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By Using Tongue Feature Extraction, Detection of Diabetes Mellitus

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***Abstract:** The major health problem in Worldwide is Diabetes Mellitus. To detect the diabetes mellitus and its NPDR, a non-invasive approach is proposed which uses tongue color, texture & geometry features for diagnosis. A tongue color gamut is established with 12 colors which represents the tongue color features. On the tongue surface, the texture values of blocks strategically located with the additional mean of all eight blocks are used to characterize the nine tongue texture features. And on the basis of measurements, distances, areas and their ratios their 13 features extracted which represents the geometry features. On the combination of these features, we can classify healthy & DM person from their tongue images.*

***Keywords:** Image pre-processing, tongue color features, tongue texture feature, tongue geometry feature, diabetes mellitus detection, non-proliferative diabetic retinopathy features, Matlab.*

I. INTRODUCTION

As we know that, tongue is very sensitive part of our mouth & body. So it is widely used diagnostic method. The tongue chromatic, geometric & texture features extraction play most important role in evaluating a person's health condition. Pathological changes of internal organs can affect the color appearance of the tongue body that believed by TCM (Traditional Chinese Medicine) practitioners. Healthy or diseased and if diseased which disease is quantitatively analysed using geometry features which gives the shape of a human tongue & its relation to a patient's state.

Diabetes Mellitus (DM) & its complications were leading to major health problem. The standard method practiced by many professionals to diagnose DM is fasting plasma glucose (FPG) test is a accurate, considered invasive & little painful. So, there is a need to detection method.

The extraction of color, texture & geometry is done for the possible colors observe on a tongue image. We have used the gamut to showcase. In the determination of texture of tongue that gabour filter of second order is used. By using mathematical formulas, the geometric features are determined. A combination of all these features is used to classify a tongue image into normal/healthy or DM/abnormal category. Color, texture & geometry features are studied solely where there are some separate researches.

II. METHODOLOGY

Figure below shows the block diagram for detecting diabetes level with the help of DM input images. Detection of DM images to obtain diabetic levels.

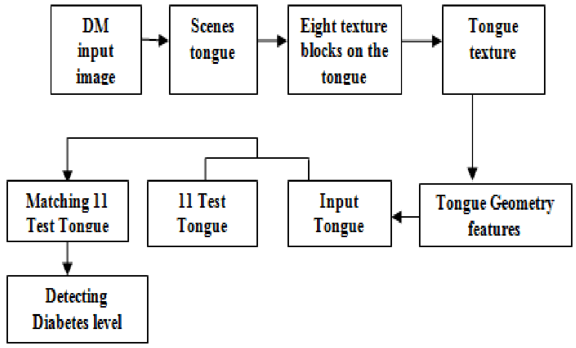

Figure1: A Block Diagram for Proposed Work

A much large volume of information on the tongue surface can use TDS which gives high-resolution CCD. To acquire more detailed color information, the CCD camera with 8 megapixels are suitable lenses were used. This is used because the color features of the tongue provide significant diagnostic information & specialized for color image acquisition. That higher degree of accuracy used for color & shape information of tongue. Let's see the detail classification of tongue feature extraction by color, texture & geometry.

Color Feature Extraction:

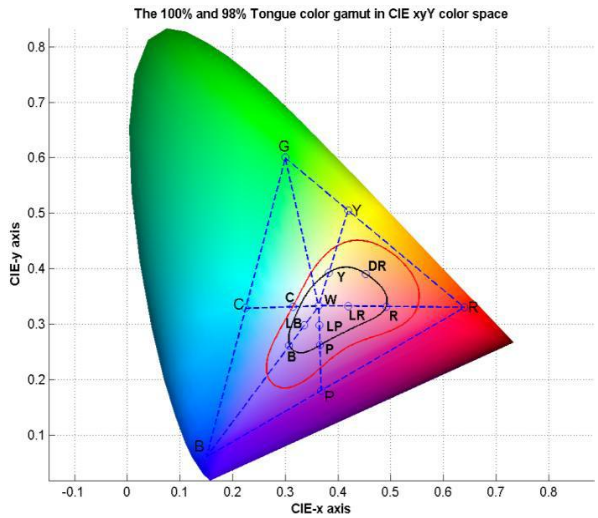

Figure 2: By Using Several Points Drawing Lines from the RGB Color Space Represents the Tongue Color Gamut

There are three aspects of tongue color which is to be considered- first is tongue color gamut to classify tongue related color with tongue unrelated colors, second is color centers value of main color categories and third is color distribution of typical image features. To form color distribution in the CIEx chromaticity diagram the representative colors are then extracted & combined together to provide an intuitionist way to describe all visible colors according to its color stimulus & its color composition observed easily & the relative position of tongue color. To meet the demanding in the tongue diagnosis of TCM, the 12 color centers are predefined.

