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Study And Review Of Various Image Classification Methods For Diabetes Mellitus Detection

Manaswi A. Kadam[1], Kiran S. Kadge[2], Soniya S. Mane[3], Shweta P. Naikwadi[4], Mrs. V. C. Kulloli[5]

[1] *Student, Information Technology, Pimpri Chinchwad College of Engineering, Maharashtra, India*
[2] *Student, Information Technology, Pimpri Chinchwad College of Engineering, Maharashtra, India*
[3] *Student, Information Technology, Pimpri Chinchwad College of Engineering, Maharashtra, India*
[4] *Student, Information Technology, Pimpri Chinchwad College of Engineering, Maharashtra, India*
[5] *Assistant Professor, Information Technology, Pimpri Chinchwad College of Engineering, Maharashtra, India*

Abstract - *Every year millions of people die because of diabetes. Diabetes Mellitus (DM) is a condition in which glucose level in the body is much higher than the normal. The traditional way to diagnosis DM is Fasting Plasma Glucose (FPG) test. As this method is slightly painful and uncomfortable several another methods which are more comfortable and non-invasive are found. Aim of this paper is to review some of the noninvasive DM detection methods. There are number of algorithms and techniques which used to detect DM non-invasively. This paper extensively reviews and compares such techniques and algorithms which are previously used to support and provide current and future researchers with a complete summary of such algorithms and techniques.*

Key Words: *Diabetes Mellitus(DM), texture feature, color feature, Neighbourhood based Modified Back propagation using Adaptive Learning Parameters (ANMBP), Sparse Representation Classifier(SRC), K-Nearest Neighbour(KNN), Support Vector Machine(SVM), facial block, computerized iris diagnosis, simplified patch ordering and improved patch ordering.*

1. INTRODUCTION

Diabetes mellitus is a main source of death and handicap on the earth. Its worldwide pervasiveness was around 8% in 2011 and is anticipated to ascend to 10% by 2030. Almost 80% of individuals with diabetes live in low-and centre pay nations. Asia and the eastern Pacific district are especially influenced in 2011, China was home to the biggest number of grown-ups with diabetes (i.e. 90.0 million, or 9% of the populace), trailed by India (61.3 million, or 8% of the populace) and Bangladesh (8.4 million, or 10% of the populace). In any case, numerous administrations and general wellbeing organizers remain to a great extent unconscious of the ebb and flow pervasiveness of diabetes and pre-diabetes, the potential for a future ascent in commonness and the genuine complexities connected with the illness. Subsequently, learning of the commonness of diabetes and pre-diabetes and of related danger components could bring issues to light of the malady and lead to new arrangements and techniques for anticipation and administration.

By International Diabetes Federation [1], the pervasiveness will be 13% by 2030. India is one of the 6 nations of the IDF SEA (South East Area) district. 415 million individuals have diabetes on the planet and 100 million individuals in the SEA Region; by 2035 this will ascend to 145 million. There were 66.8 million instances of diabetes in India in 2014. In 2014, DM caused 4.9 million deaths, which means every 7 seconds a person died from DM (5.0 million deaths). 415 million grown-ups have diabetes on the planet. By 2040 this will ascend to 642 million. By 2040, 1 grown-up in 10 (642 million) will have diabetes. 1 in 7 births is influenced by gestational diabetes. The greatest number of people have DM are between 40 and 59 years of age. 1 in 11 grown-ups have diabetes (415 million).

The Fasting Plasma Glucose Test is traditional way of diagnosis DM. As this method is slightly painful and uncomfortable several another methods which are more comfortable and non-invasive are found. The methods covered in this paper are as follows:

1. Abnormal Condition Detection of Pancreatic Beta-Cells as the Cause of Diabetes Mellitus based on Iris Image
2. Detection of DM using Optimized Tongue Image Colour Correction Scheme,
3. Detection of DM using Facial Block Color Features with the SRC,
4. Detection of DM using Facial Block Texture Features Using the Gabor Filter,
5. DM Detection Based on Iris Image and Simplified and Improved Patch Ordering for Diabetes Mellitus Detection.

