

Object Detection and Recognition Using Local Quadrant Pattern

Testing on The Skin Cancer Region

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Abstract—Object detection and recognition is one of the important techniques in computer vision for searching and scanning and identifying an object in images or videos. Object detection and recognition enters into many important fields where one of the uses of object detection and recognition is to detect region of injury and determine the type of injury. This paper suggested a new effective method called Local Quadrant Pattern (LQP). The proposed method uses a window and passes it on all pixels of the image and uses the pixel direction to arrange the adjacent pixels. It also uses four code values to encode and then produce a texture feature matrix which is used to detect objects as well as extract features based on magnitude of pixels for image classification. The experiments were conducted on the infected regions in the skin and the results showed the ability of the method to detect regions of infection as well as the high accuracy in the classification of those regions.

Keywords— Local Quadrant Pattern (LQP), Object Detection, Threshold, Local Ternary Pattern (LTP), Skin, Cancer

I. INTRODUCTION

Object detection is one of the main and important techniques in computer vision and image processing. There are many goals of object detection such as detecting, locating and labelling objects and it can be applied to both images or videos. Each object has a set of features that are specific to it and distinguish it from other objects. Object detection algorithms use these features after they are extracted to learn computers in objects. There is a difference between two important terms: objects detection and objects recognition. Objects detection is the procedure of detecting objects in an image, sometimes with the location and size of that object. Recognition is the operation of identifying detected objects. Recognition can be also considered as a classification problem, where the aim is to classify and detect objects into certain classes. There are many applications and uses of object detection such as advanced driver assistance systems, video surveillance and image retrieval. This can be also used for object tracking, for example, tracking a car [1, 2, 3, 4]. In 2010, Felzenszwalb, P. F., et. al. have described an object detection system based on mixtures of multiscale deformable part models by combined a margin-sensitive approach for data-mining hard negative examples with a formalism called latent SVM. Their system is able to represent highly variable object classes and achieves state-of-the-art results in the PASCAL object detection challenges [4]. In 2016, Kumar, K. R., et. al. have suggested two methods for object detection by using the texture that is available over the surface of the object and by the outline of the objects in an image. Both of the methods prove to have their own advantages and limitations;

so based on the applications the appropriate method can be applied [5]. In 2018, Burić, Matija, et. al. provided an overview of the current state-of-the-art detection methods that rely on convolutional neural networks (CNNs) and test their performance on custom video sports materials acquired during handball training and matches [6].

One of the most important usage of object detection is in medical fields such as detecting tumor in brain or cancer region in skin. Because of the importance of this field, which depends on the object detection, there have been research, including: In 2014, Santosh Achakanalli, et. al. presented an improved method which uses statistical features and dermoscopic features such as ABCD for detection and diagnosis. Processing steps for dermoscopic images are noise removal, segmentation using threshold, statistical feature extraction using Gray Level Co-occurrence Matrix (GLCM), and classification by using Artificial Neural Network. The results of the neural network and the ABCD parameters indicate effectively and efficiently for the skin cancer detection and diagnosis [7]. In 2015, Sumithra R, et. al. proposed method to segment and classify the skin lesion. The method first removes unwanted objects such as hair. Lesion automatic segmented based on automatic initialization of seed points to implement the region growing technique. Then, classify the skin lesion by using linear Support Vector Machine (SVM) and k-Nearest Neighbor (k-NN) classifiers [8]. In 2015, Shivangi Jain, et. al. proposed method for the detection of Melanoma Skin Cancer. The input to the system is the skin lesion image, by applying new image processing techniques. It analyses to conclude the presence of skin

cancer. The lesion image analysis tools check for the various melanoma parameters like Asymmetry, Border, Color, Diameter, etc. by texture, size and shape analysis for image segmentation and feature stages. The extracted features are used to classify the image as normal skin or melanoma cancer lesion [9]. In 2016, Reda Kasmi, et. al. at first enabled automatically detection of hair based on Gabor filters, and lesion boundaries by using geodesic active contours. Algorithm is proceeding to extract the features of ABCD attributes. Techniques used in this method combine existing methods with new methods to detect color asymmetry and dermoscopic structures [10].

