Automatic recognition of retinal diseases using mathematical models of image processing, based on multilayer-dictionary learning

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Abstract

The purpose of this study is to improve the classification of new methods using a multi-layered model to help diagnose retinal diseases. This paper presents a multi-layer dictionary learning method for classification tasks. Our multi-layer framework uses a label consistent in the K-SVD algorithm to learn a discriminative dictionary for sparse coding in order to learn better features in retinal optical coherence tomography images. In addition to using class labels of training data, we also associate label information with each dictionary item (columns of the dictionary matrix) to enforce discrimination in sparse codes during the dictionary learning process. It relies on a succession of sparse coding and pooling steps in order to find an efficient representation of the data for classification. We apply Duke Dataset for validating our algorithm: Duke spectral domain OCT (SD-OCT) dataset, consisting of volumetric scans acquired from 45 subjects 15 normal subjects, 15 AMD patients, and 15 DME patients. Our classifier leads to a correct classification rate of 95.85% and 100.00% for normal and abnormal (DME and AMD). Experimental results demonstrate that our algorithm outperforms many recent proposed supervised dictionary learning and sparse representation techniques.

Table 2. Cross-validation results on Doc Dataset

Class	proposed method
Normal	95.85%
ADM	100%
DME	100%

Table 3. Classification rate (%) comparison of different proportion images for training on the Duke Dataset.

	1/2 dataset training			2/3 dataset training		
Class/Iteration	5	10	15	5	10	15
Normal	96.45%	97.30%	100%	97.64%	99.50%	100%
ADM	94.20%	95.46%	97.02%	96.89%	97.61%	98.32
DME	99.77%	100%	99.87%	99.90%	100%	99.90

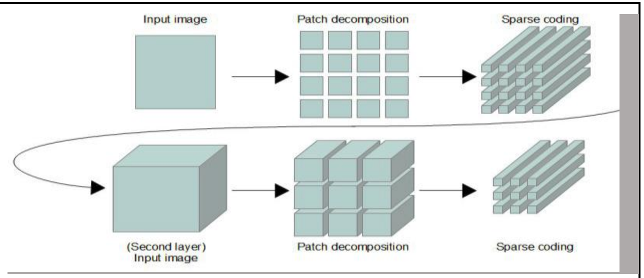

Fig. 7. Two-layered architecture of the proposed method

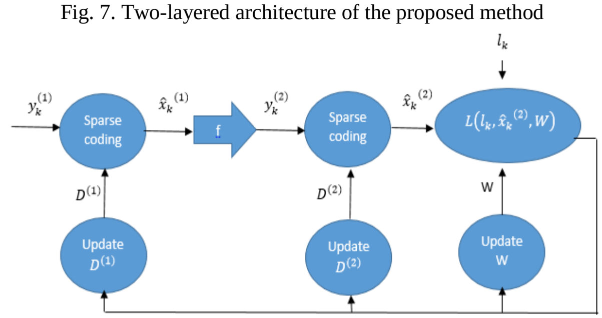

Fig. 8. Proposed structure with 2 layers.

Conclusions

The purpose of this study was to improve the performance of modern classification methods using a multi-layer model. A multi-layer model using the advanced K-SVD multi-layer algorithm to learn the dictionary matrix and base patterns to a better feature of retina's OCT images with the simplicity of models with multi-layer architecture. In addition to the use of train data class labels, label information was also used to learn the atoms of the dictionary matrix to further distinguish the process of sparse coding, which resulted in the success of the coding sequences in each piece of the image and eventually the entire image, Aimed at finding a more effective representation of the data for classification. The main idea of our method is to repeat the sparse coding layer and use K-SVD label-compatible to increase the discrimination of the features. Another goal of the proposed method is to control the size of the input data dimensions by reducing the original image sparse coding. Instead of encoding the original image, it uses sparse coding small pieces of the original image that can make processing and analysis operations much more effective. The third idea of this method is to find an optimal dictionary for promoting the classification process, which is important by using clustering algorithms and finding class centers. Another important feature of this method, compared with more complex methods, was its lack of reliance on the process of segmentation of the retinal layers because in cases where retinal diseases alter the layers, this property is important and the task of segmentation the complex layers Gets. The result of this study was to provide an automatic system for detecting some retinal abnormalities, which, by analyzing Duke Dataset, was able to successfully compare the new methods of this domain in identifying subtle patterns of disease in OCT images. By generalizing this method to more classes, can cover all retinal diseases and use it as a potentially effective tool for automatic diagnosis and screening for eye diseases.