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Automated Diabetic Retinopathy Detection using CS Based SVM Techniques

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Abstract*: Diabetes is one of the metabolic maladies where a patient has high glucose either brought about by body inability to create enough insulin or the cells inability to react to deliver insulin. This ceaseless ailment may prompt long haul inconveniences and death. It can cause high danger of kidney disappointment, nervous system harm, visual impairment and coronary illness. During the ongoing years there have been numerous examinations on programmed finding of diabetic retinopathy utilizing a few features and techniques. In this work at first the color fundus image can be utilized for processing, methods, for example, Median filtering, Morphological transformation, or Histogram equalization used to improve the nature of the image. Then to detect microaneurysms, blood vessels and optic disc using the techniques like morphological thresholding transformation, and the features are extracted from Grey level Co-occurrence Matrix (GLCM), Gabor Feature extraction and Linear Binary Pattern (LBD).At long last, for classify the various phases of diabetic retinopathy, SVM (support Vector Machine) Algorithm will be utilized, the outcomes are optimized by Cuckoo Search (CS) calculation.

Keywords* : Cuckoo Search (CS), SVM (support Vector Machine), Gabor Feature extraction, Linear Binary Pattern (LBD), GLCM, Median filtering.

I. INTRODUCTION

In the present situation, around 250 million of individuals are influenced by diabetes. On the off chance that the people are influenced by diabetes, the blood glucose level is expanded and the retina gets influenced. This prompts visual deficiency or loss of vision. Diabetic Retinopathy is an ailment which is influenced by the small scale vasculature of the retina of the eye. This vasculature is caused because of the diabetes mellitus. If this disease is not checked completely and if proper treatment is not taken, then this may lead to blindness. For initial cases, regular check of the fundus images manually should be undertaken. This is helpful in checking any morphological changes occurring in small aneurysms, any internal bleeding, inflammations, defect in the blood vessels, and any errors in macula. These checking operations will take more time and also a complex method. There are many procedures for detecting the above defined options. These are discussed for making the detection critically diabetic retinopathy.

Zhanget al. [1] presented a computer aided diagnosis method that is used for diabetic retinopathy. This method is proved to be more efficient and effective. Jeglin & Hariharan [2] proposed an automatically detection mechanism for microaneurysms in medical image processing systems. Sharma & Kaushik [3] developed a neural network and fuzzy clustering for image segmentation. In this method Diabetic Retinopathy detection is easily. However, the limitation is that this method becomes a failure in some noisy regions and as a result the resulting regions become too bright causing incorrect image segmentation. Ganesh & Basha [4] presented Diabetic Retinopathy which is automatically found out by Kirsch's edge detection algorithm. To extract the blood vessels from retinal images Kirsch template method is used. It correctly finds the new blood vessels formation in retinal images by preprocessing, vessel extraction, feature extraction and classification of retinal images. Jahiruzzaman & Aowlad [5] presented an effective method to find out the exudates and hemorrhages in fundus images. K- Means color compression method is used to reduce the color dimension in different regions of fundus images. Diabetic Retinopathy recognition is based on fuzzy inference system. The performance measures such as sensitivity and accuracy are calculated. The fundus images are classified by the fuzzy logic classifier. Falguni & Rajvi [6] proposed a detailed study on diabetic retinopathy. The major problem of Diabetic Retinopathy (DR) is that it causes blindness. Due to diabetic retinopathy, nearly 25,000 people lose vision in every year. A person who has high blood sugar is said to have diabetic retinopathy. It affects both eyes of a person. By using proper screening mechanisms in the early stages, blindness can be prevented. The above studies show the various classification models for detection of diabetic but it has some limitation. To overcome these propose a novel techniques based on cuckoo search and SVM algorithm. Here the section I describes the introduction and literature of the convolutional model. Section II explains the proposed model and explanation. Section III shows the resultant parts and conclusion is presented in section IV.

II. PROPOSED METHOD

To distinguish the presence of diabetic retinopathy phases, the essential steps to be pursued is preprocessing. Preprocessing is required to guarantee that the dataset is reliable and shows just significant features.

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Regarding the available images, the type, severity of the disease and the efficiency of a set of combined preprocessing techniques are applied to make the segmentation more accurate. The preprocessing has been carried out for color fundus image preprocessing transformations are applied to reduce noise.