The interest in the field of detection of objects has become necessary for researchers to find the best approach in this area. In this paper we have proposed a new method called Local Quadrant Pattern (LQP) to detect the injury region in the skin.

The organization of the paper as follows: Section 2 shows some techniques that related with the proposed method. Section 3 shows the proposed method. Section 4 Features Extraction. Section 5 Experimental Results and last section 6 conclusion.

II. METHODOLOGY

Texture Feature Coding Method (TFCM), Local Ternary Pattern (LTP) and Image gradient are described in this section.

A. Texture Feature Coding Method

Texture Feature Coding Method (TFCM) is a technique which is derived from Gray Level Co-occurrence Matrix (GLCM) and Texture Spectrum (TS) method [11]. This technique has been proposed by Horng by transforming an original image to texture feature image [12]. The pixels in texture feature image represent Texture Feature Numbers (TFNs). The TFN of each pixel is generated on the basis of gray-level changes of its eight surrounding pixels which is called a texture unit [13, 14]. This method can be summarized as follows:

Let x is pixel in image X with its eight neighbors where Horng [12, 14] called it 8-connectivity of the texture unit. This 8-connectivity will be divided into first and second order 4-connectivity. The first order connectivity refers to horizontal and vertical neighbors and it's denoted by α . While the second order connectivity is diagonally adjacent to x , which refers to diagonal neighbors and it's denoted by β . Each line produces vector with two pairs that calculating by the three successive connectivity with pixel x . for example the line 0-180 in α have three pixels (a, b, c) where b is the pixel x , a its right neighbor and c its left neighbor, so the vector is produced by calculating (a-b, b-c) and so on to other lines.

Then mapping the vectors to four different types of gray-level variation, depending on tolerance threshold (ϵ), that is shown in "Fig.1" and described in [14].

After that mapping each line in α and β to initial feature number with value 1-10. And finally, each α and β is mapping to produce TFN with values 0 – 54 [13].

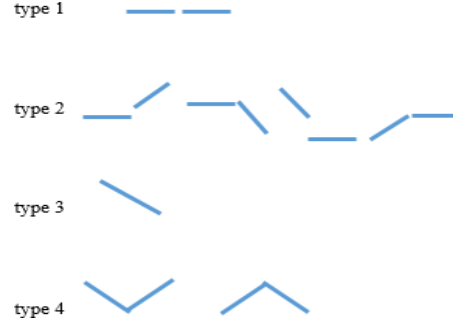


Fig. 1. Types of gray-level graphical structure variations.

B. Local Ternary Pattern

Local Ternary Pattern (LTP) is stretching of Local binary patterns where use 3×3 window. LTP extends LBP to three valued codes by using specified threshold T , in which the values around center pixel take zero value if it's in zone of $\pm T$, +1 is they above or -1 is they below [15] as next equation:

$$1 \quad N_i - N_c \geq T$$

$$C(N_i, N_c) = \begin{cases} 0 & -T \leq N_i - N_c \leq T \\ -1 & N_i - N_c < -T \end{cases} \quad (1)$$

where N_c is center pixel in 3×3 window and N_i is neighbor pixel in sequence i of this window

LTP takes a local neighborhood around each pixel, where the number of neighbors in the common is eight neighbors, i.e. 3×3 window. Then thresholds the pixels of the neighborhood as equation (1).

There is two ways to get result [16], first by use 3^n valued codes [17, 18] as equation (2):

$$LTP_{row,col} = \sum_{i=1}^8 (N_i, N_c) \times 3^{i-1} \quad (2)$$

where LTP is new value to center pixel. The second way is achieved by splitting the $C(N_i, N_c)$ into upper and lower vectors [19, 20] as equations (3 and 4):

$$UPPER = \begin{cases} 1 & \text{if } C(N_i, N_c) = 1 \\ 0 & \text{else} \end{cases} \quad (3)$$

$$LOWER = \begin{cases} 1 & \text{if } C(N_i, N_c) = -1 \\ 0 & \text{else} \end{cases} \quad (4)$$

and each vector can calculate a new value of center pixel as equation (5):

$$LBP_{row,col} = \sum_{i=1}^8 F \times 2^{i-1} \quad (5)$$

where F is UPPER or LOWER vector.

