CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
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Project Number
22252

Project Title
Can Non-contact Optical Methods Detect "Coning" in Echolocating Beluga Whales?

Abstract

Objectives/Goals
Scientists suspect that beluga whales (delphinapterus leucas) voluntarily change the shape of a part of their head known as the "melon" to focus sound waves that they emit during echolocation. This has not yet been proven, however, because scientists have had no accurate way to measure changes in the melon's shape during echolocation without disturbing the echolocation process itself. This project's objective was to determine if an optical method called "Moire photogrammetry" could be adapted for this purpose.

Methods/Materials
The Mathematica programming language was used to make a .jpg image of a sine wave "transmission grid" that was converted to a 35mm slide and projected onto a white target sphere representing the beluga whale head. Using a digital camera located symmetrically opposite from the projector a .jpg picutre was taken of the grid projected on the target. This .jpg was imported into a PC where Mathematica was used to overlay a sine wave "virtual viewing grid" on the image. If the frequencies and phases of the transmission and viewing grids are correctly matched the Moire pattern formed by the interference of the two grid patterns will form a "topo map" of the target's surface so its curvature can be measured. Comparing the curvature in a sequence of .jpgs captured during echolocation "coning" would allow scientists tot determine if there is a correlation between curvature and target range. If there is, then that is more evidence for the hypothesis that in "coning" the beluga uses the melon as an acoustic lens where different amounts of curvature are used to "focus" the echolocation pulses.

Results
By using a reference plane behind the target the experimenter was able to match the transmission and viewing grid frequencies, and a topo map of the target surface was successfully produced.

Conclusions/Discussion
Since the shape of the target surface was determined without having any equipment located directly in front of the target, this same technique could be used when the target is the melon region of an actual beluga whale, without disturbing the beluga's echolocation behavior. The reference plane needs to be near the whale, but can be behind it and to the side where it will not interfere with echolocation. Future work t€ be done should be to try to write a computer program that matches the two grid frequencies and phases automatically instead of the experimenter having to do any trial and error.

Summary Statement
This project showed that there is a way to measure "coning" in echolocating beluga whales optically from a distance without distrubing their echolocation behavior.

Help Received
The SDSU Media Lab helped me convert .jpg files into slides. Point Loma Camera developed and mounted the slides. My Dad taught me about sine waves and Moire patterns, and how to use Mathematica to make sine wave grid images and do overlays to get the interference patterns.

Preliminary