*Grenze International Journal of Computer Theory and Engineering , Special issue*

# Iris Diagnosis – A Quantitative Non-Invasive Tool for Diabetes Detection

Mithun B S[1], R Sneha[2], Vinay Raj K[3], Basavaraj Hiremath[4] and B. Ragavendrasamy[5]
[1-3]Dept. of Medical Electronics, M S Ramaiah Institute of Technology, Bangalore, India
[3]vinaykiran1998@gmail.com
[4]Assistant Professor, Dept. of Medical Electronics, M S Ramaiah Institute of Technology, Bangalore, India
[4]bvhiremath@msrit.edu
[5]Division of Yoga & Life Sciences, S-VYASA University, Bangalore, India

***Abstract*— Iris Diagnosis is a novel approach to assess various pathological conditions based on the Iris patterns. Iris Image analysis is a non-invasive technique for determining the health condition of an individual. Correct and timely diagnosis is critical, yet is the absolute requirement of medical science. In general, current approaches fail to diagnose various diseases correctly. An attempt is being made in the current research to explore the possibility of diagnosing diabetes from the representations of the Iris. Initially the images of eye are captured using Iridoscope and a database is created with their clinical history. Various algorithms are developed to assess the quality of the Iris image, and then segmentation and feature extraction techniques such as GLCM and DCT are applied. Feature extraction plays a vital role in assessment of the individual to be diabetic or not. In order to assess the presently proposed approach, 30 patient data were acquired for which the present approach was able to detect diabetic or not with an accuracy of 83%.**

***Index Terms*— Diabetes, Pathology, Segmentation GLCM, DCT.**

## I. INTRODUCTION

Iridology is a branch of science that deals with the observation and diagnosis of disease from the Iris, the coloured part of eye. Based on decades of observation and comparative study, certain indications in the iris are thought to be related to various pathological conditions. "Ref. [1]" It is known that Iris is the only externally visible organ that has its common origin from two of the three germ layers during embryogenesis. Iris represents the map of the body where changes in certain organs are reflected in specific parts of the iris. Diabetes is a group of metabolic disorders in which the body's ability to produce or respond to the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood. Areas representing the Pancreas and Liver in the Iris are the two major organs that plays a vital role in detection of diabetes mellitus in Iridology. "Ref. [2]" Fig.1 shows the Iridology Chart by Dr. Bernard Jensen. Iris is divided into 60 sectors, 3 equidistant imaginary zones from the pupillary margin to the ciliary margin of the iris and each of the three major zones are further divided into two minor zones. Each sector and zone corresponds to the specific part of the body. "Ref. [3]" According to the Iridology Chart Liver is represented between 38'- 42' of second major zone in the right Iris and Pancreas between 37'- 40' of third major zone in

*Grenze ID: 01.GIJCTE.3.4.78*

both iris. Lacunae are basically signs of weakness. According to the literature, presence of Lacunae between 37’- 42’ in the iris indicates presence of diabetes. With this claim in the literature, an attempt was made to quantify the possible existence of specific lesions in diabetic and non-diabetic individuals. The images of iris were captured and processed by using various image processing algorithms to extract the features that help us to differentiate between diabetic and non-diabetic iris patterns in the areas corresponding to the Pancreas and Liver in the Iris.

