Psoriasis Detection Based on Deep Neural Network

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***Abstract*—In this paper, a psoriasis detection method based on deep neural network (DNN) was proposed. The proposed method is composed of several learned layers: convolutional layers and fully-connected layers. These four convolutional layers are used to extract some useful multilevel features from the input image. The max-pooling operation is used to down-sample the feature maps to make the deep network faster. The fully-connected layers similar to the traditional multi-layer perceptron neural networks are used to a classifier. Experimental results show that the proposed method can determine whether the input image is psoriasis well.**

I. INTRODUCTION

Due to advancement of medical imaging technologies, the acquired medical data are getting rich to be effectively used for clinical assessment. In fact, computer technologies can analyze some cues or details in the medical images, while physicians might not be able to observe these cues. Furthermore, a computer algorithm can efficiently and consistently analyze many medical images, while physicians might make inconsistent assessments after long-time working. Therefore, Computer Aided Diagnosis (CAD) becomes more desirable and important.

Psoriasis is a skin disease which is an incurable, long-term inflammatory skin condition [1-2]. The quality of life of patients with psoriasis is often decreased due to the appearance of psoriasis on their skin. Since psoriasis disease is characterized by the images taken via camera, a computer algorithm with machine learning can be useful to evaluate the psoriasis severity. This means that image-based detection algorithm plays a very important role for risk assessment. On the other hand, the Psoriasis Area Severity Index (PASI) composed of erythema (redness), area, desquamation (scaling), and induration (thickness) is commonly used to evaluate psoriasis severity. In fact, the factor, area, is simple and important to evaluate psoriasis severity. For example, the value of area less than 10% of the total skin surface may be considered as the mild level. Therefore, psoriasis detection is a basic and important step in the analysis of psoriasis severity.

Based on the above mention, it motivates us to develop a computer-aided system for psoriasis detection. The detection methods can be roughly divided into two classes: pixel-based and region-based. The pixel-based methods only use the pixel value of a single pixel to determine whether the pixel belong to psoriasis or not. The other is region-based. The region-based methods not only use the information of the current pixel but also considers the neighboring information of the current pixel. For example, the texture information within a local area is often analyzed for psoriasis detection.

So far, existing CAD techniques [1-2] generally use feature extraction algorithms to extract color and texture in combination with machine-learning classifiers to perform psoriasis detection. As we know, feature extraction is a very important step to design an effectively CAD system. However, it is not easy to extract useful features which are the relevant information from the input data.

Currently, researchers paid more attention to deep learning belonging to machine learning. Convolution Neural Networks (CNN's) [5], one of deep learning models, extract middle-level and high-level features from input data and have been demonstrated to be effective to learn the useful features from images. The main advantage of CNN is that strong features invariant to distortion and position at the same time can be extracted for image classification. It is expected that a CAD system developed based on CNN can be useful for psoriasis detection. Therefore, we develop a psoriasis detection method based on deep neural network (DNN).

II. PROPOSED METHOD

Figure 1 illustrates the flowchart of the proposed method. As shown in Fig. 1, local texture information could be useful for psoriasis detection. The proposed method is region-based. As we can see in Fig. 1, the proposed method was developed based on DNN. The proposed DNN is composed of several learned layers: convolutional layers and fully-connected layers. We elaborate these layers in the following.

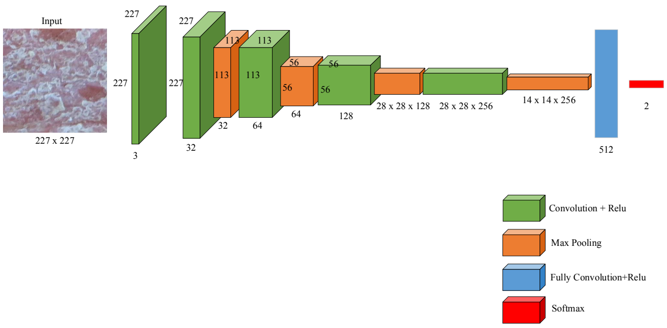


Fig. 1 Flowchart of the proposed method

As we know, feature extraction is a very important step to develop an effective classifier. In the proposed DNN, there are four convolutional layers and each convolutional layer is followed by a max-pooling operation. These four convolutional layers are used to extract some useful multilevel features from the input image for psoriasis detection. As shown in Fig. 1, there are 32, 64, 128, and 256 filters in the four convolutional layers. For each layer, the size of each filter is 5×5 and the activation function is ReLu (Rectified Linear Units) function [5]. In addition, the objective of max-pooling is to down-sample the input representation to reduce its spatial dimensions. It is expected that down-sampling the feature maps can make the deep network faster.

