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Detection of Diabetes Based on Iris Image Analysis

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Abstract : The iris is like a map of the body. Changes in certain organs is reflected in specific parts of the iris. So in health diagnosis, Iris image play very important role. 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. Irido-diagnosis 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 diabetes is present or not. This approach will be useful in the diagnosis fields, which are faster, user friendly and less time consuming.

***IndexTerms* – Diabetes, Irido-diagnosis, Iris, Feature Extraction, Feature Classification, DWT, 2D Gabor, SVM.**

I. 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. Iris recognition system is mainly employed in various security systems such as at airports, laboratories, ATM machines, etc. Iris recognition system can also be used for clinical applications. A large number of researchers have utilized iris recognition algorithms along with iridology to determine the status of the health of an individual.

Iridology is an old technique which provides an alternative to mainstream diagnosis techniques. Iridology is the branch of science that deals with the study of iris i.e. colored part of the eye. Iridology is more than 150 years old technique. The main aim of irido-diagnosis is to collect some information about underlying disease. Irido-diagnosis consists on empirical science, to look into the particular area of eye for systemic health condition of the specific organ of the body. Medical conditions and pre-disease states can be diagnosed through the abnormal pigmentation in the Iris. The location of abnormalities on the iris is associated with the location of the medical condition in the body. The iris of the eye is divided into 60 sectors where each sector corresponds to an inner organ. The iris is associated via multiple nerve connections to the organs. Depending on the features of the iris, classification is done and diabetes is detected.

II. RELATED WORK

[3]V.Lakshmi, Vanitha et al., presented a method to study the iris images with the help of iridology to predict the presence of diabetes mellitus in a human. [5]Mir, N.Khan et al., proposed a technology for smartphone-based fundus photography. [6]Padmasini. N et al., proposed a work for segmentation of the pancreas region using the iris images. [11] Shafira Nur Andana et al., proposed a system for measuring cholesterol levels through eye images. [8]Ratna Aminah et al., classified the diabetes using KNN. [1]Shreeja.A et al., developed a system which uses GLCM to obtain texture options using ThingSpeak and for feature classification, the SVM algorithm is employed. [7]Asuntha et al., in their paper used element extraction technique called Gray Level Co-Occurrence Matrix. [9]Safial Islam Ayon et al., made a study which implemented deep neural network to predict diabetes and used five-fold cross-validation with success rate is 98.35%. [2]Burcu Oltu et al., used CNN architecture for classification.

III. PROBLEM STATEMENT AND OBJECTIVES

1. Problem Statement-

From the literature, it is found that few modern technology fails in lot of cases to diagnose disease correctly and could take a lot of time to detect diseases and could be painful. This attempt is being made to explore the area of diagnosis from different perspectives. The approach used is a combination of ancestor's technology Irido-diagnosis with modern technology.

2. Objectives-

- To carry out a literature review on Detecting Diabetes using Iris Image Analysis
- To design and develop setup of our project model
- To compute the proposed model
- To program according to the requirements using suitable programming tool
- To analyze the results of developed model

IV. Proposed System

a. Acquisition of Eye Image: The first step is to capture the image of the eye with the help of iris camera, and captured images are stored in the Database, which contains both normal and abnormal images. Fig 1 shows the image of the eye captured with the help of Iris camera.

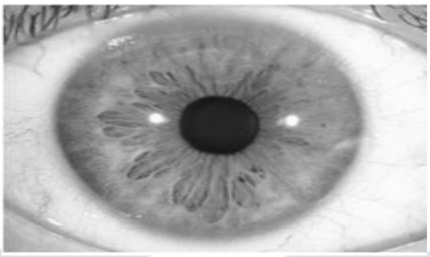

Fig 1., Captured eye image

b. Image Pre-processing: Noise Reduction is done in order to reduce the noise, which is presented in the Iris image. Enhancement is done to improve the detailing of the image, so the enhanced image will be more suitable than the original image.

c. Segmentation: Segmentation is done to find out inner and outer boundary regions of the Iris. Iris part of an eye is obtained by subtracting Pupil from Sclera. The Segmented Iris image will be in circular shape, the next step is to transform the iris region into fixed dimension.

d. Normalization: Normalization is needed to convert circular Iris patterns into rectangular shapes, the normalized image is shown in fig 2.

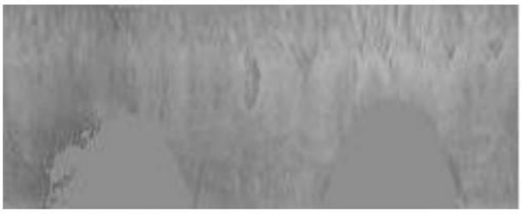

Fig 2., Normalized Iris image

e. ROI Extraction: Irido chart of both left and right Iris is shown in fig 3, ROI Extraction is nothing but cropping particular portion of normalized image.

