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Mapping shorelines to subpixel accuracy using Landsat imagery

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A promising method to accurately map the shoreline of oceans, lakes, reservoirs, and rivers is proposed and verified in this work. The method is applied to multispectral satellite imagery in two stages. The first stage is a classification of each image pixel into land/water categories using the conventional 'dark pixel' method. The approach presented here, makes use of a single shortwave IR image band (SWIR), if available. It is well known that SWIR has the least water leaving radiance and relatively little sensitivity to water pollutants and suspended sediments. It is generally the darkest (over water) and most reliable single band for land-water discrimination.

The boundary of the water cover map determined in stage 1 underestimates the water cover and often misses the true shoreline by a quantity up to one pixel. A more accurate shoreline would be obtained by connecting the center point of pixels with exactly 50-50 mix of water and land. Then, stage 2 finds the 50-50 mix points. According to the method proposed, image data is interpolated and up-sampled to ten times the original resolution. The local gradient in radiance is used to find the direction to the shore, thus searching along that path for the interpolated pixel closest to a 50-50 mix.

Landsat images with 30m resolution, processed by this method, may thus provide the shoreline accurate to 3m. Compared to similar approaches available in the literature, the method proposed discriminates sub-pixels crossed by the shoreline by using a criteria based on the absolute value of radiance, rather than its gradient.
Preliminary experimentation of the algorithm shows that 10m resolution accuracy is easily achieved and in some cases is often better than 5m.

The proposed method can be used to study long term shoreline changes by exploiting the 30 years of archived world-wide coverage Landsat imagery. Landsat imagery is free and easily accessible for downloading. Some applications that exploit the Landsat dataset and the new method are discussed in the companion poster: "Case-studies of potential applications for highly resolved shorelines."