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"A Novel Method to Get Proper Tongue Image Acquisition and Thresholding for Getting Area of Interest"

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Abstract: A need of reliable Automated tongue analysis system which may help the user to get an idea about his/her health. As per Ayurveda, Chinese medicine and homeopathy tongue appearance gives lot of information about one's health. As tongue analysis come under non- invasive method one can easily go for it without any fear for expensive invasive methods. In non-invasive method like tongue analysis Experts opinion play very important role which also, hinders proper analysis. A reliable automated tongue analysis system may overcome this problem. This paper focuses on two major problem faced while using automated tongue analysis system i.e. proper position of tongue for maximum area coverage and better thresholding method to get area of interest.

Keywords: TDS, GLCM, Thresholding, Energy, Entropy, Area, Perimeter.

I. INTRODUCTION

Due to the advancement in technology with availability of high speed devices and the scarcity of time due to the fast life style there is a need of systems which can detect the health of any person just by visualizing the image of tongue.

There are lot of pathological test and invasive methods to detect the health of person. But every one doesn't want to go for such tests without any pain of illness earlier diagnosed. Such negligence may led to severe problem in future. The medical practitioner in Ayurvedic medicine, traditional Chinese medicine and homeopathy visualize the eyes, tongue , lips, face and conclude about the disease of patient. In this process the judgment of medical practitioner depends on his/her knowledge[1][15][16][17].

Not every person can reach to such an experienced medical practitioner to get proper knowledge about their health. If a system is developed which help the user about his/her health then the person may go for other medical test if detected ill.

Proper Tongue analysis can lead to detection of several diseases. In this process Tongue is analysed on the basis of different regions, its quality, fur, coating colour etc. As discussed tongue may be a mirror to one's health.

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If the experienced medical practitioner is not present then the image of tongue is taken and send to experienced medical practitioner for analysis. Another solution is also there i.e. An automated tongue diagnostic system[20][21].

In automated tongue analysis the image of tongue is taken under the guidance of experienced person and it is being processed by this system to judge one's health. Some issues are faced in automated tongue analysis like:

1.1 Problem faced in automated tongue diagnosis

The main problem which is faced in image analysis of the tongue is capturing the proper image of tongue. The image which very close to the real tongue will produce better tongue analysis by medical practitioner. The hindrance in images capturing is focused by many researcher and developed an automated tongue analysis system.

Area of interest has to obtain from the Capture tongue. This area of interest is further processed for different analysis. Different methods are present to obtain the area of interest. one of them is using thresholding.

Some researchers has focused on these issue some of them are discussed here too. Jung et al. [2] discussed about the hardware for tongue diagnosis systems (TDS) which includes the sensing module, illumination module and control module. They have also discussed about different TDS used by different researchers with varying imaging devices and inbuilt colour calibration methods. Tadaaki Kawananbe et al. [3] used DS01-B tongue image acquisition system which has LED for light source and CCD camera which captures image. Jung, Kim et al. used frontal and profile feedback gridlines along with two CCD camera in front and on right side and monitor to locate the tongue position. User can avoid the motion of tongue by observing its image in the monitor. [4] Rahman et al[5] used portable imaging system and says that simple imaging device may improve oral screening efforts with less resources. It uses LED for illumination with blue LED having peak wavelength 455nm for fluorescence imaging. This system allows to record and store the images. Zhi Lui et al. [6] Used AOTF technology based hyper spectral tongue image system to detect the tumour. The recognition rate achieved is 96.5%.Here the spectral characteristics based algorithm was used distinguish between tumours and normal tissues.Different researchers have proposed different techniques to overcome the hindrance of image capturing issue. Some has used the light illumination, colour correction and filtering methods to improve the quality of captured image.

Zhang, H. Z., Wang et al.[7] used SVR based colour calibration method to circumvent the colour distortion and image interchangeable problems in the image acquisition of tongue.

Tadaaki Kawananbe Et al. [3] used DS01-B which has analysis software colour correction and clipping algorithm, to improve the quality of captured image.