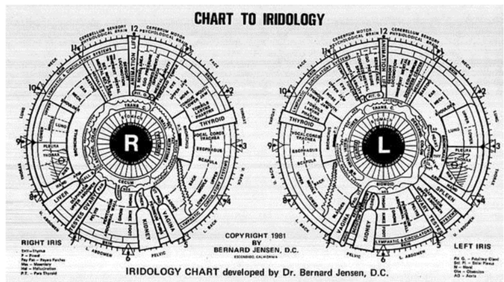


Figure1. Iridology Chart

## II. LITERATURE SURVEY

“Ref. [4]” Rupali Deshmukh, et al proposed a new framework by using geometric deformation techniques in order to determine the level of cholesterol in our body by analysing Iris image. “Ref. [5]” Manigandan, et al proposed a new framework for classification of iris images into pre-defined categories such as diabetes, cholesterol and effects of drugs. “Ref. [6]” Bhatia, et al proposed a new framework for detection of diabetes from the iris image by using image processing techniques. “Ref. [7]” Demea, et al proposed a new framework for Iris sector examination in diagnostic approach for small groups of medical pathologies. “Ref. [8]” Wibawa, et al developed a new framework for early detection on the condition of pancreas as a cause of diabetes mellitus by real time image processing. “Ref. [9]” Salankar, et al provided recognition rate of various features extraction methods such as Gabor Wavelet, DCT, Haar Transform, PCA, Log Gabor Wavelet based on CASIA iris database. “Ref. [10]” Elgamal, et al developed a robust Iris matching system by using several image processing techniques.

## III. PROPOSED FRAMEWORK

The main purpose of this research was to apply image processing algorithms via computer using MATLAB code to the images acquired and find out whether the patient is diabetic or not. Fig.2 shows the block diagram of the Proposed Framework.

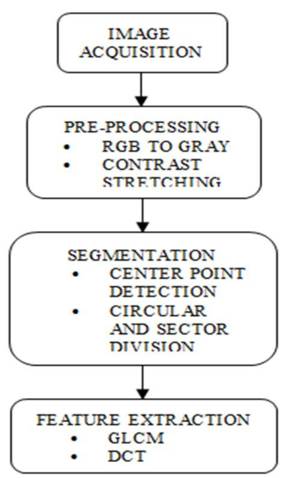


Figure2. Block Diagram of the proposed framework

*A. Image Acquisition*

Colour Images of eye were acquired using a 5MP camera Iridoscope and a database was created which contained normal as well as abnormal eye images. Fig.3 shows Iridoscope.
Fig.6 (a) shows the acquired iris image.

Figure.3 Iridoscope

*B. Preprocessing*

Preprocessing is a technique to enhance the image so that the resultant is more suitable than the original. This helps in removing low frequency background noise, normalizing the intensity of individual pixel and removing reflections.

*RGB to Gray Conversion*

This is done to convert colour images of eye into Gray scale format and also helps in reducing the computation time.

- Luminosity

Luminosity or Weighted method gives more importance to green colour as it gives soothing effect to human eyes, has lesser wavelength compared to red and blue. Following is the equation,

$$GS = 0.21 \times R + 0.72 \times G + 0.07 \times B \ldots\ldots\ldots 1$$

According to this Eq.1 red contributes 21%, green contributes 72%, and blue contributes 7%. Fig.6 (b) shows the Gray image.

*Contrast Stretching of Pupil*

Contrast Stretching is the simplest enhancing technique that improves the contrast by expanding the range of intensity levels in an image. Semi automotive method is used by choosing two extreme points at the boundaries of the pupil. The pixels within the pupil which are less dark are brought down to zero. Fig.7 shows the contrast stretching of pupil.

*C. Segmentation*

Segmentation is a process of partitioning an image into its constituents or objects.

*Center point detection*

Both $X_c$ and $Y_c$ coordinates of the center point of the eye image is determined.

Algorithm:
Step1: Find the column that has maximum number of zeros.
Step2: Take an average of those columns that has same number of maximum zeros.
Step3: Along the same column, calculate the distance between outer boundary of iris to that of pupil's boundary ($L'$), hence diameter ($D'$) and radius ($R'$) of the pupil is obtained. Fig.8 (b) shows the vertical line.
Step4: Determine the $Y_i$ coordinate of the center point by adding $L'$ with $R'$. Following is the equation,

$$Y_i = L' + R' \ldots\ldots\ldots 2$$

Step5: Using Basic property of chord, a perpendicular drawn from the center of the chord within the circle passes through the center of the circle. Using the above property, determine $X_i$ coordinate of the center point. Fig. 8(a) shows the horizontal line obtained using the above property.
Step6: Therefore, $(X_i, Y_i)$ coordinates of the center is obtained.