Fig. 1 explain the block diagram of the proposed framework. In the proposed framework, the Diabetic

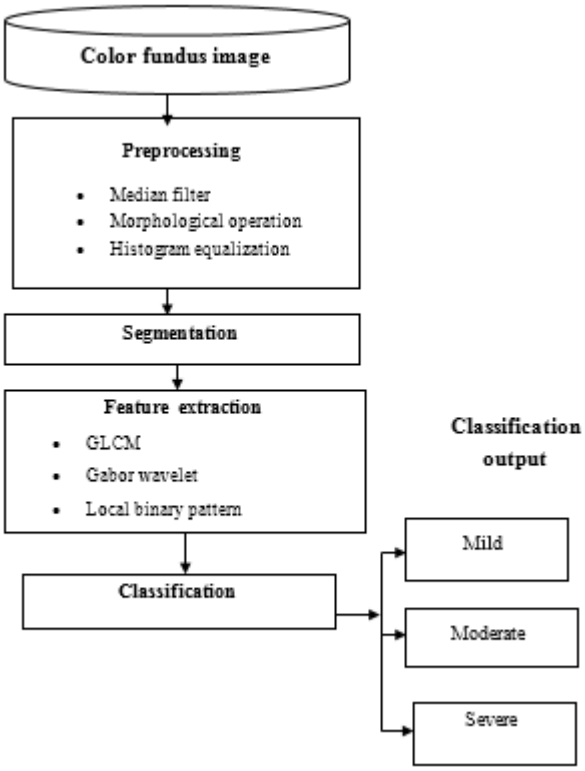


Fig. 1. Block diagram of proposed method

Retinopathy and the Diabetic Retinopathy and its seriousness types are classified by CS based SVM classification procedures. To begin with, the retinal or fundus images are taken as information and the preprocessing strategy is applied to the color fundus images and different preprocessing transformations are applied for noise removal in diabetic images. To identify the optic disc, microaneurysms and blood vessels extraction, several techniques have been utilized.

A. Preprocessing

Preprocessing method is the preliminary step in the diagnosis. Before the segmentation process the input images are should be preprocessed. The noise reduction steps are initially performed. These steps are necessary because the available database is often noisy and poorly illuminated due to unknown noise and camera settings. Thus accuracy and time consumption can be improved by cropping background and noisy regions from diabetic images or retinal images.

The intensity adjustment is finished by utilizing the 2D median filter. Additionally, the noise present during image acquisition is eliminated in the changed fundus image and the outcomes are improved in preprocessing stage. 2D median filter is of nonlinear kind and when utilized, the noise is decreased without obscuring the sharp edges. The steps in median filter incorporate arranging the pixel esteem ascending or descending order and afterward ascertaining the median value of neighborhood pixels. Different preprocessing changes are utilized in the Diabetic Retinopathy screening of diabetic images.

At that point morphological change is connected to the input image. This model is based on the image shape. This method needs two inputs; original image and structural element. Dilation and erosion operations are involved for the morphological transformation. Dilation on binary images is to make wider the areas of foreground pixels at their borders of image. Erosion on a binary image is to erode away the boundaries of foreground pixels. This will shrunk the area of foreground pixels and larger the holes within those area.

Histogram equalization out is a strategy used to modify the force estimations of the image which upgrades the differentiation. At that point the histogram of yield area is coordinated with other determined histogram. Histogram equalization out is utilized to improve the complexity of the fundus image. This is completed by changing the histogram. Difference improvement method is utilized to upgrade the fundus image; the histogram just plots the recurrence event of each gray level for example from 0 to 255.

B. Segmentation

Thus the fundus image is enhanced and it has a tendency to achieve its brightness. The microaneurysms are structures with sharp edges and circular in shape. Here for segmentation Morphological based thresholding is used. The morphological operations are used to detect the microaneurysms to extract blood vessels. Optic disc is the collection point of the nerve fiber layer in the eye. The optic disc is about 1.5millimeters in diameter.

Thresholding is the most straightforward technique for image division. From a gray scale image, thresholding can be utilized to make binary images. Binary images are delivered from color image by division. Division is the way toward allocating every pixel in the source image to at least two classes. On the off chance that there are multiple classes, at that point the typical outcome is a few binary images. In image processing, thresholding is utilized to part a image into smaller sections, utilizing in any event one color or gray scale image an incentive to characterize their limit. The benefit of acquiring initial a binary image is that it diminishes the unpredictability of the information and improves the procedure of acknowledgment and classification. Based on the value of T the gray image is converted in to binary image.

