A Novel Approach for Diagnosis of Diabetes Using Iris Image Processing Technique and Evaluation Parameters

J L Mudegaonkar[1*], Shilpa Jagtap[2], Sanjay Patil[3] Dinesh Bhoyar[4]

[1,3]Karmayogi Engineering College Shelve Pandharpur
[2]DY Patil college of Engineering Akurdi Pune
[4]YCCOE, Nagpur

*Corresponding author
doi: https://doi.org/10.21467/proceedings.118.37

ABSTRACT

This paper presented here deals with study of identification and verification approach of Diabetes based on human iris pattern. In the pre-processing of this work, region of interest according to color (ROI) concept is used for iris localization, Dougman's rubber sheet model is used for normalization and Circular Hough Transform can be used for pupil and boundary detection. To extract features, Gabor Filter, Histogram of Oriented Gradients, five level decomposition of wavelet transforms likeHaar, db2, db4, bior 2.2, bior6.8 waveletscan be used. Binary coding scheme binaries' the feature vector coefficients and classifier like hamming distance, Support Vector Machine (SVM), Adaptive Boosting (AdaBoost), Neural Networks (NN), Random Forest (RF) and Linear Discriminative Analysis (LDA) with shrinkage parametercan be used for template matching. Performance parameters such as Computational time, Hamming distance variation, False Acceptance Rate (FAR), False Rejection Rate (FRR), Accuracy, and Match ratio can be calculated for the comparison purpose.

Key words-Iridology, diabetes, Feature extraction, wavelet transform, Haar, db2, db4, bior2.2, bior6.8 wavelets FAR, FRR, Accuracy, Match ratio.

1 Introduction

Authentication of an individual using biometric system based on human characteristics such as face, finger, voice, and iris has always been an interesting area of research. Among these, iris recognition system is considered to be the most accurate and reliable biometric identification system. Diabetes Mellitus is now becoming a mass silent killer in the society because it does not show any signs previously to the patients until it has been in the dangerous level. Most people just realize their diabetic condition when the stage was already too late. In many cases, Diabetes Mellitus causes many complications to other organs, such as kidney, cardiovascular, liver or blood pressure. Iridology is an alternative medicine that claims to predict tissue weaknesses in the body by looking at the iris. The main object of this proposed work is to predict diabetes with the help of iridology. Iridologists claim that signs of body weakness will appear in the iris sooner than the organ itself, so iridology can be used to predict the risk of diseases.

2 Literature review

In 2015, AtulBansal, *et al.*[3] studied Iris images and explains model in which Iris Image Acquisition, Image pre-processing, segmenting region of interest, feature extraction and Disease recognition are the five stages. Iris images for the experimental work have been acquired using I-SCAN-2 dual iris scanner of Cross match Technology Inc. Data base of 40 healthy people and Left eye of 40 cases of type II diabetic people has been used. In iris pre-processing, Iris segmentation is carried out using circular Hough Transform, Normalization is carried out using homogeneous rubber sheet model, Segmented ROI is between 7 to 8 o'clock and of size 200x90refer Fig 1. In this work, 2-D discrete wavelet transform (DWT) has been implemented to extract the significant features from iris images. DWT decomposes an image into four sub-sampled images, namely, approximation (LL), horizontal (HL), vertical (LH), and diagonal (HH). Author decomposes the

© 2021 Copyright held by the author(s). Published by AIJR Publisher in the " Proceedings of National Conference on Relevance of Engineering and Science for Environment and Society" (R{ES}² 2021) July 25th, 2021. Organized by Shri Pandurang Pratishthan's Karmayogi Engineering College, Shelve, Pandharpur, India.

Proceedings DOI: 10.21467/proceedings.118; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-947843-6-4

image up to third level using pyramidal type(i.e. LL sub band (approximation sub band) using db2 wavelet.SVM has been used as a classifier in the proposed model which is an upcoming template matching technique. Different kernal functions like Gaussion, Radial Basis Function, Polynomial 2nd order and Polynomial 3rd order are used and the maximum accuracy of 87.5% is obtained for RBF kernel function. System performs has been measured false positive rate(specificity) and false negative rate(sensitivity).