Zhong et al.[24] used mouth location method to active appearance model (AAM) for automatic tongue segmentation. This method was infeasible since it method requires different initial contour for tongue body.

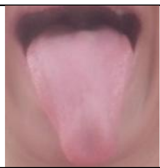
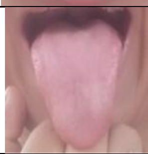
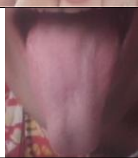
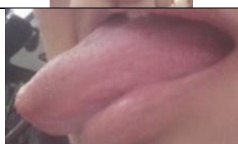
For fixing the tongue position, Jung et al.[4] proposed frontal and feed-back gridlines method. In this the shape feature was compared using intra class correlation coefficient, and shape feature was found to be lower as compared to the color feature.

Then also tongue position is yet to be issue for getting maximum area coverage and proper image acquisition.

II. METHOD AND PROPOSED SOLUTION

Despite of development in the tongue analysis system still there is need of improvement in the tongue image acquisition in proper manner so, as to do the analysis in better way. The dedicated setup used in tongue image analysis couldn't be available everywhere. If a low cost setup is needed for analysis. As position of tongue plays an important role in image acquisition, this paper proposes a better tongue position without use of expensive Tongue diagnostic system available now a days. The image capturing is done by simple digital camera present mobile phone. Subject is asked to take different positions to cover maximum area of tongue. 21 Participants took part in this experiment with the age group 2yr to 82 yrs including both male and female. 74 digital images of top view of tongue are analysed for best position, 57 images for right side view are analysed and 58 left side tongue images are analysed in this experiment. The main aim of this is to cover the maximum area of tongue. Day light is used for illumination to avoid the expensive illumination setup. The image is taken while keeping the camera 6 inch apart of the subject. Out of 5 positions best position is given .The subject is asked to wash mouth with warm water and given tissue paper to wipe off extra saliva which hinders the image capturing quality. Then he/she is asked to take positions given in table 1.

Table 1: Different tongue positions for getting top and side view of tongue.

S. No.	Position	Area covered in tongue image	Image	Camera position
1	Simple sitting and take out tongue	Top		In front 6 inch apart
2	While sitting take out tongue and give support to chin with fist	Top		In front 6 inch apart
3	While sleeping take out tongue	Top		In front 6 inch apart
4	Lean forward and give fist support to lower lip and take out tongue	Top		In front 6 inch apart
5	Stretch out tongue in right side	Left Side		In front 6 inch apart
6	Stretch out tongue in right side and stretch the lips corner in left side	Left Side		In front 6 inch apart
7	Turn face right 45^0 Stretch out tongue in right side and stretch the lips corner in left side	Left Side		In front 6 inch apart

The top view is obtained from four different positions (1,2,3,4) and the side view is obtained from three different positions (5,6,7) keeping the digital mobile camera 6 inch apart of tongue.

Distance between the camera and tongue also affects the quality of image so, an optimum position of 6 inch was kept fixed for each image acquisition.
The tongue images obtained from above positions are processed using the Gray level co-occurrence metrics (GLCM) and the area perimeter and shape are obtained.

2.1 Gray Level co-occurrence Matrix (GLCM) :

The Gray Level co-occurrence Matrix (GLCM) method is a way of extracting second order statistical texture features. The approach has been used in a number of applications. A GLCM is a matrix where the number of rows and column is equal to the number of gray levels, G, in the image. The matrix element P(i, j | Δx, Δy) is the relative frequency with which two pixels, separated by a pixel distance (Δx, Δy), occur within a given neighbourhood, one with intensity i and the other with intensity j. One may also say that the matrix element P(i, j | d, θ) contains the second order statistical probability values for changes between gray levels i and j at a particular displacement distance d and at a particular angle (θ) [10][12].

