Asian Journal of Information Technology 15 (3): 424-436, 2016
ISSN: 1682-3915

Tongue Image Analysis for Diabetic Diagnosis Detection Using Image Segmentation

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Abstract: The tongue is a burly organ used to speak, taste and swallow the food. The purpose of the organ extends to identify the inner working of a human body. Any unexpected reaction of the human body parts such as stomach, pancreas, liver and intestines will reflect on the tongue. The changes in the tongue ensures the misbehavior of the internal organs of the human being. The working mirror of the doctor reflects the discomforts occur not only in stomach and intestine but also, the variation of the presence of sugar level in the human body. It could be analyzed by the changes in the color and texture of the tongue. In this study, we propose the processing of tongue image by using PSO along with SRG method and then analysis the texture by using local binary pattern, local directional pattern and efficient local binary pattern. The filters are used to identify the exact changes in the tongue by comparing the images. We proposed the Image segmentation method; the segmented study of the tongue reflects the presence of Diabetes of a person in addition optimization technique is used to obtain the best result. The system framework comprises of capturing the image, preprocessing of the image, identifying the texture and color feature are implemented and identifies the problem effectively and the result achieved better performance when compared to all other existing techniques.

Key words: Tongue images, image segmentation, texture analysis, diabetic diagnosis, India

INTRODUCTION

The tongue analysis is the important and easiest method to identify the problem in the human body. By analyzing the patient tongue, the doctor can identify and came to an assumption that the patient has an issue or not. The tongue is also called as mirror this reflects the state of the body's inward organs, especially the organs of assimilation and the digestion system. The tongue reflects the general digestive, nutritive and metabolic state of the whole living being. The patient is requested to show out his/her tongue beyond what many would consider possible while opening his/her mouth as wide as could be allowed. The doctor looks at the tongue and analyzes deeply using a light which is free of any undue tinting or shading. The best and most common light is, obviously, daylight. The doctor must have the capacity to analyze the entire tongue from the root or base to the tip.

The human tongue has two parts: precedent and posterior. The precedent part is the visible part available at the front and hardly defined as two-thirds of the length of tongue. The posterior part is the area nearest to the throat and roughly one-third of length. The core organs of the vital faculty are located in the thoracic cavity are represented on the precedent section of the tongue, towards the tip. Initially, the organs are the heart and lungs with the heart at the very tip and the lungs are more posteriorly located. The precedent part of the tongue is visible at the apex, thin and narrow; it is easily forwarded against the lingual surfaces of the lower incisor teeth (Fig. 1).

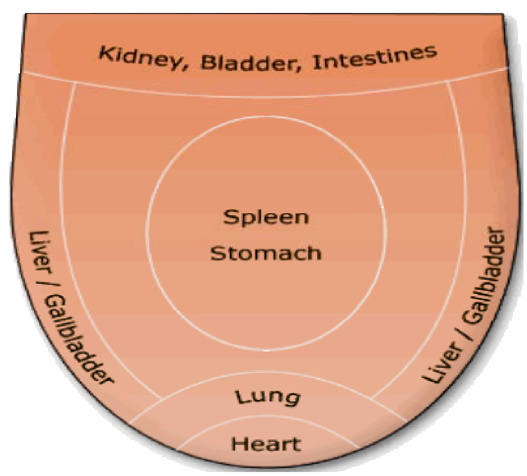

Fig. 1: Structure of a tongue

In this study, attention on the patient with diabetes is emphasized hence. not only the segmentation and

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specification of another region is corresponds to pancreas organs. By considering the middle rectangular region of the tongue and analyzing the color of the tongue and the coating, the diagnosis could be done by the examiner on this process. Many surveys have been focused recently aiming at solving the problems such as region growing for that it takes shadow characteristics of photography into consideration. FCM and shortest path are introduced to compensate the shortage of region growing. Combining the multi-hyper spectral features it constructs support vector machines for segmentation, etc. All above existing technique are applied to tongue segmentation and it solves some problems. The most widely used method in this field is Active Contour Model (ACM) or the Snake model which evolves an energy minimizing curve, initialized manually or automatically and then, it propagate to a real boundary on both internal and external force.

Issues found in the existing system: The following are the few of the reasons that are leads to the development of the tongue analysis continuously:

- The irregular shape of the tongue (it changes person to person) badly affects the gradient on parts of the boundary that result in bad segmentation result
- Analyzing the color mixture of the tongue is a difficult process where the minute changes don't identified effectively

Literature review: In study (Dhanalakshmi *et al*., 2013), the diagnosis of the tongue is done based on the color, shape, cracks and pimples. The difficulty faced by the doctors is the overlapping of colors, irregular shape and dominance of the saliva in the cracks of the tongue. The image enhancement method for processing the tongue image was proposed, in order to get the required features of the tongue. The proposed method mainly consists of two techniques: first is contrast enhancement with edge detection in grey scale. This is implemented for highlighting the shape, cracks, buds and pimples. Second; color enhancement, this is introduced for identifying the true nature of colors and coating on different parts of the tongue. The aim of the proposed method is to reduce the complexity in tongue understanding. Tongue images are the elementary features for diagnosis of various diseases. For the ease of the diagnosis, the tongue images should be processed clearly and properly. The main features that are used for diagnosing the tongue include shape, color, pimples, cracks and texture of the tongue. Tongue color varies widely from person to person but is a good indicator of the overall nature of what is going on in the body. As a result of this proposed technique shows a good result in diagnosing the tongue and leads to effective identification of the issues.

In study a novel method for automated tongue segmentation is presented by combining polar edge detector and active contour model (Zuo *et al*., 2004). Automated tongue segmentation is difficult process due to the complexity of pathological tongue, variance of tongue shape and interference of the lips. The following steps explains the steps to obtain the automated tongue segmentation, initially a novel polar edge detector is proposed to effectively extract the edge of the tongue body. A local adaptive edge bi level thresholding technique is also introduced. Finally, initialization and active contour model are proposed to segment the tongue body from the image. Polar edge detection is an innovative polar edge detector is proposed to extract the exact tongue boundary. This step is used to filter out the unwanted edge and binarize edge image.