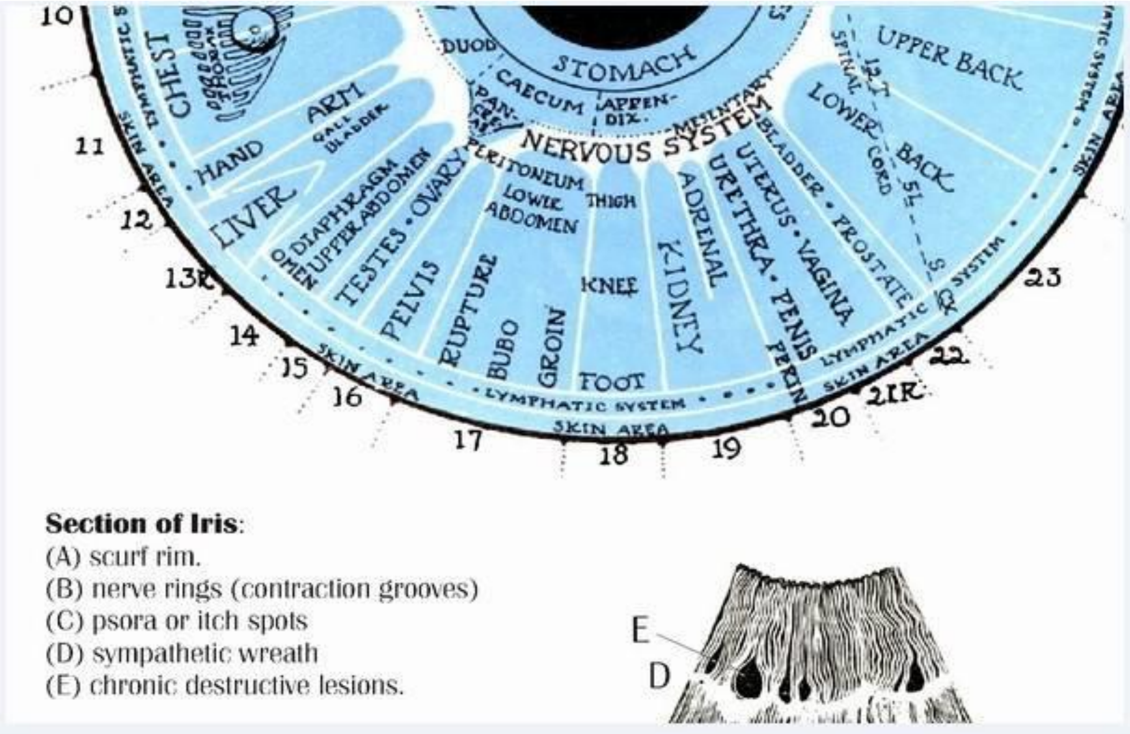

Figure 1. Region of interest between 7 to 8 O' Clock

In 2018, ParsaMoradi *et al.*[4] captured 106 diabetic and 124 healthy iris images of resolution 3456x 2304 in Farabi eye hospital. Author extracted the area between outer edge of pupil and iris using Circular Hough Transform. In this study Active counter algorithm is used to detect the boundaries and pupil.Normalization is carried out using homogeneous rubber sheet model. This work used three of the most common feature extraction methods in texture detection: Gabor Filter, Histogram of Oriented Gradients and local binary pattern. To classify the diabetic and healthy subjects, five different classifiers have been tested to choose the best model: Support Vector Machine (SVM), Adaptive Boosting (AdaBoost), Neural Networks (NN), Random Forest (RF) and Linear Discriminative Analysis (LDA) with shrinkage parameter. In the work (pixels, HOG, LBP and Gabor filter as a feature and AdaBoost as a classifier) the accuracy of the classifier is 91.8%, which is found to be better than using the pancreas region, which results in an average accuracy of 87.7%.

In 2016, AgusPrayitno *et al.*[5] studied an existing iris chart introduced by Bernard Jensen was used to analyze the Kidney organ condition. The location of kidney organ in iris is at 200° -210°, when image of iris was divided by 360°. Image of 47 patient iris was taken by using a specific iris camera Dino-Lite ver. 2.0. Region of interest (ROI) was then determined by using the iris chart. Color constancy and independent component analysis were used to analyze the ROI of iris image. Broken tissue in iris image would be the feature for detecting the complication of kidney organ. From 47 participants, the result showed that 76% of participants showing a relation of kidney' complication with their iris image.