2.2 Extraction of texture features using GLCM:

GLCM is used to calculate the spatial dependence of gray levels in an image. Co-Occurrence matrices are constructed in four spatial orientations (0^0,45^0,90^0 and 135^0).Gray level tongue image is used to extract the features. Initially the value of each element in GLCM (I, j) is zero. The relation between pixels is calculated horizontally towards right (0^0 second pixel apart.)The value of each element is updated as per the occurrence of pixels together. The features calculated using the GLCM are Autocorrelation, contrast, energy, entropy [13][14]. The formula of these features are given in table 2.

Table 2: Details of formula for calculating the different features from GLCM

S.No	GLCM Parameter	Formula
1	Correlation	$\sum_{i,j=0}^{N-1} \mathrm{Pi,j}[\frac{(\mathrm{i}-\mu\mathrm{i})(\mathrm{j}-\mu\mathrm{j})}{\sqrt{(\sigma\mathrm{i}2)(\sigma\mathrm{j}2)}}]$
2	Contrast	$\sum_{i,j=0}^{N-1} \mathrm{Pi,j(i-j)(i-j)}$
3	Energy	$\sum_{i,j=0}^{N} Pi,j^2$
4	Entropy	$\sum_{i,j=0}^{N-1} \mathrm{Pi,j}(-\ln Pi,j)$

2.3 Extraction of shape features using connected regions:

Shape is a binary representation of extend of the object. Shape features gives the geometric properties of an object and the external boundary is used to calculate these features. Major features based on shape are Area, Perimeter and Circularity. Image can be classified based on the extracted shape features. Shape features are basically calculated using the connected regions of the image. Pixels present on the Boundary region are used to calculate the perimeter and area. The area and perimeter of same tongue is calculated for different tongue positions to know which position gives maximum area coverage. The formulas used to calculate shape features are given in Table 3

Where Ed(i,j) is the boundary pixels of the region

$$Ed(i,j) = \begin{cases} 1, if\ connectivity\ of\ b(i,i) == 2 \\ 0, else \end{cases}$$

$$b(i,j) = \begin{cases} 1, f(i,j) \geq T \\ 0, f(i,j) < T \end{cases}$$

$$T = \frac{1}{2}[maxf(i,j) - minf(i,j)]$$

Table 3: Details of formula to calculate the area and perimeter using connected regions.

S.No	GLCM Parameter	Formula
1	Area	$\sum_{i,j=0}^{M,N} b(i,j)$
2	Perimeter	$\sum_{i,j=0}^{M,N} Ed(i,j)$

2.4 Obtaining Tongue area of interest:

The automated image analysis can be done after eliminating the background in tongue image.

The boundaries of tongue can be obtained by using different methods. Thresholding is used in area/perimeter calculation of tongue area done is last step.

Different thresholding methods are present but this study paper aims to obtain the better thresholding method for getting maximum possible features in ROI .

Here we compared different thresholding methods for getting tongue area of interest. The comparison is done in between a) global image threshold using iterative ISO data method[8] b)Adaptive thresholding method [9] c) Thresholding using fixed intensity value. The results of different thresholding methods are shown in table 6 and

7.After getting the tongue area of interest any analysis can be done further.

III. RESULTS AND DISCUSSION

A. Using the Area and Perimeter formula both the parameters are calculated for the same tongue with different positions of tongue. The details obtained for the top view with different positions are shown in table 4 and the details obtained for side view with different positions are shown in table 5.

Table 4: Comparison of area and perimeter of different tongue positions for getting top view of tongue.

S.No.	Area/perimeter of tongue with different positions				
	Parameter	Sleeping (Position 3)	Simple sitting (Position 1)	Simple sitting with fist support (Position 2)	Lean down with fist support (Position 4)
1	Area(number of pixel)	205584	204405	187170	374272
2	Perimeter (number of pixel at boundary)	2005.017	1784.444	1879.497	2501.535

Table 5: Comparison of area and perimeter of different tongue positions for getting side view of tongue.

