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The Improvement of Automatic Skin Cancer Detection Algorithm Based on CVQ technique

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Abstract

Nowadays, by increasing the number of deaths related to skin cancer, this kind of cancer has been converted as one of the important issues in humans' life. However, the main key is early detection of skin cancer in order to save the life of people. By considering this fact that there is a near similarity between cancer moles and normal ones, attention to artificial systems with the ability of distinguishing between these kinds of moles can be very important, undoubtedly. The accuracy of this kind of system must be considered in order to find better results, especially in the cases which are related to human‘s life. In this paper, with regard to the fact that the raising of a kind of skin cancer, Melanoma, has increasing, we have employed neural networks in the aim of function improvement of an approach based on compressed image technique, namely, Classified Vector Quantization (CVQ) technique. This suggested method has been examined on some images and the results show that this method is a proper way in order to automatic skin cancer detection.

Keywords: Skin Cancer, Classified Vector Quantization, Neural Networks, Image Coding

Introduction

Nowadays, Skin cancer, in the form of a malignant tumor, raises in the skin cells and has allocated the greatest number of deaths. America, Canada and New Zealand have the highest skin cancer rates in the world in comparison with other countries (Abu Mahmoud and AI-Jumaily,2003), in which, more than 1 million persons in USA are diagnosed with this disease in each year (http://www.chw.org). More than forty percent of cancers are from the kind of skin cancer. Malignant melanoma, as a type of skin cancer, is the most deadly cancer in comparison to other types of skin cancer (Abdul Jaleel, and Salim,2012). So, this disease has been considered as a main public health problem in the world (http://www.ncbi.nlm.nih.gov/pmc/articles).

However, the main key to conquer this cancer is early detection. On the other word, skin cancer, even Melanoma, can be treated successfully, if it detected early. So, the main point in the right treatment is early detection and the key to reach this aim is regular screening (Kreutz et al, 2000) between normal moles and cancer ones. To do it, an artificial system will be certainly useful.

Existing artificial systems are based on image processing, Neural Networks and Fuzzy systems, in order to detect the moles, classify and extract the features in images (Abdul Jaleel, and Salim, 2012).

Classified Vector Quantization technique, as an image compression technique, have had better results in comparison of other existing method and even It has this ability to classify the different types of skin cancers, which other existing types cannot.

In this paper, we expand existing novel approach based on CVQ technique and optimize its accuracy, with the aim of distinguishing between main different types of skin cancers and between normal moles and cancer ones.

For this purpose, we need to take following steps (Fassihi et al and Abdul et al, 2011 and 2012):

1. Collecting the related images to create a database of skin cancer images.
2. Preprocessing the images for removing the noises in images, including air bubbles, fine hairs, ...
3. Post processing for enhancing the shape of images.
4. Segmentation of images for extracting the unhealthy regions.
5. Feature extraction in order to find useful information.
6. Classification with the aim of detecting the type of skin cancer and then normal and cancer moles.

The rest of this paper has been organized as follows:

Section 2, introduce skin cancer, the main different types of skin cancers, especially about Melanoma. Some details about automatic skin cancer detection are clarified in section 3. Sections 4 explains vector quantization and classified vector quantization techniques, Section 5 is about the detection of skin cancer types and moles and finally the proposed method and the results of evaluation of our proposed method has been given in sections 6 .

Skin Cancer

Skin cancer, which grows in skin cells, is a kind of tumor and has struck more people all around the world. The main factor in developing skin cancer is the existence of ultraviolet (UV) in sunlight (http://www.chw.org).

Skin cancers can divide into different types including Basal cell, Squamous cell and malignant Melanoma, which the later is the most deadly type (See Fig.1). However, if diagnosed in early stages, it can be treated.

Figure 1: Basal cell, Squamous cell and malignant Melanoma

For this aim, clinical methods can be used, including pattern analysis and "ABCD" parameters, which are the Asymmetry of mole shape, the irregular Border of mole, Color varies and the Diameter of mole (Gola et al,2010). The shape and color of moles are main factors for detecting skin cancers.