In study tongue is an effectively available organ for the assessment of wellbeing in patients (Preshiya, 2015). Any unexpected working of the stomach, pancreas, liver gall blader and intestines will be reflected on the tongue. The characteristic changes happen in the tongue reflects the issues in the human being can be truly helpful and will provide some clues for diagnosing a percentage of the diseases. The following factors are to be considered in tongue for diagnosing such as shape, color, size and texture to identify the disease at the prior phase of any disease. To address these issues, this study presents a Tongue Computing Model (TCoM) for the finding of Diabetes in light of chromatic andtextural measurements. These metrics are computed from true color tongue images by using appropriate techniquesof image processing.

In study the color of the patient tongue is analyzed in different way with reference to the color of the tongue. Using the tongue color gamut, tongue foreground pixels are first extracted and assigned to one of 12 colors representing this gamut. A set of database is taken and analyzed based on the color of the tongue initially it classified into two major categories. The tongue color gamut represents all possible colors that appear on the tongue surfaceand exists within the red boundary. From a tongue image, the tongue color analysis system is able to first distinguish as a healthy versus disease with an average accuracy. To obtain the result with high performance proposed method uses a special capture device with image correction and extracts a tongue color feature vector from each image. This can potentially lead to a new painless and efficient way to examine patients.

In study a novel scheme of application of linear wavelets in digital image processing and statistical evaluation of tongue image for diagnosis in Ayurveda medical system is proposed (Dhanalakshmi *et al*., 2014).

The proposed system approaches to differentiate the tongue of a person with healthy or unhealthy conditions. It consists of two techniques applied sequentially: first, enhancement of the tongue image is done for extracting the real colors and textures on different parts of the tongue and then it apply wavelets transform. In the second step, the statistical features are identified and categorized whether the tongue image belongs to a healthy or unhealthy category. The analysis of the results reveals that our method can significantly assist in the tongue diagnosis. In addition, the proposed method helps in expanding the scope of tongue diagnosis system in Ayurveda medical system towards reliable and computationally inexpensive diagnostic model.

In study implement a fully automated active contour initial method by using the prior knowledge of tongue shape and location in tongue images (Shi *et al*., 2013). The geometrical snake model with the parameterized is combined and produces a GVF snake model, a novel approach of automated tongue segmentation: C2G2F snake (Color Control-Geometric and Gradient Flow snake) is introduced, this increases the curve velocity thereby decreases the complexity. Initially, the contour is firstly obtained based on the special shape of tongue body and its location on mouth. Then, the whole image is divided into two parts for evolution separately. As for concrete evolution, two steps would be carried on rough evolution and refine evolution. In rough evolution, a simplified geometric active contour model is adopted to quickly converge the curve to the neighborhood of real boundary and thenit is gradient vector flow model force the curve kiss-coating the real boundary. Color space information is innovatively introduced with the control informationto update the parameter of external force that helps in realizing seamless inter-grade between rough and refine evolution.

In study a novel method is suggested in order to extract tongue image accurately, it implements a multi objective greedy rules and makes fusion of color and space information (Zhu *et al*., 2014). Tongue image with coating is of important clinical diagnostic meaning this over comes the issue of traditional tongue image extraction method is not competent for extraction of tongue image with thick coating. The proposed method achieves ideal segmentation results whatever the types of tongue images may be and efficiency of the proposed method is also acceptable for the application of 1quantitative check of tongue image. Due to the important clinical diagnostic meaning of tongue image with coating, in the case of traditional tongue image extraction method cannot handle this kind of tongue image well so the proposed tongue image extraction method with fusion of color and space information which can handle tongue image with coating quite well. The results show, the effect of geodesic active contour isnot very ideal. When it comes to the tongue with thick tongue coating; only proposed method achieves ideal results.

In this study a tongue diagnosis method the process is divided into two steps (Park *et al*., 2011). In the first step, it detects the tongue from face image and then it divides the tongue area into six areas and finally generates tongue coating ratio of each area. For the first step, it uses the ASM as one of the active shape models, it detects the tongue area from face image. From the detected tongue area is divided into six areas widely used in the Korean traditional medicine and the distribution of tongue coating of the six areas is examined by SVM (Support Vector Machine). For SVM, it uses a 3-dimensional vector calculated by PCA (Principal Component Analysis) from a 12-dimentional vector consisting of RGB, HIS, Lab and Luv. As a result of this technique, the tongue area stably detected using ASM and found that PCA and SVM helped raise the ratio of tongue coating detection. PCA and SVM-based marking of tongue coating area for the divided subareas was found to allow for analysis of health condition ofthe body part corresponding to each subarea.

In study usually tongue diagnosing is carried out by processing the tongueimages but the processing of tongue image is not easy task tocarry out (Dhanalakshmi *et al*., 2012). The difficulty arises because of the irregular shape of the tongue, the different shape of the tongue and interference of lip with the tongue, etc. The proposed method implements a sequential method for processing the tongue image. This method consists of mainly three phases, first, shape detection phase; an edge detector with the aid of region growing algorithm is used for extracting the shape of the tongue. Secondly, color extraction, crack detection and pimple detection are done with help of colorintensity extraction method. Finally, the texture extraction ofthe tongue is done using the LGXP method which is efficient infinding texture from an image.

In study the purpose of the direct examination of the tongue was to emphasize morphological features: such as shape, type, characteristics of the longitudinal medial septum and the related grooves as well as the lingual apex type, all of these being preserved using the alginate moulding which helped taking the impression of the dorsal surface through directapplication (from the level of the oral commissures up to the lingual tip) and that of the lateral lingual edges up to the lingualapex level. Thus, the lingual impression, next to its photographic image, may constitute secure methods forforensic dentistry identification, showing that the inspection of the tongue is a real proof of life and genetic independence, in the sense that there are no two tongues with shape and texture, since lingual morphological aspects are difficult to copy and displaystability over time. This study states the primary features of the tongue such as shape, type and characteristics of a tongue.

