OPTIMAL EDGE DETECTION TECHNIQUE FOR DIAGNOSIS & TREATMENT OF LEUKOPLAKIA IN ORAL MUCOSA

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Abstract: Tongue inspection plays a very important role to monitor the health of patient and it is commonly used in Traditional Chinese Medicine (TCM). Texture analysis of Tongue Contours is an important issue in development of disease diagnostic expert system using analysis of tongue images. In this paper we present an approach of medical biometrics to detect and diagnose Leukoplakia. The aim of this paper will be to enhance the extracted part of the tongue, finding the severity of affected part and decide the proper treatment of the same. In this proposed system we not only extract the affected area but also calculate the same using geometrical and textural features of image.

physiological and pathological changes and get a patient physical condition. Traditional tongue diagnosis mainly depends on the doctor's experience and knowledge, this can't cause the diagnosis of subjectivity and difficult to repeatability. It is required to combine TCM expert's clinical experience with modern information technology. In order to analyze tongue image, the important premise is to accurately segment tongue from original tongue image. Because of the various shapes and colors, and lots of noise information from the mouth, nose and face, segmenting the tongue effectively becomes a difficult problem. And the segmentation result will directly affect the accuracy of image analysis. So we need to improve the efficiency of the technique used to segment the tongue image.

M. Dhanalakshmi et al. [1] had introduced a sequential image processing technique for automated tongue segmentation in which a gradual, step by step sequential process for extraction of the shape feature, color feature and so on for the tongue analysis. The aim of this method was to reduce the complexity in tongue segmentation. Lam

***Keywords*-Tongue Image, Leukoplakia,**

ISEF, TCM, Tongue Extraction.

I. INTRODUCTION

A tongue is an organ that reflects the physiological and clinic pathological condition of the body. Tongue diagnosis is one of the most widely used diagnostic methods in Traditional Chinese Medicine (TCM). Through the observation of tongue, the doctors can understand the body's ia Jaafar Belaidet al. [2] presented a new method for image segmentation based on the watershed transformation using mathematical morphology.

In which topological gradient approach is used to avoid an over segmentation. Yian-Leng Chang et al. [3] propose a simple, yet general and powerful, region growing framework for image segmentation in which no parameter tuning or a priori knowledge about the image is required.

M. Kasset al. [4] firstly introduced the basic model of snake or active contours in 1987, which are curves defined within an image domain that can move under the influence of internal forces coming from within the curve itself and external forces computed from the image data. The defects of traditional dynamic contour are: (1) Smaller convergence domain, (2) Exist re-entrant corner in the target cannot be convergence. Therefore this method is less automatically, can't be completely out of people's participation, not suitable for large sample and clinical applications. Therefore Zhai Xue-Ming et al. [5] presents a new segmentation method called dual snake method, namely the use of two Snakes on both sides from inside and outside the body to locate the outline of the tongue, and then the exact division of the tongue part. Experiments show that the accuracy of the single-Snake is 81.63%, and the accuracy of the double Snake is 92.89%. So compared with the traditional segmentation, double Snakes have a lower request on the initialization of outline, and more accurate results of the segmentation.

The paper has been fragmented into six parts. Section 2 discusses the tongue anatomical precancerous diseases and its related problems. Section 3 comprises of the basic concepts of leukoplakia, extraction, its detection and further details. In section 4 we propose an approach for detection of leukoplakia. Section 5 concludes the paper. Acknowledgments are being provided to specialized dental doctors, without their massive support nothing would have been possible in section 6.

II. PROBLEM DEFINITION

In oral mucosa apart from all diseases related to tongue, we are particularly interested in Leukoplakia. The presence of white or gray colored patches on the tongue, gums, roof of your mouth, or the inside of the cheeks of your mouth may be a sign of leukoplakia. The patch may have developed slowly over weeks to months and be thick, slightly raised, and may eventually take on a hardened and rough texture. It usually is painless, but may be sensitive to touch, heat, spicy foods, or other irritation.

In the Traditional Chinese Medicine, patient physical condition was checked by the doctor through the observation of tongue but it mainly depends on auto biopsy done by doctor, later by his knowledge and experience to diagnose that part of tongue. Therefore it is very important to use computer technology to achieve the quality tongue diagnosis for a better treatment.

III. BASIC CONCEPTS OF LEUKOPLAKIA

Leukoplakia is a white or gray patch that develops on the tongue, the inside of the cheek, or on the floor of the mouth. It is more frequently found in men, can occur on any mucosal surface, and infrequently causes discomfort or pain. Leukoplakia usually occurs in adults older than 50 years of age. The presence of leukoplakia does not necessarily mean cancer, but this precancerous condition has the highest risk of developing into cancer.

For this diagnosis we suggest a technique as briefed in Table-I. The detail description of the same is explained below it.

