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AUTOMATIC HAZE DETECTION AND PREDICTION IN SATELLITE CLOUD IMAGES

Abstract

Haze has been the most serious air pollution in China. Detecting haze and predicting its diffusion as early as possible are beneficial to human health and city traffic undoubtedly. A new algorithm is proposed to achieve this goal automatically.

Saliency detection and Graph-cut are first used to segment those Regions Of Interest(ROI) out. Saliency detection can indicate the foreground and background in an image, which are used as the label information for Graph-cut. In saliency detection, HSV color space is utilized, where hue and saturation are more appropriate representation of color than other color space. Color value and corresponding spatial distribution are the main features to determine whether a pixel is salient or not. After all pixels are evaluated, the saliency map is generated. According to the foreground and background, Graph-cut is used to segment those ROIs out. In practice, satellite cloud images are quite large, and using Graph-cut directly is rather time-consuming. Consequently, pre-segmentation is indispensable. Watershed algorithm is used to pre-segment an image, and super-pixels in pre-segmentation result are used to replace those pixels in the Graph, and the similarities between these super-pixels are used as the weights of the Graph.

Regarding these ROIs in an satellite cloud image, it is necessary to determine whether they are haze or not, which can be achieved by machine learning. Generally, feature and classifier are as important as each other. As to haze, color and texture are quite discriminative. Color histogram is computed in HSV color space, and LBP histogram is generated in the gray version of an satellite cloud image. Both color histogram and LBP histogram are used as representation for ROIs. Successively, Support Vector Machine(SVM) with chi-squared kernel is utilized to classify all ROIs. Additionally, feature level and decision level fusion are used to improve classification accuracy.

After haze has been detected, velocity field of haze diffusion is generated by optical flow method. Kalman filtering, as a widely known and practical model, is taken advantage of to predict the area and diffusion velocity of haze in serial satellite cloud images.

Experimental results demonstrate that the algorithm proposed can detect haze in satellite cloud images automatically with low time and computation consumption, and the prediction model can evaluate the area and diffusion velocity of haze precisely. More discriminative features will be exploited to upgrade detection and prediction in the future.