Recovery of Coral Reef Rugosity from Stereo Image Pairs

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Abstract: Small (cm-m) scale topography of the seabed is important for a number of applications. For example, ecologists are concerned with roughness on this scale (rugosity) because it is an important characteristic of habitat complexity that can be correlated to species diversity, fish abundance, and past disturbance events such as hurricanes. Systematic measurements of rugosity through time can be used to determine changes in habitat due to accretion and erosion of the substrate.

The traditional method of measuring rugosity uses the ratio of the total length of a chain draped over the substrate to the linear distance between the end points as an index of topographical complexity. This "chain-transect" method is tedious, time consuming and retrieves only an index related to topography, not the topography itself.

In this project stereo imagery is used to reconstruct the small scale seabed topography for several sites near Lee Stocking Island, Bahamas, which span a wide range of topographical complexity, from nearly flat hard bottom to a coral patch reef with over 1m of relief. Stereo imagery is formed from pairs of monocular images acquired by divers 1-2m above the bottom. After correcting for lens distortion, these pairs are rectified using the fundamental matrix, which is estimated from matched prominent features. Multi-resolution optical flow methods are applied in order to determine the horizontal disparity in the rectified stereo images. To determine absolute height from these disparities-- i.e., to overcomes the scale factor ambiguity of monocular sequences-- a scale bar is placed over the terrain which is imaged in each frame. The results are compared with measurements made using the chain transect technique.

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