C. Image Gradient

An image gradient is a directional variation in the density or color in an image. The gradient of the image is one of the primary structures in image processing. It is used in many methods such as Canny edge detector. Image gradients can be used to extract information from images. Gradient images are formed from the original image by convolving with a filter, such as Sobel, prewitt filter, etc. Each pixel of a gradient image measures the change in intensity of that same point in the original image, in a given direction [21].

As mentioned in the explanation, for each pixel the degree of change in gradient called magnitude and direction. Following steps are to calculate these two values[22]:

By using prewitt filter window “Fig. 2”, convolutes each window with all the image to produce two matrices, meaning that each pixel has two values d, dy :

$$d(r, c) = \sum_{i=-1}^1 \sum_{j=-1}^1 p_i(r+i, c+j) * Pr(i, j) \quad (6)$$

$$d(r, c) = \sum_{i=-1}^1 \sum_{j=-1}^1 p_i(r+i, c+j) * Pr(i, j) \quad (7)$$

then calculate magnitude:

$$(row, col) = \sqrt{dx^2 + dy^2} \quad (8)$$

and calculate direction:

$$(row, col) = \tan^{-1} \frac{dy}{dx} \quad (9)$$

Finally, using the following equations to calculate the destination pixel location:

$$\overline{row} = row - \sin \theta(row, col) \quad (10)$$

$$\overline{col} = col + \cos \theta(row, col) \quad (11)$$

where row, col are the location of center pixel, $\overline{row}, \overline{col}$ are the location of destination neighbor pixel.

1	0	-1
1	0	-1
1	0	-1

(a) horizontal window

1	1	1
0	0	0
-1	-1	-1

(b) vertical window

Fig. 2. Prewitt Window.

III. THE PROPOSED METHOD

This section represents a new method called Local Quadrant Pattern (LQP) to produce texture feature image from original image. This production has texture information which helps to detect objects in this image as well as to classify original image after extract features. LQP, same to LBP and LTP, use 3×3 window around entire image to get information neighbors of center pixel and save the new value in this center.

In LQP, the sequence of neighbors will be different from previous methods. It will not be arranged in random form but will use the direction of the pixel to see from the first pixel neighbor and then sequence in the direction of the clock “Fig. 3” if we suppose that the direction of center pixel is to the left neighbor. The pixel orientation is calculated by using the equation (9) and then using the equations (10,11) to calculate the destination pixel location.

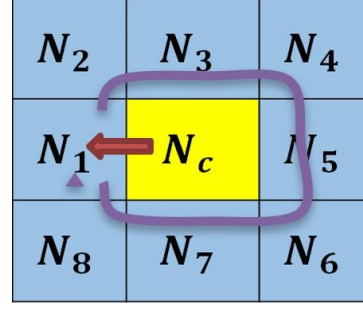


Fig. 3. 3×3 window and order of neighbor.

These neighbors are encoding (threshold) into four code values which called gray-level class numbers. Each value represents the degree of variation. The equation of LQP technique is improved by checking if the absolute of $D_{i,1}$ and $D_{i,2}$ bigger than threshold value and choosing 3 or 4 without need to check all four code values as follows:

$$T_i = \begin{cases} 3 & \text{sign}(Dif_1) = \text{sign}(Dif_2) \\ 4 & \text{else} \end{cases} \quad \text{if } |Dif_1| \text{ and } |Dif_2| > \varepsilon$$

$$\begin{cases} 1 & |Dif_1| \text{ and } |Dif_2| \leq \varepsilon \\ 2 & \text{else} \end{cases} \quad \text{else} \quad (12)$$

where i is neighbor number, its value from 1 to 4, $Dif_1 = N_i - N_c$ and $Dif_2 = N_c - N_{i+4}$.

Now, each class (or value) used two neighbors of center pixel where these neighbors are opposite. (as shown in “Fig. 4”)

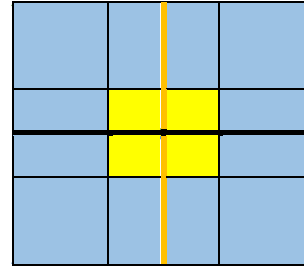


Fig. 4. Figure shown the opposite neighbors.

