DOCTORAL THESIS

Feature extraction in pattern recognition and document analysis by fractal and wavelet

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Feature Extraction in Pattern Recognition and Document Analysis by Fractal and Wavelet

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Abstract

This work addresses several issues in the topic of feature extraction based on fractal and wavelet including the theory and experiments for pattern recognition and document analysis. We are investigating the utility of several emerging techniques to extract the feature from regions of the image. These methods include utilizing fractal features to enhance pattern discrimination, central projection transform to describe the shape of a region, and wavelet features to aid in segmentation and boundary identification. Use of these new techniques has yielded very promising results.

In particular, the new method of feature extraction reduces the dimensionality of a two-dimensional pattern by way of a central projection method, and thereafter, performs Daubechies' wavelet transform on the derived one-dimensional pattern to generate a set of wavelet transform sub-patterns, namely, curves that are non-self-intersecting. The divider dimensions are readily computed from the resulting non-self-intersecting curve. These divider dimensions constitute a new feature vector for the original two-dimensional pattern, defined using the curves' fractal dimensions. Once these feature vectors have been captured, we can compare them to the training set by calculating the Euclidean Distance between the different feature vectors. The smallest distance will be selected for matching and classifying.

Variance in orientation is one of the common intrinsic uncertainties in pattern recognition. To solve this problem, a novel method of feature extraction with rotation invariant property is presented in this thesis. One of the main contributions of this study is that a rotation invariant signature of two-dimensional contours based on the fractal theory is proposed. The rotation invariant signature is a measure of the fractal dimensions, which is rotation invariant based on a series of central projection transform (CPT) groups. As the CPT is applied to a two-dimensional object, a unique

contour is obtained. In the unfolding processing, this contour is further spread into a central projection unfolded curve, which can be viewed as a periodic function due to the different orientations of the pattern. We consider the unfolded curves to be non-empty and bounded sets in $I\!R^n$, and the box computing dimension is applied to them. It has been proved that the box computing dimensions of the central projection unfolded curves of a rotated pattern are equal to each other, i.e. the central projection unfolded curves with respect to the box computing dimension are rotation invariant.

In this study, a new approach based on modified fractal signature (MFS) and modified fractal feature (MFF) for script classification and handwritten signature verification is also developed in this thesis. The modified fractal signature approach has been chosen to extract the geometric structure of the document image. The upper and bottom layers are used to segment the document image into small blocks. Then, according to the modified fractal feature algorithm described in this thesis, the MFF value of every block is obtained. The MFF will be used in the identification and classification of a selected set of document images with good results.

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