In 2019, Mohammadreza Azimi,*et al.*[6] studied The Effects of Gender Factor and Diabetes Mellitus on the Iris Recognition System and find out Accuracy and Reliability of the same and found that, for male users, diabetic effects on the performance of the system are more intense that for female users.

In 2018, Dr.Prakash H. Patil,*et al.*[7] studied the Literature and describe the elements of method to Detect Diabetic Patient using Iris Image. The elements are Iris Image Acquisition, Image pre-processing, segmenting region of interest, feature extraction and Disease recognition and also explained that Iridodiagnosis is an alternative branch of medical science, which can be used for diagnostic purposes the various algorithms are developed for image quality assessment, segmentation of iris, iris normalization and clinical feature classification for clinical diagnosis. The entire process shows classification accuracy of 90 ~ 92 percent between diabetic and non-diabetic subjects. This approach will be useful in the diagnosis fields, which are faster, user friendly and less time consuming.

In 2015,Prof. S. K. Bhatia,*et al.*[8], studied and explained that, For clinical diagnosis, Iris image analysis is one of the most efficient non-invasive diagnosis method which helps to determine the health status of organs. From the literature survey that we have done, is observed that lot of modern technologies also fails in diagnose disease correctly. From different perspectives this attempt explores the area of diagnosis. Iridodiagnosis is the branch of medical science, with the help of which different diseases can be detected. Initially the images of eye are captured, database is created with their clinical history, features are found out and finally the classification is done whether the diabetic is present or not. Several classification methods can be used for training and classification purpose. Support vector machine will be useful in the diagnosis field which is faster and user friendly

3 Methodology

Iris recognition algorithms along with clinical iridology can be used to design an automated computer model to determine the status of health of an individual. There are mainly five stages in iris recognition-based diagnosis model as shown in Figure2. These stages have been briefly discussed in the following subsections.

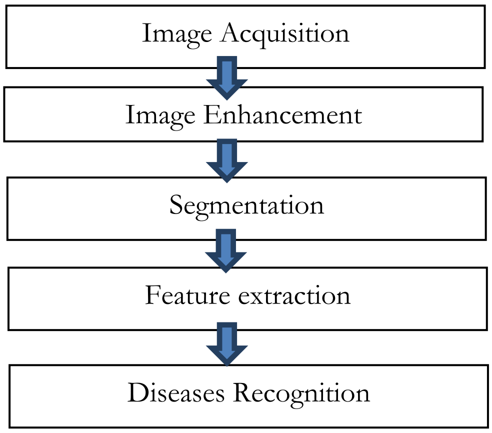

Figure 2: Iris recognition-based diagnosis model

In image acquisition, for high quality images CCD cameras in infrared light are used. Lighting and distance of camera is maintained. In Iris Localization, first step is detection of pupil for this by reading the original image from database histogram of original image is taken and from this histogram, threshold for pupil in terms of pixel intensity is obtained. Using region of interest according to color only pupil is detected and noise due to eyelids and eyelashes is eliminated. The following is the formula (2.1) for thresholding (T) of image.

$$g(m,n) = 1 \ \ if\,(m,n) \le T$$
$$0 \ \ if\,(m,n) \ge T \qquad (2.1)$$

To find radius of pupil, by scanning the pupil image horizontally in downward direction and vertically in forward direction four points are located on pupil circumference. Using these points' center and radius of pupil is detected[1]. In this work iris radius=pupil radius+38,this relation is used [2] figure 3 shows Iris Localization.

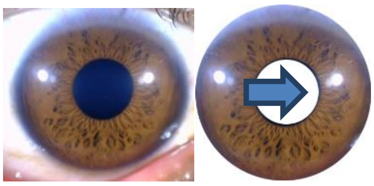

Figure3: Iris localization

3.1 Normalization of Iris

Once the pupil is detected the iris section can be extracted easily. We have taken the small part of iris section for further processing. We use only the lower half part of the iris section because diabetic ROI is between4 to 5 o' clock and 7 to 8 o'clock also most of the time the upper iris section is deeply covered by the eyelashes which can decrease the accuracy of the system. Once the region of interest has been isolated, it is transformed to a dimensionless polar system. This form is standard irrespective of iris size, pupil diameter or resolution. The implemented algorithm [3] is based on Dougman's stretched polar coordinate system. Figure 4 Shows Dougman's rubber sheet model. The results of Dougman's rubber sheet model are shown in figure 5.