MATERIALS AND METHODS

Loading the image: Initially, the image obtained from the patient is taken for further process where the exact retrieval of tongue part from the face region is an important part because the shape of the tongue won't be in a regular shape for all the human beings. Extraction of the required part from the whole image, by binarization the resolution of the image is enhanced then the axis is detected. The axis detected outcome is then forwarded to the thinning process where it is a morphological process and it is used to erect selected foreground pixels from binary images. It protects the topology (extent and connectivity) of the original region while throwing away most of the original foreground pixels. By implementing the PCC, it obtains minimal improvements in interpolation fidelity over the traditional, separable approach. Denoising process remove the noise from the image, getting as more relate to the original image with more possibility. To retrieve the exact needed image form the loaded image curve reconstruction is used (Fig. 2).

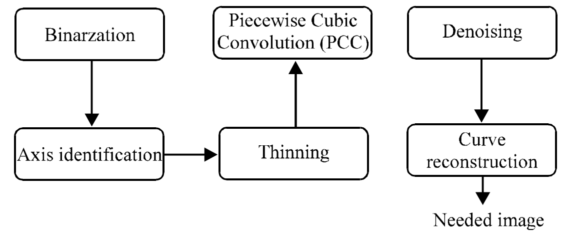

Fig. 2: Retrieving the required image

Fast fourier transformation: The fast fourier transformation is implemented to convert the image into real and imaginary components this result represent the image in the frequency domain. The input image is considered as number of frequencies in the frequency domain is equally considered as number of pixels in the image or spatial domain. The fast fourier transformation is used to convert the image into frequencies and by the inverse fourier transformation is used to transfer the frequencies into images in the spatial domain. The FFT of a 2D image is given as:

$$F(x) = \sum_{n=0}^{N-1} f(n) e^{-j2\pi\left(x\frac{n}{N}\right)} \tag{1}$$

The inverse FFT of a 2D image is given as:

$$F(n) = \frac{1}{n}\sum_{n=0}^{N-1} f(x) e^{-j2\pi\left(x\frac{n}{N}\right)} \tag{2}$$

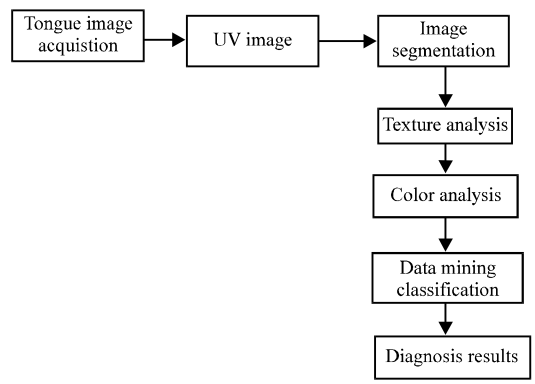

Fig. 3: System architecture

The FFT is used effectively by names of the 2D transform can be done as 2 step, Initially, 1D transforms, one is the horizontal direction followed by the other in the vertical direction at last results in the result of the horizontal transformation. The final results are having the capability to performing the 2D transformation in the frequency space:

$$F(x,y) = \sum_{m=0}^{M-1}\sum_{n=0}^{N-1} f(m,n) e^{-j2\pi\left(\left(x\frac{m}{M}\right)+y\left(\frac{n}{N}\right)\right)} \tag{3}$$

$$F(m,n) = 1/MN\sum_{m=0}^{M-1}\sum_{n=0}^{N-1} F(x,y) e^{j2\pi\left(x\left(\frac{m}{M}\right)+y\left(\frac{n}{N}\right)\right)} \tag{4}$$

The above mentioned Eq. 3 and 4 shows that the computations results can be reused thus avoiding the expensive operations. This filters the erquired image in order to retrieve the image by enhancing or detecting the image (Fig. 3).

Algorithm; image-construction:

- Input: spatial domain data
- Output: constructed frequency domain image
- Step 1: read in the spatial domain DATA
- Step 2: apply FFT in (x, y) direction
- Step 3: FFT shift
- Step 4: image display

Seeded region optimization: Seeded region optimization is an easy and error free method of partitioning which is fast and free of running parameters. The growth of seeded region is based on the growth of conventional postulate of similarity of pixels within the particular regions. SRG is comprised by selecting a (usually small) number of pixels known as seeds. Seeded Region Growing approach (SRG) is introduced for image segmentation is implemented to segment an image into regions with respect to a set of q seeds. Consider the set of seeds S1, S2 …Sq, each and every step of SRG includes detecting one additional pixel like S_n+1 from the original seed sets. Therefore, the primary seeds are further interchanged by centroids of the newly generated homogenous regions R1, R2...Rq by taken into the consideration of the additional pixels step by step. To detect and differentiate the regions, the pixels in the homogenous regions are represented by the samesymbol and the pixels in the different regions are labeled by different symbols. It consists of two steps; in step 1: calculates the area of interest on background and object properties of image. In order to place the seedcenter of the image is identify using the particular region generated. In step 2, region start to grow from initial seed placed in step 1. Growth of region depends upon the intensity value of the neighboring pixels as well as threshold value. If the intensity value of the neighboring eight pixels is same and it lies in the given threshold value the region will initiated to grow. In addition, it also verifies the already visited pixels. If a pixel is already grown therefore the particular part of region will not be sited repeatedly it is not considered if it comes as a neighboring pixel. This will reduce computational overhead. The algorithm is presented as follows:

- Select seed pixels within the image
- From each seed pixel grow a region
- Set the region prototype to be the seed pixel
- Calculate the similarity between region prototype and the candidate pixel
- Calculate the similarity between candidate and its nearest neighbor in the region
- Include the candidate pixel if both similarity measures are higher than experimentally set thresholds
- Update the region prototype by calculating the new principal component
- Go to the next pixel to be examined

Local binary pattern: Local Binary Pattern (LBP) is a simple and efficient texture operator, the pixels of an image is named by thresholding the neighborhood of each pixel and the result obtained will be in binary number format. This is a unique technique implemented effectively to analyze the texture of the tongue. From the previous step, we obtain the required retrieval of the image, the error free image is retrieved and undergone for the texture analysis.

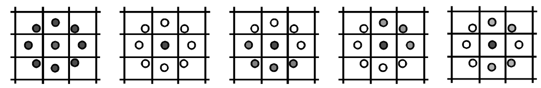

Fig. 4: Black or white dot representation of the input image

Figure 4 shows an example results in black or white representation with an intension of showing pixels that are less or more with respect to the central pixel. The pixel is surrounded by black and white region and then the image region is taken into consideration to be a flat region. The continuous group of black and white pixels is considered as uniform patterns that are considered to be edges and corners. If the pixels are arranged in non-sequence manner then it is consider being as non-uniform pattern. As the output of the phase the texture is analyzed effectively. This leads to the effective diagnosis of a patient.

