Three-dimensional modeling of trophy Largemouth Bass

Patrick Kroboth[1], Dr. Angelos Barmpoutis[2], and Allen Martin[1]
[1] Florida Fish and Wildlife Conservation Commission, Division of Freshwater Fisheries Management, Lake City, Florida
[2] University of Florida, Digital Worlds Institute, Gainesville, Florida

Background

Started in October 2012, the Trophy Catch program run by the Florida Fish and Wildlife Conservation Commission (FWC) has been used to encourage catch-and-release of the largest, oldest, and most valuable bass in Florida's waters. A trophy bass is defined by the program as one that weighs greater than eight pounds.

The Trophy Catch program provides incentives for anglers to serve as citizen scientists by properly recording data on their catch and submitting it online so that FWC can better enhance, conserve, and promote trophy bass fishing. Trophy Catch participants who successfully submit a "Hall of Fame" bass, which is a bass weighing greater than thirteen pounds receive a replica mount of their fish.

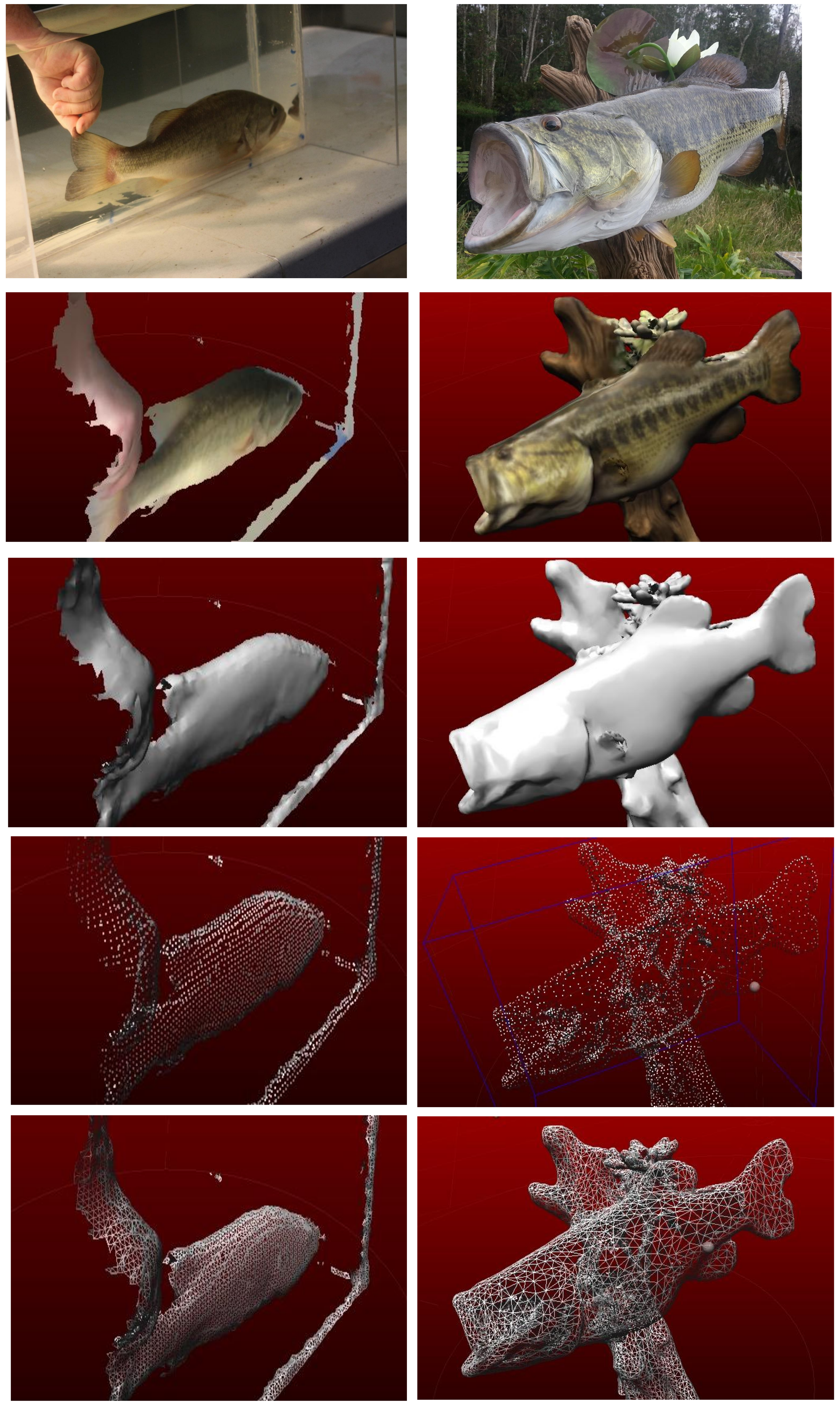
The current process to create a replica mount requires taxidermists to have a collection of fish molds of similar length and girth to the fish the angler caught. The trophy fish used to make these molds are rare and must be sacrificed to make the mold. Most taxidermists' collections consist of only a few molds. Our goals are to explore the suitability of three-dimensional (3D) modeling to capture the structure of a trophy Largemouth Bass and to assess the current limitations of the technology to produce models suitable for 3D printing.