Image Segmentation = separation image into regions or sets of pixels. The pixels are partitioned upon their power esteem. Fragment the image into foreground and background.

g(x, y) = 1 if f(x,y) is foreground pixel

g(x, y) = 0 if f(x, y) is background pixel

In real applications histograms are more complex, with many peaks and not clear valleys and it is not always easy to select the value of T.

g(x,y) = (0 f(x,y) <T)/(1 f(x,y)=>T)

This technique can be expressed as:

T=T[x, y, p(x, y), f(x, y]

Where f(x, y) is the gray level and p (x, y) is some local property.

F(x, y) >T called an object point otherwise the point is called a background point.

C. Feature Extraction

The feature extraction techniques utilized for extracting the features from the image are Gray Level Co-occurrence Matrix (GLCM), Gabor wavelet and local binary pattern.

- Gray Level Co-occurrence Matrix

In this exploration work, Gray level co-occurrence matrix is utilized for highlight extraction. Here the RGB image is changed over into grayscale image for the element extraction. The gray level co-occurrence matrix denotes to spatial c distribution and gray level reliance inside the neighborhood. There are numerous texture highlights accessible, however in the proposed work, energy, contrast, correlation and homogeneity are utilized in the component extraction process. The GLCM highlights are depicted below.

$$\text{Energy} = \sum_{i=0}^{N_p-1}\sum_{j=o}^{N_p-1} p^2(i,j) \quad (1)$$

$$\text{Contrast} = \sum_{i=0}^{N_p-1}\sum_{j=o}^{N_p-1} (i,j)^2\, p(i,j) \quad (2)$$

$$\text{Correlation} = \sum_{i=0}^{N_p-1}\sum_{j=o}^{N_p-1} \frac{(i-\mu)(j-\mu)\,p(i,j)}{\sigma_i \sigma_j} \quad (3)$$

$$\text{Homogeneity} = \sum_{i=0}^{N_p-1}\sum_{j=0}^{N_p-1} \frac{p(i,j)}{1+|i-j|} \quad (4)$$

- Gabor Wavelet

The 2D Gabor capacity has been perceived as an exceptionally valuable instrument in highlight extraction of image, because of its ideal restriction properties in both spatial and recurrence space. Notwithstanding exact time-recurrence area, they likewise give robustness against shifting brightness basic cell in the essential information and differentiation of image .Furthermore, the filters can display the responsive fields of information. This technique center around separating some basic measurements of Gabor filtered image as highlight portrayal for image acknowledgment. The brightness and feature value for each scale and direction are determined likewise for more robustness after image filtered by Gabor filters, separated into the S x S sub-square and the mean and standard deviation from each sub-squares are removed and are set in highlight vector.

- Local Binary Pattern

LBP is a straightforward yet proficient texture operator which names the pixels of an image by thresholding the area of every pixel and thinks about the outcome as a binary number. Because of its discriminative power and computational effortlessness, LBP texture operator has turned into a prominent methodology in different applications. It tends to be viewed as a unifying approach way to deal with the customarily unique measurable and auxiliary models of texture investigation. Maybe the most significant property of the LBP administrator in certifiable applications is its power to monotonic dim scale changes caused. Another significant property is its computational straightforwardness, which makes it conceivable to break down image in testing constant settings.

D. Paper Submission Criteria

Classification techniques such as cuckoo search based SVM are used to classify the stages of DR in color fundus images.

- Support Vector Machine (SVM)

Support Vector Machine (SVM) is used for learning and classification. The main properties are achieving high high speculation by augmenting the edge and supporting an effective learning of nonlinear capacities. The binary classifier is the initial form of SVM classifier, where the output is either positive or negative. SVM is utilized for investigation and characterization of fundus images. SVM is an supervised learning procedure connected for examining the training information to discover ideal approach to arrange DR images into particular classes: Mild, moderate and Severe. SVM models build a hyper plane for isolating the given information straightly into discrete classes. The grouping parameters are shaped by the determined highlights utilizing SVM calculation. For nonlinear grouping of given information, SVM utilizes nonlinear kernel function to guide given information into high dimensional component space where given information can be characterized straightly. The high dimensional data is used to calculate and process the image and it is a general expression and modeling diverse sources of data. A kernel method is named in the general category of an image and it depends upon the data, especially through dot product. Sometimes kernel method is used to replace the dot product. In this research work multi class SVM classifier is used for classifying fundus images into various DR stages. The SVM classifier output displays the stages of DR from the classifier result. The accuracy will be improved.