In the following sections, overviews of the existing work on various methods of detection of DM are presented, with the principles, merits, and demerits of each method outlined. It should be pointed out that the experiments of various methods reported in this paper are conducted by

the authors of the work being reviewed. The remainder of this paper is organized as follows. Section II describes related work. Summery table is presented in Section III. Section IV concludes this paper.

2. RELATED WORK

2.1 Abnormal Condition Detection of Pancreatic Beta-Cells as the Cause of Diabetes Mellitus Based on Iris Image

Beta cells are extraordinary cells in the pancreas that deliver, store and discharge the hormone insulin. The fundamental capacity of a beta cell is to create and discharge insulin - the hormone in charge of directing levels of glucose in the blood. In individuals with diabetes, be that as it may, these cells are either assaulted and wrecked by the resistant framework (type 1 diabetes), or can't deliver an adequate measure of insulin required for glucose control (type 2 diabetes).The approach to quantify an inadequacy of insulin from the Beta-cells of pancreatic islets is iris diagnosis [4]. By detection of the presence of some damaged tissue in iris the iris is evaluated.

This paper proposed a modernized iris finding technique went for wiping out the subjective and subjective attributes of ordinary iris determination and building up the relationship between iris appearance and the state of pancreas organ. ANMBP [5] classifiers in view of quantitative components to be specific textural estimations, is utilized as the choice models for determination.

First iris image is captured and quantitative and textural features are extracted using Back propagation algorithm. Then Neighbourhood based Modified Back propagation using Adaptive Learning Parameters (ANMBP) method is employed to model the relationship between quantitative features and pancreatic abnormalities as caused of insulin deficiency. Thus, whole process is of two major steps:
1. Feature extraction
2. Matching process.

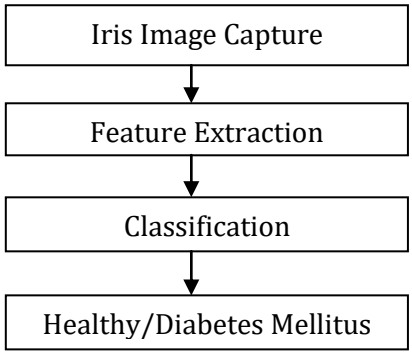

Fig -1: Flowchart for DM detection using ANMBP

2.2 Detecting Diabetes Mellitus and Non proliferative Diabetic Retinopathy Using Tongue Color, Texture and Geometry Features

Diabetic retinopathy is the consequence of harm to the small veins that sustain the retina. The condition as a rule influences both eyes. It is connected with the drawn out hyperglycaemia of diabetes mellitus and with different diabetes mellitus-connected conditions, for example, hypertension. Diabetes mellitus can bring about an assortment of eye issues, the most widely recognized being DR, which is the most well-known reason for extreme sight weakness among individuals.

This paper proposed, a non invasive way to classify Healthy/DM and NPDR/DM-sans NPDR tests utilizing three gatherings of features separated from tongue image. These three features are color, texture, and geometry. A tongue color gamut [6-7] was initially connected such that every tongue image can be spoken to by 12 colors. Later, eight squares deliberately situated on the tongue were separated and its texture value is calculated. The Gabor filter [2-3] is a linear filer used in picture handling, and is generally utilized as a part of texture representation. To calculate the texture value of every square, the 2-D Gabor filter is applied. At long last, 13 geometry features from tongue pictures taking into account measurements, distances, areas, and their proportions were extracted. Using k-nearest neighbor (K-NN) [9] (with k = 1) and a support vector machine (SVM) [8] classification was performed. In classification of Healthy / DM and NPDR/DM-sans NPDR samples the next step is optimization by feature selection using sequential forward selection (SFS) [10]. SFS is a feature selection method that begins with an empty set of features.

