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DETECTION OF DIABETES MELLITUS USING NON-INVASIVE AND NON-PROLIFERATIVE METHOD

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Abstract

In the past decades lot of researchers have developed non-invasive methods by facial image analysis to discover Diabetes Mellitus. Detection of Diabetes Mellitus by using facial image evaluation doesn't motive any pain to the patient, because this method is a non-invasive and handy to come across Diabetes Mellitus. In this paper 4 facial blocks are used to extract the features from the facial photograph. Histogram feature is used to represent the intensity values of the facial image. Genetic Algorithm is used to pick out the features from the Histogram characteristic. At closing, the classifier (K-Nearest Neighbors with weights) is used to sort the Healthy and Diabetes Mellitus character. On this paper, the take a look at dataset contains 284 Diabetes Mellitus and 142 Healthful samples, 99.48% of accuracy is attained.

Keywords:

Diabetes Mellitus; Feature Extraction; Feature Selection; Histogram feature; Genetic Algorithm; K- Nearest Neighbors with weights.

1. Introduction

In 2015, the International Diabetes Federation (IDF) [1] founded that, 415 million humans are suffering from diabetes in the worldwide that is one individual dies in every 6 seconds. If in addition movement isn't always taken via the authorities, then this number will be improved to 642 million humans by the way 2040. Lancet study [2] reported that, China, India and USA are the pinnacle countries having greater variety of diabetes people. In 1980, 11.9 million people are suffering from diabetes in India and it is going to be progressed to 64.5 million by the year 2014. Prevalence of diabetes among the men is increased by 50% and women were improved by 80% in India. Diabetes Mellitus (DM) [3] can be characterized into two types. They are Type 1 DM and Type 2 DM. Type 1 DM is produced due to the failure of insulin production in the pancreas and it needs insulin to inject daily. Type 2 DM is caused by the insulin resistance and also deficiency of insulin production. Large number of people are affected by Type 2 DM. There is no remedy for both diabetes, but we can control Diabetes by frequently doing the exercises, keeping diets and using medicine. High glycemic index food, genetic problem, avoiding breakfast, late night sleeping, late night working, stress, excess weight and sitting full day are the most common factor [4] for increasing diabetes in India. Diabetes will be a source [5] for heart problem, stroke, hearing loss, nephropathy, neuropathy and eye complication such as damage the blood vessels, cataract.

Fastest Plasma Glucose (FPG) test [6] is used to identify the Diabetes Mellitus. In FPG method blood samples are taken from the body to measure the glucose level. FPG is traditionally used method for discover DM. It is a invasive method (it will produce pain to the patient, when the blood samples are taken from the body). It has the disadvantage that the patient should not consume food for 8-10 hours before taking the blood samples.

2. Existing Method

In the past decades lot of researchers have developed non-invasive methods [7] – [9] by facial image analysis to discover Diabetes Mellitus. Tongue capturing device [7] is used for capture the tongue image. After capturing the image, Segmentation is applied to separate the object from its background pixels. From the Segmented image, extract the features such as color, texture and geometry. Here 12 color features are extracted from the tongue image. 8 texture blocks are located on the tongue and the dimension of the each block is 64x64. Mean of the 8 blocks are calculated. Totally 9 texture features are extracted from the Image. Finally, 13 geometry features are extracted from the image. In this method

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totally 34 features are used for sort healthy and diabetes mellitus person, the accuracy was 80%.

3. Literature survey

In paper [8], four facial blocks are located on the facial image, facial color features are extracted from the block and Sparse Representation Classifier (SRC) is used. In this method, the dataset comprises 248 DM and 142 Healthy samples and attain the accuracy as 97.54%. It is a time consuming process because 11 norms used in SRC. Due to the huge size of the image database, SRC took more time to complete the process. In paper [9], the DM can be discovered by, Improved Patch Ordering, the texture features of the facial blocks are extracted by using the Gabor filter. 100 DM and 100 Healthy samples are taken and 99.38% of accuracy was attained. To examine their methods, proper combinations of the facial blocks are used in [8] and [9] the relationships between the four blocks are not considered. So we take these relationships as a advantage to put forward our method having a classifier with weights determined using the four blocks.

4. Proposed method

The facial image can be captured by using the captured device. In paper [8] the brief description about the device is given. The facial block size is 64x64 in both [8] & [9] and the similar block size is used in our proposed method. Figure1 shows, how the four facial blocks are placed on the facial image.