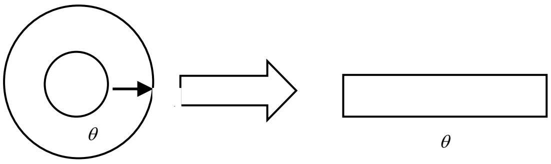

Figure 4: Dougman's rubber sheet modal

The remapping of the iris image $I(x, y)$ from raw Cartesian coordinate to polar coordinates $I(r,\theta)$ can be represented as,

$$I(x(r,\Theta), y(r,\Theta) = I(r,\Theta) \quad (1)$$

Where, r lies in the unit interval [0, 1] and θ is the angle between [0,2π].

The above equation can be further explained as follows,

$$x(r,\theta) = (1-r) * x_p(\theta) + r * x_i(\theta) \quad (2.3)$$

$$y(r,\theta) = (1-r) * y_p(\theta) + r * y_i(\theta) \quad (2.4)$$

Where, $(x_p(\theta), y_p(\theta))$ and $(x_i(\theta), y_i(\theta))$ are the coordinates of pupil and iris boundary points respectively.

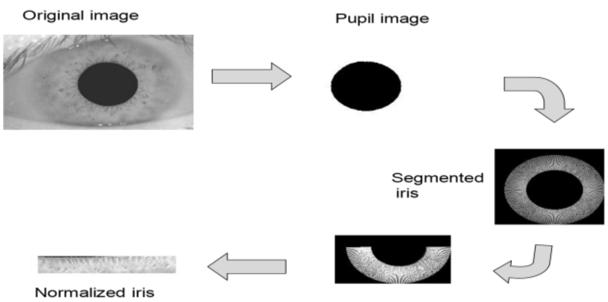

Figure5: Results up to normalization

Proceedings DOI: 10.21467/proceedings.118
ISBN: 978-81-947843-6-4
Series: AIJR Proceedings
ISSN: 2582-3922

3.2 Feature Extraction

Gabor Filter, Histogram of Oriented Gradients, five level decomposition of wavelet transforms like Haar, db2, db4, bior 2.2, bior6.8 wavelets can be used for feature extraction. An attempt has been made for comparative study. A wavelet is a kind of mathematical function used to divide a given function or continuous-time signal into different frequency components and study each component with a resolution that matches its scale. A wavelet transform is the representation of a function by wavelets. The wavelets are scaled and translated copies (known as "daughter wavelets") of a finite-length or fast-decaying oscillating waveform (known as the "mother wavelet"). Wavelet transforms have advantages over traditional Fourier transforms for representing functions that have discontinuities and sharp peaks, and for accurately deconstructing and reconstructing finite, non-periodic and/or non-stationary signals.

The unwrapped iris image is decomposed using different wavelets in to a maximum of 5 levels. These levels are cD_1^h *to* cD_5^h horizontal coefficients, cD_1^v *to* cD_5^v vertical coefficients and cD_1^d *to* cD_5^d diagonal coefficients. The coefficient that represents the core of iris pattern has to be picked up. Therefore those that reveal redundant information should be eliminated [4]. Each image applied to the Haar wavelet can be represented as the combination of six matrices $cD_4^h, cD_5^h, cD_4^v, cD_5^v, cD_4^d$ *and* cD_5^d .These matrices are combined to build one single vector characterizing the iris patterns. This vector is called the feature vector.

3.3 Binary Coding Scheme

It is very important to represent the obtained vector in a binary code because it is easier to find the difference between two binary code-words than between two number vectors. In fact Boolean vectors are always easier to compare and to manipulate. In order to code the feature vector first observed some of its characteristics. Now found that all the vectors that we obtained have a maximum value that is greater than 0 and a minimum value that is less than 0. If the Coefficient is the feature vector of an image than the following quantization scheme converts it to its Equivalent code word

$$\text{if coef(i)} \geq 0 \text{ then coef(i)} = 1$$

$$\text{if coef(i)} < 0 \; then \; coef(\text{i}) = 0$$

The next step is to compare two code-words to find out if they represent the same person or not.