After several convolutional layers for feature extraction, these feature maps are feed into two fully-connected layers. The ReLu function is used as the activation function in the first fully-connected layer. Because psoriasis detection is two-class classification problem, a softmax function is adopted in the second fully-connected layer as the activation function to output the final decision result. The softmax function is used to squash a feature vector of arbitrary real values to a vector of real values in the range [0, 1]. Thus the fully-connected layers similar to the traditional multi-layer perceptron neural networks are used to determine whether the input image is psoriasis or not.

III. Experimental Results

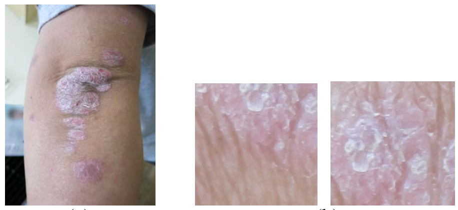
To evaluate the proposed psoriasis detection method, we implemented a system based on Python and PC with AMD Ryzen5 CPU @ 3.6 GHz and 16 GB RAM. There are 5700 normal and psoriasis images collected for testing. Figure 2 illustrates some images of psoriasis. Figure 2(a) is an original clinic image and Fig. 2(b) are psoriasis images. There are 5700 normal and psoriasis images collected for performance evaluation. To train the deep neural network, the loss function is binary cross-entropy and Adam is used to optimize the proposed DNN [6].

The accuracy rate is one traditional criteria that are widely used to measure the performance of classification [4]. The definition of accuracy is expressed as follows:

$$\text{Accuracy} = \frac{N_{TP} + N_{TN}}{N_{TP} + N_{FP} + N_{TN} + N_{FN}}, \quad (1)$$

where N_{TP}, N_{TN}, N_{FN}, and N_{FP} are the numbers of correct detected psoriasis pixels, correct detected non-psoriasis pixels, missed detections, and false alarms, respectively; ($N_{TP} + N_{FN}$) is the total number of true psoriasis pixels; and ($N_{TP} + N_{FN}$) is the total number of detected psoriasis pixels. Theoretically, if a psoriasis detection method achieves high accuracy rate, its performance is considered good.

Figure 3 illustrates the accuracy rates for training and validation sets. As shown in Fig. 3, the accuracy rate for validation set can be above 95% after 40 epochs. For test image set, the accuracy rates are 91.5%. The experimental result demonstrates that the proposed system can analyze image content for feature extraction and then achieve psoriasis detection.



(a) (b)

Fig. 2 Some test images of Psoriasis.

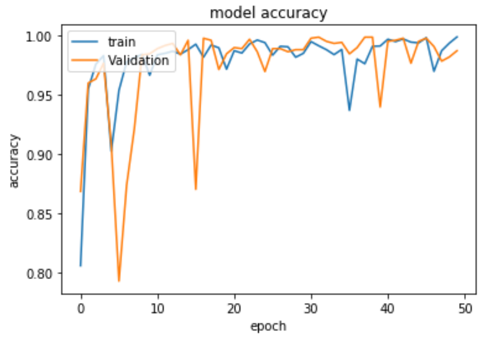


Fig. 3 The accuracy rates for training and validation sets.

IV. Conclusions

In this paper, a psoriasis detection method based on deep neural network (DNN) was proposed. The proposed method is composed of several learned layers: convolutional layers, fully-connected layers, and softmax layer. These four convolutional layers are used to extract some useful multilevel features from the input image. The max-pooling operation is used to down-sample the feature maps for making the deep network faster. The fully-connected layers similar to the traditional multi-layer perceptron neural networks are used to a classifier.

To evaluate the performance of the proposed method, a lot of normal and psoriasis images are collected for testing. For the test image set, the accuracy of the proposed method can achieve 91%. Experimental result shows that the proposed method can well determine whether the input image is psoriasis or not.

References

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