecology. Todos os Santos Bay.

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structure of corals and other benthic species to be obtained (Levy et al., 2022; Young et al., 2017) [2,3]. Structural complexity is the number of irregularities and indentations in the reef, indicating the amount of shelter it provides to marine fauna (Graham and Nash, 2012; Willis et al., 2005) [4,5]. Population structure describes the age distribution of species and is positively correlated with structural complexity.

In this work, we present the application of a 3D photogrammetry method to measure structural complexity in coral reefs through video transect images.

Materials and Methods

The video transects used are 20 meters long by 48 centimeters wide, with an average duration of two to three minutes. To construct the models, 280 to 350 deinterlaced images are extracted from

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each video, ensuring a high overlap rate. The models were generated using Metashape 2.0.0 (Agisoft) on an Intel i7-8550u CPU @ 1.8GHz with 16 GB of RAM and a 2 GB GeForce MX150 GPU.

The images were automatically aligned with high accuracy. The mesh was generated using depth map source data, with an arbitrary surface type, high quality, and a high number of faces. Texturing was performed using an occlusion map, 3D model source data, and an orthogonal mapping model. The tiled model was built from depth map source data, with high quality and a high face count per megapixel.

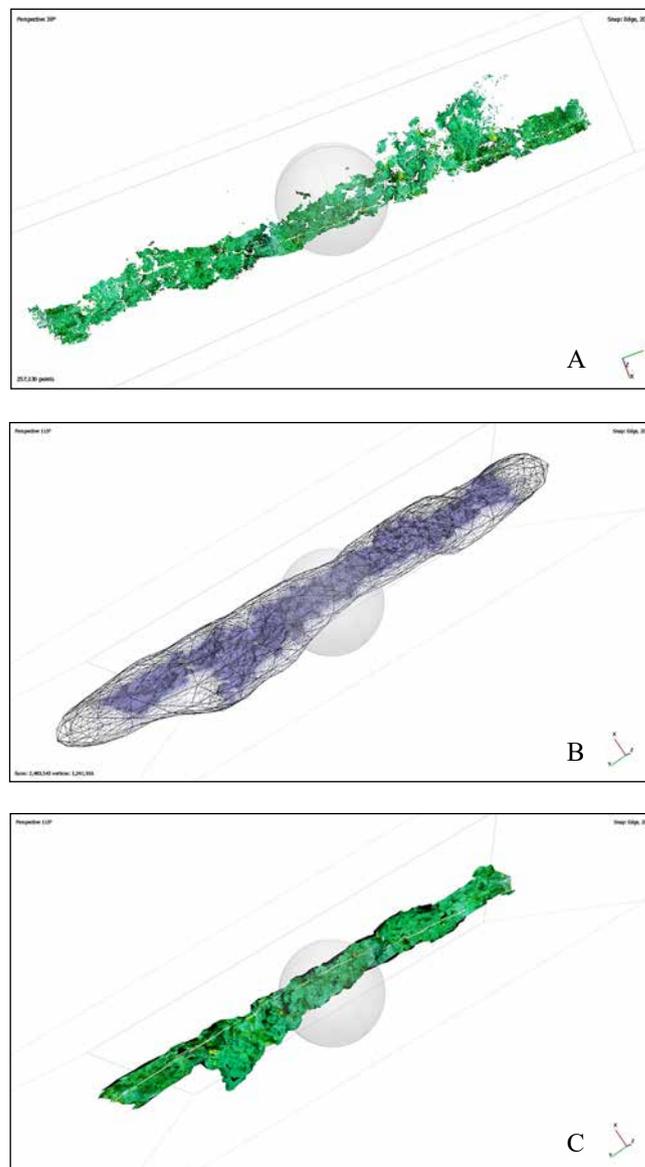
The spatial scale was calibrated using ten one-centimeter markings placed along a 20-meter measuring tape. Structural complexity was estimated as the ratio between the number of points and vertices and the reconstructed area of the transect. To ensure comparability between models, it is essential to standardize the parameters used during processing to avoid bias. Variations in camera lens, resolution, and image quality can also affect the results.

Results

In the example of transect 2 of Cardinal Reef from April 2022, 295 images were used, of which 143 were aligned, generating 157,130 intersection points and 2,483,543 easy points. In the following images, we observe the intersection and easy points used to construct the 3D images of the reef transects (Figure 1A); the 3D images of the transect itself, with the roughness and complexity of the reef transect in Figure 1B; and the texture 3D models in Figure 1C.