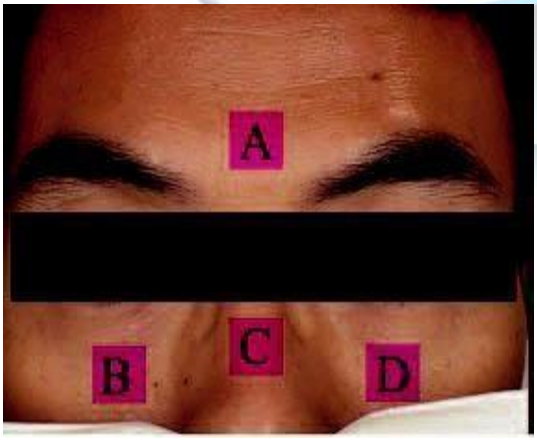

Figure1: Facial image with four blocks

In our recommended method, four facial blocks are instated on the face. Four facial blocks are represented by Block A, Block B, Block C, Block D. In the forehead Block A is located, below the left and right eyes Block B and Block D are located and Block C is located on the nose. After capturing an image, Segmentation is applied to extract the object from the background and also used to detect the exact edges. The range of intensity values of the facial images are represented by using the histogram. All the intensity values of the blocks are taken to represent histogram feature.

Genetic Algorithm is used to choose the features from the Histogram feature and it also used to eliminate the unnecessary information from the Histogram. From [11] – [13], Genetic Algorithm is an efficient and effective method. In our proposed method Genetic Algorithm is used for selecting the features from the Histogram feature. K-Nearest Neighbors [14] – [16] classifier with weights is used to sort the Healthy and Diabetes Mellitus person. These weights are trained using the training data which decreases the distance of sample from the same class. To attain the best accuracy, 284 DM and 142 healthy samples are used.

Block A Block B Block C Block D

Healthy samples

Block A Block B Block C Block D

DM samples

Figure2 : Healthy and DM samples

The rest of this paper is ordered as follows: In Section 4.1, Extracting features from the facial block using Histogram feature, picking the features using Genetic Algorithm, In Section 4.2, Classification of DM and Healthy person by using K-NN with weights classifier, Experimental results are described in Section 5. Conclusion is explained in Section 6. Figure3 shows the block diagram of our proposed method.

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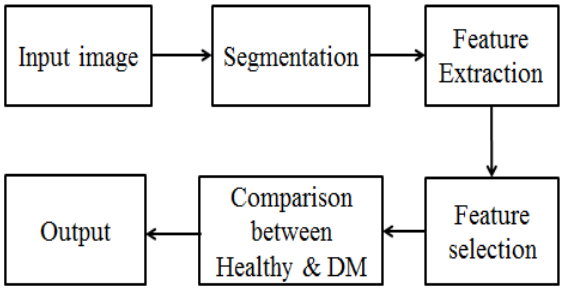
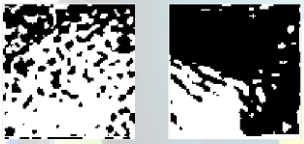


Figure3 : Block diagram for detecting DM

Feature extraction and selection from facial block

First Segmentation is applied in the facial images to obtain the objects or foreground pixels from its background. Figure4 shows the segmentation of Healthy and DM person from Block A. Nowadays, many research areas use Genetic Algorithm and demonstrate that, it is an efficient and effective searching method. From the histogram feature, select the new features by using Genetic Algorithm. Histogram is used to extract features from facial block.



Healthy DM

Figure4: Segmentation of Healthy and DM person from Block A

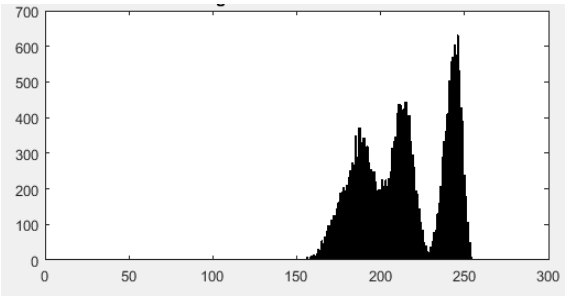
Histogram feature

In this section, extraction of features from each block can be explained. Figure2 report that, candidate skin only present in the facial blocks. The facial blocks are smooth, edges and other shapes are not involved in the block. So the intensity values of all blocks are in the similar range. Histogram feature is used to extract the features from each facial block. It calculates all intensity values present in the block.

