Abstract

Image segmentation is a fundamental part in low level computer vision processing. It has an essential influence on the subsequent higher level visual scene interpretation for a wide range of applications. Unsupervised image segmentation is an ill-defined problem and thus cannot be optimally solved in general.

Several novel unsupervised multispectral image segmentation methods based on the underlaying random field texture models (GMRF, 2D/3D CAR) were developed. These segmenters use efficient data representations that allow an analytical solutions and thus the segmentation algorithm is much faster in comparison to methods based on MCMC. All segmenters were extensively compared with the alternative state-of-the-art segmenters with very good results. The MW3AR segmenter scored as one of the best available. The cluster validation problem was solved by a modified EM algorithm. Two multiple resolution segmenters were designed as a combination of a set of single segmenters. To tackle a realistic variable lighting in images, the illumination invariant features were derived and the illumination invariant segmenter was developed.

For the proper evaluation of segmentation results and ranking of algorithms, a unique web-based texture segmentation benchmark was proposed and implemented. It was used for comprehensive comparisons of results of developed algorithms with ten different state-of-the-art segmentation methods. Finally, the proposed methods were validated through use in various applications from a range of different fields.

In the medical imaging field, they were used for automatic segmentation of mammograms into regions of interest. Proposed solutions based on the random field model could also be used in automated inspection systems. Developed segmenters work on aerial images up to a size of 8000×8000 pixels, which are standard in the remote sensing field. The algorithm can also be used in areas related to digital cultural heritage. At last, an advantage of our methods is the need to tune just a few application dependent parameters.