- Cuckoo Search Algorithm

Cuckoo Search (CS) Algorithm is produced by Yang and Deb in 2009 which is a heuristic calculation. Cuckoo seek calculation (CS) is a sort of
bionic swarm advancement calculation, in other words it is helpful and simple model for differentiating the features. Despite the fact that it has evident favorable circumstances, it can't join to the ideal arrangement when managing high dimensional complex issues, so its worldwide pursuit capacity should be improved. The CS calculation successfully solves the improvement issue by implementing the parasitic parenting and Levy flight of the cuckoo.

The cuckoo does not utilize the home during reproducing it laid its own eggs in different birds creatures settle.

This will discover the birds which is like their own self, and rapidly spawn eggs while the birds is in out, allowing the bird to replace the offspring which is referred as parasitization. In this CS calculation another egg of different birds is called as solution and egg of cuckoo is represented as new solution.

Levy flight is an irregular walk, this arbitrary stroll by producing a specific length of the long and shorter strides to adjust the neighborhood and worldwide improvement. To streamline the procedure of cuckoo parasitism in nature this will be regularly utilized.

Steps:

1. Every cuckoo lays one egg at any given moment and shrouds the egg in another host bird creature settle.
2. The cuckoo chosen the best host bird creature home and egg was carried for the next generation.
3. The accessible host bird creature homes is settled, and the egg laid by a cuckoo is found by the host bird with a probability pa∈ (0, 1).

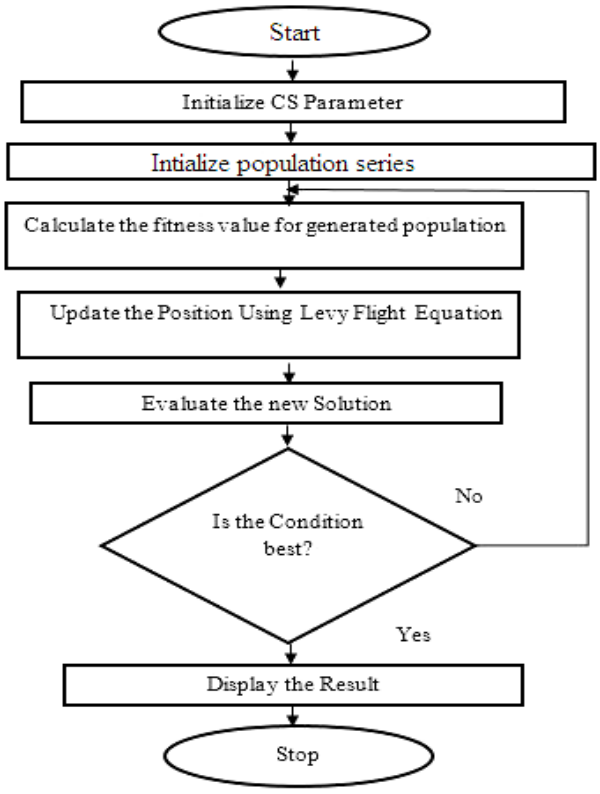


Fig. 2. Flow Chart of Cuckoo Search algorithm

The CS algorithm utilizing unbiased grouping of controlled parameter with a local and universal explorative random walk, it can be written as

$$s_i^{t+1} = s_i^t + x \otimes H(pa - \varepsilon) \otimes \left(s_j^t - s_k^t\right) \quad (5)$$

Where s_j^t *and* s_k^t is represented as various random permutation selected for the process, H(u) is a Heaviside parameter, ε is a arbitrary digit drawn from a uniform distribution and x is the step size.