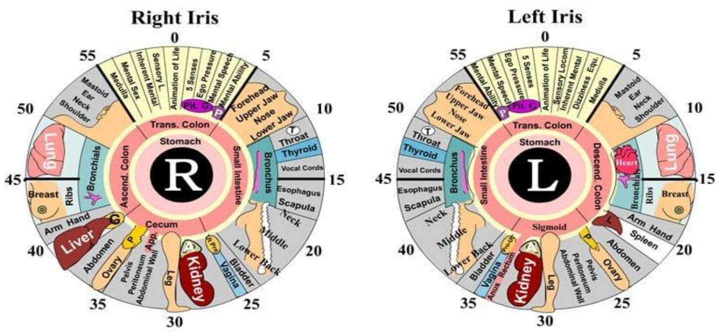

Fig 3., Irido chart of Right and Left Iris eye image.

f. Feature Extraction: For Feature extraction we are using Discrete Wavelet Transform and Gabor Filter.

1. Discrete Wavelet Transform : Iris consists of rich texture information and breaking of tissues of iris is directly associated with these texture features. Depending on the health of individual, changes can be observed in these texture features into the ROI.
2. Gabor Filter : The 2D Gabor filter is a feature extraction that has a good ability to distinguish space dan frequency domain. The purpose of this is to bring out the special features of an image by conducting convolution.

g. SVM classification: Support Vector Machines (SVM) are strong but simple supervised algorithms for machine learning which are used for classification and regression. However, they are usually used in classification issues.

The following are essential terms in SVM :

1. Support Vectors.
2. Hyperplane
3. Margin

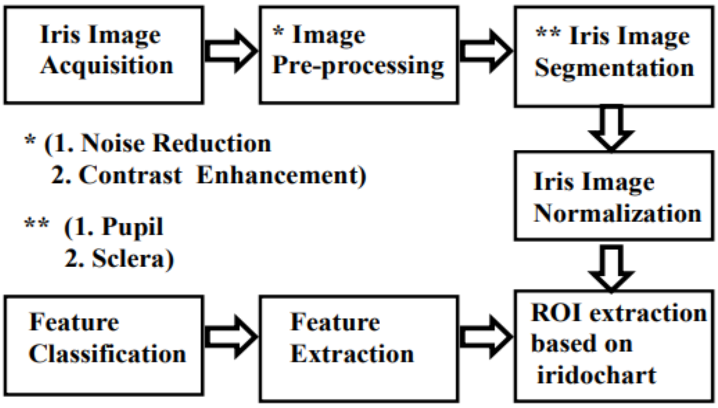

Fig 4., Block diagram of proposed approach

V. Algorithm

For feature extraction we are using Discrete Wavelet Transform and Gabor Filter. For feature classification we are using Support Vector Machine.

1. *Discrete Wavelet Transform*

Iris consists of rich texture information and breaking of tissues of iris is directly associated with these texture features. Depending on the health of individual, changes can be observed in these texture features into the ROI. At the same time, wavelet transforms show its great potential in various fields like in matching, biomedical, telecommunication, etc. Discrete Wavelet Transforms (DWT) are very suitable for non-stationary image analysis. DWT has been implemented to extract the significant features from iris images.

In encoding stage, two level Discrete Wavelet Transformation (DWT) is applied on the above segmented and normalized iris region to get approximation. In order to make matter easier. The proposed system uses DWT coefficients as feature vector. The wavelet is a powerful mathematical tool for feature extraction, and has been used to extract the wavelet coefficient from normalized iris images. Wavelets are localized basis functions, which are scaled and shifted versions of some fixed mother wavelets. The main advantage of wavelets is that they provide localized frequency information about a function of a signal, which is particularly beneficial for classification. A review of basic fundamental of Wavelet Decomposition is introduced as follows: The continuous wavelet transform of a signal X(t), square integrable function, relative to a real-valued wavelet, Ψ(t) is defined as:

$$W_\Psi(a,b) = \int_{-\infty}^{\infty} f(x) * \Psi_{a,b}(t)dx$$

where

$$\Psi_{a,b}(t) = \frac{1}{\sqrt{|a|}}((t-a)/b) \quad \rightarrow (1)$$

It is a tool that separates data into different frequency components, and then studies each component with resolution matched to its scale. DWT can be expressed as,

$$DWT_{x(n)} = \begin{cases} d_{j,k} = \sum(x(n)h_j * (n-2jk)), \\ a_{j,k} = \sum(x(n)g_j * (n-2jk)). \end{cases} \quad \rightarrow (2)$$

The coefficients dj,k refer to the detail components in signal x(n) and correspond to the wavelet function, whereas aj,k refer to the approximation components in the signal. The functions h(n) and g(n) in the equation represent the coefficients of the high-pass and low-pass filters, respectively, whilst parameters j and k refer to wavelet scale and translation factors. The main feature of DWT is multi-scale representation of function. By using the wavelets, given function can be analyzed at various levels of resolution. Fig 5., illustrates DWT schematically.