Histogram generation: The histogram generation is implemented to identify the color analysis of the tongue. The color histogram is used for various purpose are listed as image retrieval, segmentation, color and intensity-based clustering, individual identification and authentication using biometric aproach as well as in many other applications. The implementation of color histogram results in an effective manner. The two images of same process is taken for analyze, the difference cannot be easily identified by the human eye. The HSV (Hue, Saturation, Value), the hue scale is segregated into eight groups, saturation scale is partitioned into two segments and the intensity scale is isolated into four groups. By combining above mentioned groups, it forms a total of 64 cells to represent a 64-component HSV color histogram. The reason behind this is having a various number of sets for the three scales that, of the three axes. One is hue, it is considered to be the most important, followed by intensity and saturation. For the H, S and V combination of values, the mentioned histogram component is identified. The respective histogram component is incremented by one for each pixel with the corresponding color combination. The single color region in large area is extracted initially and then followed by variant color regions. They use the binary color sets to indicate the color content as a color histogram:

$$N_h = [2\pi MULT\_FCTR] + 1 \quad (5)$$

Here, MULT-FCTR determines the quantization level for the hues. The number of components representing gray values is:

$$N_g = [I_{Max}/DIV\_FACT]+1 \quad (6)$$

Here, Imax is the maximum value of the Intensity, usually 255 and DIV-FCTR determines the number of quantized gray levels. We, typically, choose DIV-FCTR = 16.

RESULTS AND DISCUSSION

Tongue image of the both diabetic and normal tongue of the patient images are taken and processed under the analysis steps to identify. From the above steps, it shows the tongue image patient is affected by diabetic.

This is the initial step, the image is analyzed before the in taking the food. All the steps that are discussed in the proposed techniques are implemented (Fig. 5).

In this step, the image is analyzed after taking the food. All the steps that are discussed in the proposed techniques are implemented (Fig. 6). From the images taken before and after taking food segmentation is applied to identify the difference (Fig. 7).

After the segmentation process texture analysis is done by comparing both before and after food taken images (Fig. 8).

Once, the segment and texture analysis process gets completed the image is taken as an input for the color analysis (Fig. 9).

Figure 10 shows the diagnosis result of the tongue before food with the segmentation, texture and color analysis of the image.

Figure 11 shows the diagnosis result of the tongue after food with the segmentation, texture and color analysis of the image.

This result shows whether the patient have the diabetics or not from the analysis process that are taken before (Fig. 12).

Similarly, below result images shows normal patient without diabetic. The same procedures are followed and that are explained below. However, the procedures and steps are done similarly the result image shows exactly the patient is without diabetic.

The input tongue image is analyzed before the in taking the food. All the steps that are discussed in the proposed techniques are implemented (Fig. 13).

In this step, the image is analyzed after taking the food. All the steps that are discussed in the proposed techniques are implemented (Fig. 14).

From the images taken before and after taking food segmentation is applied to identify the difference (Fig. 15). After the segmentation process texture analysis is done by comparing both before and after food taken images is shown in Fig. 16.

Once, the segment and texture analysis process gets completed the image is taken as an input for the color analysis is shown in Fig. 17. The color analysis of the input image after taking food is shown in Fig. 18.

Figure 19 shows the diagnosis result of the tongue before food with the segmentation, texture and color analysis of the image.

Figure 20 shows the diagnosis result of the tongue after food taken with the segmentation, texture and color analysis of the image.