Step7: Consider the diagonal coordinates; $(X_i - 1, Y_i - 1)$, $(X_i + 1, Y_i - 1)$, $(X_i - 1, Y_i + 1)$, $(X_i + 1, Y_i + 1)$

And determine 4 points (x1, y1), (x2, y2) (x3, y3), (x4, y4) by moving along the same diagonal direction until it reaches the pupil's boundary.

Step8: Determine the centroid of pupil $(X_0, Y_0)$ by taking the average four points. Following is the equation,

$$(X_0, Y_0) = \frac{(x1 + x2 + x3 + x4)}{4}, \frac{(y1 + y2 + y3 + y4)}{4} \ldots\ldots\ldots 3$$

Step9: Take an average of $(X_i, Y_i)$ and $(X_0, Y_0)$ in order to reduce the error. Following is the equation,

$$(X_C, Y_C) = \frac{(X_i + X_0)}{2}, \frac{(Y_i + Y_0)}{2} \ldots\ldots\ldots 4$$

Step10.Therefore, Center coordinates of the iris $(X_C, Y_C)$ is obtained.

*Circular Division*

Since Pancreas and Liver lie in the second and third major zones of the iris, the required region is extracted by dividing the iris into 6 concentric circles.

Algorithm:

Step1: Determine the 6 circular regions $(C_N)$ from the pupil center of the iris by using the following equation,

$$C_N = \left(\frac{L'}{6} \times n1\right) + R' \ldots\ldots\ldots 5$$

Where N and n1 various from 1 to 6.

Step2: Required regions 2 and 3 is obtained by the following equation,

$$R_{mn} = C_n - C_{m-1} \ldots\ldots\ldots 6$$

Where (n, m<=n1)

Fig. 9(a-f) shows the 6 zones of the iris image.

*Sector Division*

Since the position of Pancreas and Liver is at 38'- 42' and 37'- 40' respectively, the required region is extracted by dividing the iris into quarter circles. Fig.4 shows the required quarter sector of the iris.

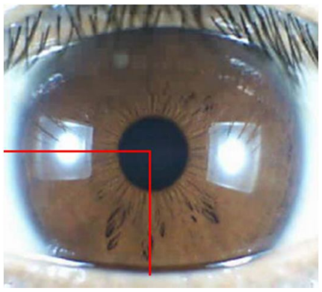

Figure4. Quarter sector of the iris

Algorithm:

Step1: Let $(X_C, Y_C)$ be the center point of the iris.

Step2: Decrease the value of $X_C$ coordinate in steps of one from $(X_C, Y_C)$ to $(X_C - n, Y_C)$ where n is an integer, and stop when $X_C - n = 1$

Step3: Increase the value of $Y_C$ in steps of one from $(X_C, Y_C)$ to $(X_C, Y_C - m)$, where m is an integer, and stop when $Y_C - m = 1$, thus the quarter circle is obtained. Fig.10 shows the sector division of the iris.

*Region of Interest Extraction*

According to the iridology chart, Pancreas and liver are positioned at second major zone between 38' - 42' and third major zone between 37' - 40' respectively. Fig.5 shows ROI of iris.

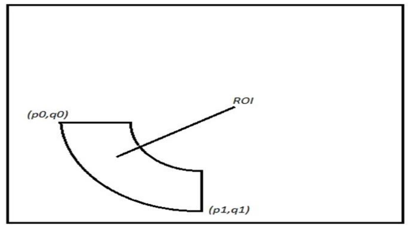


Figure5. ROI of Iris

Fig.11 (a) shows ROI of iris sector image.
The dimension of the above image can be reduced by cropping the image from $(P_0, Q_0)$ to $(P_1, Q_1)$ and this also helps in reducing the computational time. Fig.11 (b) shows the cropped sector image.

*D. Feature Extraction*

GLCM as well as DCT is used for extracting features of region of interest.

*Gray Level Co-occurrence Matrix (GLCM)*
"Ref. [11]" GLCM is defined as the distribution of co-occurring values at a given offset over an image.

Algorithm:
Step1: Construct 64 × 64 matrix and move it along the required region without overlapping.
Step2: Take GLCM of all the matrices with offset in 4 directions.