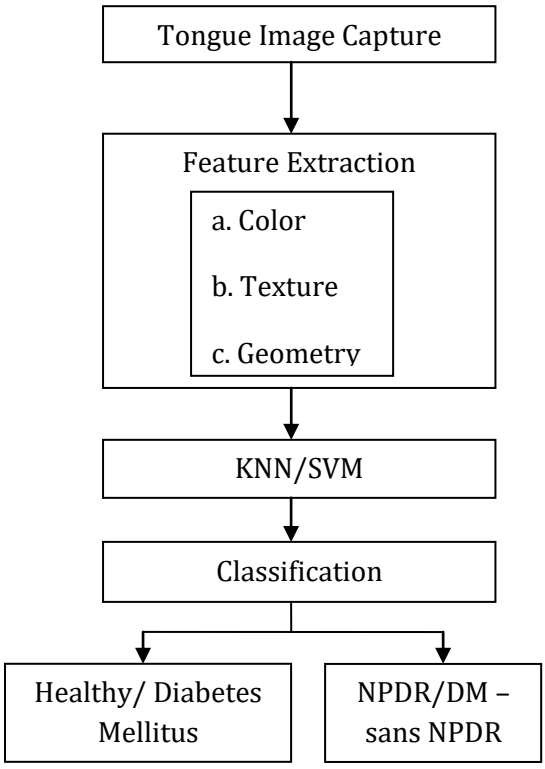

Fig -2: Flowchart for DM detection using color, texture and geometry features

2.3 Non-invasive Diabetes Mellitus Detection Using Facial Block Color with a Sparse Representation Classifier (SRC)

This Non-invasive method proposes to distinguish DM samples vs. Healthy samples based on facial block colour features using the SRC classifier. From a given set of training and test samples the main concept of SRC is to define to represent the test sample as a linear combination of the given training samples, while requiring that the representation of coefficients are as sparse as possible. SRC is the non-invasive approach to classify Healthy and DM samples using facial colour features extracted from facial blocks. For non-invasive Diabetes Mellitus detection we first captured the facial image then performed a color correction procedure [14] before feature extraction and classification of facial image then divide facial image into four blocks.

Four facial image blocks, one is on the nose and forehead and two below the left and right eyes are extracted to represent a face automatically. Firstly, a six centroids from a facial color scale are applied to calculate the facial colour features of each block of facial image. This means that a facial colour scale was first applied such that each facial block is represented by six colors. Secondly, six centroids are applied on facial image to calculate a facial color feature vector for each facial block. After extracting the facial block color features using the statistical pattern recognition techniques [11] such as SRC, SRC two sub dictionaries used, one is characterizing Healthy facial colour features and the other is DM facial colour features and then first SRC classifier is applied on feature extraction then traditional classifier such as *K*-NN and SVM are used to classify DM samples vs. Healthy samples.

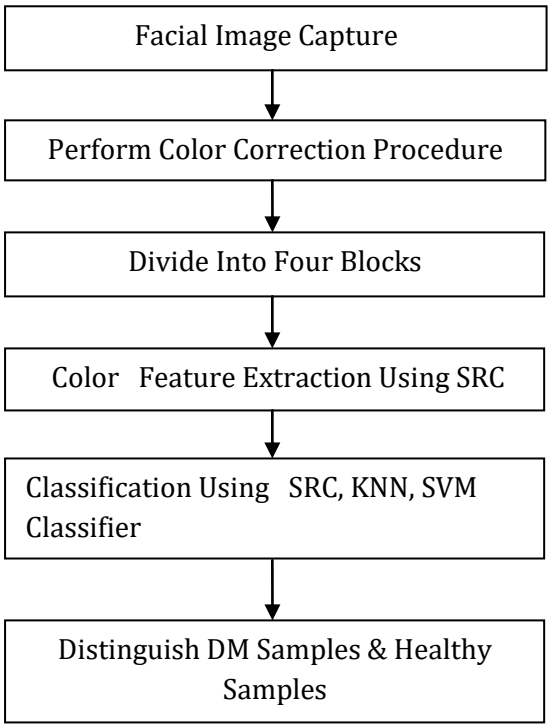

Fig -3: Flowchart for DM detection using SRC

2.4 Diabetes Mellitus Detection Based on Facial Block Texture Features Using the Gabor Filter

Recently, for DM detection algorithms have been developed which are based on facial block colour features. In this paper, a novel method is proposed for Diabetes Mellitus detection which is based on facial block texture features by using the Gabor filter. For Diabetes Mellitus detection first captured the image using standard device [12]. Then applied color correction procedure on that image [14]. Then the facial image is divided into four block of size 64 × 64. The first block is taken from the forehead, second and fourth blocks are taken which are below the left and right eyes and third block on nose. Then for extracting the texture features Gabor filter is applied. Finally, Diabetes Mellitus and Healthy samples are classified using K-NN and SVM classifiers.