Automated Skin Cancer Detection

In the first step, an input image of a mole is given to the system. Then preprocessing step for removing the undesirable parts is done (Fassihi et al,2011). The segmentation of image is the next step in order to get rid of the healthy skin regions from the image and discover interesting regions (Abdul Jaleel, and Salim,2012).

This step is one of the difficult processes and the results are directly depended on the quality of image segmentation. Methods such as Binder, Ganster and XU are some of the segmentation algorithms (Tang et al, 2011; Xu et al, 2009; Fassihi et al,2011).

Now, feature extraction from input image must have done with the purpose deciding about the existence of cancer in image (Elgamal,2013) . Different methods such as Expert Networks, Neural Networks and Fuzzy systems can be employed for this purpose. In these methods, some parameters from input image are extracted as the inputs of networks and the output is the type of mole. The final phase of above steps is the main difference between other ways and the way based on CVQ technique.

Classified Vector Quantization (CVQ)

In fact, CVQ is one of the branches of VQ technique can improve the function of VQ in the cases which the number of data are more than normal. In VQ technique (Nasrabadi and King,1988), original image is partitioned into several blocks with the size of $n \times m$ and then they are arranged to form of vectors. According to these vectors, codebook is updated, which is a 2D array and is initialized randomly. Now, difference between each vector of original image in comparison with code words in codebook is calculated by using of Euclidean distance:

$$D(B^i, C^j) = \sqrt{\sum_{j=1}^{n} (B_i - C_j)^2} \quad (1)$$

In this equation, Bi is the ith vector of input vectors, Cj is one of the code words from 1 to n and n is the number of code words in codebook. Thus, by using this distance formula, the nearest codeword, with index j, from point of distance, to selected block with index i, is found and finally code words are updated by the centroid of all training vectors, which were mapped during coding (Allen and Gray,1991).

Finding the optimized codebook is the major goal in VQ. Optimality of VQ design has been shown in (M. A. Jushi,2006) and is depicted in Fig. 2.

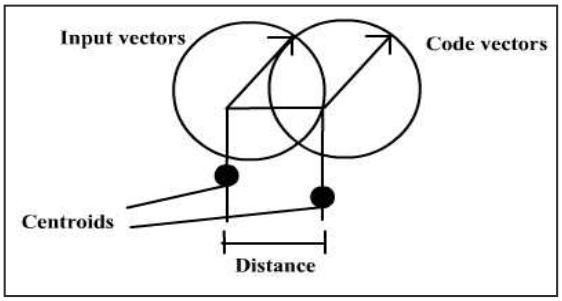

Figure 2: Optimality of VQ design

In VQ technique, each block of the original image is indexed with an index (number of nearest code word in code book).VQ is commonly used for image compression (Hsieh, et al, 2008; Kekre and Sarode,2008) . In the decompressing phase, replacing of each index i with code word with index i in code book is achieved. The response time is an important factor in real time applications (Chang and Wu,2007) and VQ-based recognition provides this feature.

Edge is a very significant feature perceptually in an image. A truthful coding that preserves the edge information is of important (Tseng and Chang,2005). Classified Vector Quantization (CVQ) has proved to be an efficient technique for image compression at low bit rates (Quweither and Farison,1998). CVQ technique can be used to reduce the computational complexity of VQ technique (Gersho and Gray,1991). In this technique (Kim and Lee,1992), each input vector is

located into a class and then VQ is achieved on vectors of each class. Now, we have two indexes for each input vector: One for specifying the number of class and another for specifying the index of the nearest codeword in codebook. This is shown in Fig. 3.