*Discrete Cosine Transform (DCT)*
"Ref. [12]" Formally, the discrete cosine transform is a linear, invertible function (where denotes the set of real numbers), or equivalently an invertible $N \times N$ square matrix.

Algorithm:
Step1: Construct 64 × 64 matrix and move it along the required region without overlapping.
Step2: Take DCT of all the matrices and take an average of the resultant

IV. RESULTS

*A. Pre-processing*

*RGB to Gray Conversion*

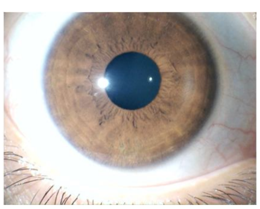

Figure6 (a). Original Image

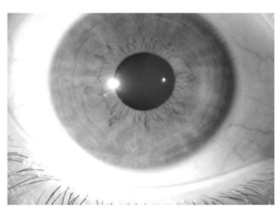

Figure6 (b). Gray Image

*Contrast Stretching*

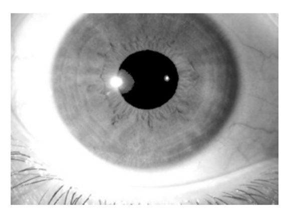

Figure7. Contrast Stretching of pupil

*B. Segmentation*

*Center Point Detection*

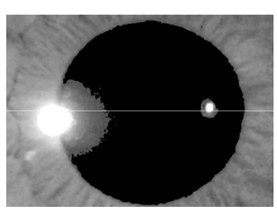

Figure8 (a). Horizontal Line

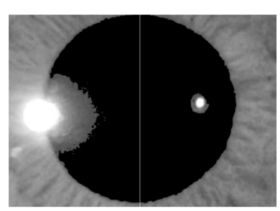

Figure8 (b). Vertical Line

### C. Circular Division

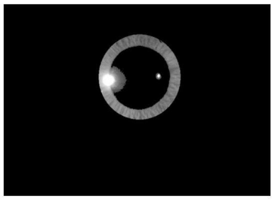

Figure9 (a). First Minor Zone

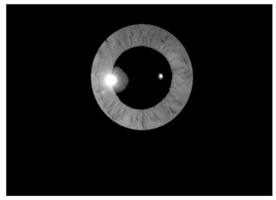

Figure9 (b). Second Minor Zone

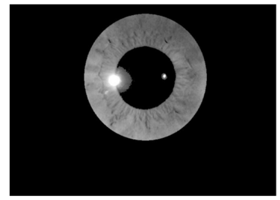

Figure9 (c). Third Minor Zone

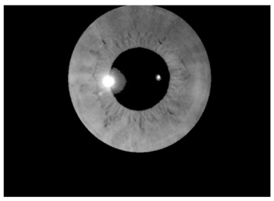

Figure9 (d). Fourth Minor Zone

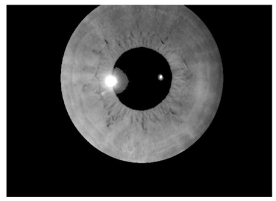

Figure9 (e). Fifth Minor Zone

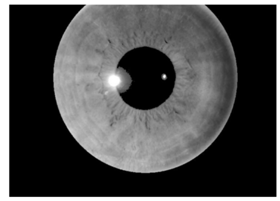

Figure9 (f). Sixth Minor Zone

### Sector Division

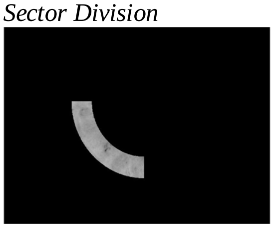

Figure10. Quarter Division

Figure11 (a). ROI of iris sector

### ROI Extraction

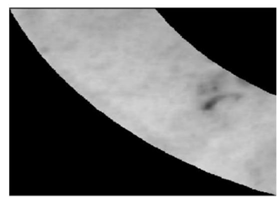

Figure11 (b). Cropped Image

### D. Feature Extraction

TABLE I. GLCM AND DCT VALUES

| Diabetic | | Non-diabetic | |
|---|---|---|---|
| GLCM | DCT | GLCM | DCT |
| 82 | 11827 | 155 | 9454 |
| 65 | 14568 | 117 | 8758 |
| 99 | 13425 | 124 | 9321 |
| 78 | 14356 | 146 | 7512 |
| 83 | 15478 | 165 | 6541 |
| 59 | 15425 | 105 | 9123 |
| 68 | 12336 | 125 | 8451 |
| 77 | 10364 | 135 | 5432 |
| 125 | 14785 | 142 | 8795 |
| 140 | 13254 | 98 | 7564 |

Table I shows the GLCM and DCT values Diabetic and Non-Diabetic iris images.