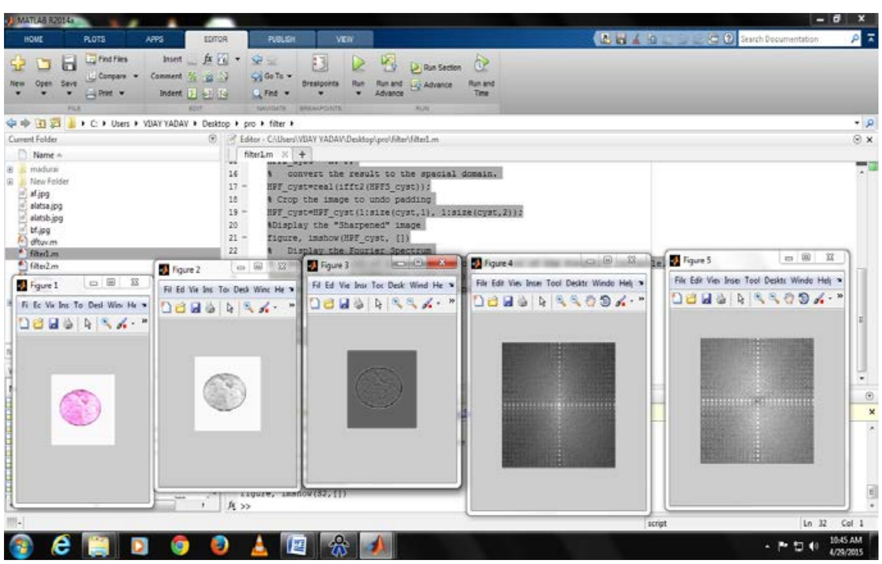

Fig. 5: Image analysis before food

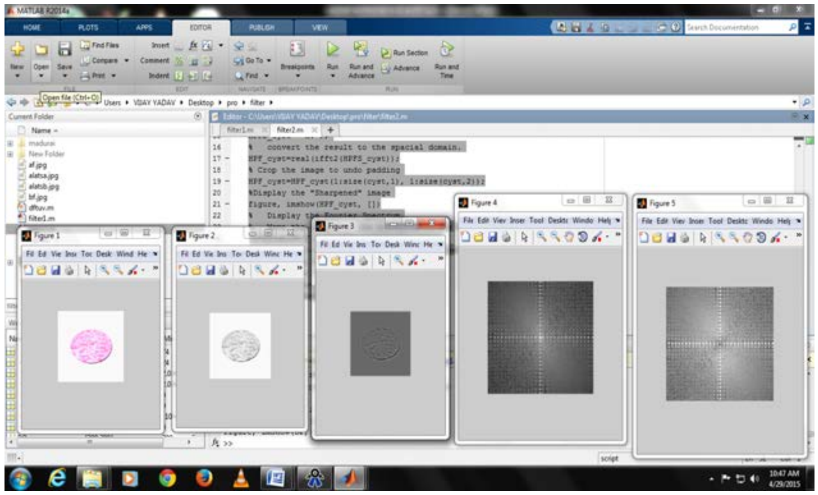

Fig. 6: Image analysis after taking the food

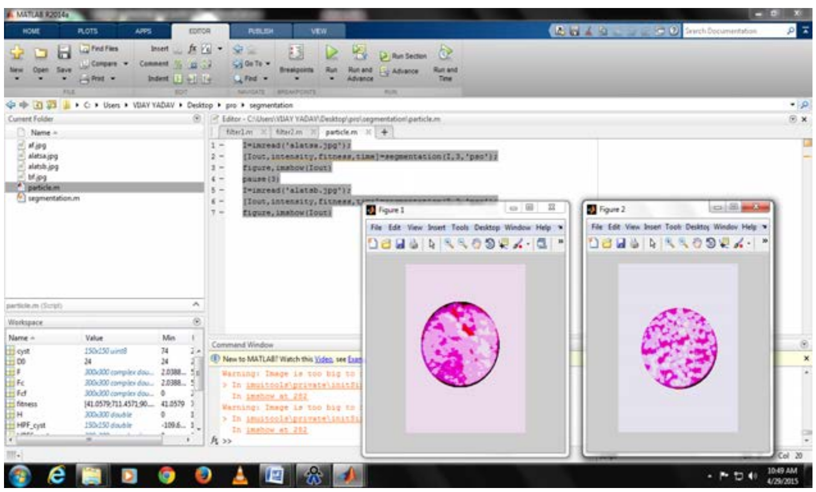

Fig. 7: Image segmentation: before and after food

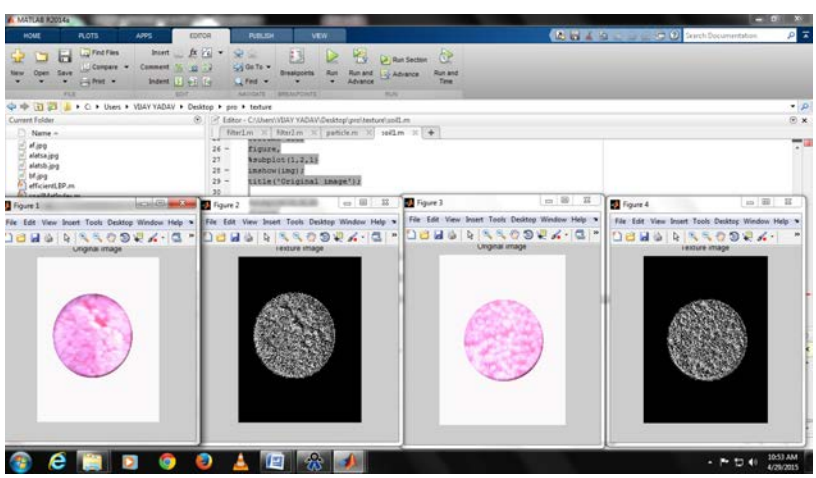

Fig. 8: Texture analysis: before and after

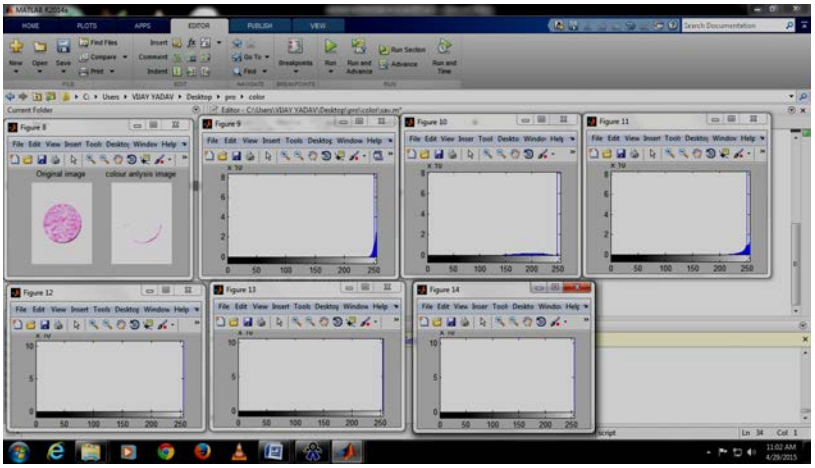

Fig. 9: Color analysis: after food

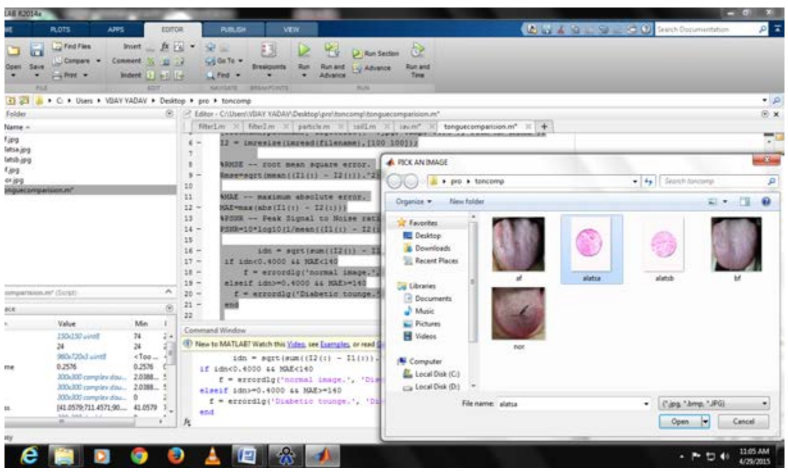

Fig. 10: Diagnosis results: before food

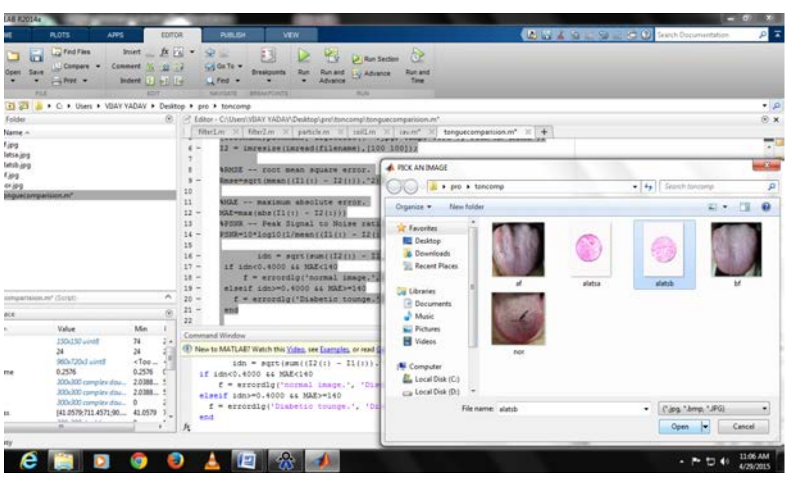

Fig. 11: Diagnosis result: after foo

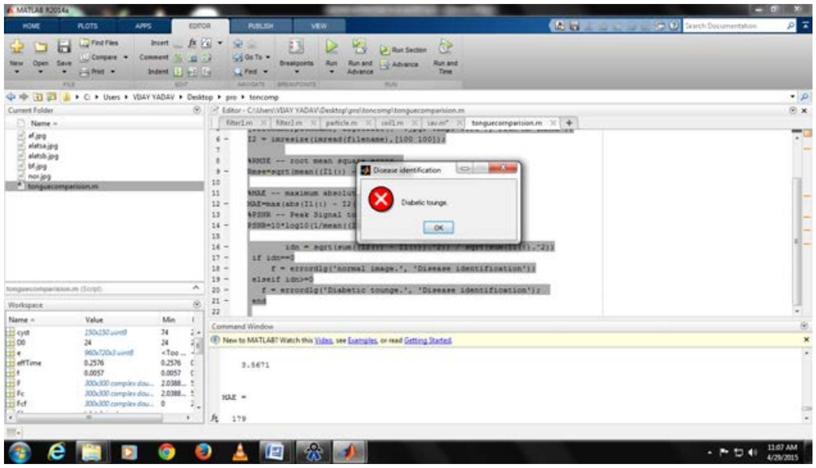

Fig. 12: Diagnosis result

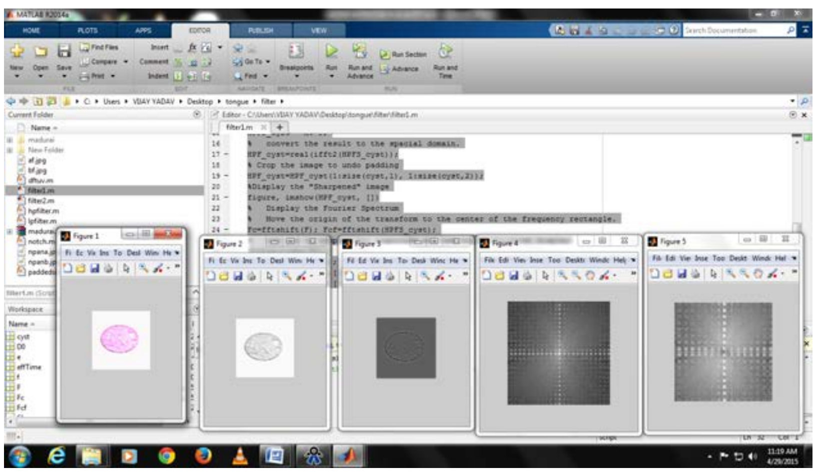

Fig. 13: Image analysis before food

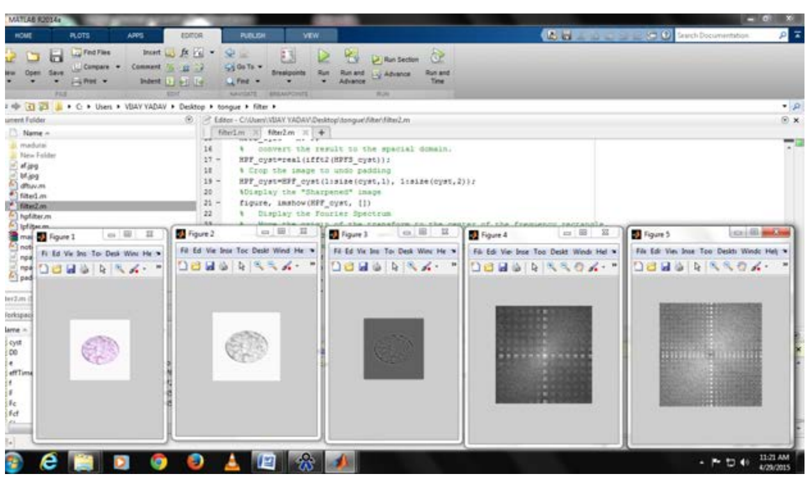

Fig. 14: Image analysis after taking the food

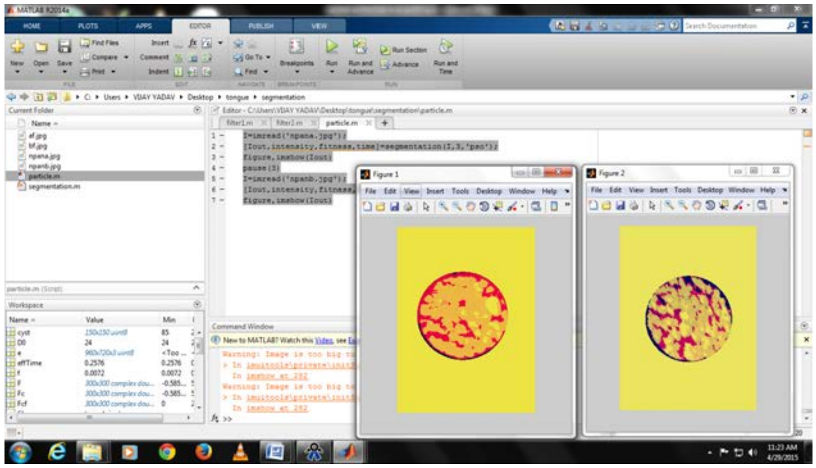

Fig. 15: Image segmentation: before and after food

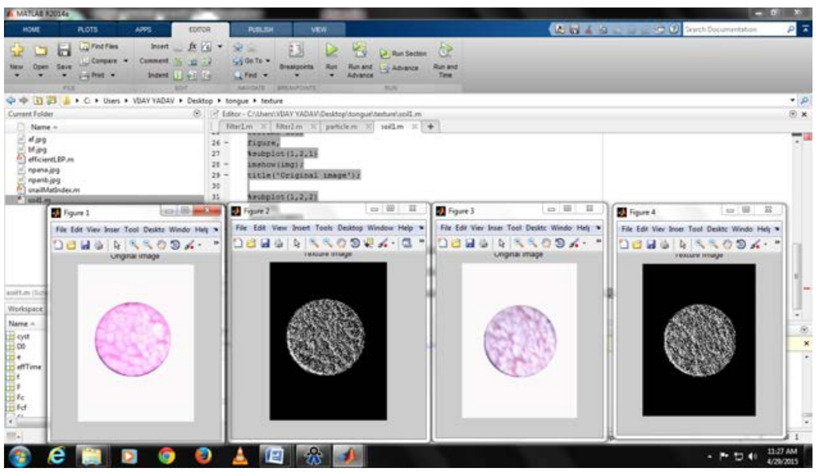

Fig. 16: Texture analysis: before and after food

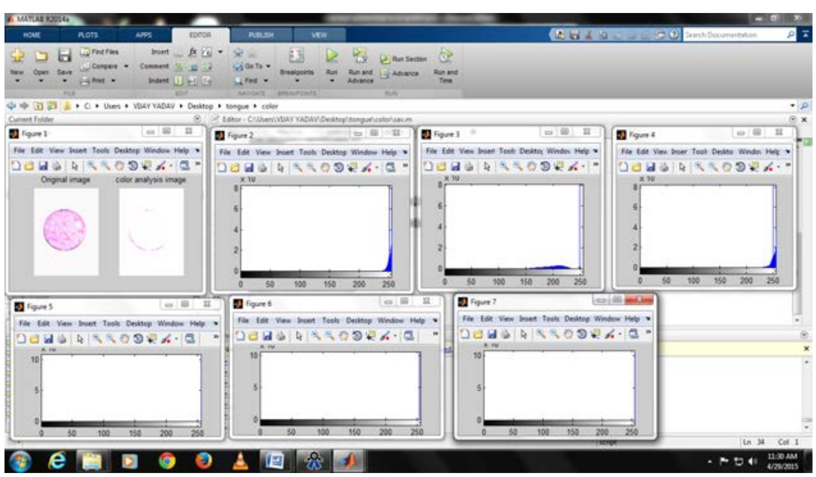

Fig. 17: Color analysis: before food

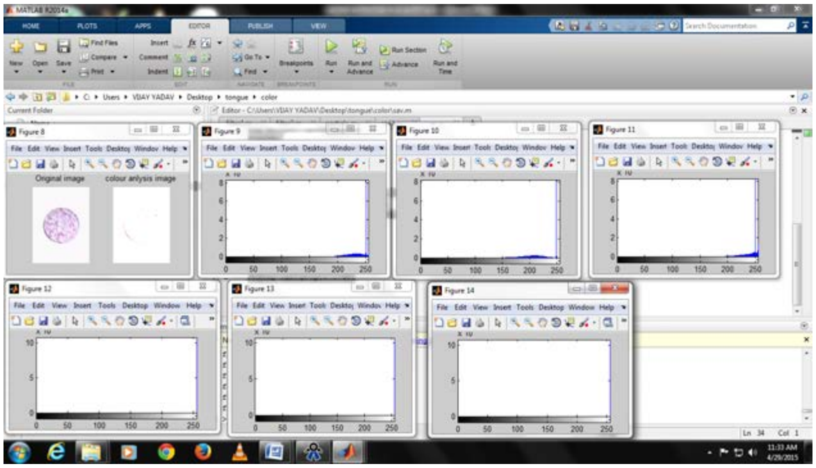