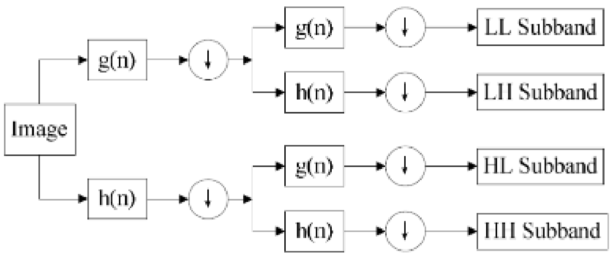

Fig 5., Schematic diagram of 2D DWT

The original image is process along the x and y direction by h(n) and g(n) filters which, is the row representation of the original image. As a result of this transform there are 4 sub-band (LL, LH, H H, H L) images at each scale. Sub-band image LL is used only for DWT calculation at the next scale. To compute the wavelet features in the first stage, the wavelet coefficients are calculated for the LL sub-band using Haar wavelet function.

2. *Gabor Filter*

The 2D Gabor filter is a feature extraction that has a good ability to distinguish space dan frequency domain. The purpose of this is to bring out the special features of an image by conducting convolution. Gabor features based blob detector is employed that extracts features based on different color and contrast patterns. The 2D Gabor filters used for iris recognition are defined in the doubly dimensionless polar Coordinate system. The Gabor function has the property of finite effective width in both the spatial and spectral domains. The property is relevant to texture analysis, especially texture segmentation since different textures tend to concentrate. Segmented region from 2D normalized iris images can be convolved with Gabor filter to extract features.

The Gabor function has the property of finite effective width in both the spatial and spectral domains. The property is relevant to texture analysis, especially texture segmentation since different textures tend to concentrate, in many cases, their significant energies into certain narrow frequency ranges. It consists in convolution of image with complex Gabor filters. As a product of this operation, complex coefficients are computed with one-level decomposition. The feature of the iris texture combines the position information and orientation in formation. The normalized iris images are divided into blocks.

The 2D Gabor filter in spatial domain is expressed as:

$$h(x,y) = h'(x,y) \, . \exp(j2\pi\omega)$$
$$h'(x,y) = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{x^2+y^2)}{2\sigma^2}\right.$$
$$\omega = x \, . \cos\theta + y \, . \sin\theta \qquad \rightarrow(3)$$

where, (x, y) is coordinates of spatial region, σ is the standard deviation represents frequency component and θ is direction parameter of filter. Iris feature vector is created by combining 12 texture energy features computed along four different directions and with three different frequencies. Initially for each filter channel (ωi , θj) (i=1, 2, 3) and (j=1, 2, 3, 4) the segmented lungs region of iris image I (x, y) is convolved with Gabor filters h (x, y) to obtain an image S (x, y) in frequency domain. The energy for each channel was then computed as:

$$e(\omega_i, \ \theta_j) = \sqrt{\text{Re} \ \ (S^2 + \text{Im}(S^2)} \qquad \rightarrow(4)$$

where, Re (S) and Im (S) are the real and imaginary part of image S (x, y). The feature vector so obtained is as shown in Equation 5.

$$F=(e\,(\omega_1, \theta_1), e\,(\omega_1, \theta_2), e\,(\omega_1, \theta_3), e\,(\omega_1, \theta_4),..., e\,(\omega_3, \theta_1), e\,(\omega_3, \theta_2), e\,(\omega_3, \theta_3), e\,(\omega_3, \theta_4)) \qquad \rightarrow(5)$$

3. *Support Vector Machine*

Support Vector Machines (SVM) are strong but simple supervised algorithms for machine learning which are used for classification and regression. However, they are usually used in classification issues. SVM has successful applications in many complex, real-world problems such as text and image classification, hand-writing recognition etc. It is a relatively new machine learning technique which is based on the principle of structural risk minimization. SVMs are helpful in text and hypertext categorization as their application can significantly reduce the need for labelled training instances in both the standard inductive and transductive settings. SVM works more effectively than any other classifiers.

SVM classification is of two types: linearly separable and non-linearly separable.

- Linear SVM:
  Linear SVM is used for linearly separable data, implying that if a dataset can be divided into two classes with a single straight line, it is considered linearly separable data, and classifier is considered a linear SVM classifier.
- Non-linear SVM:
  Non-linear SVM is used for non-linear data, which implies that if a straight line can not categorize a sample, the data is considered non-linear data and the classifier used is considered non-linear SVM.