The equation (12) produces vector with four values (each two neighbors to be one value). To calculate the result, use 4^n code to create LQP matrix, each value in this vector coding with its index and summation all values to get new value for center pixel as the next equation:

$$LQ_{(row,col)} = \sum_{i=1}^4 (T_i - 1) \times 4^{i-1} \quad (13)$$

where (row, col) is position of pixel in origin image.

LQP matrix can be converted to binary matrix in order to full all its holes. The new matrix consists of ones and zeros values where the ones values consider as objects while the zeros as the background. The location of objects can be determined by using *matlab* code “*regionprops*”. These objects can be also subtracted by removing the zeros values from original image. The flowchart of Local Quadrant Pattern is shown in “Fig. 5”:

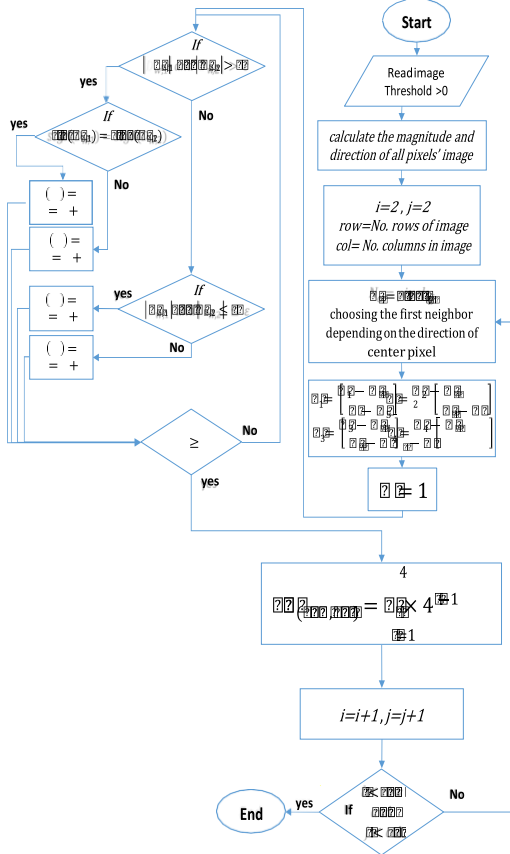


Fig. 5. Flowchart of Local Quadrant Pattern.

IV. FEATURES EXTRACTION

The classification of images done by using some features that are extracted from image. When produce texture feature image from original image, we can get useful features.

In this work, features can be extracted from LQP matrix. The LQP matrix contains texture feature number (TFN). We would like to compute the frequency of TFN around all matrix with the weight of the pixel. The weight of pixels here is the magnitude of each pixel. For example, this frequency LQP matrix can be calculated by counting all TFNs which equal to 0, 1, ..., 255. As next equation:

$$F_i = \sum_{x=1}^N \sum_{y=1}^M \rho(i, LQP_{x,y}) \times w_{x,y}, \quad (14)$$

$$(A, B) = \begin{cases} 1 & \text{if } A = B \\ 0 & \text{otherwise} \end{cases}$$

where $i = 0, 2, \dots, 255$, M, N are size of image and $w_{x,y}$ is magnitude of pixel.

V. EXPERIMENTAL RESULTS

This section showing the experimental results of using the proposed method on skin dataset. The database used is PH2 data. The PH² dataset has been developed for research and benchmarking purposes, in order to facilitate comparative studies on both segmentation and classification algorithms of dermoscopic images. The dermoscopic images were obtained at the Dermatology Service of Hospital Pedro Hispano (Matosinhos, Portugal) under the same conditions through Tuebinger Mole Analyzer system using a magnification of 20x. They are 8-bit RGB color images with a resolution of 768x560 pixels. This image database contains a total of 200 dermoscopic images of melanocytic lesions, including 80

common nevi, 80 atypical nevi, and 40 melanomas [23]. The tests will be about detecting the infected area in the skin and classifying the area as cancer or normal.

A. Detecting The Infected Area

Next is steps for detecting the region in skin that applied on image "Fig. 6" as example:



Fig. 6. Skin image example.

