ELVIS

Echolocation Visualisation Interface System

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Introduction

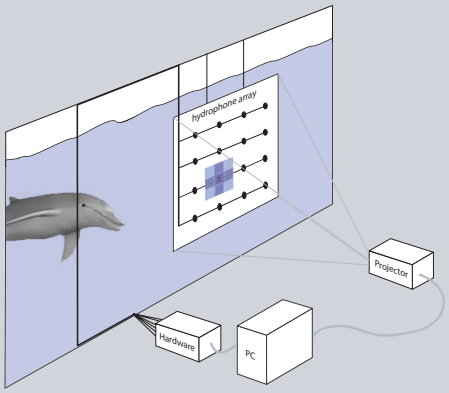
Dolphins are known to have one of the most advanced sonar systems in the animal kingdom. Extensive research has been done over decades in order to learn and understand how they interpret their surroundings and how they utilize their sonar system. The "Echolocation and Visualisation Interface System", ELVIS, is a new approach to the sonar studies of dolphins. The system would offer the possibility to visualize and study the ultra-sonic field of free swimming dolphins instead of having them placed in a fixed set-up.

Bottlenose dolphin at Kolmården- mother with calf

It would be possible to study how the dolphins scan an object during target discrimination by tracing the sonar beam on the computer screen. The visualized sonar beam can also be presented online and underwater to the dolphins making it possible to explore their response and give valuable insight into the connection between visual and acoustic stimulus processing.

Materials and methods

The ELVIS-system consists of a hydrophone matrix mounted on a semitransparent plastic screen which is submerged into the water. After amplification and filtering the ultrasonic pulses detected by the hydrophones are sampled by a computer and processed to create a two dimensional image of the sonar beam. This image is projected on the plastic screen in the water through a glass window, thus presenting the image in real time to the dolphins.

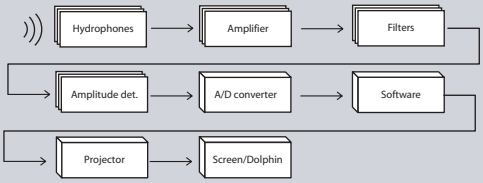


Schematic illustration of the ELVIS-system

Scanning the hydrophones continuously results in an image feed at video quality making it possible for the dolphins to see the effects of their sonar almost instantly. Different sonar parameters, e.g. intensity and frequency, can be indicated in the image using colour and intensity modulation.

Results

A simplified version of the system has been developed at the department of Electrical Measurements, LTH, and tested with bottlenose dolphins at the "Dolphin Lagoon" at Kolmården Zoo. The system comprised a small hydrophone matrix of 16 transducers over an area of 1 m^2 and was designed to measure only the amplitude of the detected sonar signals.



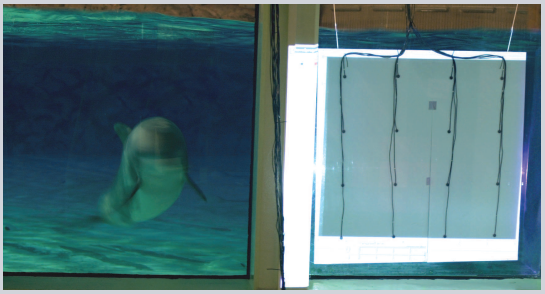
Schematic of simplified system detecting only the signal amplitude

Although the system was simple and had a rather limited spatial resolution, the underwater screen made it possible to observe how the dolphins scanned the transducer area with their sonar. The dolphin's response to the visual feedback was that of an intense interest. They schooled in front of the screen vividly discharging their sonar in order to activate the screen and they could often be seen following the images visually while they created them using their sonar.

Two different examples of sonar activities measured with the ELVIS-system as seen from the software controlling the system.

Discussion

With the continued development of the ELVIS-system it can provide not only a powerful tool for the biologists studying the sonar behavior of marine mammals, but also a way to give the public a chance to understand more of the acoustical world of the dolphins.



Curious bottlenose dolphin examines the screen during

It would also be possible to use the system as a computer interface for the dolphin. When the dolphin points its sonar beam towards the screen, it will correspond to what a person does when touching a point screen with his finger. This allows the dolphin to indicate selective responses to scientific questions and opens up for a variety of studies of dolphin perception and psychology.

Bottlenose Dolphin sees the graphic image of an emitted sonar pulse.