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

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>
<thead>
<tr>
<th>Sr.No.</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apply ISEF Filter in X direction</td>
</tr>
<tr>
<td>2</td>
<td>Apply ISEF Filter in Y direction</td>
</tr>
<tr>
<td>3</td>
<td>Apply Binary Laplacian Technique</td>
</tr>
<tr>
<td>4</td>
<td>Apply Non Maxima Suppression</td>
</tr>
<tr>
<td>5</td>
<td>Find the Gradient</td>
</tr>
</tbody>
</table>

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:

\[ Y_1[i,j]\text{=}\frac{1-b}{1+b} I[i,j] + b Y_1[i,j-1], \]
\[ j=1,...,N, i=1,...,M \quad (1) \]

\[ Y_2[i,j]=b \left(1-b\right) I[i,j] + b Y_1[i,j+1], \]
\[ j=1 \ldots N, i=1 \ldots M \] (2)

\[ r_{i,j} = Y_1_{i,j} + Y_2_{i,j+1} \] (3)

Recursion in y direction:
\[ Y_1_{i,j} = \frac{1-b}{1+b} I_{i,j} + b Y_1_{i-1,j}, \]
\[ i=1 \ldots M, j=1 \ldots N \] (1)

\[ Y_2_{i,j} = b \frac{1-b}{1+b} I_{i,j} + b Y_1_{i+1,j}, \]
\[ i=1 \ldots M, j=1 \ldots N \] (2)

\[ Y_{i,j} = Y_1_{i,j} + Y_2_{i+1,j} \] (3)

\( b = \text{thinning factor (0<} b <1) \)

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 cutoffs 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](image)

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](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.

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, 5.7464, 6.7062,
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.

VII. ACKNOWLEDGMENT

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