Multi-Beams Sonar Image Processing and Three Dimensional Analysis of Fish Schools

Chafia Hamitouche, Valérie Burdin, Carla Scalabrin, Laurent Lecornu

Image and Information Processing Department
ENST de Bretagne, Technopôle de Brest-Iroise, B.P. 832, 29285, Brest Cedex, France

Abstract: The aim of this work is to provide 3-D fish school descriptors. Digital data from a high resolution multi-beams sonar were processed and several processing steps including data corrections, 2D low level processing and 3D simulated reconstruction were necessary to reach this objective.

INTRODUCTION

Digital data from a high resolution multi-beams sonar were processed to provide 3-D fish school descriptors. The multi-beams sonar operates at a carrier frequency of 455 kHz, with 60 beams of 1.5 degree each, allowing an observation angle of 90 degrees. The pulse duration is 0.06 ms providing a 5 cm resolution along propagation direction. The usual operating range is 100 m with a ping rate of 7 pings / sec (i.e. 7 two-Dimensional frames per second).

The characteristics of recorded images are described on Figure 1:

Figure 1. 3D characteristics of the recorded data base

This huge amount of data provides larger bio-volume samples with higher data resolution than standard fisheries research vertical echo-sounders used until now to describe fish school structures [1].

TWO-DIMENSIONAL PROCESSING

In order to obtain 3D useful data, the frames were first processed in 2D plane by specially designed image algorithms such that only the information related to the fish schools is retained (for example detection and extraction of the bottom echo).

TOWARDS THREE-DIMENSIONAL VISUALIZATION AND QUANTIFICATION: SIMULATION

The most important step is the simulation which consists in creating a database taking into account all the recording parameters (anisotropy, heave, pitch and roll). A noise model is to be considered, based on the characteristics of the various noises present in real images (background noise, parasite echoes, acoustical and electrical noises) in order to define and implement high performances processing reducing noise while preserving the image structure. 3D segmentation operators could then be developed. This step is also very important to understand the relationship between the classical sonar screen images and the rectangular digital sonar images. A geometric transformation must be available to display images depending on geometry (Fig. 2). A calculated screen sonar image is much greater than the digital image without more information. So, it is suitable to use the digital image for noise attenuation processing, for fish school detection, etc... However the parameters obtained from the automatic shape detection must be corrected in actual geometry (sonar screen).
3D simulation of fish school has been performed (Fig.3). The hypotheses of the simulation are the following: 3D shape is ellipsoidal, slices are perpendicular to the major axis, the length of axes and the intensities of pixels (density variation) are randomly calculated. It was useful to describe and visualise the possibility of the final presentation of fish school.

FIGURE 2. Lateral viewing of a digital sonar image (left) and the correspondent calculated sonar screen image (right).

(a) (b) (c)

FIGURE 3: Simulated fish school slices added to the images of figure 2 (a,b). Simulation of 3D reconstruction – Fish school and vessel along a transect (c).

On real data the objective of quantification and visualization simultaneously of fish schools requires a combination of surface extraction and volume rendering approaches.

CONCLUSION

The final goal of shoal description will be performed using measures relating to the bathymetric position, the morphology, the size and the energy. Moreover, 3-D pattern description tools (invariant with respect to translation, rotation and scaling) [3] will be studied. This study will lead to the classification of the detected structures, using pattern recognition.

REFERENCES