## V. CONCLUSION

The present work emphasizes about a new Framework for diabetes detection from the Iris image. The images from the right eye are acquired and the pupil's gray level is enhanced by using contrast stretching. The ROI is obtained by segmentation and feature extraction. Significant changes are observed with respect to the features of diabetic and normal individual. The present method however needs validation and future exploration of using the iris for diagnosis purpose.

## FUTURE SCOPE

A better equipment with higher resolution can be used for acquiring the image, decreasing the amount of due to flash shall improve the image analysis. Owing to its non-invasive nature and less time consumption, this method if proven effective shall be used for screening pathologies. This method can also be extended for predictive diagnosis. Further studies are mandatory to understand efficacy of iris diagnosis in detecting diabetes and other pathological conditions.

## REFERENCES


[1] http://www.cl.cam.ac.uk/~jgd1000/anatomy.html
[2] http://www.iriscope.org/iridology-chart
[3] Theodor Kriege, Fundamental Basis of Irisdiagnosis
[4] Jyoti Prasad, Divya Patel, Megha Jadhav, and Rupali Deshmukh, “Iris based medical analysis by geometric deformation features”, International Research Journal of Engineering and Technology (IRJET), Volume 03, Issue 04, April-2016
[5] D. Ram Nivas, T. Manigandan, “Classification of Human Eye Image using Different Methods for Medical Applications”, International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 4, April 2015
[6] S. K. Bhatia, Priyanka Atole, Sarika Kamble, Pooja Telang, “Methodology for Detecting Diabetic Presence from Iris Image Analysis”, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET),Volume 4, Issue 3, March 2015
[7] Sorina Demea, Rodica Holonec, Florin Drăgan and Horea Demea, “Iris Sector Image Analysis - Correlations with General Medical Pathology”, 1st International Conference on Advancements of Medicine and Health Care through Technology, MediTech2007, 27-29th September, 2007, Cluj-Napoca, ROMANIA
[8] Adhi Dharma Wibawa, Mauridhi Hery Purnomo, “Early Detection on the Condition of Pancreas Organ as the Cause of Diabetes Mellitus by Real Time Iris Image Processing”, Circuits and Systems, 2006. APCCAS 2006. IEEE Asia Pacific Conference on 4-7 Dec. 2006
[9] Ms. Aparna G. Gale, DR. S. S. Salankar, “A Review on Advance Methods of Feature Extraction in Iris Recognition System”, International Conference on Advances in Engineering & Technology, 2014 (ICAET-2014)
[10] Mahmoud Elgama, Nasser Al-Biqami, “An Efficient Feature Extraction Method for Iris Recognition Based on Wavelet Transformation”, International Journal of Computer and Information Technology (ISSN: 2279 – 0764), Volume 02, Issue 03, May 2013
[11] Adegoke, B. O., Omidiora, E. O, Ojo, J.A., and Falohun, “Iris feature extraction: a survey”, Computer Engineering and Intelligent Systems, Volume 4, Issue 9, 2013
[12] https://en.wikipedia.org/wiki/Discrete_cosine_transform, DCT-I
[13] J. Alex Star, “Adaptive Image Contrast Enhancement Using Generalizations of Histogram Equalization”, IEEE Transaction on Image Processing, Volume 9, Issue 5, May-2000
[14] Shirke Swati D, Prof.Gupta Deepak, “Iris recognition using Gabor”, Int.J.Computer Technology & Applications, Volume 4 (1), Jan-Feb 2013
[15] Le Chang, “Overview of abnormal feature detection method in iris image”