- Convert image to gray level:

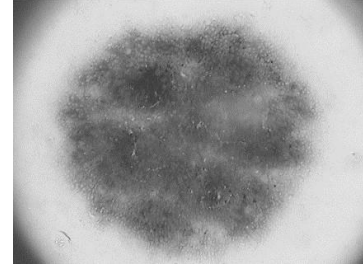


Fig. 7. Gray level of skin image.

- Calculate magnitude and direction using *imgradient* with *prewitt* filter:

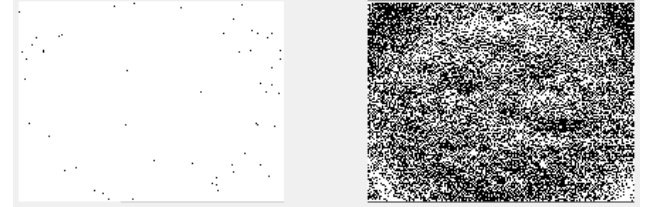


Fig. 8. Magnitude and Direction of skin image

- Use the proposed method:

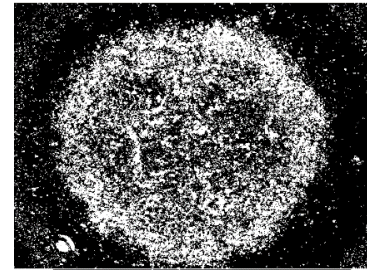


Fig. 9. LQP for skin image.

- convert the producing matrix to binary matrix.
- We can observe that after application of the method that white region appeared. So, we use the *matlab* code (*imfill*) to close the holes in the matrix. In "Fig. 10" shows how the affected area becomes clear.



Fig. 10. LQP image after close holes.

- Thin the edge of object which produce the infected region:



Fig. 11. Thinning the edge of object.

- In the last step, subtract the region from the background:

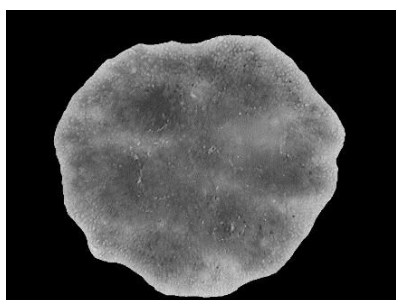


Fig. 12. Subtracting the region from background.

“Fig. 13” shows the detection in proposed method and the expert and the difference between them:

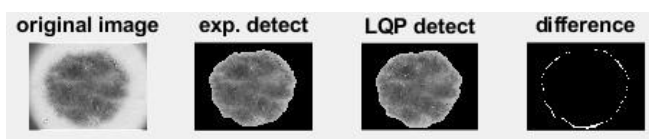


Fig. 13. Compare between LQP detection and expert detection.

The above “Fig. 13” shows that the proposed method has the ability to detect the affected region in the skin. The difference was a little and simple compared with the detecting of the expert.

The next figure indicates the results of tests on some infected skin images and compares them with expert detecting:

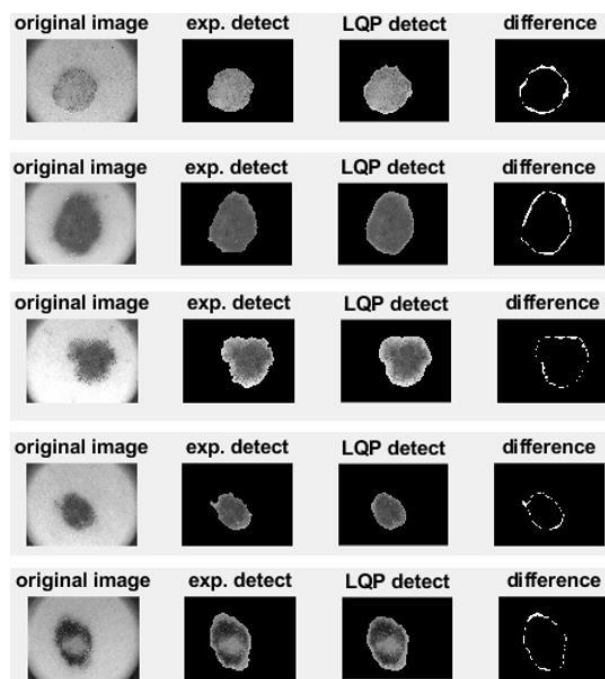


Fig. 14. Five examples of detecting object in skin images.

