A Survey on Detection of Diabetes Based on Iris Image Analysis

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Abstract—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. Our survey is concentrated on different techniques employed to detect diseases, especially diabetes. This paper aims to help the researchers entering into the field of iridology by providing the complete understanding of the different methods employed for extraction and classification.*(Abstract)*

***IndexTerms*—Diabetes, Iridology, Feature Extraction, Feature Classification.** *(Keywords)*

I. Introduction

Diabetes has become an epidemic disease, and International Diabetes Federation estimated that 381.8 million people are affected by diabetes mellitus. In India more than 62 million people are diagnosed with diabetes [4]. It is a metabolic disease in which a person contains high blood sugar because of insufficient insulin in the body or cells in the body does not respond to the insulin produced [5] . The diagnosis of diabetes must always be established by a blood glucose measurement made in an accredited laboratory. The alternative way to measure a deficiency of insulin uses iris diagnosis [2]. Iridology is an alternative method in evaluating the condition of our internal organ by looking at the image of iris. Evaluating the iris is done by detecting the presence of some broken tissues in iris [3].Iris image is used as an input to the system, and it helps to know the condition of our internal organs and parts of the body. An Iridology chart gives the location and placement on the part of the iris for a particular organ or part of the body [9].Various algorithms are developed to assess quality of iris image, and then segmentation and feature extraction techniques are applied [11].

II. Implementation

Detection of diseases can be done in 7 stages:

1. Eye Image Acquisition: Initially the eye image is captured with the help of certain cameras, and stored in the database which contains normal as well as abnormal results of iris.

2. Image pre-processing: The pre-processing is done in order to reduce the presence of noise in the iris image and enhancement is done in order to manipulate an image so that the result is more suitable than the original. It makes the hidden features of an image more available for us. Enhancement is done for improving the details of an image.

3. Segmentation: Segmentation is done in order to find inner and outer boundaries of the iris. By subtracting pupil from sclera, we will get the iris part of an eye. After subtraction, we will get the iris pattern into circular shape.

4. Normalization: This is done to convert circular iris pattern into rectangular shape.

5. ROI extraction: After normalization, the next step which comes into picture is ROI extraction. ROI extraction is nothing but cropping particular portion of normalized iris image according to "irido-chart".

6. Feature extraction: Feature extraction includes the features of the extracted region such as mean, variance, standard deviation etc. It will show all these features into the command window.

7. Feature classification: Once the features are extracted, classification is done. Here only two classes are made. So, testing image is classified as normal iris or diabetic iris.

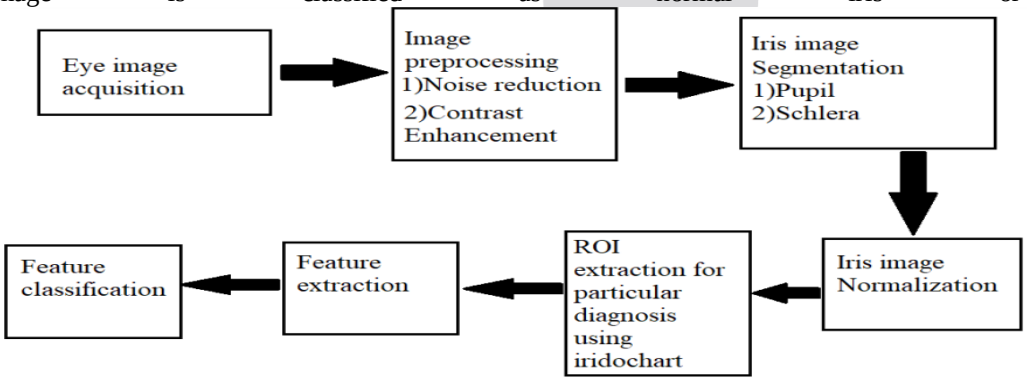

Figure 1: Block diagram of Implementation

III. Techniques For Feature Extraction

The aim of feature extraction is to find a transformation from an n-dimensional observation space to a smaller m-dimensional feature space. Main reason for performing feature extraction is to reduce the computational complexity for iris recognition.

3.1. 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[4,5]. 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) [12 ,20]. The wavelet is a powerful mathematical tool for feature extraction and has been used to extract the wavelet coefficient from normalized iris images [24].