The following are essential terms in SVM :

● Support Vectors − Data Points are considered to help vectors and are nearest to the hyperplane. With the aid of these data points, a dividing line is established.

● Hyperplane − It is a plane of judgment or space that a group of objects splits with various groups.

● Margin − The distance between two lines on the data points of different groups can be described. It can be measured as the perpendicular angle between the line and the support vectors. Big margins are called healthy margins, while low margins are known as poor margins.

SVM's key objective is to partition the datasets into classes to find a maximal marginal hyperplane (MMH) that can be achieved in the following two phases− First, it's aspect is determination of the optimal hyper-plane which will optimally separate the two classes, and the other aspect is transformation of non-linearly separable classification problem into linearly separable problem. It is based on the principal of structural risk minimization. The hyper plane was constructed in such a way that the margin of separation between two classes is maximum.

VI. Results And Discussions

- First step includes training of database.
- Once the training is done, a pop up window shows up showing that training is completed.
- After the training is done, the iris that has to be tested can be selected from files explorer by selecting Read Iris Image pushbutton.
- After selecting the image from files explorer, pre-processing of image is done where image is enhanced and noise

reduction is done.

- Segmentation of the image is done by selecting Segmentation pushbutton so that the iris is free of any noise such as eyelids and eyelashes. Once the segmentation is done, the circular iris pattern is converted into rectangular shapes using rubber sheet normalization. The features of iris are extracted.
- During matching the iris is tested whether the selected iris has diabetes or not.

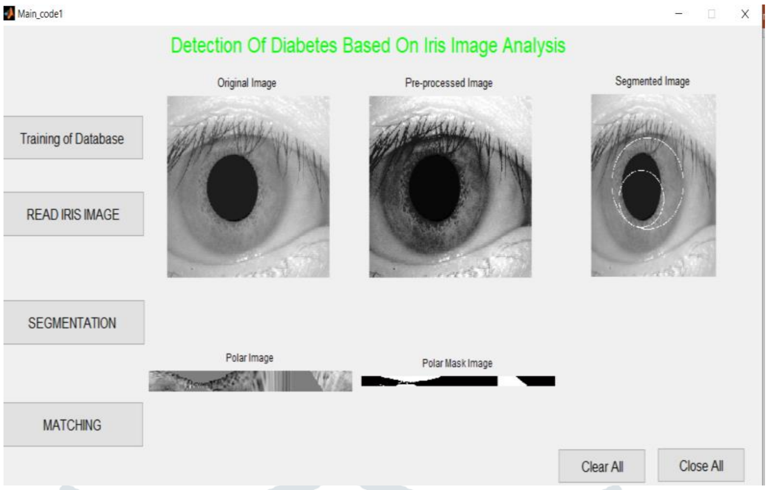

Fig 6., After Training, Reading, Segmentation and Matching of Iris Image

- If there is no presence of diabetes in the iris then a pop-up window opens up showing Normal Iris.

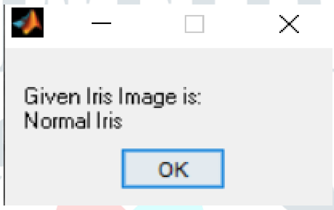

Fig 7., Pop-up window showing that there is no presence of diabetes

- If there is presence of diabetes in the tested iris then a pop-up opens up showing Detected Diabetes.

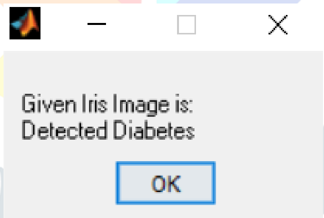

Fig 8., Pop-up window showing that there is presence of diabetes

VII. Conclusion

We conclude that there is a simple and non-invasive method to detect diabetic in body and iris recognition is not only mainly for biometric identification but it can also be used as a mean to detect diabetic or maybe detect any diseases as iridology claimed it is supposed to be. A system to predict the diabetes using iris images has been proposed and implemented. The technique depends mainly on two stages, iris localization and iris recognition. In the recognition stage a robust algorithm have been introduced which reduces the size of the iris image database and correspondingly the computational cost with high accuracy. The located iris's feature extracted using DWT, and then reduced to a compact size using PCA. SVM based classifier has been implemented for classifying subjects into healthy or one prone to diabetes.

A better equipment with higher resolution can be used for capturing the image, decreasing the amount of due to flash shall improve the image analysis. Due to its non-invasive nature and less time consumption, If proven effective this method shall be used for screening pathologies and for predictive diagnosis.

VIII. Acknowledgment

While bringing out this thesis to its final form, we came across a number of people whose contributions in various way helped our field of research and they deserve special thanks. It is a pleasure to convey our gratitude to all of them.

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