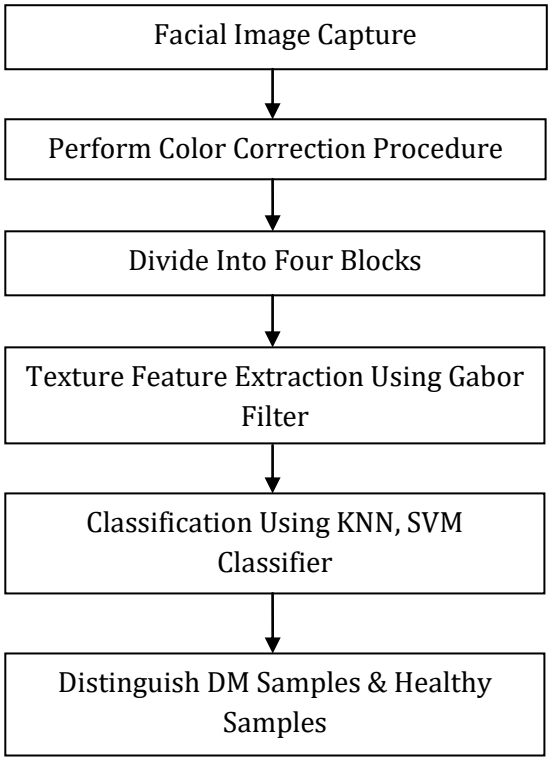

Fig -4: Flowchart for DM detection using Gabor Filter

2.5 Simplified and Improved Patch Ordering for Diabetes Mellitus Detection

Recently, for detecting Diabetes Mellitus researchers have developed non-invasive methods which are based on human facial block. Even though a few algorithms are also developed to detect Diabetes Mellitus based on facial block but Diabetes Mellitus detection remains a challenging problem. First problem [12] is if the size of the facial image database is larger than it takes a more time to complete the SRC process i.e. SRC is very time consuming process. Another problem [7] is about detection of DM using tongue color, texture, and geometry features, in this paper they separated DM and Healthy samples with an average accuracy 80.52% employing Sequential Forward Selection (SFS) with the Support Vector Machines (SVM) on 130 Healthy and 296 DM tongue images. However, by applying each feature individually their highest average accuracy achieved 66.26% only via SVM. However, their result is not as good as [12].

In this paper to overcome these problems, they developed two algorithms to detect Diabetes Mellitus by using non-invasive method which is based on the facial texture features. These texture features are extracted by using the Gabor filter and the algorithms used are Simplified Patch Ordering and Improved Patch Ordering [13]. Firstly capture the image by using standard device [12]. Then apply the color correction procedure on facial image [14]. According to Traditional Chinese Medicine (TCM) theory [15], health status of the internal organs can be reflected by different regions of the human face. So the facial image is divided into four blocks (A, B, C, and D) of size 64 × 64. A block is taken on the forehead, Blocks B and D are taken below the left and right eyes and Block C is located on the nose. Then apply a Gabor filter for extracting the texture features. Finally, for classifying Diabetes Mellitus and Healthy samples Simplified Patch Ordering and Improved Patch Ordering are applied. Simplified Patch Ordering can classify Diabetes Mellitus and Healthy samples with an accuracy of 95.83%, while Improved Patch Ordering can classify Diabetes Mellitus and Healthy samples with an accuracy of 99.38%, both methods are based on a combination of facial blocks. So this method is better than other methods.