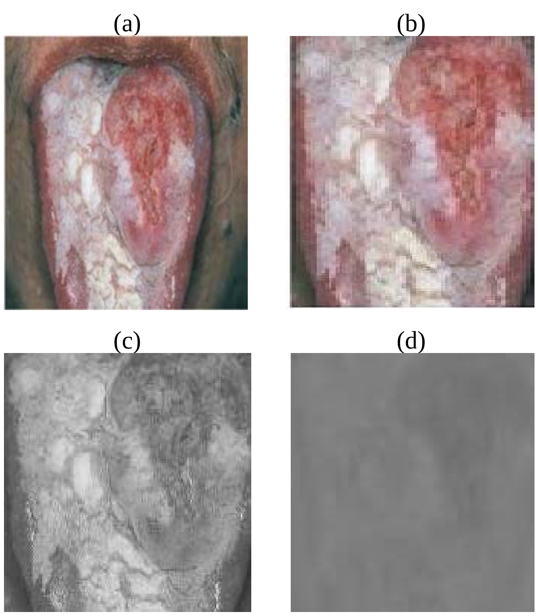
TABLE I: PROPOSED ALGORITHM

Sr.No.	Steps
1	Acquire tongue anatomical images.
2	Select the Region of Interest (ROI).
3	Convert RGB image into YCbCr plane.
4	Apply pre-processing technique to remove noise and enhance the image.
5	Extraction of leukoplakia from image.

6	Edge detection using optimal edge detection technique.
7	Measurement of severity geometrical and textural analysis.

A. Image Enhancement

The original tongue image was captured by digital camera under standard light source situation. It usually contained tongue body, upper lip, partial lower lip and face. In which we require only the area of tongue body. So we extract the part in which we are interested from the original image. After that image is converted to YCbCr. Separating the three different planes of Y, Cb, Cr. Out of three planes Y plane has more information than Cb and Cr as can be seen in fig. 1. So here we select Y plane for further enhancement. Now for image enhancement we apply thresholding to separate out foreground and background region from the image.



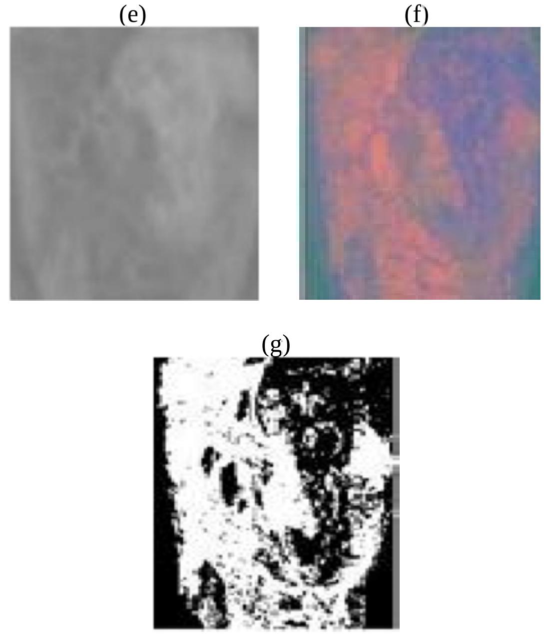


Figure 1: (a) Original Image (b) ROI (c) Y plane (d) Cb plane (e) Cr plane (f) YCbCr (g) Threshold

B. Edge Detection using ISEF

In our proposed system edge detection of leukoplakia is done by ISEF (Infinite Symmetric Exponential Filter). The steps for ISEF algorithm are shown in Table II.

TABLE II: ISEF ALGORITHM

Sr.No.	Steps
1	Apply ISEF Filter in X direction
2	Apply ISEF Filter in Y direction
3	Apply Binary Laplacian Technique
4	Apply Non Maxima Suppression
5	Find the Gradient

Shen Castan Infinite Symmetric Exponential Filter is an optimal edge detector. In which first of all the whole image will be filtered by the recursive ISEF filter in X and Y direction respectively which can be implemented by using following equations:

Recursion in x direction:

$$Y_1\,[i,j]=(1-b)/(1+b)\ I\,[i,j] + b\ Y_1\,[i,j-1],\quad j= 1\ldots N, i= 1\ldots M \qquad (1)$$

$$Y_2\,[i,j]=b\ (1-b)/(1+b)\ I\,[i,j] + b\ Y_1\,[i,j+1],$$

$j= 1\ldots N, i= 1\ldots M$ (2)

$r[i,j]= Y_1[i,j]+ Y_2[i,j+1]$ (3)

Recursion in y direction:

$Y_1[i,j]=(1-b)/(1+b) I[i,j] + b Y_1[i-1,j],$

$i= 1\ldots M, j= 1\ldots N$ (1)

$Y_2[i,j]=b(1-b)/(1+b) I[i,j] + b Y_1[i+1,j],$

$i= 1\ldots M, j= 1\ldots N$ (2)