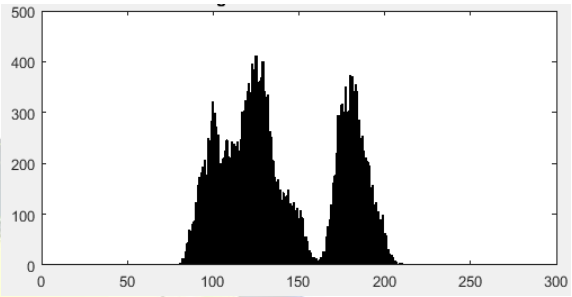
Histogram feature of each block can be expressed as H= {h(0),h(1),h(2),…h(255)}. Where, h(i) denotes the intensity value of the block i then, we get

$$h(i) = \sum \quad (1)$$

Where i represents the intensity values, i=0,1,2…,255.



(a) Histogram of Healthy person



(b) Histogram of DM person

Figure5 : Histogram of Healthy and DM person

Figure5 shows that, it is an example for Histogram of Block A for both DM and Healthy person also show the intensity value of the DM person and is in the range of 100 to 200 and intensity value of Healthy person is in the range of 150 to 250. Figure3 states that Histogram feature is also used to sort DM and Healthy person.

Genetic Algorithm

Feature selection can be described in this section. Genetic Algorithm is used to select the features from the Histogram and eliminate the inordinate information from Histogram feature. The population is initialized, after initialization the individual is selected based on the fitness of an individual. For each generation new children is generated by cross over and mutation of selected individual. Finally, select the best individual from the population.

4.2 K-NN classifier with weights

K-NN-W classifier is used for sort Healthy and Diabetes person. Figure6 shows the fatigue and non-fatigue condition of a person. Fatigue is one of the symptoms to find the person is affected by diabetes. Figure b shows that the person is having fatigue. From the figure we won't conclude that the

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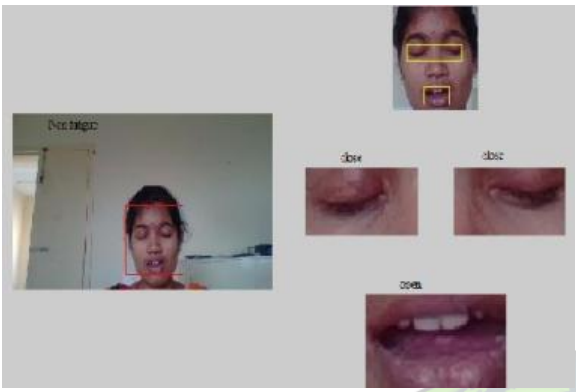
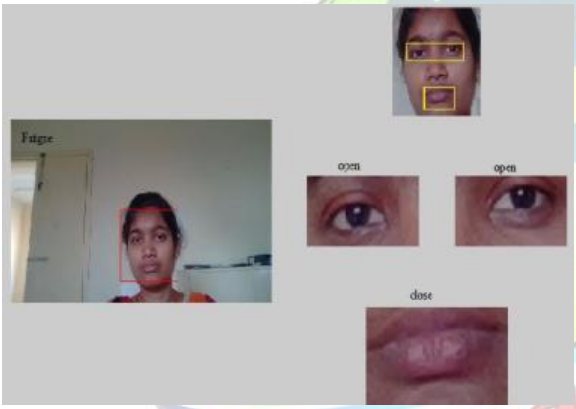
person is diabetes. So I am proposed to extract the features from the facial blocks to identify the person is diabetes or not.



(a) Non- fatigue



(b) Fatigue

Figure6 : Fatigue and non-fatigue images

In order to take these relationships as a advantage to put forward our method having a K-NN classifier with weights determined using the four blocks. Four facial block weights can be represented as w = [w1, w2, w3, w4]. Where w1, w2, w3, w4 are the weights of Block A, Block B, Block C, Block D respectively. Let x = [x1, x2, x3, …. ,xn] which represents the training data and the label of the training data is y = [y1, y2, y3,…,yn]. In training data n samples are present. One of the training data sample is given by, . It states that, 4 blocks are presented and m represents the size of the feature of each block. One of the testing data is denoted as (α). K-NN with weights used for classify the data and it is expressed as,

classify(α) = ^{2} (2)

The above equation is the modified form of K-NN where K=1. Based on the training data w is trained which creates the sum values of distances between the samples from the same class to be decreased. W can be given below,

$\Sigma \quad \Sigma \quad \Sigma \quad ^{2}$ (3)

Where represents j^{th} sample from the i^{th} block which is in the a^{th} class, denotes mean value of the i^{th} class. α can be calculated by using above equation.