The global random walk is represented as

$$s_i^{t+1} = s_i^t + \alpha L(s, y) \quad (6)$$

Where

$$L(s, y) = \frac{\lambda r(y)\sin(\pi y/2)}{\pi} \quad s > s_0 > 0 \quad (7)$$

III. RESULT AND DISCUSSION

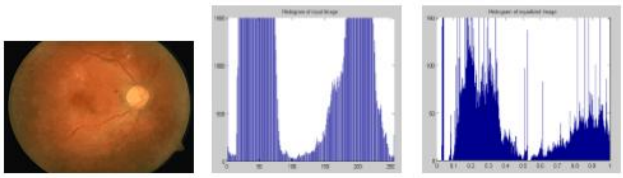
This proposed model discusses the analysis of DR phases by considering the sample fundus images of mild, moderate and severe stages which are taken from the medical personnel in the hospital. The Fig. 3 shows the sample medical color fundus image. The sample image is preprocessed and the optic disc is detected. The segmentation process is done and the features are extracted for trouble-free classification. Here CS based SVM classification used to classify the stages of fundus image.

(a) (b) (c)

Fig. 3. Diabetic retinal images stages (a) Medium (b) Moderate (c) Severe

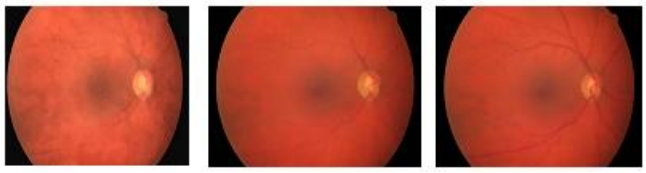
Preprocessing an image is an essential process for every classification since it makes the image ready for further steps. Normally for an easy analysis the Red-Green-Blue (RGB) image is altered into gray scale image but here the entire processing is performed in the RGB image.

(a) (b) (c)

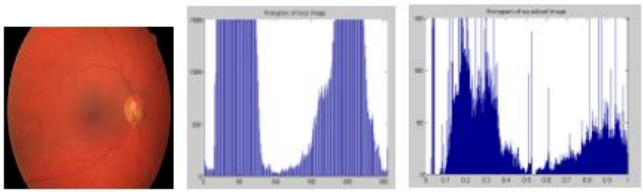


(d) (e) (f)

Fig. 4. Severe diabetic retinal preprocessed image (a) Median filtered image (b),(c) Morphological dilated and eroded image (d) Histogram equalized image (e), (f) Histogram equalized plot original and preprocessed image

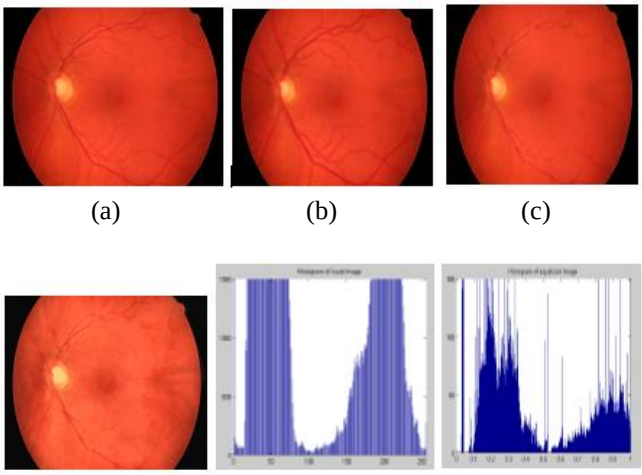


(a) (b) (c)



(d) (e) (f)

Fig. 5. Moderate diabetic retinal preprocessed image (a) Median filtered image (b),(c) Morphological dilated and eroded image (d) Histogram equalized image (e), (f) Histogram equalized plot original and preprocessed image



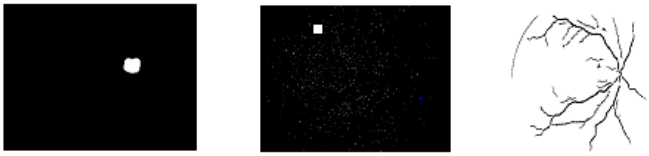
(a) (b) (c)

(d) (e) (f)

Fig. 6. Medium diabetic retinal preprocessed image (a) Median filtered image (b),(c) Morphological dilated and eroded image (d) Histogram equalized image (e), (f) Histogram equalized plot original and preprocessed image

In each and every observations of an image, some noise can be added. This can be filtered by blurring the image using median filter and the noise in the image is eliminated. Median filter algorithm is used to removes the noise of the image. Morphological operation is performed in the noise removed image. Then the histogram of the image has generated for both the original image and enhanced image. Fig. 4 & 5& 6 shows the mild, moderate, severe stages of preprocessed image.

