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DETECTION OF DIABETES MELLITUS WITH THE TONGUE FEATURES

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ABSTRACT
A non-invasive approach is proposed which uses color, texture and geometry features for diagnosis to detect diabetic mellitus. Diabetic Mellitus (DM) & its complication towards retinopathy is world's major health problem. This paper suggest technique for classifying health & DM samples by obtaining tongue images using capture device. By color space conversion & region based segmentation, images are pre-processed. Then the extraction of features i.e., color, texture & geometry is done. The classification of healthy(normal) /DM(abnormal) tongues are obtained by combination of all these features fuzzy logic.

KEYWORDS: Diabetes Mellitus Detection, Non-Proliferative Diabetic Retinopathy features, Image Pre-processing, Tongue color features, Tongue texture features, and Tongue geometry features, Matlab.

INTRODUCTION:

In the year 2000, there are 171 million people in the world & it may get increased upto 366 million people in 2030 of Diabetes Mellitus (DM) by the estimation of World Health Organization which may lead to cause of death, disabilities & economic hardship in the world because of diabetes. The people who require insulin injection they are fails to produce insulin those are type 1 DM & the people who are insulin resistance are the type 2 DM which are common type. Insulin resistance type DM is controlled by eating well, exercising & maintaining a healthy lifestyle. The fasting plasma glucose (FPG) test is the one of the best method for professionals to diagnose DM. By taking a sample of the patient's blood (by piercing their finger) in order to analyse its blood glucose levels. The FPG test is performed after the patient has gone at least 12h without food. This method is considered invasive & slightly painful (piercing process) but it is accurate. Well-conducted clinical trials proved that good control of diabetes & hypertension significantly reduces the risk for diabetic retinopathy. By the studies, spanning more than 30 years that treatment of retinopathy can reduce the risk for visual loss by more than 90%. Diabetic retinopathy is a well-known complication of diabetes mellitus.

In this paper, there are three major attributes of tongue color, texture & geometry are extracted. 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 formulaes, 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. There are also some separate researches where color, texture & geometry features are studied individual. But when these three features are combined, it give better result.

PROPOSED 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.

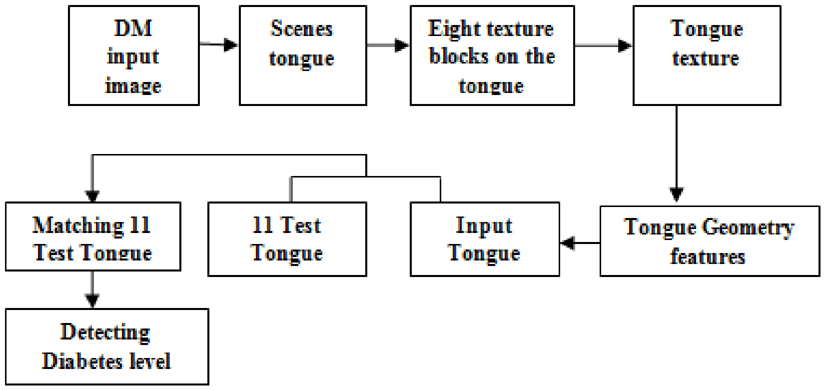

Figure1: A block diagram for proposed work

A. TONGUE IMAGE PREPROCESSING

For acquiring accurate & high-quality tongue images, there are various hardware systems have been developed. Tongue image can be taken by commercial digital camera for tongue diagnosis with there own internal color bias & environmental noise distortion color intensity. By using color checker, several color correction methods as like polynomial regression & topology resolve-map model have been pro-posed for medical image. For future development with preferred direction, the implementation of an accurate color acquisition system done because the color features of the tongue provide significant diagnostic information. Thus, the space resolution of the acquisition module is another important characteristic of TDS hardware resources with high resolution CCD camera of resolution of 8 megapixels with suitable lenses.

The high level image segmentation techniques have been improved to achieve a higher degree of accuracy in the tongue segmentation method but there are some problem in automation of the segmentation process. To segment the tongue objects, the active color model is an effective method. The contour is determined by the sum of energies, namely gradient around the contour position, elastic force & curvature of contour & these energies are calculated from the color information of the tongue image. The color & shape information of a tongue are used for tongue segmentation.

Then the tongue classification, the clinical features, such as a color of tongue coating, teeth-mask, fissure & shape of tongue, should be quantified & relations between the features & the technical properties, which are extracted from a tongue image should be identical.

B. COLOR FEATURE EXTRACTION

The classify tongue related colors with the tongue unrelated colors. Color centers value of main color categories & color distribution of typical image features, the color gamut is used. The tongue 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 colors stimulus with relative position of tongue color & its color composition.