Fig. 18: Color analysis: after food

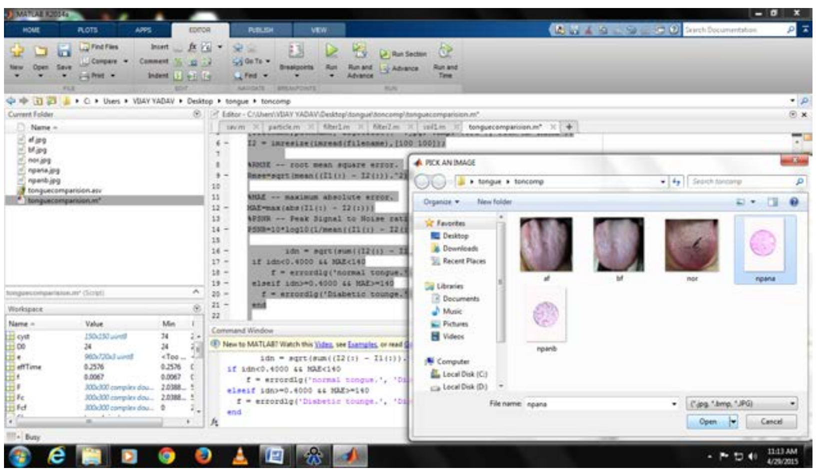

Fig. 19: Diagnosis results: before food

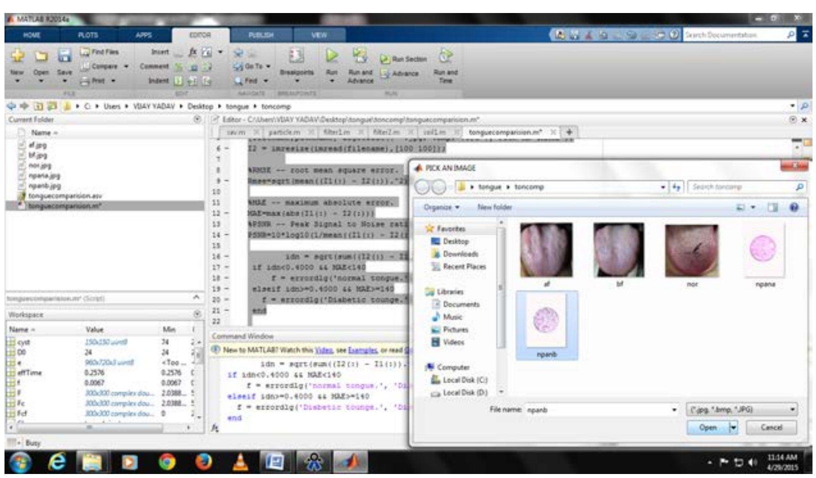

Fig. 20: Diagnosis result: after food

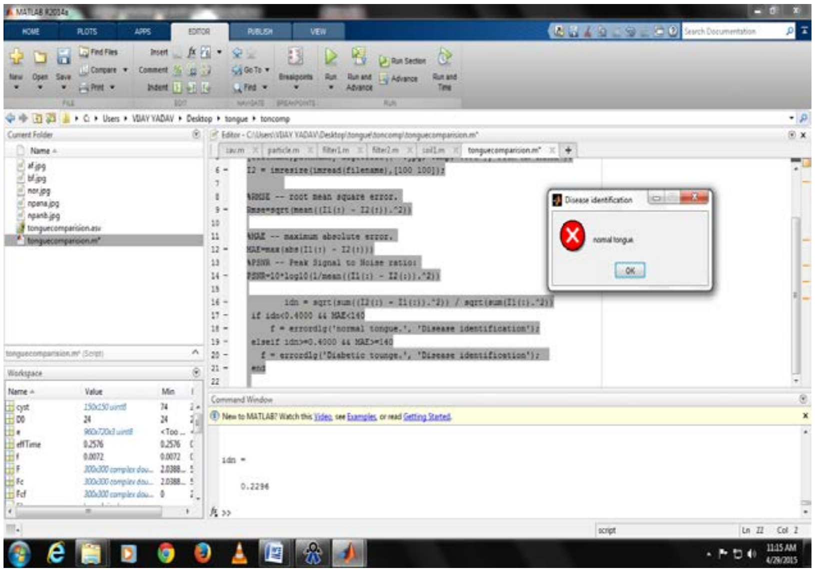

Fig. 21: Diagnosis result

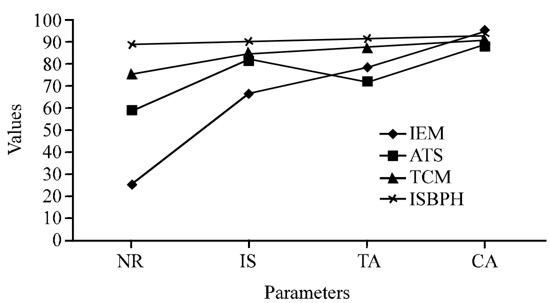

Fig. 22: The performance analysis parameters: NR = Noise Reduction; IS = Image Segmentation; TA = Texture Analysis; CA = Color Analysis

This result shows whether the patient have the diabetics or not from the analysis process that are taken before. The result shows the patient is a normal patient without diabetics (Fig. 21).

Performance analysis: The performance analysis graph shows the result of how the proposed techniques are works on the parameters such as noise reduction, image segmentation, texture analysis and color analysis. The performance analysis shows that the proposed algorithm work effectively compared to existing algorithms by comparing the parameters shown in Fig. 22.

Compared Algorithm: IEM = Image Enhancement Methods, ATS = Automated Tongue Segmentation, TCM = Tongue Computing Model and ISBPH = Image Segmentation Binary Pattern Histogram.

