SYSTEM CALCULATION OF VOLUMES BY IMAGE ANALYSIS ON SHARKS

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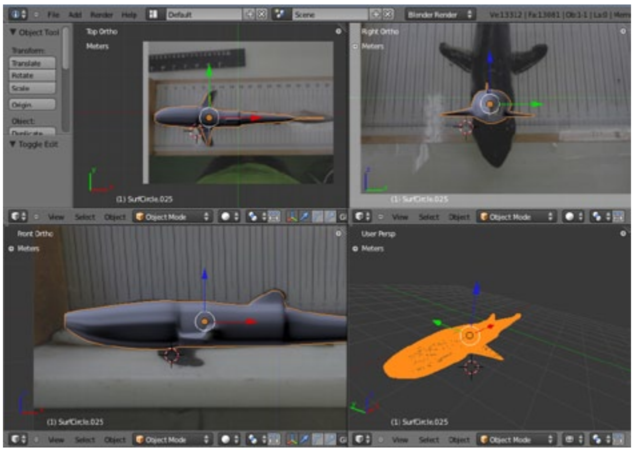
Abstract – Determining the volume of an animal can help us to understand certain aspects of its hydrodynamics and thermodynamics, such as behavioral thermoregulation and energy consumption. This determination is difficult due to the irregular shapes of the animal's body. On the other hand, large calibrated tanks are needed for measurements and this is not functional.
We have designed an innovative mechanism to register morphological characteristics in a fast, low-cost way, using standard digital photography.

Keywords – measure morphological data, photography, mesh, low-cost, volume, shark

I. INTRODUCTION
Pelagic sharks play a vital role in maintaining the balance of marine ecosystems. They have been under increasingly intense fishing pressure due to a higher demand for shark products. This over-exploitation affects populations that are generally fragile and is leading some species to the brink of extinction. In this context, more investigation is necessary to know those animals.
Determining the volume of an animal helps us to understand aspects of its hydrodynamics and thermodynamics, such as behavioral thermoregulation and energy consumption. Calculating the volume of animals is complicated because they have irregular shapes of the bodies. On the other hand, large calibrated tanks are needed for measurements and this is not functional.
In this work we present an innovative system to calculate volumes by image analysis. In a first step, we need to create a mesh in 3 dimensions from two photographs of 2 dimensions. In a second step, a program determines the volume analyzing the figure. It is important that the mesh is well adapted to the body. This system could be used for the automatic counting and monitoring of other species in the environment.

II. OBJETIVES
1. Finding a way to accurately measure the volume of large sharks. This method should be able to be used in ships.
2. Quantifying the error to create a 3D model through 2 photos.
3. Implementing the process for measuring volumes in other species.



III. EXPERIMENTAL CHARACTERIZATION
We worked with the blue shark (Prionace glauca). Preliminary tests had helped us to set the range of measures that we were bound to work with, from 0.5 to 15 l.
We conducted experiments with small sharks. These sharks' volume was calculated accurately as they could be introduced in test tubes. Indeed, the only way to accurately measure volume is through volume displacement techniques, using a big test tube (2 meters high and 400mm in diameter), specifically designed for the test.
In a second step we set the characteristics of the photos that we would use for the estimation of the volume: zenital position, and lateral position.
Finally, we took zenital and lateral pictures of the shark against a background scale. This enabled us to establish common axes. In the computer, the photos are transferred to the Blender program, an open source 3D graphics application that can be used for modeling and creating interactive 3D applications. It creates a 3D NURBS mesh and converts it into a triangulated mesh to calculate the volume.
This calculation is performed by AdMesh software (program for processing triangulated solid meshes in STL file format) that checks the integrity of the mesh and closes the holes. The software gives the result of the volume by finite elements. This result is compared with the one obtained in the test tube.

IV. PRELIMINAR RESULTS
The first 3D models had an error of 24% approximately. As we made new measurements with larger animals and obtained new meshes the error decreased to under 10%.

	Tiny Shark	Medium Shark	Large Shark
Real Measure	0,185	1,98	10,95

Mesh 3d	With fins	Without fins	With fins	Without fins	With fins	Without fins
	0,230	0,195	2,28	2,15	13,3	11,9
Error	24,3%	5,4%	15,1%	8,6%	51,4%	8,6%

An interesting observation is that taking into account the shark fins on the 3D model increased the final error by a constant value. On the other hand, the mesh is easily adaptable to a spindle-shaped smooth profile, but does register nooks and crevices of a real animal (mouth, holes). We believe that both errors compensate each other.

V. CONCLUSIONS
The volume measurement of large sharks is not easy to perform accurately, and less on board of a ship. The proposed model is the indirect calculation through photographs and finite approximations through a digital model of the shark. This process gives us a 10% error in the calculation, which is better than the one done in the field.

VI. REFERENCES
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