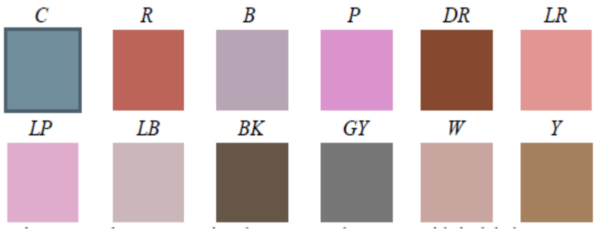

Figure 3: Tongue Gamut Represented in Colors with its Label on Top

For each foreground pixel, corresponding RGB values are first extracted & converted to CIELAB by transferring RGB to CIEXYZ using

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad \text{... (1)}$$

And followed by CIEXYZ to CIELAB via

$$\begin{cases} L* = 166.f\left({}^{Y}/_{Y_0}\right) - 16 \\ a* = 500.\left[f\left({}^{X}/_{X_0}\right) - f\left({}^{Y}/_{Y_0}\right)\right] \\ b* = 200.\left[f\left({}^{Y}/_{Y_0}\right) - f\left({}^{Z}/_{Z_0}\right)\right] \end{cases} \quad \text{... (2)}$$

Where f(x)=x^1/3 if x>0.008856 or f(x)=7.787x + 16/116 if x<=0.0088856

From the reference white point x0, y0 & z0 in 3 are the CIEXYZ tri stimulus values.

The color which is closest to the LAB values are then compared to 12 colors from the tongue color gamut. The total of each color is summed & divided by the total number of pixels are evaluated by all tongue foreground pixels. This ratio of the 12 colors forms the tongue color feature vetor v, where,

v = [c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12] & ci = the sequence of colors.

Texture Feature Extraction:

The texture of tongue images with eight blocks of size 64*64 strategically located on the tongue surface. These eight blocks covers all eight surface areas very well. First locating the center of the tongue using a segmented binary tongue foreground image, the blocks are calculated automatically. Block 8 is at the center, block 1 is at the tip, block 2, 3 & block 4,5 are on either side. Block 6 & 7 are at the root. For texture filter as linear filter is used. The 2D gabour filter is applied to compute the texture value of each block is as

$$G_k(x,y) = \exp\left(\frac{x^2+\gamma^2.y^2}{-2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}\right) \quad \text{... (3)}$$

Where x'=x.cos θ+y.sin θ, y'=-x. sin θ+y. cos θ, σ is the variance, λ is the wavelength, γ is the aspect ratio of the sinusoidal function & θ is the orientation. A total of three σ (1,2,3) & four θ(0,45,90&135) choices are investigated to achieve the best result. Each filter is convolved with a texture block to produce a response.

$$R_k(x,y): R_k(x,y) = G_k(x,y) * im(x,y) \quad \text{... (4)}$$

Where im (x,y) is the texture block & represents 2D convolution. Responses of a block are combined to form Fri & its final response evaluated as follows.

$$FR_i(x,y) = max(R1(x,y), R2(x,y), \dots, Rn(x,y)) \quad \text{... (5)}$$

This selects the maximum pixel intensities & represents the texture of a block by averaging the pixel values of Fri. In the end, σ equal to 1 & 2 with three orientations (45, 90 & 135) was chosen.

Geometry Feature Extraction:

The geometry feature extraction includes various measurements of length, areas & angle extracted from tongue images. Every image is segmented with the background removed & tongue foreground remaining from each tongue image consisting of a tip, body & root.

On the basis of measurements, distance, areas, & their ratios, we describe 13 geometry features extraction of tongue images.