$Y[i,j]= Y_1[i,j]+ Y_2[i+1,j]$ (3)

b=thinning factor ($0<b<1$)

Subtract the filtered image from the original image to obtain the Laplacian image. In the filtered image, there will be zero crossing in the second derivative at the location of an edge pixel because the first derivative of the image function should have an extreme at the position corresponding to the edge in image. Non maxima suppression is used for thinning purpose for false zero crossing. The gradient is either a maximum or a minimum at the edge pixel. If the second derivative changes sign from positive to negative, it is known as positive zero crossing and if it changes sign from negative to positive, it is known as negative zero crossing. We will permit positive zero crossing to have positive gradient and negative zero crossing to have negative gradient. We considered all other zero crossing as false zero crossing. Thresholding is applied on gradient image. One cutoff is used in simple thresholding but ShenCastan suggests for Hysteresis thresholding in which two cut offs are used. Thresholding is applied on the output of an edge detector to decide significant edges. Noise will create spurious response to the single edge that will create a streaking problem. Streaking is defined by breaking up of the edge contour caused by the operator fluctuating above and below the threshold.

Hysteresis thresholding is used to eliminate streaking problem. Individual weak responses usually correspond to noise, but if these points are connected to any of the pixels with strong responses, they are more likely to be actual edge in the image. Such connected pixels are treated as edge pixels if their response is above a low threshold. The ISEF algorithm is given in table II. Output is shown in fig. 2.

Figure 2: Leukoplakia extracted using ISEF

For the output shown in fig. 2 the thresholding value is kept constant for all the acquired samples.

C. Leukoplakia Extraction

We extract the leukoplakia from the resultant threshold image, so that leukoplakia affected area can be visible more properly as shown in fig. 3. The need of thresholded image was not only to see the affected area but also to measure the geometrical and textural features of the image. Based on the geometrical and textural features one could easily identify the affected part as well the next step for diagnosis.

Figure 3: Extracted Leukoplakia from thresholded image

IV. RESULTS AND DISCUSSION

As discussed above the leukoplakia affected areas of tongue were analyzed from the given set of database from Dr. Dhrumin Patel. It is to be noted here that the results so obtained after the geometrical and textural based feature extraction are quite satisfactory and approved even by the doctor. Moreover the results are satisfying as compared to clinical laboratory diagnosis. In case of clinical laboratory data destructive analysis is to be done where the sample of the affected area of patients tongue is taken and being analyzed. Whereas in this particular approach the technique so used is not only quick, but even it is nondestructive in nature. The information so gathered can be used for further treatment of the patient. The threshold so taken for the rest samples of tongue were same and hence the results too were satisfactory as per the doctor's approval. The images shown below clear depict the above said approach for the purpose of further diagnosis and treatment.

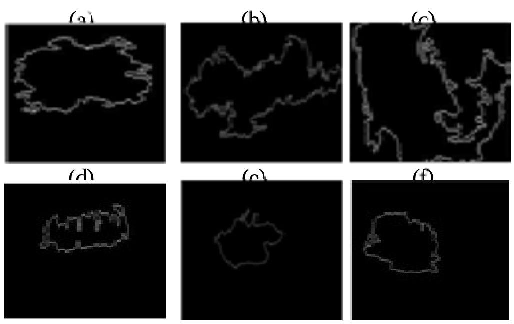


Figure 4 Results of various tongue images of various patients for detection of leukoplakia

V. GEOMETRICAL AND TEXTURAL FEATURES

For severity measurement, geometrical and textural features must be analyzed. As these two things are the basic fundamental component of analysis for further treatment and medication in case of tongue. In case of such measurements the two things required is the area being affected and the other is its severity. For geometrical features, as shown in fig. 2 the edges are being detected which help in first of all finding the area which can done by finding out length of the horizontal and vertical level of white pixel from top to bottom. In case of textural analysis the region bounded boxes would be clearly depicting the area more and less affected as based on the white patches intensity such rectangular shapes would be produced to understand the severity in the affected area of tongue as shown in fig. 5. As shown in the fig. 4 (a)-(f) are 6, 5.9161, 7.1414, 5.7446, 6.7082, 7.4833 and 7.8740 respectively are the diagonal length of the pixels in the affected area. Similarly for the case of textural features the fig. 6 as shown below clearly indicates the boxes where the white patches are growing presently and the left over areas are the most affected part of the image having strong white patches. Even based on those boxes one can calculate the area being affected.

VI. CONCLUSION

At present, to realize the recognition and diagnosis of tongue image is very important to the development of tongue diagnosis in **TCM**. We suggest a new approach for automatic tongue area extraction in the system of tongue inspection.

The figures shown in 4 & 5 clearly depict its effect on tongue and the various approaches through which one can find the extracted and affected part of tongue.

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