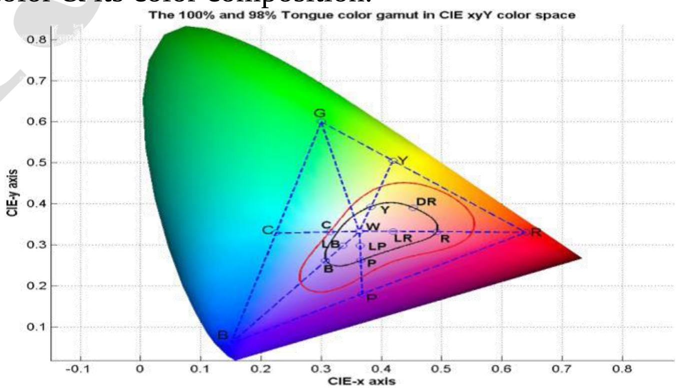

Figure 2: By using several points drawing lines from the RGB color space represents the tongue color gamut.

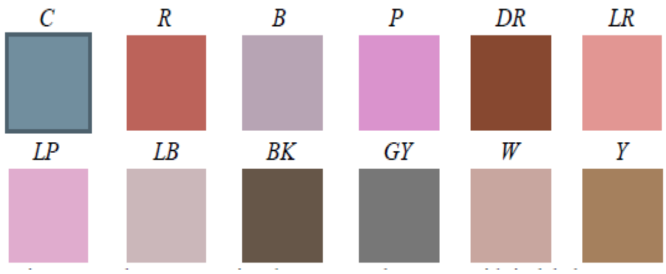

Figure 3: the tongue gamut represented in colors with its label on top

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.

C. TEXTURE FEATURES EXTRACTION

This section presents the texture feature extraction of tongue images. Eight blocks of size 64*64 strategically located on the tongue surface to represent the texture of tongue image. These block size are chosen for that it covers all eight surface areas vary well while achieving minimum overlap. The blocks are calculated automatically by first locating the centre of the tongue using a segmented binary tongue foreground image. From its centre to position the eight blocks, the edges of the tongue are established and equal parts are measured. Following figure shows the distribution of blocks for texture representation, the gabor filter is a linear filter is commonly used.
The 2D gabor filter is applied to compute texture values of each block as

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

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.

$$FR_i\,(x,y) = max(R1\,(x,y), R2\,(x,y),\ldots,Rn\,(x,y)) \quad \ldots (5)$$

Which 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.

D. GEOMETRY FEATURE EXTRACTION

In traditional medicines such as traditional Chinese medicine (TCM) the shape of a tongue can be used to determine a patient's illness. Geometry extraction includes various measurements of length, area & angle extracted from tongue images. The background removed and tongue foreground remain that segmentation is done in every image. Each tongue image consist of tip, body & root. The features we define 5 tongue shapes based on TCM by using 13 geometry features derived from measurements, distance, areas, & their ratio are extracted.

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

$$W = x(max) - x(min) \ldots (6)$$

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

$$l = y(max) – y(min) \ldots (7)$$

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

$$lw = l/w \quad \ldots (8)$$

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

$$z = min(l,w) / 2 \ldots (9)$$

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

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

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

$$cdr = cd/l \ldots (11)$$

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.

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

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)

RESULT 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 4.

