Classification of Melanoma Lesions Using Sparse Coded Features and Random Forests

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ABSTRACT

Malignant melanoma is the most dangerous type of skin cancer, yet it is the most treatable kind of cancer, conditioned by its early diagnosis which is a challenging task for clinicians and dermatologists. In this regard, CAD systems based on machine learning and image processing techniques are developed to differentiate melanoma lesions from benign and dysplastic nevi using dermoscopic images. Generally, these frameworks are composed of sequential processes: pre-processing, segmentation, and classification. This architecture faces mainly two challenges: (i) each process is complex with the need to tune a set of parameters, and is specific to a given dataset; (ii) the performance of each process depends on the previous one, and the errors are accumulated throughout the framework. In this paper, we propose a framework for melanoma classification based on sparse coding which does not rely on any pre-processing or lesion segmentation. Our framework uses Random Forests classifier and sparse representation of three features: SIFT, Hue and Opponent color angle histograms and statistics, and RGB intensities. The experiments are carried out on the public PH^2 dataset using a 10-fold cross-validation. The results show that SIFT sparse-coded feature achieves the highest performance with sensitivity and specificity of 100% and 90.3% respectively, with a dictionary size of 800 atoms and a sparsity level of 2. Furthermore, the descriptor based on RGB intensities achieves similar results with sensitivity and specificity of 100% and 71.3%, respectively for a smaller dictionary size of 100 atoms. In conclusion, dictionary learning techniques encode strong structures of dermoscopic images and provide discriminant descriptors.

Keywords: Melanoma, Classification, Sparse coding, Random forests, Dermoscopy

1. DESCRIPTION

Malignant melanoma is a type of skin cancer and although it accounts for almost 2% of all skin cancer cases, it is the deadliest type and causes the vast majority of deaths. The incidence of melanoma has increased in the past decades and according to *World Health Organization*, annually 132,000 melanoma cases occur globally. Only in United states the incidence of melanoma has increased 15 times in the last 40 years which is the most rapid increase among all the cancers. In 2014, *American Cancer Society* reported the estimated number of deaths as 9710 individuals. Nevertheless during the same time, there has been a significant rise in patients survival, thanks to early diagnosis and treatment of melanoma. Nevertheless, melanoma is the most treatable kind of cancer, if it is diagnosed early. The clinical prognosis of early stage of melanoma is based on "ABCDE" rule, where Asymmetry, irregular Borders, variegated Colors, Diameter greater than 6 mm and Evolving stages over time of the lesions are visually inspected in each clinical routine. The inspection is performed using different imaging techniques such as dermoscopy. Visual inspection, similarity between the lesions and the necessity to perform patients follow-up over years makes this task difficult and more prone to errors. Thus Computer-Aided Diagnosis systems based on machine learning and image processing techniques have been proposed to assist the dermatologists and clinicians. The proposed algorithms generally attend to mimic the characteristics of "ABCDE" rule and consist of common steps of pre-processing, segmentation and classification of extracted features. This sequential architecture is complex and dependent on individual dataset. The aim of this research is to design a more genera system which does not require pre-processing and segmentation of the lesions based on sparse coded features and Random Forests classifier. In this paper we propose a more general framework which does not necessitate pre-processing and segmentation of the lesions based on sparse coded features and random forests classifier.

2. METHODOLOGY

The proposed method is based on sparse coding techniques. Sparse signal representation has become very popular in the past decades and lead to state-of-the-art results in various applications such as face recognition, image denoising, image inpainting, and image classification. Here we intend to use sparse representation of the dermoscopic images for melanoma classification. need more help here The main goal of sparse modeling is to efficiently represent the images as linear combination of a few typical patterns, called atoms, selected from the dictionary. In this regard, SIFT, and two color descriptors are extracted as low-level features from local patches of each image. The first color descriptor consists of Hue and opponent color space angel histogram (C_1). While the second color descriptor represent the images in the simplest form by concatenating R, G and B intensities (C_2). These features are extracted from local patches of the dermoscopic images and a sparse dictionary is created using K-SVD algorithm. The K-SVD algorithm is a generalize version of K-means clustering, which uses singular value decomposition for creating the sparse represented dictionary. By using local patches from the whole dermoscopic images and spares representation of the low-level extracted features, the necessity to perform pre-processing or segmenting the lesions prior to feature extraction and classification are eliminated. finally each image is sparsely represented after coding with the learned dictionary and max-pooling and classified using RF.

3. CONTRIBUTION

We present a novel approach using sparse learned dictionary. The presented framework is highly general and adaptable, since no pre-processing or segmentation is required. It also presented that using our framework low-level features such as intensity values can be used directly for classification of the lesions.