B. Classification The Infected Area

In this experiment we will classify the affected region as cancer or natural using 150 images from the dataset. The following steps are preprocessing of the input image:

- Convert the input image to gray-level image:

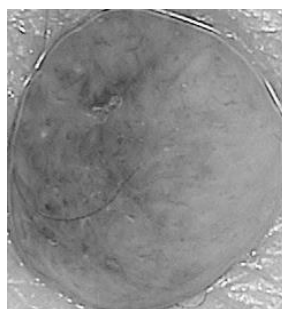


Fig. 15. Infected area of skin image.

- Calculate both magnitude and direction of each pixel:

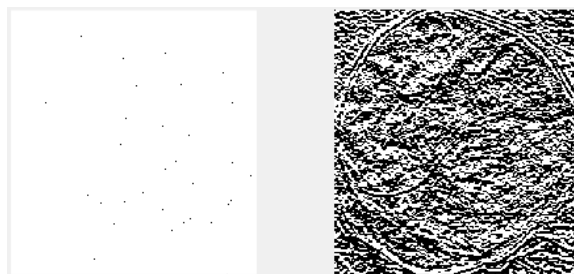


Fig. 16. Magnitude and direction for infected area of skin.

- Produce the LQP matrix for this image that used the direction of each pixel to determine the first adjacent pixel:

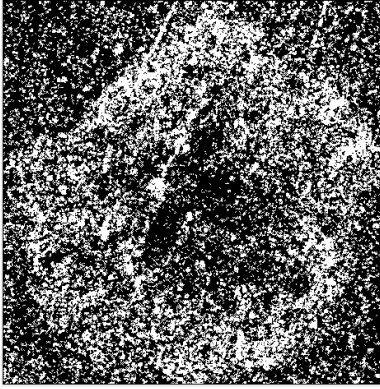


Fig. 17. LQP matrix of skin.

- Extract features of producing matrix and save these features in a vector.

The K-Nearest Neighbour (K-NN) technique has used in the classification where K is 1. Firstly, all required features are extracted from each image through both training set and testing set. Secondly, we calculate the distance between each feature of the test image with the corresponding features in the training image by using Euclidean method. In the next step, sorting for distances as ascending is performed such that the first value is considered the smallest distance. The closest class with the training D.B. considered as a class of the test image. Instead of calculating the distance between test image and the average of each class, we calculate the distance between the test image and each image of the training. The reason of that is: test image can be closer to a particular image within this class while this test image is far away from the average of the class.

We conduct the tests by taking 75% and then 80% of the data to training. The results of these tests are shown as in the TABLE I where the time represent the time that takes to extracting features for all 150 images by calculating the time of CPU at the beginning and the end of the program. The table presents the results of classification and the time for LBP, LTP and LQP methods to compare between them.

TABLE I. ACCURACY OF CLASSIFICATION INFECTED AREA OF SKIN

Method	Time Taken (Sec.)	Percentage of training data	
		75%	80%
LBP	4135.593	89.18	86.66
LTP	5200.031	83.78	83.33
LQP (Proposed)	1567.968	100	100

Fig. 18 shown the chat of accuracy for each percentage that taken for training data, however Fig. 19 shown the chart of time that taken to extract features.

