A Novel Approach based on CVQ Technique for Automatic Skin Cancer Detection

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Abstract—In recent decades, the increasing of the amount of deaths due to skin cancer is one of the important issues in humans ‘life. However, early detection of skin cancer can provide an opportunity to save the patients ‘life.

In recent years, tension towards artificial systems, which have the ability of detection this kind of cancer, is increasing day by day. In this paper, by consideration this fact that the raising of a kind of skin cancer, Melanoma, we propose a novel approach based on a compressed image technique. 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, Image Processing, Vector Quantization

I. INTRODUCTION

Skin cancer, as a deadly type of cancer, is a malignant tumor that raises in the skin cells [1]. From statistical point of view, America, Canada and New Zealand have the highest skin cancer rates in the world [2], in which, more than 1 million persons in USA are diagnosed with this disease in each year [1]. Between 40 and 50 percents of cancers have been allocated to skin cancer. Malignant melanoma, as a type of skin cancer, is the most deadly cancer in comparison with other types of skin cancer [1,3]. So, this disease has been considered as a main public health problem in the world [4]. However, skin cancer, even Melanoma, can be treated successfully, if it detected early [5]. So, the main point in the right treatment is early detection and the key to reach this aim is regular screening [5] between normal moles and cancer ones. To do it, an artificial system will be useful, certainly.

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 [3].

In this paper, we propose a novel approach based on an image compression technique (CVQ), with the aim of distinguishing between normal moles and cancer ones. So, we need to take following steps [2,6] :

1- Collecting the related images to create a database of skin cancer images.
2- Pre-processing 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 informations.
6- Classification with the aim of distinguish between normal and cancer moles.

The rest of this paper has been organized as follows:

Section II. introduce skin cancer, specially about Melanoma. Some details about automatic skin cancer detection are clarified in section III. Sections IV and V explain vector quantization and classified vector quantization techniques, respectively and finally the proposed method and the results of evaluation of our propcased method has been given in sections VI and VII.

II. SKIN CANCER

Skin cancer, which grows in skin cells, is a kind of tumar and has stricked more people all around the world. The main factor in developing skin cancer is the existence of ultraviolet (UV) in sunligh [1].

Skin cancers can divide into different types. Main types of them are: Basal cell, Squamous cell and malignant Melanoma, which the later is the most deadly type. However, if diagnosed in early stages, it can be recovered.

For this aim, clinical methods can be used, including pattern analysis and “ABCD” parameters, which are the Asymetry of mole shape, the irregular Border of mole, Color varies and the Diameter of mole [7].

III. AUTOMATED DIAGNOSIS OF SKIN CANCER

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 [6]. 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 [3]. 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 [6,8,9].

Now, feature extraction from input image must have done with the purpose deciding about the existence of cancer in image [10]. 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.
IV. VECTOR QUANTIZATION (VQ)

In VQ technique [11], original image is partitioned into several blocks with the size of n×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:

$$D (B_i, C_j) = \sqrt{\sum_{j=1}^{n} (B_i - C_j)^2}$$ (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 [12].

Finding the optimized codebook is the major goal in VQ. Optimality of VQ design has been shown in [13] and is depicted in Fig.1.

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 [14, 15]. In the decompressing phase, replacing of each index i with code word with index i in code book is achieved.

![Fig. 1 Optimality of VQ design](image)

The response time is an important factor in real time applications [16] and VQ-based recognition provides this feature. CVQ

V. CLASSIFIED VECTOR QUANTIZATION (CVQ)

Edge is a very significant feature perceptually in an image. A truthful coding that preserves the edge information is of importance [17]. Classified Vector Quantization (CVQ) has proved to be an efficient technique for lossy image compression at low bit rates [18]. CVQ technique can be used to reduce the computational complexity of VQ technique [19]. In this technique [20], 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. 2.

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.

VI. THE PROPOSED APPROACH

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. These patterns are defined according to the curves that are most seen in cancer moles. Fig. 3 depicts some samples of patterns.

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.

![Fig. 2 A schematic of CVQ design](image)

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. Suppose that all blocks have been classified into classes C1 to Cn. So, there would be a number for each block between 1 to n, so that it can describe the class number of the block.
- After all, we can do vector quantization (VQ) technique on all original blocks which have the same class number. Thus, we will have n code book.

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. So, we can compare the edges of image with patterns and then search for finding the nearest vector of code book is achieved.

VII. 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 with 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. Finally, VQ technique is used for all the blocks of the same pattern. We have implemented this method using the Java language. Table 1 shows the results of our proposed method in comparison with some other methods.

Fig. 3 Some samples of patterns

VIII. CONCLUSION

In this paper, a new approach based on Classified Vector Quantization (CVQ), for skin cancer detection, has been proposed. We extended the concept of this technique in order to classify components of cancer mole images into some patterns and then we used Vector Quantization in order to create a code book for each pattern. In Comparison with other methods, our algorithm can be implemented without using hard mathematical computations.

<table>
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<tr>
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<th>False Positive</th>
<th>False Negative</th>
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<td>0 %</td>
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<tr>
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<td>0 %</td>
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<td>4.398 %</td>
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<td>Biorssplines 1.5</td>
<td>5.564 %</td>
<td>5.883 %</td>
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<tr>
<td>Our Method</td>
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REFERENCES

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