CUDA based Level Set Method for 3D Reconstruction of Fishes from Large Acoustic Data

Acoustic images present views of underwater dynamics, even in high depths. With multi-beam echo sounders (SONARs), it is possible to capture series of 2D high resolution acoustic images. 3D reconstruction of the water column and subsequent estimation of fish abundance and fish species identification is highly desirable for planning sustainable fisheries. Main hurdles in analysing acoustic images are the presence of speckle noise and the vast amount of acoustic data. This paper presents a level set formulation for simultaneous fish reconstruction and noise suppression from raw acoustic images. Despite the presence of speckle noise blobs, actual fish intensity values can be distinguished by extremely high values, varying exponentially from the background. Edge detection generally gives excessive false edges that are not reliable. Our approach to reconstruction is based on level set evolution using Mumford-Shah segmentation functional that does not depend on edges in an image. We use the implicit function in conjunction with the image to robustly estimate a threshold for suppressing noise in the image by solving a second differential equation. We provide details of our estimation of suppressing threshold and show its convergence as the evolution proceeds. We also present a GPU based streaming computation of the method using NVIDIA's CUDA framework to handle large volume data-sets. Our implementation is optimised for memory usage to handle large volumes.