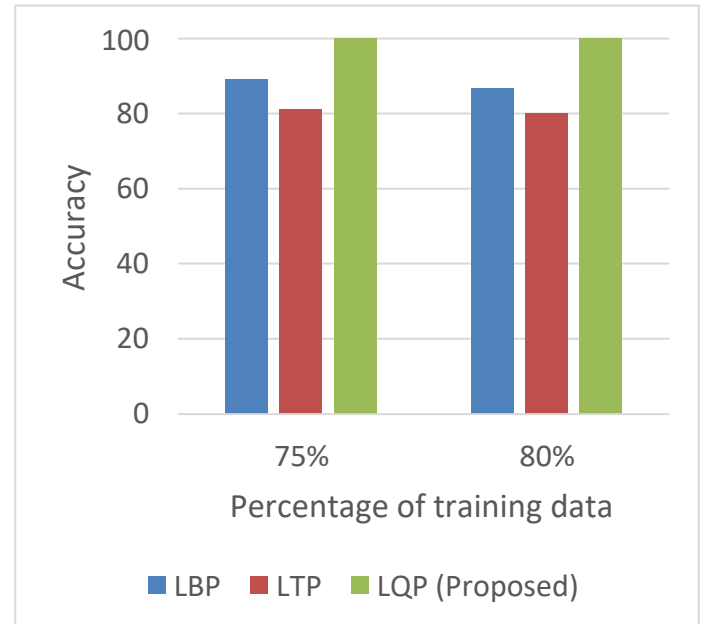


Fig. 18. Chart of the accuracy.

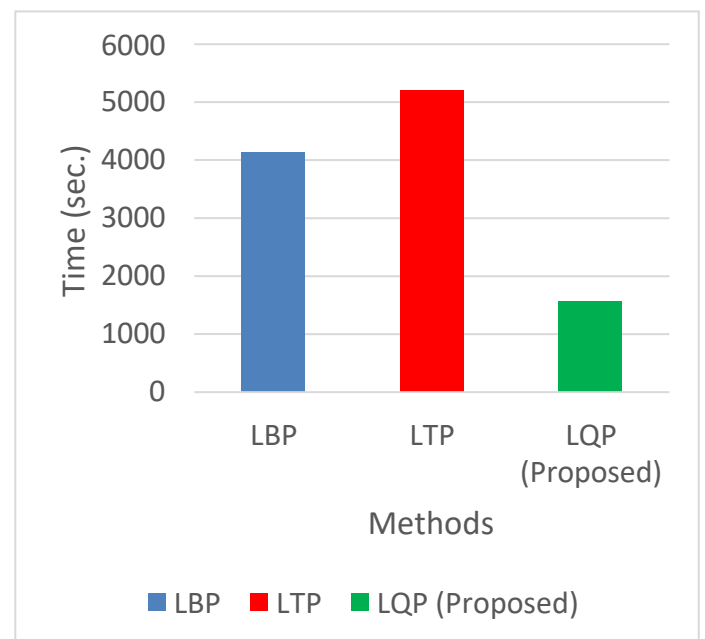


Fig. 19. Chart of the time taken in extracting features.

We can conclude that the proposed method is effective in classifying the affected region of the skin as well as much faster extraction features.

VI. CONCLUSIONS

Local Quadrant Pattern is a new method suggested in this paper. The proposed method has developed previous methods in local patterns where the 3×3 window has been used to get the information of pixel and its neighbors. This method was suggested to use the direction of pixel and to set the first neighbor instead of the random and non-uniform assignment as in the previous methods. The proposed method also used the magnitude of each pixel as a weight for the pixel and used with the extracted features. The tests were conducted on the proposed method as follows:

- The results have been revealed that the ability of improved method was high quality to detect the infected area in the skin by comparing the results with the expert detection.
- The classification experiment was done using an algorithm k-NN where K is equal to 1 and the results of the classification for proposed method were compared with LBP and LTP methods. The results showed that the proposed method is better than the other methods where the accuracy is 100% while the other methods are less than 90%. The time taken to extract the features was also calculated and the results show that the proposed method is faster than the other methods.