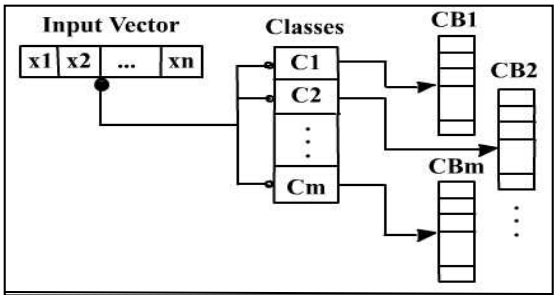

Figure 3: A schematic of CVQ design

On the other hand, input vectors are partitioned into some patterns and then quantization is achieved in all vectors of each pattern. So, this can be a proper technique for the topic of face recognition. Since CVQ technique classifies the vectors in several classes, it is more precise than VQ.

Detection of Skin Cancer Types and Moles

VQ technique is very robust in clustering. But, the main problem is when the number of training vectors of images is increased, VQ cannot distinguish among a lot of vectors and it is the only limitation in the usage of this technique. Now, each block is indexed with a number of each pattern. After this, when all of image blocks were indexed, VQ technique is applied over all the vectors of each pattern‘s vectors.

CVQ has been applied to overcome the issues of the aforementioned problem. In our proposed approach, each block of original image of the mole is compared with several predefined patterns. For increasing the amount of accuracy, these patterns are selected according to the curves that are most seen in different cancer moles by using a neural network. For this aim, a perceptron neural network has been used. For each kind of skin cancer, a neural network has been trained. Thus, we employed 3 neural networks for 3 main skin cancer types, namely, Basal cell, Squamous cell and malignant Melanoma. From each group, we found some common patterns which are proper for detecting the skin cancer types.

Our focus on all features in mole can guide us to the better results in skin cancer recognition field. Since edge rendition in mole and also skin correlation are important factors in the recognition process, the application of Classified VQ would be obviously appeared. According to the above descriptions, we can present our method in the following steps:

• First, we need to detect the edges of the skin cancer moles related to each original image. For example, Sobel filter can be used for this purpose.

• According to the first step, we can classify each block of the original image to one of the predefined patterns by Neural Networks. By using MSE formula, the class of each input image is selected (C1 to C3). So, there would be a number for each image between 1 to 3, that it can describe the class number of input image.

• After all, we can do vector quantization (VQ) technique on all original blocks which have the same class number. Thus, we will have 3 code book, each one for one class.

Now, an image of a mole is given to system. It passes the first steps of preprocessing. Then an edge detection algorithm is done on the image. comparing the edges of image with predefined

patterns by neural networks are done. So, our system find the type of skin cancer. Then, the codebook of related class employed for detecting skin cancer moles.

Results

Observing the results obtained from the implementation of CVQ technique demonstrates that it has much potential for skin cancer at high accuracy. As mentioned before, VQ is a robust technique for clustering, especially in real time systems. However, when the number of input vectors of images is increased, it is no longer beneficial. Nevertheless, CVQ classifies the vectors into some patterns and then VQ can be used for vectors of each class. Moreover, by using this technique, we can utilize the two unique characteristics in skin cancer moles, geometric structure of the mole(Asymmetry), and mole correlations in skin. Hence, recognition rate is improved in comparison to other existing methods. The proposed method was implemented and tested using some clinical images. At the first step, the moles in images are cropped. Then a filter such as Sobel filter is applied on each cropped mole image in order to detect edges in them. This enables us to classify each block of the size n×n in each of predefined patterns. These patterns are prepared by using a Perceptron Neural Network with 3 layer: input, hidden and output.

Table 1: The comparison between some methods

Method	False Positive	False Negative
Globular	8.57 %	0 %
Reticulated	5.71 %	0 %
Daubechies 2	5.489 %	4.398 %
Symlet 2	4.246 %	5.638 %
Coitler 3	6.632 %	2.102 %
Biorsplines 1.5	5.564 %	5.883 %
Our Method (Without NN)	5.32 %	1.25 %
Our Method (With NN)	4.90 %	0.19 %

Table 1 shows the results of our proposed method in comparison to some other methods. By these patterns, we find the class of each mole. The class is, in fact, the type of skin cancer. Finally, VQ technique is used for all the blocks of the same class. We have implemented this method using the Java and C# language.

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