S.No.	Area/perimeter of tongue with different positions, left/right						
	Parameter	Simple left turn	Simple left turn with lip stretch	Neck 45 degree left turn with lip stretch	Simple right turn	Simple right turn with lip stretch	Neck 45 degree right turn with lip stretch
	Tongue left turn for right side tongue image			Tongue right turn for left side tongue image			
1	Area(number of pixel)	188813	312343	355331	174075	235133	245813
2	Perimeter(number of pixel at boundary)	1946.78	2498.25	3121.31	1824.79	2256.54	2244.79

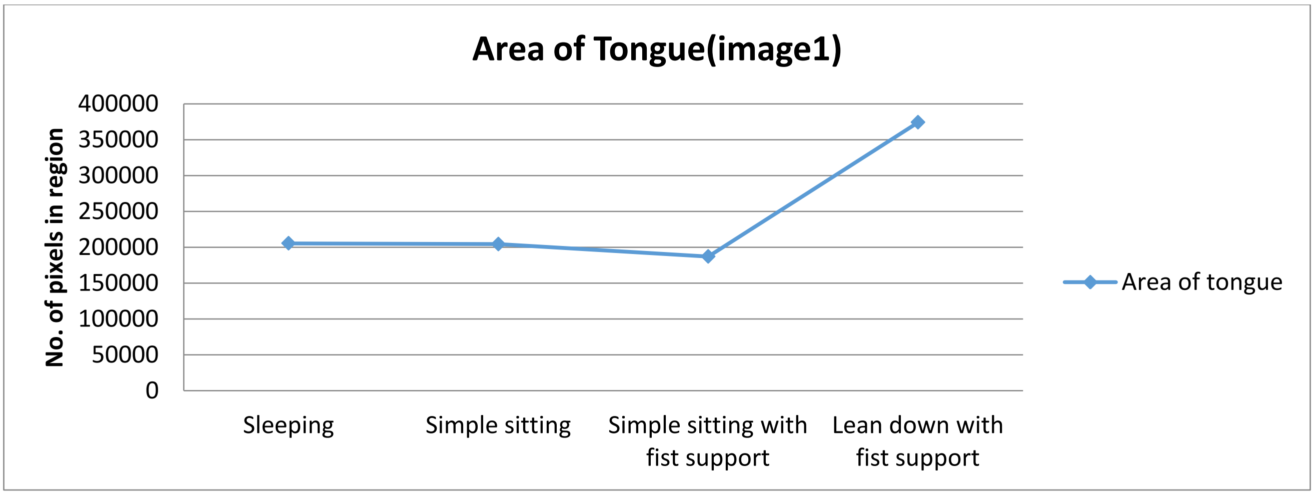


Fig:1.1 Comparison of area and perimeter of different tongue positions for getting top view of tongue.

