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A volumetric interferometric synthetic aperture sonar reconstruction algorithm

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Interferometric synthetic aperture sonar (InSAS) bathymetric reconstruction is an inverse problem that is often simplified to a time delay estimation problem. This uses a simple system model of a continuous scattering surface with single scatterer per resolution cell. This model is violated by layover, multiple scattering, occlusions, or sea-surface multipath producing artefacts in the reconstructed image. While some artefacts, such as from occluded shadow regions, can be rejected by using a threshold on the correlation coefficient, this does not work in general. Moreover, since each pixel is reconstructed independently it is difficult to improve the reconstruction by adding prior information.
In this paper we propose a reconstruction algorithm using a probabilistic volumetric model; similar to those used for photometric 3-D scene reconstruction from multiple cameras. While significantly slower than time delay estimation methods, the bathymetric reconstruction can be improved due to better scene modelling and the incorporation of priors such as surface continuity. Furthermore, an advantage of a volumetric model is that correction for the footprint shift is implicit. We demonstrate the algorithm using both simulated and real data.