5. Experimental result

In this section, experimental results are discussed. In our method the database contains 284 DM and 142 Healthy samples. The training data of all experiment result explained below contains only 28 DM and 14 Healthy samples which represents only 10% are used as training data from the whole dataset, remaining 90% are considered as testing data. Three modules are presented in our method. They are (1) histogram feature, (2) Genetic Algorithm, (3) K-NN with weights classifier.

At the beginning stage the output of the four combinations of module 2 & 3 (with or without Genetic Algorithm and with or without weight) is discussed. Then the result of Local Binary Pattern (LBP) [17] – [19] was discussed (histogram is replaced in our method). When Genetic Algorithm is not used means, histogram feature is first applied and then sort the DM and Healthy samples directly by using the K-NN with weights classifier. In without weights, K-NN classifier is used, where K=1. Finally LBP method is explained instead of histogram feature. Five experiments are given in the Table. In order to differentiate those experiments function ID is given.

Function ID	Method
1	Histogram feature + GA + K-NN-W
2	Histogram feature +without GA + K-NN-W
3	Histogram feature + GA + K-NN
4	Histogram feature +without GA + K-NN
5	LPB+ GA + K-NN-W

Table 1: Comparisons of five methods

Genetic Algorithm is used in three methods. Method 1 and 3 uses Histogram feature from that we

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select the features by using Genetic algorithm. Selected feature size is displayed in Table2.

Function ID	Facial block			
	Block A	Block B	Block C	Block D
1	134	113	142	125
3	143	115	121	135
5	127	125	133	129

Table 2: Dimensions of selected feature

The size of the feature is lesser than 145, which represents more than 100 features are eliminated in the feature selection process (each block have 256 values for both LBP and Histogram feature). Figure6 (Graph) shows that result of Genetic Algorithm is better than without Genetic Algorithm. From the above result we can say that, Genetic Algorithm is used for reduce the feature size and also it enhances the experimental result.

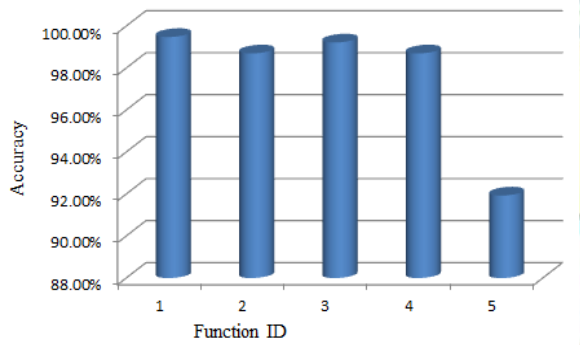

Figure6 : Result comparison

From the graph, we can say that our proposed method (Histogram feature + Genetic Algorithm + K-NN with weights) achieve 99.48% of accuracy. In fifth method LBP is used for feature extraction instead of Histogram feature. It produces 91.93% of accuracy. Accuracy of this method is lower when compared with our method.

Classifier	With GA	Without GA
K-NN	99.22%	98.70%
K-NN-W	99.48%	98.70%

Table 3: Comparisons of with and without GA

Table 3 explains the weights of with and without GA. In without Genetic Algorithm both classifiers have same accuracy level that is 98.70%. When Genetic Algorithm is used means the accuracy is enhanced to 99.48% for K-NN with weights. The above statements states that K-NN with weights (K- NN-W) classifier has high accuracy than K-NN classifier when Genetic Algorithm is used.

When Genetic Algorithm is used means, we obtain above 99% of accuracy for both the classifier. When Genetic Algorithm is not used means, we get accuracy as below 99%. From the above result we said that Genetic Algorithm is essential for our method. Genetic algorithm with K-NN-W produces higher accuracy than KNN. So K-NN-W is more applicable for our method. [10] proposed a system in which OWT extracts wavelet features which give a good separation of different patterns. Moreover the proposed algorithm uses morphological operators for effective segmentation. From the qualitative and quantitative results, it is concluded that our proposed method has improved segmentation quality and it is reliable, fast and can be used with reduced computational complexity than direct applications of Histogram Clustering.

6. Conclusion:

In this paper, Histogram feature, Genetic Algorithm and K-NN-W classifier are used for attain 99.48% accuracy. Histogram feature is used to represent the distribution of the intensity value of the four facial blocks. Genetic Algorithm is used to select the features from the from the histogram. K-NN with weights is used to sort the DM and Healthy person and also it consider the relationships between the four facial blocks. From the experimental result conclusion is made, the efficient and effective way of detecting diabetes is our proposed method.

In future work, use other features to detect DM and also improve dimensions of our image database.

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