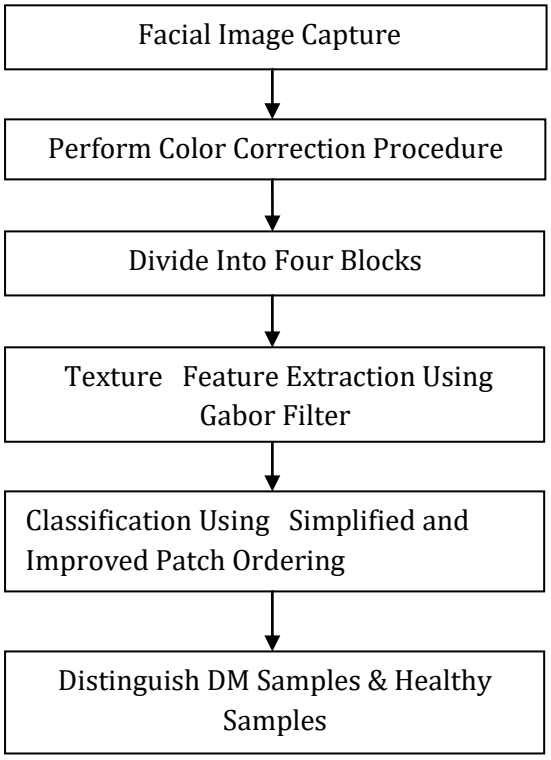

Fig-5: Flowchart for DM detection using simplified and improved Patch Ordering

Table 1: Review Of Image Classification Methods For Diabetes Mellitus Detection

Sr. No	Authors	year	Features	Techniques		Accuracy (%)
1	Putu Dody Lesmana, Ketut Eddy Purnama, Mauridhi Hery Purnomo[1]	2011	Texture	ANMBP(Neighbourhood based Modified Back propagation using Adaptive Learning Parameters)		83.30
2	Bob Zhang, B. V. K. Vijaya Kumar, David Zhang[2]	FEB 2014	Color, Texture, Geometry	Gabor Filter	KNN	67.87
					SVM	80.52
3	Bob Zhang, B. V. K. Vijaya Kumar, David Zhang[3]	APRIL 2014	Color	SRC		97.54
				KNN		92.96
				SVM		94.72
4	Shu Ting, Bob Zhang[4]	2014	Texture	Gabor Filter	KNN	99.82
					SVM	99.82
5	Ting Shu, Bob Zhang, Yuan Yan Tang[5]	2015	Texture	Gabor Filter	SPR(Simplified Patch Ordering)	95.83
					IPR(Improved Patch Ordering)	99.38

3. CONCLUSIONS

We have described here the different Methods of Diabetes Mellitus Detection. Although many papers have been published on Diabetes Mellitus Detection, but the detection of DM is still an issue. Diabetes Mellitus can be detected noninvasively using different features. Feature extraction is done using SRC and Gabor Filter and classification is done using different classifiers such as KNN and SVM.

The choice of Gabor filter gives highest accuracy and faster result as compare to other methods like SRC method. For classification of featured image two classifiers are used first is SVM and second is KNN which are comparatively simple algorithm, where KNN is most suitable classifier because of its faster speed. Hence, they used separate texture features and color features for DM Detection. The Future scope can be Combine texture features with facial block color Features.

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BIOGRAPHIES

Ms. Manaswi A. Kadam is presently pursuing her B.E in Information Technology from Savitribai Phule Pune University. Her area of interests is Image Processing and Data Mining.

Ms. Kiran S. Kadge is presently pursuing her B.E in Information Technology from Savitribai Phule Pune University. Her area of interests is Image Processing and Data Mining.

Ms. Soniya S. Mane is presently pursuing her B.E in Information Technology from Savitribai Phule Pune University. Her area of interests is Image Processing and Data Mining.

Ms. Shweta P. Naikwadi is presently pursuing her B.E in Information Technology from Savitribai Phule Pune University. Her area of interests is Image Processing and Data Mining.

Mrs. V. C. Kulloli received her M.E (CSE) from Pune University. She is pursuing her Ph.D. (CI) from Pune University. She has Sixteen years long experience in the field of teaching. Her research areas are Data Mining, Image Processing. Her research work has been published in many national and international journals and Conferences.