Seafloor in 3D

Corals cover less than 0.1% of the ocean floor, yet contain levels of biodiversity that rival the rainforest. Coral reefs support multi-million dollar fishing and tourist industries in Hawaii, provide coastline protection from storms and typhoons, shelter countless organisms, and are the life-line for many families that rely directly on the ocean for sustenance. Worldwide, coral reefs are facing an ever-increasing number of natural and human-induced threats including: pollution, increasing sea-surface temperatures, over-fishing and destructive fishing practices, increasing disease occurrence, and ocean acidification.

Despite their crucial role, coral reef research and education are still in their infancy. Astonishingly, there are no reliable and cost effective methods of determining coral growth, a basic and essential parameter for understanding the health of a coral reef ecosystem. Furthermore, corals exist in three-dimensional (3D) space, and current methods of measuring coral growth rely on two-dimensional (2D) measurements.

Most corals are inaccessible to anyone who does not SCUBA dive, especially children. Until now, the only way to visualize corals has been to view static pictures or non-interactive films. As a result, public interest in the complexities of coral reefs pales in comparison to other charismatic megafauna such as sharks, whales and dolphins. We must continue to find ways to stimulate coral reef education.

Outcomes

Education: In the past, the only way to view a coral reef was through static, 2D photos, film, or in person. This new technology makes coral reefs accessible to people around the world. Educators are well aware that interaction is the key to an enriching learning experience. These interactive models will bring a new dimension to coral reef education and outreach. Ultimately, this technology will enhance the stimulation of an emotional interest to preserve, monitor, and conserve these precious resources.

Science: If this project proves to be successful, a new ability for Inventory & Monitoring Program scientists to accurately measure the surface area of corals over time will be a powerful tool to aid in long-term benthic monitoring efforts.

–S. Lee, NPS
Marine Biological Technician

Kalaupapa Project

During the week of May 19-23, 2014 a diverse team of scientists conducted a preliminary experiment examining the use of the latest 3D modeling software by *Autodesk, Inc.*, to model corals for scientific and educational purposes. This revolutionary software, *Reality Capture*, utilizes photogrammetry (making measurements using photographs), and is the first of its kind. For five days, a team of 8 divers captured Kalaupapa National Historical Park's coral reefs, gathering more than 2 terabytes of data (over 25,000 photographs). We photo-captured more than 30 corals, as well as 4 dead corals that will serve as the "controls". These "controls" will be laser scanned above water to serve as the reference model to which we will compare our 3D models (by comparing our models with the laser-scanned version, we can determine the accuracy of our methodology).

The Team

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Collaborating Organizations
The Hydrous
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Example of 2D Images Becoming a 3D Model

Step 1. Multiple pictures are taken around a coral head. The more complex the coral, the more pictures required. Proficient experience in SCUBA diving, underwater photography, and the software are required. Previous 3D modeling methods would require much more equipment including LIDAR (Laser Depth and Range), which is incredibly costly; this method only requires a camera.

Step 2. Individual Images are edited to optimize processing by the modeling software. Elements such as temperature, contrast, exposure, and saturation are adjusted.

Step 3. Images are imported into the software. Grey rectangles in this figure show where each image was taken in 3D space relative to the subject being modeled. The software automatically calculates the vantage point of each photo. It takes 1-2 hours to generate a model, which is superior to previous 3D model rendering methods, which required days to weeks.

Step 4. The software creates a mesh composed of hundreds of thousands to millions of mesh triangles. Previous 3D modeling software could only produce models with resolutions of a few thousand mesh triangles.

Step 5. Models are further post-processed through 3D editing software. The final product is an ultra-high resolution, true-color interactive 3D model. In previous methods, the entire process from photographing features to producing a 3D model took days to months. In this new method, the entire process can be completed in a few hours. You can visit this interactive model at http://thehydro.us/coral-in-3d/