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Residential area extraction based on saliency analysis for high spatial resolution remote sensing images ☆

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ABSTRACT

Traditional residential area extraction methods for remote sensing image depend on classification, segmentation and prior knowledge which are time-consuming and difficult to build. In this paper, an efficient, saliency analysis-based residential area extraction method is proposed. In the proposed model, an adaptive directional prediction-based lifting wavelet transform (ADP-LWT) is introduced to obtain the orientation feature. A logarithm co-occurrence histogram is employed to compute the intensity feature. The color opponency and diagram objection based on the information are proposed to extract color feature from the contrast in the red–green opponent channel. The saliency map is obtained through a weighted combination based on the feature competition and the residential area is extracted by saliency map threshold segmentation. The experimental results reveal that the residential area extracted by our model has more demarcated boundaries and better performance in background subtraction.

1. Introduction

With an increase of the spatial resolution in remote sensing images, remote sensing image analysis has become much more complicated and important than before [1,2]. Residential area extraction is an important application in remote sensing images processing such as change detection, land utilization and disaster warning.

As a product of the interaction between man and nature, residential area is the central place for human daily life and activities. Currently, researchers have proposed a variety of automatic and semi-automatic method based on the classification and segmentation to extract residential area.

Considering the difference in course of the classification, the methods based on the classification and segmentation can be divided into two categories, the supervised methods and unsupervised methods. The supervised methods make use of the prior knowledge to classify the residential area and backgrounds, such as neural network model [3], support vector machine method (SVM) [4,5] and decision tree method [6]. Zhicheng and Itti extracted saliency feature and gist feature from satellite images and employed SVM to detect and classify targets automatically [7]. In those methods, the classification is implemented on the basis of the selection and learning of various training samples which may causes high computational complexity and makes the methods vulnerable to human factors. The un-supervised methods extract the initial feature to implement the classification with certain rules [8], such as *k*-means method and fuzzy clustering method. Chen proposed an improved 2D Otsu segmentation method [9]. The improved method calculates probabilities of diagonal quadrants in 2D histogram separately and obtains better performance of segmentation than the traditional Otsu method. Zhang employed an improved 2-D gradient histogram and minimum mean absolute deviation (MMAD) model to segment the roads and residential area from vegetation area in remote sensing images [10]. Comparing to the supervised methods, the unsupervised methods have little dependence on artificial factors. However, it extracts regions with relatively lower classification precision.

Residential area can also be seen as a kind of significant ROI and can be obtained using the method of ROI extraction. In recent years, saliency analysis based on image feature and visual attention mechanism has been widely researched and is the most efficient way to obtain ROI for natural scene images. Saliency analysis doesn't need to build the prior knowledge library as well as conduct segmentation and classification in the whole image. And it has lower computation complexity.

Saliency analysis is usually based on the biological models that simulate the visual attention mechanism in the human visual system (HSV) [11–14], such as ITTI model and GBVS model. The ITTI model [15] is one of the most famous biological models. This

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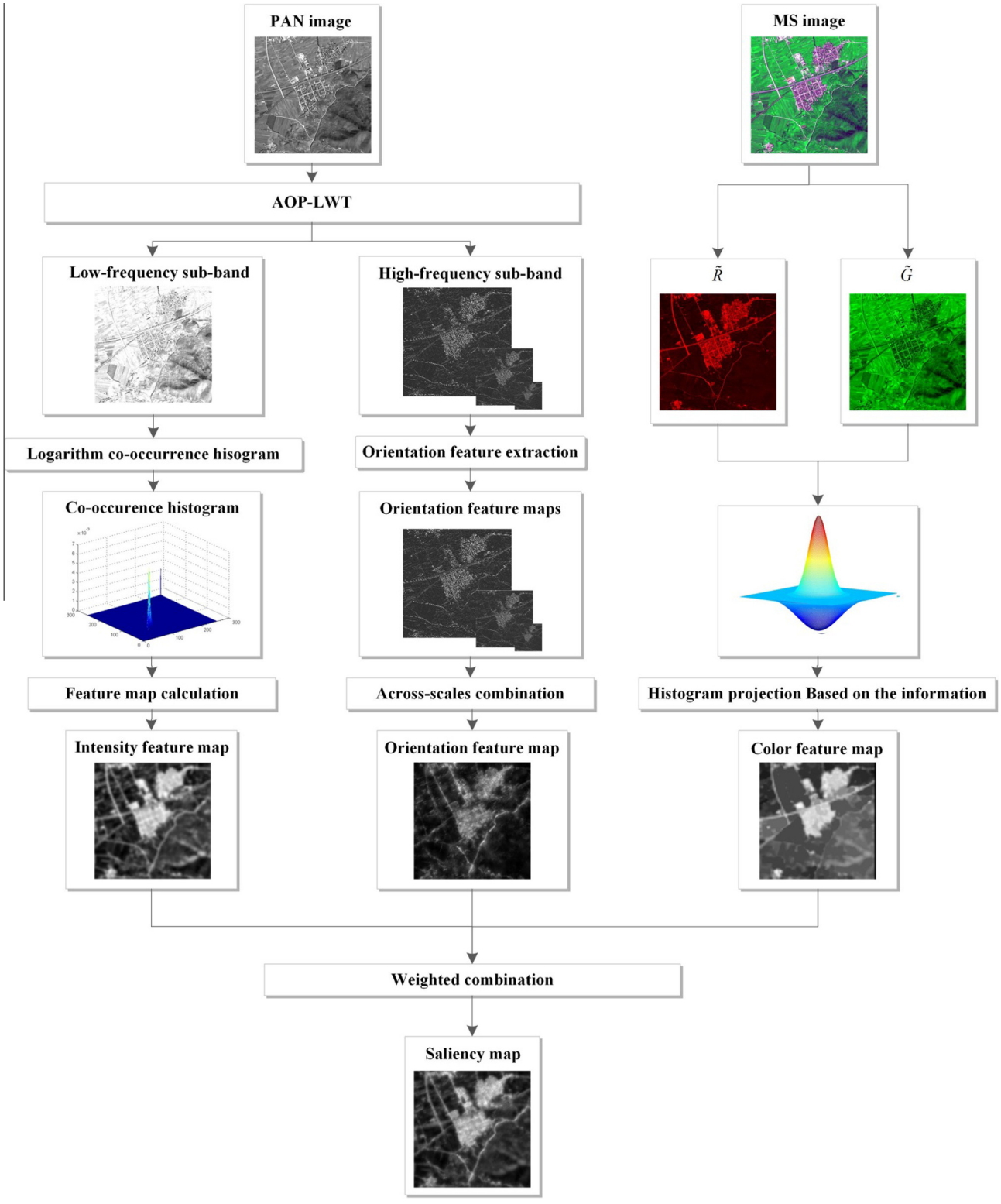

Fig. 1. Framework of the proposed model.

method generates saliency maps based on intensity, color and orientation features. Harel's graph-based visual saliency method (GBVS) [16] is proposed on the basis of the ITTI model. The GBVS model obtains feature maps using the approach of the ITTI method and takes advantage of graph theory when it comes to the generation of the saliency map. More importantly, the GBVS model assumes the unique existence of the salient regions in the image.

In recent years, computational model has been proposed for a faster calculation of the saliency. The spectral residuals method (SR) [17], was inspired by Shannon information theory and it generates saliency maps through the extraction of spectral residuals in the frequency domain without considering the color features. Achanta et al. proposed a frequency-tuned approach (FT) [18] that transforms the input images from RGB color space to CIE Lab color