1) Width: The horizontal distance along the x-axis from a tongue's furthest right edge point (x max) to its furthest left edge point (x min) the width w feature is measured as

W = x(max) - x(min) … (6)

2) Length: The vertical distance along the y-axis from a tongue's furthest bottom edge(y max) point to its furthest top edge point (y min) the length l feature is measured as

l = y(max) – y(min) … (7)

3) Length–Width Ratio: The length–width ratio lw is the ratio of a tongue's length to its width

lw = l/w … (8)

4) Smaller Half-Distance: Smaller half-distance z is the half distance of l or w depending on which segment is shorter.

z = min(l,w) / 2 … (9)

5) Center Distance: The center distance cd is distance from w'sy-axis center point to the center point of l(ycp)

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$$cd = \frac{(max(y_{xmax}) + max(y_{xmin}))}{2} - ycp \quad \ldots (10)$$

6) Center Distance Ratio: Center distance ratio (cdr) is ratio of cd to l

cdr = cd/l … (11)

7) Area: The area (a) of a tongue is defined as the number of tongue foreground pixels.

8) Circle Area: Circle area (ca) is the area of a circle within the tongue foreground using smaller half-distance z, where r = z.

$ca = \pi r2$ ... (12)

9) Circle Area Ratio: Circle area ratio (car) is the ratio of ca to a.

car = ca/a … (13)

10) Square Area: Square area (sa) is the area of a square defined within the tongue foreground using smaller half-distance z

sa = 4z^2 … (14)

11) Square Area Ratio: Square area ratio (sar) is the ratio of sa to a

sar = sa/a … (15)

12) Triangle Area: Triangle area (ta) is the area of a triangle defined within the tongue foreground. The right point of the triangle is x(max), the left point is x(min), and the bottom is y(max).

13) Triangle Area Ratio: Triangle area ratio (tar) is the ratio of ta to a.

tar = ta/a …(16)

III. RESULTS AND DISCUSSION

We select an input image from the database. The image is resized to obtain a standard data set. To remove any noises from the image the image is filtered, cropped, and segmented. As shown in figure.

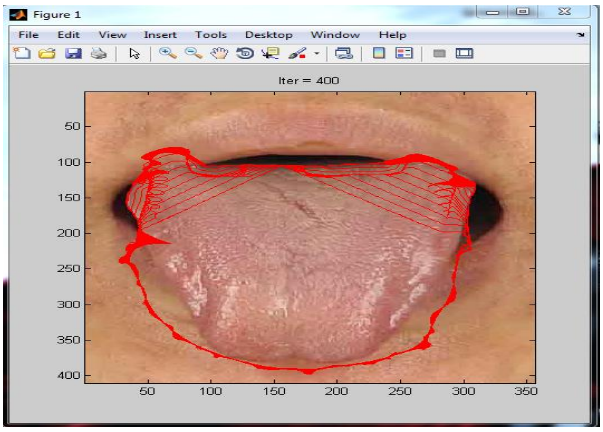

Figure 4: Cropped Input Tongue for Detection

The color features are extracted from the input image. Color tongue image in L channel, A channel, B channel are obtained. Then the tongue image is labeled with cluster index image. Then it will compare with 12 color gamut. As shown in figure.

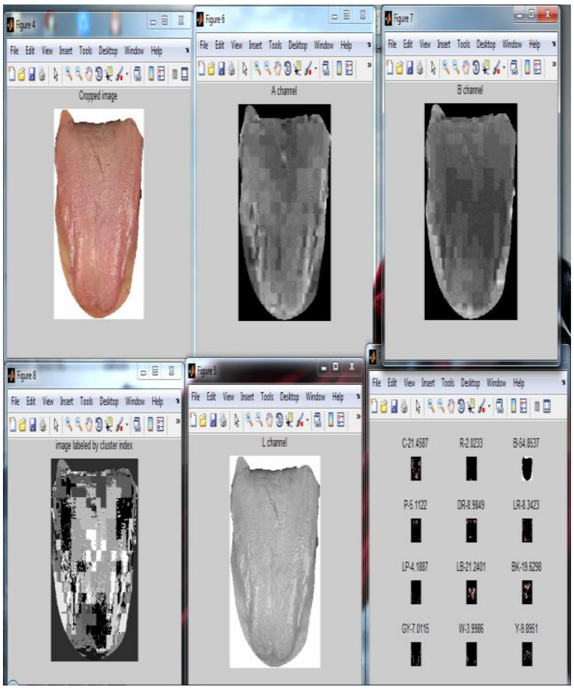

Figure 5: Tongue Images in Color Feature Extraction

Geometric feature extraction is done in command window, as it contains all the measurement, calculation & geometric values etc. Thus its result is obtained in command window of Matlab. As shown in figure