REFERENCES

- [1] O. Stenroos, "Object detection from images using convolutional neural networks," Master, , Communication and Information Sciences, Aalto University, 2017.
- [2] H. A. Mohammed, "Object detection and recognition in complex scenes," Master, Computer Science Engineering, University of Algarve, 2014.
- [3] Y. Amit and P. Felzenszwalb, "Object Detection," *Computer Vision: A Reference Guide*, pp. 537-542, 2014.
- [4] P. F. Felzenszwalb, R. B. Girshick, D. McAllester, and D. Ramanan, "Object detection with discriminatively trained part-based models," *IEEE transactions on pattern analysis and machine intelligence*, vol. 32, pp. 1627-1645, 2010.
- [5] K. R. Kumar, V. B. Prakash, V. Shyam, and M. A. Kumar, "Texture and Shape based Object Detection Strategies," *Indian Journal of Science and Technology*, vol. 9, 2016.
- [6] M. Burić, M. Pobar, and M. Ivašić-Kos, "Object Detection in Sports Videos," in *41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, 2018.
- [7] A. Santosh and G. Sadashivappa, "Skin cancer detection and diagnosis using image processing and Implementation using neural networks and ABCD parameters," *International Journal of Electronics, Communication & Instrumentation Engineering Research and Development (IJEIERD)*, vol. 4, pp. 85-96, 2014.
- [8] R. Sumithra, M. Suhil, and D. Guru, "Segmentation and classification of skin lesions for disease diagnosis," *Procedia Computer Science*, vol. 45, pp. 76-85, 2015.
- [9] S. Jain and N. Pise, "Computer aided melanoma skin cancer detection using image processing," *Procedia Computer Science*, vol. 48, pp. 735-740, 2015.
- [10] R. Kasmi and K. Mokrani, "Classification of malignant melanoma and benign skin lesions: implementation of automatic ABCD rule," *IET Image Processing*, vol. 10, pp. 448-455, 2016.
- [11] J. Liang, X. Zhao, R. Xu, C. Kwan, and C.-I. Chang, "Target detection with texture feature coding method and support vector machines," in *Acoustics, Speech, and Signal Processing, 2004. Proceedings.(ICASSP'04). IEEE International Conference on*, 2004, pp. ii-713.
- [12] M.-H. Horng, Y.-N. Sun, and X.-Z. Lin, "Texture feature coding method for classification of liver sonography," *Computerized medical imaging and graphics*, vol. 26, pp. 33-42, 2002.
- [13] E. Tanyildizi, "A hybrid color texture image classification method based on 2D and semi 3D texture features and extreme learning machine," *Przeglad Elektrotechniczny*, vol. 11, 2012.
- [14] M.-H. Horng and J.-H. Zhuang, "Texture feature coding method for texture classification," *Optical Engineering*, vol. 42, pp. 228-239, 2003.
- [15] L. N. S. B. A. Lumini, "Selecting the best performing rotation invariant patterns in local binary/ternary patterns," in *International conference on IP, computer vision, and pattern recognition*, 2010.
- [16] L. Ji, Y. Ren, X. Pu, and G. Liu, "Median local ternary patterns optimized with rotation-invariant uniform-three mapping for noisy texture classification," *Pattern Recognition*, vol. 79, pp. 387-401, 2018.
- [17] X.-H. Han, Y.-W. Chen, and G. Xu, "Integration of spatial and orientation contexts in local ternary patterns for HEp-2 cell classification," *Pattern Recognition Letters*, vol. 82, pp. 23-27, 2016.
- [18] M. H. Z. Mu and H. Zeng, "A New Method of Image Classification Based on Weighted Center Symmetric Local Ternary Pattern Feature," *Journal of Computers*, vol. 26, 2015.
- [19] I. M. Revina and W. S. Emmanuel, "Face expression recognition using LDN and Dominant Gradient Local Ternary Pattern descriptors," *Journal of King Saud University-Computer and Information Sciences*, 2018.
- [20] J. Shajeena and K. Ramar, "OBJECT TRACKING WITH ROTATION-INVARIANT LARGEST DIFFERENCE INDEXED LOCAL TERNARY PATTERN," *ICTACT Journal on Image & Video Processing*, vol. 7, 2017.
- [21] Y. Dandawate, M. Jadhav, and N. Pisharoty, "Full reference colour image quality assessment based on natural scene statistics in gradient domain for JPEG compressed images," *IETE National Journal for Innovation and Research*, vol. 1, pp. 44-49, 2013.
- [22] C. Solomon and T. Breckon, *Fundamentals of Digital Image Processing: A practical approach with examples in Matlab*: John Wiley & Sons, 2011.
- [23] T. Mendonça, P. M. Ferreira, J. S. Marques, A. R. Marcal, and J. Rozeira, "PH 2-A dermoscopic image database for research and benchmarking," in *2013 35th annual international conference of the IEEE engineering in medicine and biology society (EMBC)*, 2013, pp. 5437-5440.