CONCLUSION

In this study, we have presented an effective method of analyzing the diabetics by means of tongue analysis. The process is done in two ways, before taking food and after taking food. Initially the image is loaded and the tongue image is identified and extracted from the loaded image. Then, the filter is applied to eliminate the irrelevant particles. Fast fourier transformation is implemented to convert the image into frequencies similarly by inverse fourier transformation, it converted to image. Seeded region optimization, local binary pattern and histogram generation are implemented to analyze the texture and color of the tongue. Hence, the experimental result shows a better result in diagnosing of diabetic by tongue analyzing with respect to analyzing it in before and after taking food.

REFERENCES

Dhanalakshmi, M., P. Premchand and A. Govardhan, 2012. An approach for tongue diagnosing with sequential image processing method. Int. J. Comput. Theory Eng., 4: 322-322.

Dhanalakshmi, M., P. Premchand and A. Govardhan, 2013. Tongue diagnosing with sequential image enhancement methods. Int. J. Eng. Adv. Technol., 2: 831-835.

Dhanalakshmi, M., P. Premchand and A. Goverdhan, 2014. Applying linear wavelet transforms and statistical feature analysis for digital tongue image. IOSR. J. Comput. Eng., 16: 95-102.

Park, J.W., S.K. Kang and S.T. Jung, 2011. Tongue diagnosis system based on PCA and SVM. World Acad. Sci. Eng. Technol. Int. J. Comput. Electr. Autom. Control Inf., 5: 1729-1732.

Preshiya, D.J., 2015. Diagnosing diabetics with reflex zones of the tongue using colourimage segmentation. J. Chem. Pharm. Res., 7: 876-881.

Shi, M., G. Li and F. Li, 2013. C2G2FSnake: Automatic tongue image segmentation utilizing prior knowledge. Sci. China Inf. Sci., 56: 1-14.

Zhu, M., J. Du and C. Ding, 2014. A comparative study of contemporary color tongue image extraction methods based on HSI. J. Biomed. Imaging, 2014: 1-10.

Zuo, W., K. Wang, D. Zhang and H. Zhang, 2004. Combination of polar edge detection and active contour model for automated tongue segmentation. Proceedings of the Third International Conference on Image and Graphics (ICIG'04), December 18-20, 2004, IEEE, Hong Kong, China, pp: 270-273.