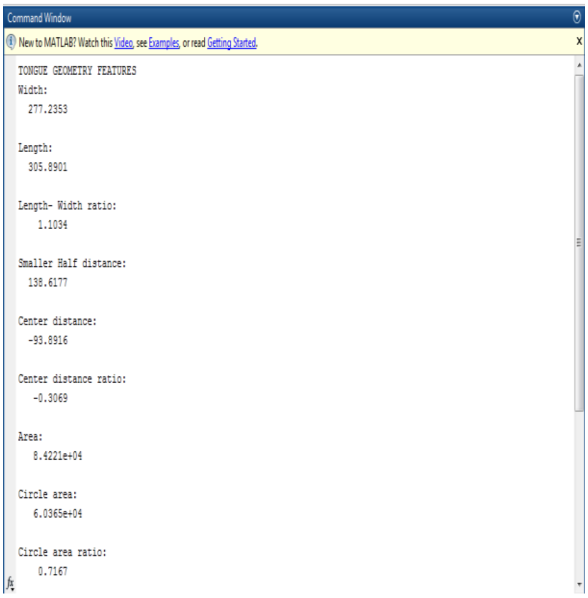

Figure 6: Tongue Geometric Calculation

For texture feature extraction, first the image is divided into blocks. Each block is then convolved with 2D Gabor filter. This will give us the texture features of the input tongue image. Figure shows the block separation of input tongue image. We obtain different values for texture for tongue images from Healthy, DM dataset.

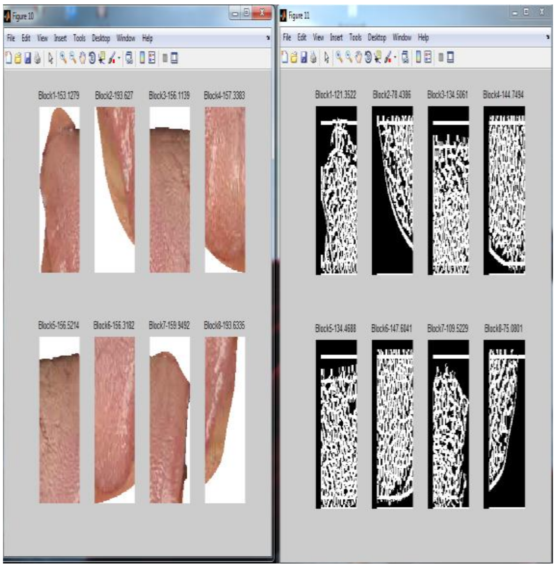

Figure 7: Tongue Texture Feature Extraction

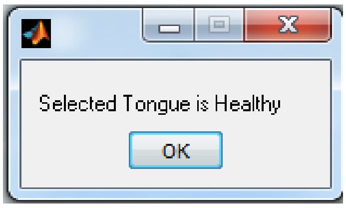

Figure 8: Diabetes Result

IV. CONCLUSION

From the three groups of color, texture & geometry a non-invasive approach to classify Healthy & DM samples was extracted from tongue images was proposed. 12 color representing tongue image was first applied to tongue color gamut. Then the texture value is calculated by 8 blocks strategically located on the tongue were extracted. On the basis of measurements, distances, areas & their ratios were extracted and got 13 geometry features from tongue images. A non-invasive technique to use tongue images and detect diabetes mellitus using color, texture & geometry features together. This method requires minimum human intervention & can be used at the diabetes screening laboratories. Further, we can include algorithms to determine the age group of the patients and percentage of diabetes in body. This lays a work for a new way to detect DM for providing a means to detect NPDR without retinal imaging or analysis.

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