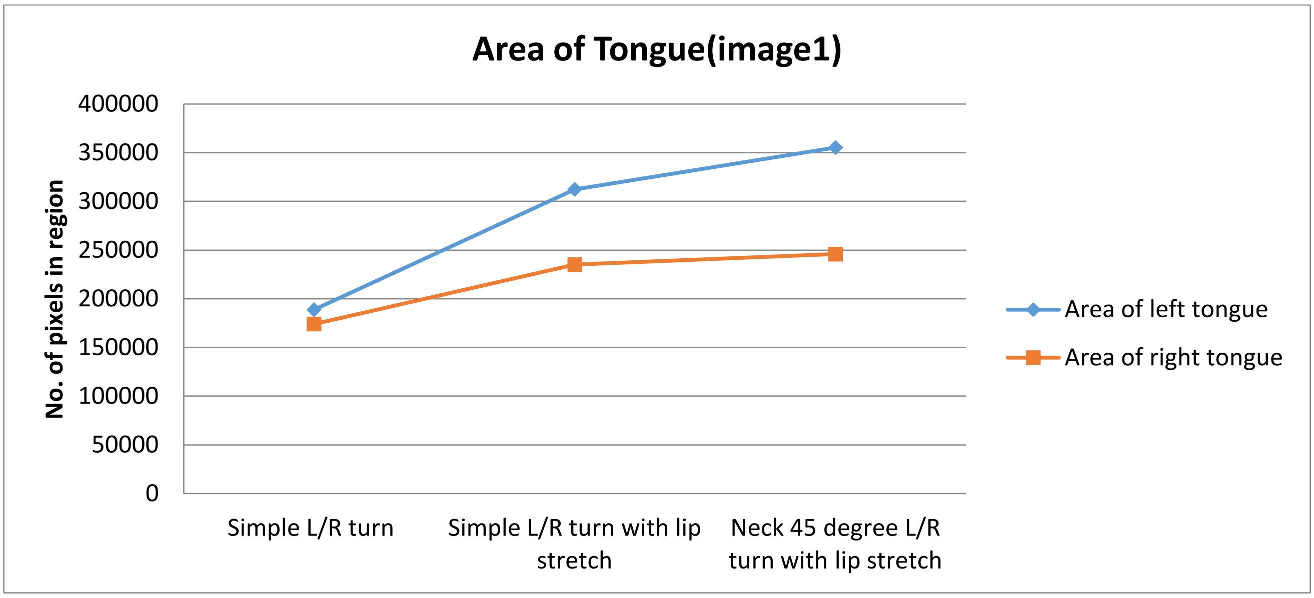


Fig:1.2 Comparison of area and perimeter of different tongue positions for getting side view of tongue.

After the analysis of above parameters one can conclude that:

1. For the top view of tongue Position 4 (Lean forward and give fist support to lower lip and take out tongue) covers maximum top area out of four tongue positions(1,2,3,4).
2. For the side view of tongue Position 7 (Turn face right 45^0 Stretch out tongue in right side and stretch the lips corner in left side) covers maximum area out of three positions(5,6,7).

After the analysis of tongue images position 4 give 100% better results and position 7 gave 63% result for left side image and 95% results for right side image.

B. The values kept for different threholding methods are: In fixed intensity thresholding the intensities are kept less than 80 and 120. For the Adaptive thresholding mean filter is used with varying window size 3 or 5 and C= 0.01 or 0.03. Thus a comparison is done in between seven different thresholding methods for two different tongue images. Two different tongue images are taken and GLCM based features Autocorrelation, contrast, energy and entropy are studied to know which thresholding method is better for tongue image analysis. The results are shown in table 6 and 7.

Table 6: Comparison of different features for tongue image1 using different thresholding methods.

Features	Adaptive thresholding (w=3,C=0.01)	Adaptive thresholding (w=3,C=0.03)	Adaptive thresholding (w=5,C=0.01)	Adaptive thresholding (w=5,C=0.03)	ISO thresholding	Simple thresholding (Intensity<80)	Simple thresholding (Intensity<120)
Autocorrelation	3.66	3.88	3.47	3.80	2.45	1.35	2.00
Contrast	0.11	0.04	0.16	0.06	0.04	0.02	0.04
Energy	0.73	0.89	0.61	0.83	0.46	0.76	0.51
Entropy	0.58	0.26	0.79	0.38	0.86	0.46	0.81