Methods

Dr. Barmpoutis from the University of Florida's Digital Worlds Institute met with FWC staff at the FWC Black Bass Conservation Center in Richloam Florida in August 2015 to assess the limitations of the current technology on live fish and fish mounts. Live fish were lightly sedated using tricaine methanesulfonate. Live fish were scanned in a narrow Plexiglas tank designed to restrict movement, a shallow tub where they were held stationary just above the water, and held out of water by the lip and abdomen. These three methods were used to minimize stress on the fish while determining the limitations of the technology to scan live specimens. Fish mounts were used to capture high resolution scans of the fish without the error created by the fish's movement.

The 3D scanner "Structure Sensor" by Occipital was used to collect 3D data. This scanner operates with an infrared projector and camera. The projector emits laser beams in the infrared range and the camera observes the projected light. The camera then estimates the depth of the object in the field of view. Several other scanners operate with similar technology like the Microsoft "Kinect". Unlike other scanners this technology does not require a pre-calibrated environment and can be used in any setup. This is contrary to platform-based scanners which require an environment with calibrated markers and external light sources.

Live fish | **Replica model**



The limitations of this technology includes 1) low resolution of the raw data (~0.3cm 3D point accuracy) 2) subjects must remain motionless 3) susceptibility to interference from external infrared light, such as the sun. Low resolution of the raw data results in loss of finite details. For example on fish the scale pattern is not detected and the resulting model is smooth. To make the model more representative of the actual object, two-dimensional images are recorded at the same time as infrared scanning. These images are wrapped around the model so that it can be rendered with the color contrast and the details of the original object. Scanning an object requires several passes of the scanner as it sends out infrared light beams that reflect off of the object and return a depth reading that is plotted in 3D space. During this time the object must remain motionless. This makes modeling subject such as live fish difficult.

Results

Each of the 3D models consisted of ~30,000 triangular faces connecting plotted points (depicted in the bottom scanned images). These faces connect points and create the surface of the object giving it dimensionality. As you can see scanning of the rigid replica fish mounts captured more detail than scanning the live subject. Live fish despite sedation and confinement within the tank, still moved. This decreased the accuracy of the tail and fins which the fish constantly moved to maintain position. The best scan occurred when staff held the fish's tail in place during the process. Holding the fish in position in the tank and holding the fish in a shallow tub only produced a model of half the fish. To produce a full model both sides would need to be scanned or the existing scan would need to be mirrored to replicate the whole fish. Holding the fish out of water was successful at capturing the majority of the fish, but again live subjects moved before the whole scan was completed. Stationary replica molds produced the highest detailed models, but still resulted in a smooth surface without well represented fins, scales, and distinguishing details.

Discussion

The next step is to fit a frame to the model created from the replica mold. With that frame, size and dimensions of the fish can be changed without changing the proportions allowing for fish of different lengths and girths to be replicated. Next high resolution photos will be used to replicate the fine details of the fish's structures using the naturally repeated patterns of scales and fin rays. This process is an art and will take time for professionals in the Digital Worlds Institute to reproduce. Once a sufficient model has been reproduced internal structure and supports for the fins will be added to support a printable 3D model.

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