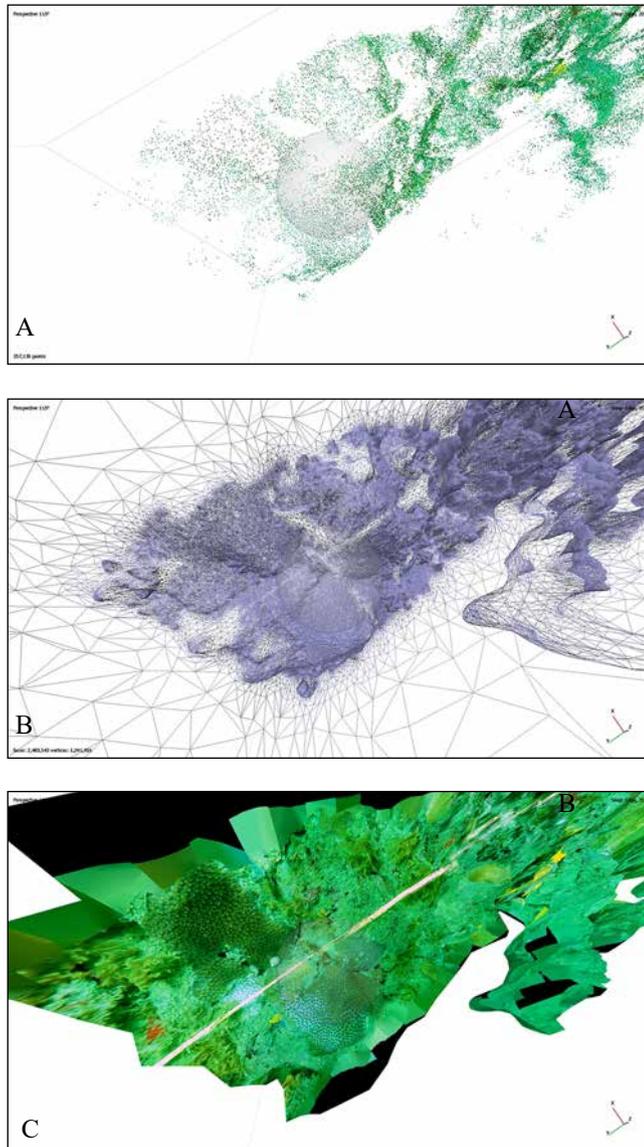
In Figure 2, we observed the intersection points (Figure 2A) and easy points (Figure 2B) used to construct 3D images of the corals (Figure 2C) with the images of the coral species. Here, two species can be identified: *Montastraea cavernosa* and *Siderastrea* spp. by photogrammetry used in the Pedra Cardinal reef transect (close-up showing coral species).

Figure 1. Reconstructed images, as intersection points (A), 3D models with phases (B) and textured 3D models (C).



The use of this technology can help us gain increasingly accurate insights into the seabed. Fixed monitoring areas can help us better understand changes in reef quality over time, including the roughness and complexity that maintain reefs and are extremely important for maintaining marine diversity and, consequently, for food production and tourism. Ways to measure these characteristics still need to be developed in future studies and research.

Figure 2. Detail of first one meter of reconstructed images, as intersection points (A), 3D models with phases (B) and textured 3D models (C).



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References

1. Carleton, C.B., Done, T.J., 1995. Quantitative video sampling of coral reef benthos: Large-scale application. *Coral Reefs* 14, 35–46.
2. Graham, N.A.J., Nash, K.L., 2012. The importance of structural complexity in coral reef ecosystems. *Coral Reefs* 32, 315–326. <https://doi.org/10.1007/s00338-012-0984-y>
3. Levy, N., Berman, O., Yuval, M., Loya, Y., Treibitz, T., Tarazi, E., Levy, O., 2022. Science of the Total Environment Emerging 3D technologies for future reformation of coral reefs : Enhancing biodiversity using biomimetic structures based on designs by nature. *Sci. Total Environ.* 830, 154749. <https://doi.org/10.1016/j.scitotenv.2022.154749>
4. Willis, S.C., Winemiller, K.O., Lopez-Fernandez, H., 2005. Habitat structural complexity and morphological diversity of fish assemblages in a Neotropical floodplain river. *Oecologia* 142, 284–295.
5. Young, G.C., Dey, S., Rogers, A.D., Exton, D., 2017. Cost and time-effective method for multi-scale measures of rugosity, fractal dimension, and vector dispersion from coral reef 3D models. *PLoS One* 12, e0175341.