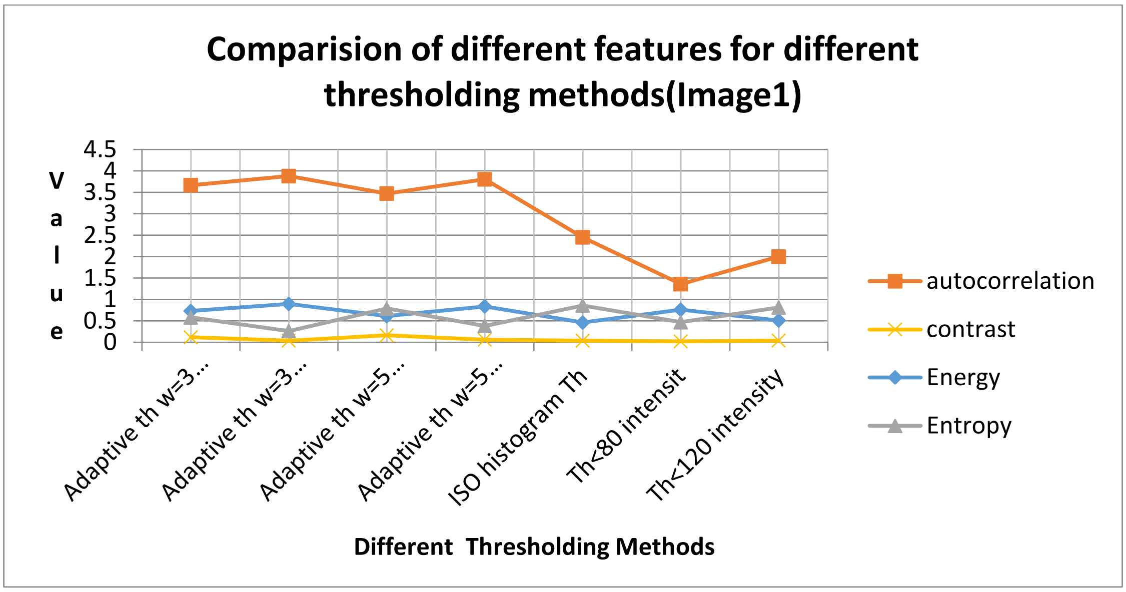


Fig 2.1: Comparison of different features for tongue image1 using different thresholding methods

After comparing the details one can conclude that thresholding with Intensity<80 is similar to Adaptive threshold result w=3, c=0.01.

Same analysis is also done for another image who's results are given in table 7.

Table 7: Comparison of different features for tongue image2 using different thresholding methods.

Features	Adaptive thresholding (w=3,C=0.01)	Adaptive thresholding (w=3,C=0.03)	Adaptive thresholding (w=5,C=0.01)	Adaptive thresholding (w=5,C=0.03)	ISO Thresholding	Simple thresholdin(Intensity<80)	Simple thresholdin(Intensity<120)
Autocorrelation	3.51	3.84	3.38	3.75	3.33	1.15	1.40
Contrast	0.17	0.06	0.21	0.10	0.02	0.02	0.02
Energy	0.62	0.86	0.55	0.78	0.63	0.87	0.72
Entropy	0.75	0.33	0.88	0.47	0.65	0.30	0.52