3.2. Gray Level Co-occurrence Matrix-

Gray Level Co-Occurrence Matrix (GLCM) can reveal certain properties about the spatial distribution of the gray levels in the texture image [2]. GLCM is defined as the distribution of co-occurring values at a given offset over an image [9 ,11]. The grayish value of an eye image is different from each other. It defines the connection between two neighbouring pixels in a grayscale image. The primary picture element is named as the reference picture element and also the second is named the neighbouring picture element [29]. Following is the steps to use GLCM feature extraction:

1. Initialize the matrix area.
2. Set the spatial relation of the neighbor and the reference pixel, and set the distance d and the angle θ.
3. Calculating the concurrency matrix with the transposes concurrency matrix to make it symmetric.
4. Transform the matrix to probability form (Pd) by normalizing it [27].

3.3 Gabor Filter-

The 2D Gabor filter is a feature extraction that has a good ability to distinguish space dan frequency domain [27]. The purpose of this is to bring out the special features of an image by conducting convolution [16]. Gabor features based blob detector is employed that extracts features based on different color and contrast patterns [19]. The 2D Gabor filters used for iris recognition are defined in the doubly dimensionless polar Coordinate system [23]. 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 [18 ,21]. Segmented region from 2D normalized iris images can be convolved with Gabor filter to extract features [20].

3.4 Principal Component Analysis-

Principal Component Analysis (PCA) is used for extracting the features of region of interest. PCA is a well-known statistical tool that converts a set of highly correlated variables into linear uncorrelated variables using orthogonal transformation [28]. PCA is a classic technique used for compressing higher dimensional data sets to lower dimensional ones for data analysis, visualization, feature extraction, or data compression [21]. To apply the PCA on this ROI, matrix manipulation is necessary. Basically PCA assigns the specific weightage to the particular feature [1]. PCA can produce spatially global features. The original data are thus projected onto a much smaller space, resulting in data reduction. Given a set of data, PCA finds the linear lower-dimensional representation of the data such that the variance of the reconstructed data is preserved. The main idea behind using PCA is to reduce the dimensionality of the wavelet coefficients leading to more efficient and accurate [24].

IV. Techniques For Feature Classification

The classification function is an algorithm to predict and make a decision either the testing data is suffered from the disease or not.

4.1 Random Forest-

Random Forest is a popular machine learning. It can be used for both Classification and Regression problems. It is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.It contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset. Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output. The greater number of trees in the forest leads to higher accuracy and prevents the problem of over fitting.

4.2 Deep Neural Network-

A deep neural network is a complex structure of a neural network where a neural network with multiple hidden layers between the input and output layers. Neural network [17] is developed for predicting results and discovering the relation and pattern within the data set. In neural network, the elements or nodes are interconnected just like the human neuron. The accuracy of the output depends on the inter-unit connected strength. In neural network, the output layer neurons most commonly don't have an activation function because the last output layer is usually taken to represent the class labels. In deep neural network, there are many hidden layers and in every hidden layer, there are several neurons. In each layer of nodes, output depends on the previous layer's output [6].

4.3 k-Nearest neighbour-

k-NN is a method for classifying objects based on closest training examples in the feature space [8].k-NN is based on the principle that the instances within a dataset will generally exist in close proximity to other instances that have similar properties. If the instances are tagged with a classification label, then the value of the label of an unclassified instance can be determined by observing the class of its nearest neighbours. The k-NN locates the k nearest instances to the query instance and determines its

class by identifying the single most frequent class label. It is usual to use the Euclidean distance. The training phase for k-NN consists of simply storing all known instances and their class labels [24].

4.4 Support Vector Machine-

Support vector machines are strong but simple supervised algorithms for machine learning which are used for classification and regression. However, they are usually used in classification issues [29].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 [26]. SVM classification is of two types: linearly separable and non-linearly separable [1]. SVM works more effectively than any other classifiers [5]. SVM is a binary classifier that optimally separates the two classes. The first aspect is determination of the optimal hyper-plane which will optimally separate the two classes [14 ,20], and the other aspect is transformation of non-linearly separable classification problem into linearly separable problem [19 ,12]. It is based on the principal of structural risk minimization [27]. The hyper plane was constructed in such a way that the margin of separation between two classes is maximum [20 ,8].

V. Conclusion

The potential of the diagnosis utility of the iridology along with machine learning modes had been studied. For the effective realization of feature based predictive analysis, it is essential to evaluate and compare various predictive modelling methods. This paper shows that alternative medicine techniques have the potential to solve problems related to diagnose diseases in a fast, cheap and non-invasive way. It is very essential to perform extensive study and investigation to validate iridology for diabetes diagnosis and to open an entirely new path for disease diagnostics.

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