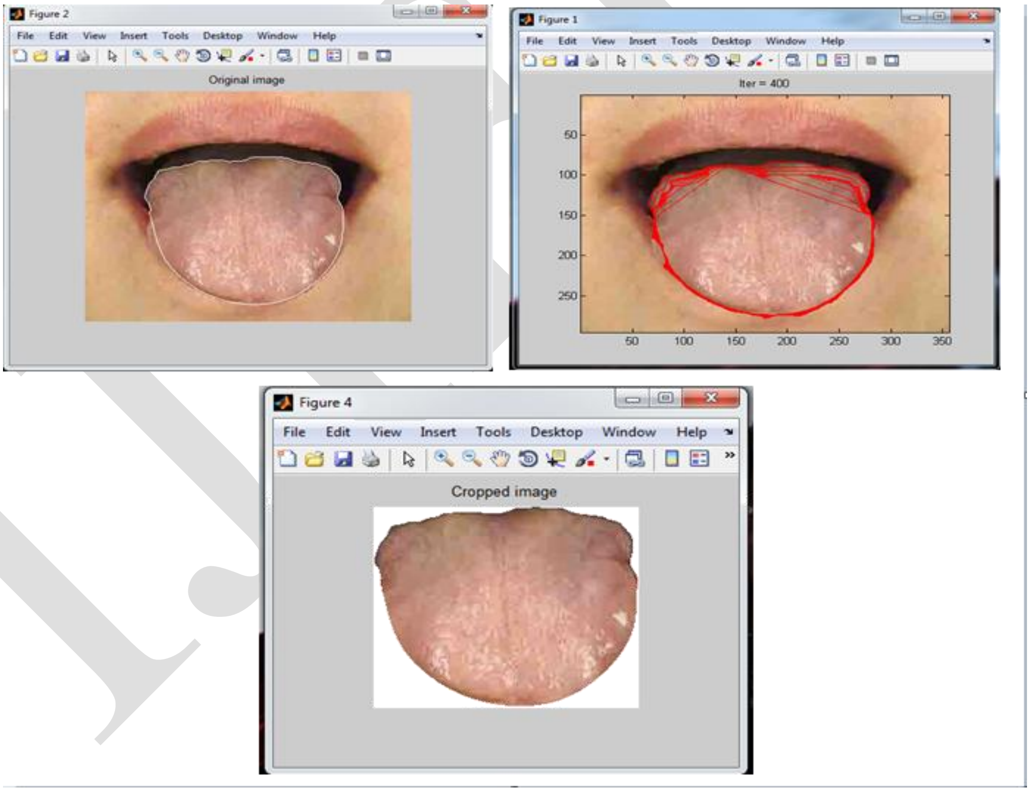

Figure 4: input image and its cropping

The colour 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 compared with 12 color gamut. As shown in figure 5.

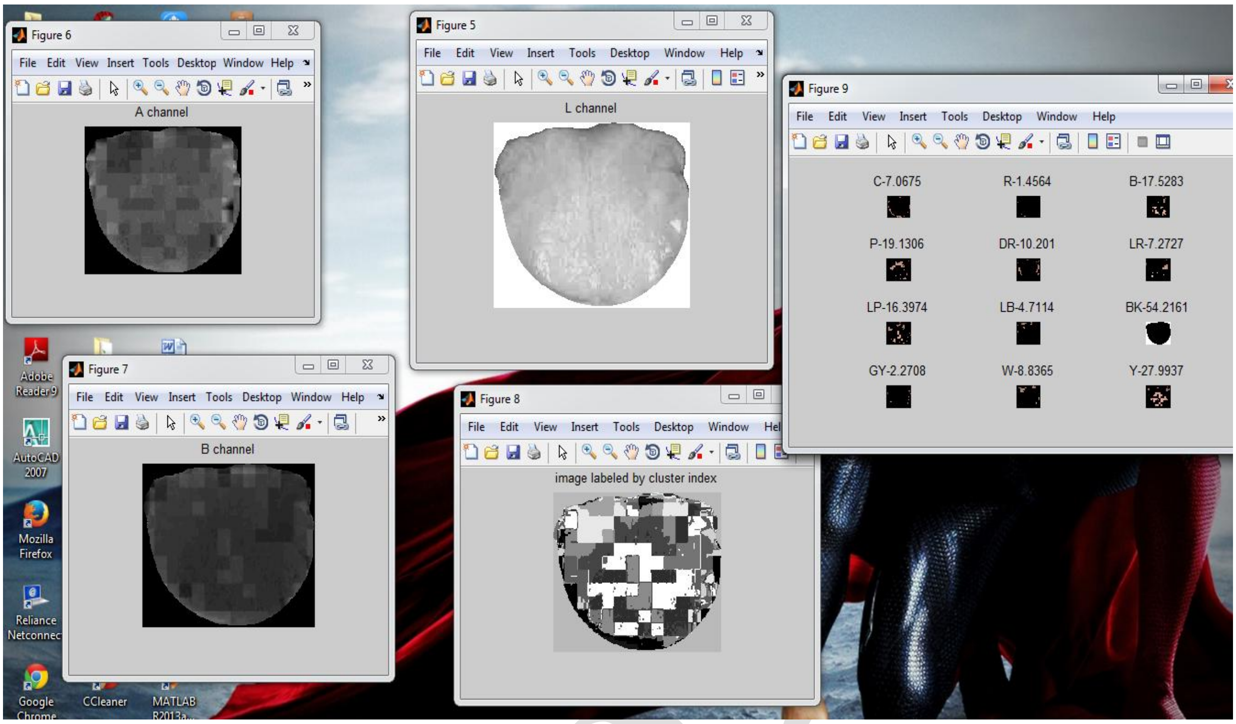

Figure 5: tongue images in color feature extraction

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 6.