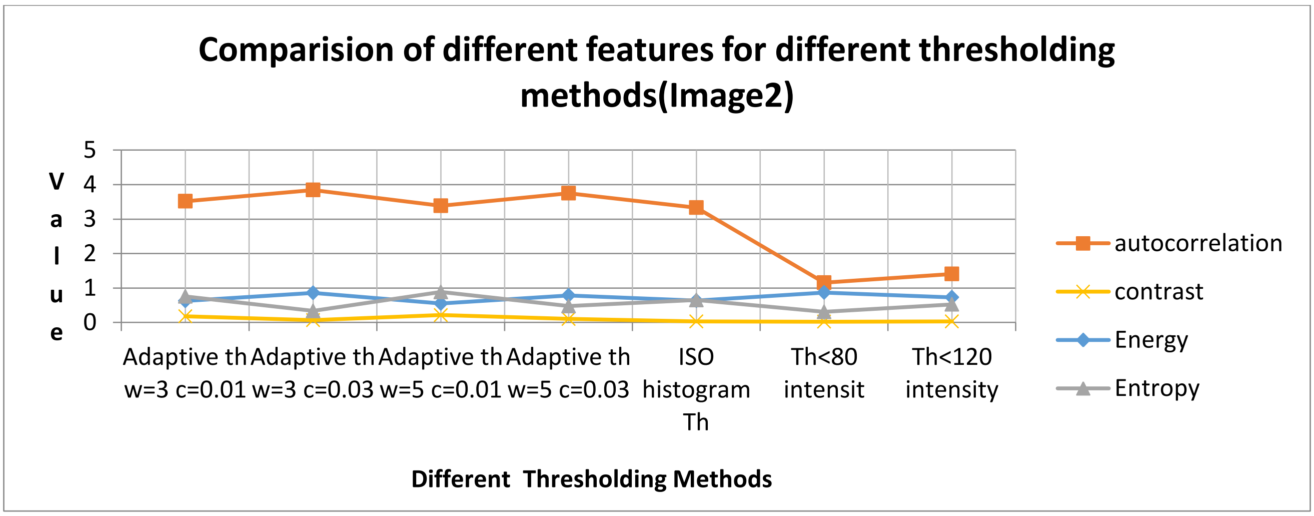


Fig 2.2: Comparison of different features for tongue image2 using different thresholding methods.

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After comparing the details one can conclude that thresholding with intensity <120 is similar to adaptive thresholding w=3, c=0.01.The output of one of the thresholded image is shown in figure 3.1

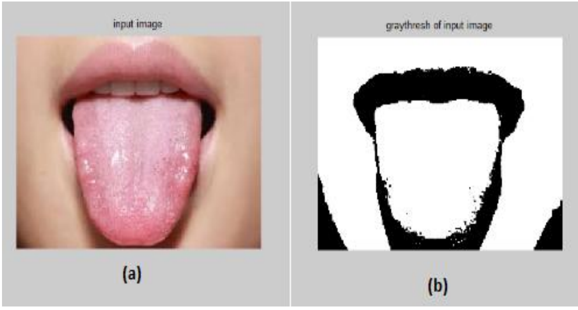

Fig.3.1 Output of thresholded image (a)Input Image (b)Gray thresholded Image.

IV. CONCLUSION

Different tongue image positions are proposed to cover maximum area of top and side view of tongue. This paper proposes a new tongue position for both top view and side view of tongue taken by digital camera. Position 4 covers maximum area in top view of tongue image and position 7 covers maximum area of side view of tongue image.

Comparison of different thresholding methods were presented and concluded that Adaptive thresolding give better result for Energy, Entropy and Autocorrelation as compared to other thresolding methods. Shape feature area and perimeter has higher values using proposed method as compared to other methods. In the shape feature calculation Adaptive thresholding is used since it gives better results than other being compared.

FUTURE SCOPE

Automated tongue analysis systems are available in the market. Looking towards the growth in technology and the health consciousness among common people. If an automated disease detection system is available which may guide the user about their health with respect to the image of tongue it will be of great use. Generally an experience person is required to guide the patient to take image of tongue for further analysis. Result one try's to give a tongue position which covers maximum area of tongue in the form of image with respect to other positions. Also, different thresholding methods are used for image segmentation. Results two shows Adaptive thresholding gives better results with respect to other methods being compared.

These methods can be used to obtain a better automated tongue image based disease diagnostic system.