3.4 Matching using Hamming Distance:

This test enables the comparison of two iris patterns. One is healthy iris and other is diabetic iris. This test is based on the idea that the greater the HammingDistance between two feature vectors, the greater the difference between them. Two similar irises will fail this test since the distance between them will be small. In fact, any two different irises are statistically "guaranteed"' to pass this test as already proven. The Hamming distance (HD) between two Boolean vectors is defined as follows:

$$HD = \frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B(j) \qquad (5.1)$$

Where, C_A and C_B are the coefficients of two iris Images and N is the size of the feature vector.

4 Performance evaluation

4.1 Computational Time

The processing time taken by the system to get final out put.

4.2 False Acceptance Ratio (FAR)

False Acceptance Ratio of this system can be calculated using formula

$$\% FAR = \frac{No.of\ times\ different\ persons\ match}{No.of comparissions\ between\ differnt\ persons} * 100\ \% \qquad (6.1)$$

4.3 False Rejection Rate (FRR)

$$FRR = \frac{no.of\ times\ person\ rejected}{no.of\ comparision\ between\ same\ person} * 100\ \% \qquad (6.2)$$

4.4 Accuracy

Accuracy of the system can be calculated using formula

$$\%\,Accuracy = 100 - \frac{FRR + FAR}{2} \qquad 6.3$$

4.5 Match Ratio

$$match\ ratio = \frac{T_z}{T_B} * 100\ \% \qquad (6.4)$$

Where, T_z = Total No. of zeros calculated by Hamming Distance vector

T_B = Total No. of bits in iris template

5 Conclusion

Maximum accuracy of 87.5% is obtained from three level decomposition using 2-D discrete wavelet transform (DWT), SVM as a classifier in the work [3] with the help of RBF kernel function. System performs has been measured by the parameters false positive rate(specificity) and false negative rate(sensitivity). In the work [4] pixels, HOG, LBP and Gabor filter as a feature and AdaBoost as a classifier is used to get accuracy 91.8%, which is found to be better than using the pancreas region, which results in an average accuracy of 87.7%. As per the work carried out in [6] diabetic effects on the performance of the system are more intense to male compare to female users. Robust design of algorithm using 5 level decomposition and suitable classifiers may improve the accuracy in detection of diabetes.

References

[1] JL Mudegaonkar and MG Khogare "Iris Recognition using Wavelet & Performance Evaluation Parameter" Proceeeding of 2012 National conference on Algorithm & Intelligent System (NCAIS-2012)" at RIT, Rajaram Nagar, Sakrale, Tal Walwa, DistSangli.

[2] A.Poursaberi and B.N.Araabi,"A Half Eye Wavelet Based for Iris Recognition", Proceedings of the 2005 5th International Conference on Intelligent Systems Design and Applications (ISDA'05)

[3] AtulBansal, RavinderAgrawal, R.K. Sharma, "Determining diabetes using iris recognition system", International Journal of Diabetes DevCtries, published on 18 Feb 2015, DOI 10.1007/s13410-015-0296-1

[4] ParsaMoradi, NaghmeNazer, AmirhoseinKhasAhmadi, HodaMohammadzade, HasanKhojastehJafari, "Discovering Informative Regions in Iris Images to Predict Diabetes", 2018 25th national and 3rd International Iranian Conference on Biomedical Engineering (ICBME).

[5]AgusPrayitno, Adhi Dharma Wibawa, MauridhiHeryPurnomo, "Early Detection Study of Kidney Organ Complication Caused By Diabetes Mellitus using Iris Image Color Constancy", 2016 International Conference on Information, Communication Technology and System (ICTS) 978-1-5090-1381-4/16/$31.00 ©2016 IEEE pp 146-14

[6]MohammadrezaAzimi,Seyed Ahmad Rasoulinejad, "The Effects of Gender Factor and Diabetes Mellitus on the Iris Recognition System's Accuracy and Reliability", IEEE signal processing (SPA 2019) Sept 18th- 20th 2019 Poland.

[7]Dr. Prakash H. Patil , Roshan M. Patil , Nidhi H. Manek, Harsh V. Ladda, "Smart Lab Detection for Diabetic Patient using Iris Image", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 7, Issue 5, May 2018, PP 2254 -2260

[8] Prof. S. K. Bhatia , PriyankaAtole , SarikaKamble, PoojaTelang, "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

[9]John Daugman, "How Iris Recognition Works", available at http:// www.ncits.org/tc_home/m1htm/docs/m1020044.pdf.

[10]http://www.sinobiometrics.com/