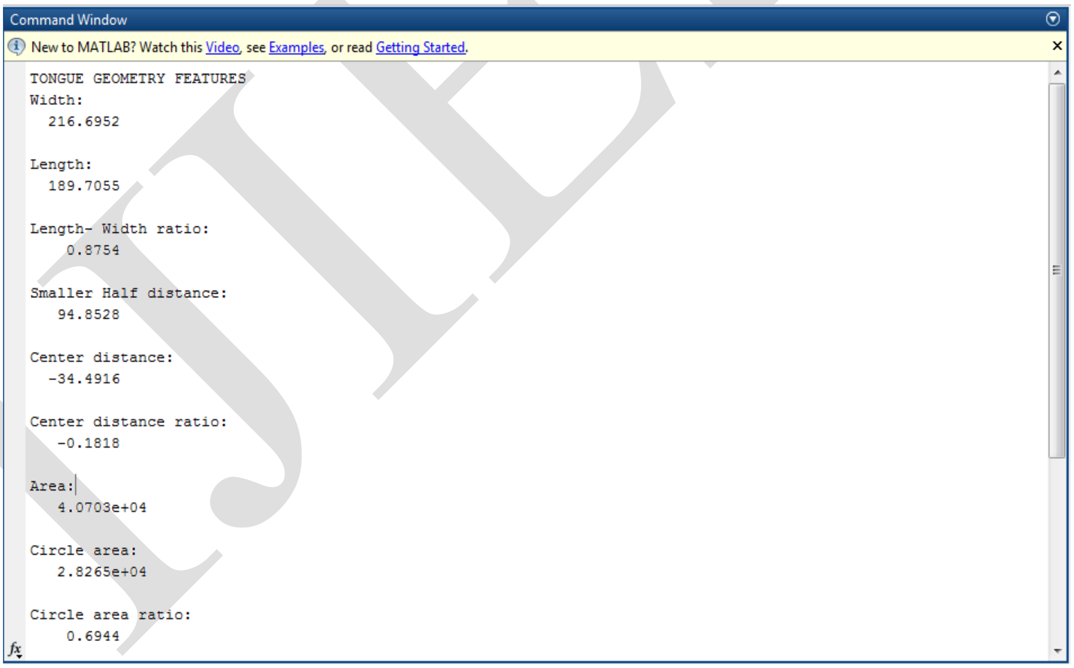

Figure 6: tongue geometric calculation

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 7 shows the block separation of input tongue image. We obtain different values for texture for tongue images from Healthy, DM dataset.

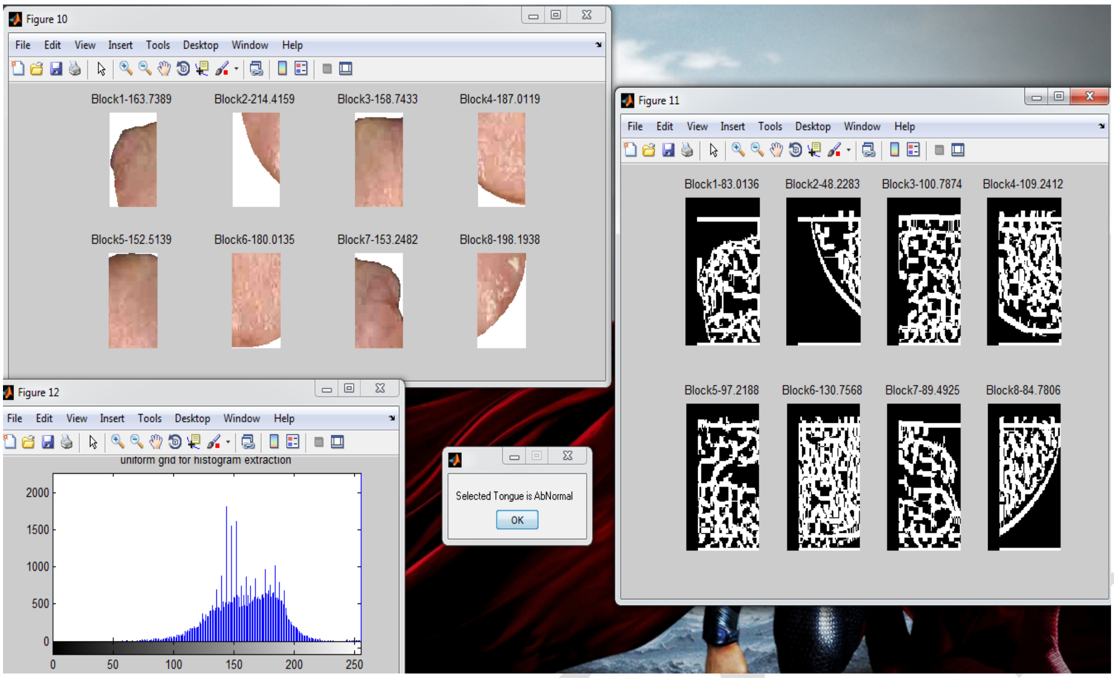

Figure 7: tongue texture feature extraction and result of tongue.

After all the colour, texture & geometry features are extracted, they are analyzed. SVM is used for classification. After training, the classifier is able to distinguish between healthy & DM patients with the help of the extracted features. And finally the result is displayed as shown in figure 7.

CONCLUSION

We have implemented 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.

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