REFRENCES

1. Kawanabe, T., Kamarudin, N. D., Ooi, C. Y., Kobayashi, F., Mi, X., Sekine, M., ... & Hanawa, T. (2016). Quantification of tongue colour using machine learning in Kampo medicine. European Journal of Integrative Medicine, 8(6), 932-941.
2. Jung, C. J., Jeon, Y. J., Kim, J. Y., & Kim, K. H. (2012). Review on the current trends in tongue diagnosis systems. Integrative Medicine Research, 1(1), 13-20.
3. Kawanabe, T., Kamarudin, N. D., Ooi, C. Y., Kobayashi, F., Mi, X., Sekine, M., ... & Hanawa, T. (2016). Quantification of tongue colour using machine learning in Kampo medicine. European Journal of Integrative Medicine, 8(6), 932-941.
4. Jung, C. J., Kim, K. H., Jeon, Y. J., & Kim, J. (2014). Improving colour and shape repeatability of tongue images for diagnosis by using feedback gridlines. European Journal of Integrative Medicine, 6(3), 328-336.
5. Mohammed S Rahman, Nilesh Ingole, "Research Evaluation of a low-cost, portable imaging system for early detection of oral cancer," Head and Neck Oncology 2010
6. Zhi Liu, Hongjun Wang, " Tongue Tumor Detection in Medical Hyperspectral Images," Sensors ISSN 1424-8220
7. Zhang, H. Z., Wang, K. Q., Jin, X. S., & Zhang, D. (2005, August). SVR based color calibration for tongue image. In 2005 International Conference on Machine Learning and Cybernetics (Vol. 8, pp. 5065-5070). IEEE.
8. Reference :T.W. Ridler, S. Calvard, Picture thresholding using an iterative selection method IEEE Trans. System, Man and Cybernetics, SMC-8 (1978) 630-632.
9. http://omepages.inf.ed.ac.uk/rbf/ HIPR2/ adpthrsh .htm
10. Albregtsen, F. (2008). Statistical texture measures computed from gray level coocurrence matrices. Image processing laboratory, department of informatics, university of oslo, 5.
11. Kumar, P. S., & Dharun, V. S. (2016). Extraction of Texture Features using GLCM and Shape Features using Connected Regions. International Journal of Engineering and Technology (IJET), 8(6).
12. Akshada A. Gade, Arati J. Vyavahare, "Feature Extraction using GLCM for Dietary Assessment Application", International Journal Multimedia and Image Processing (IJMIP), Volume 8, Issue 2, June 2018
13. ROBERT M. HARALICK, K. SHANMUGAM, AND ITS'HAK DINSTEIN, "Textural Features for Image Classification", IEEE Trans. on Systems, Man and Cybernetics, Vol. SMC-3, pp. 610-621, 1973.
14. JC-M. Wu, and Y-C. Chen, "Statistical Feature Matrix for Texture Analysis", Computer Vision, Graphics, and Image Processing; Graphical Models and Image Processing, Vol. 54, pp. 407-419, 1992.
15. Cui, Z., Zhang, H., Zhang, D., Li, N., & Zuo, W. (2013). Fast marching over the 2D Gabor magnitude domain for tongue body segmentation. EURASIP journal on advances in signal processing, 2013(1), 190.
16. Tania, M. H., Lwin, K., & Hossain, M. A. (2018). Advances in automated tongue diagnosis techniques. Integrative Medicine Research.
17. Lo, L. C., Cheng, T. L., Chen, Y. J., Natsagdorj, S., & Chiang, J. Y. (2015). TCM tongue diagnosis index of early-stage breast cancer. Complementary therapies in medicine, 23(5), 705-713.
18. Lo, L. C., Chen, Y. F., Chen, W. J., Cheng, T. L., & Chiang, J. Y. (2012). The study on the agreement between automatic tongue diagnosis system and traditional chinese medicine practitioners. Evidence-Based Complementary and Alternative Medicine, 2012.
19. Jung, C. J., Kim, K. H., Jeon, Y. J., & Kim, J. (2014). Improving color and shape repeatability of tongue images for diagnosis by using feedback gridlines. European Journal of Integrative Medicine, 6(3), 328-336.
20. Devi, G. U., & Ravi, D. T.(2015) Disease Diagnosis for Various Signs using Tongue Color Image Segmentation. Australian Journal of Basic and Applied Sciences, 9(10), 341-348.
21. Miryala, D., Parvataneni, P., & Aliperi, G. (2014). Computer Aided Image Enhancement Of Tongue For Diagnosis In Ayurvedic Medical Treatment. Applied Medical Informatics, 34(1), 46-56.
22. Zhang, B., Wang, X., You, J., & Zhang, D. (2013). Tongue color analysis for medical application. Evidence-Based Complementary and Alternative Medicine, 2013.

23. Jung, C. J., Jeon, Y. J., Kim, J. Y., & Kim, K. H. (2012). Review on the current trends in tongue diagnosis systems. Integrative Medicine Research, 1(1), 13-20.
24. Zhong X, Fu H, Yang J, Wang W. Automatic segmentation in tongue image by mouth location and active appearance model. In: 8th IEEE Int Symp Dependable, Auton Secur Comput DASC 2009. 2009:413–7, http://dx.doi.org/10.1109/DASC.2009.118.

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