For segmentation process, the morphological operations based thresholding technique is used. Fig. 7, 8 & 9 show the segmented image of mild, moderate and severe stages of diabetic retinopathy segmented image, here Microaneurysms, Blood Vessel and optic disc are segmented. The morphological closed image was taken for optical disc detection which is similar to dilation process that tends to enlarge the boundaries of foreground (bright) regions in an image, but it is less destructive of the original boundary shape. In Fig. Images are shown. For the detection purpose, connected component based segmentation and morphological operators are used.



(a) (b) (c)

Fig. 7. Severe diabetic retinal segmented image (a) Optic disc (b) Microaneuryms (c) Blood vessels

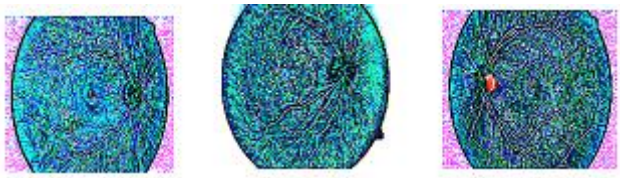
(a) (b) (c)

Fig. 8. Moderate diabetic retinal segmented image (a) Optic disc (b) Microaneuryms (c) Blood vessels

(a) (b) (c)

Fig. 9. Mild diabetic retinal segmented image (a) Optic disc (b) Microaneuryms (c) Blood vessels

For feature extraction, GLCM, Gabor wavelet and local binary pattern features are to be extracted. By these features, the CS based SVM classifier classifies the disease in the retinal image. The Fig. 10 shows the efficient LBP image.



(a) (b) (c)

Fig. 10. Local binary pattern image (a) Severe (b) Moderate (c) Mild

The table 1 shows the feature values of grey level co-occurrence matrix. Here the energy, contrast, homogeneity and correlation values are extracted for the further processing. Then the Gabor wavelet features such as brightness and feature values, LBP feature values are extracted which are shown in table 2.

Table- I: GLCM feature values

Image No	GLCM Feature			
	Contrast	*Correlation*	*Energy*	*Homogeneity*
1	0.221368	0.920896	0.217135	0.905167
2	0.234337	0.938375	0.20258	0.999626
3	0.247941	0.937361	0.18984	0.990459

4	0.248234	0.9247	0.201126	0.995023
5	0.237276	0.938529	0.182952	0.900777
6	0.235507	0.93797	0.226352	0.911877
7	0.258746	0.924528	0.210335	0.989489
8	0.255463	0.915677	0.18263	0.990845
9	0.236449	0.934181	0.211497	0.995751
10	0.234337	0.938375	0.20258	0.999626

Table- II: Gabor wavelet and LBP feature values

Algorithm	**Gabor wavelet**		**Local binary pattern**
Image No	***Brightness***	***Feature value***	***LBP Value***
1	0.30058	7.204081	80.58011
2	0.404648	7.22156	80.6871
3	0.405593	7.220547	80.68544
4	0.359435	7.207885	80.63897
5	0.396277	7.881185	80.67573
6	0.382119	7.530718	80.66164
7	0.359109	7.207713	80.63869
8	0.345338	7.283185	80.62486
9	0.394062	7.217367	80.67359
10	0.404648	7.22156	80.6871

The optimization technique such as cuckoo search algorithm is applied in this model it improves the performance of the system. Here the cost values are calculated. The graphs are plotted for cuckoo search iteration Vs cost values. This is shown in Fig. 11.

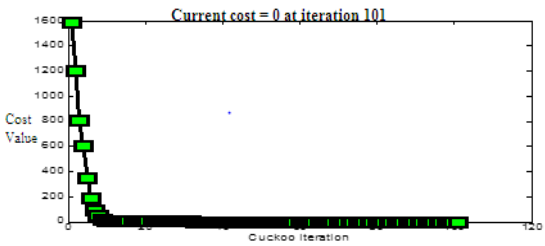


Fig. 11. Cuckoo search algorithm plot

The performances are analyzed based on the accuracy. Fig. 12 shows the confusion matrix of SVM classifier which classifies the Diabetic Retinopathy images based on the combination of GLCM, wavelet and LBP features value. The diagonal area of the confusion matrix shows the perfect identification of mild, moderate and severe stages.

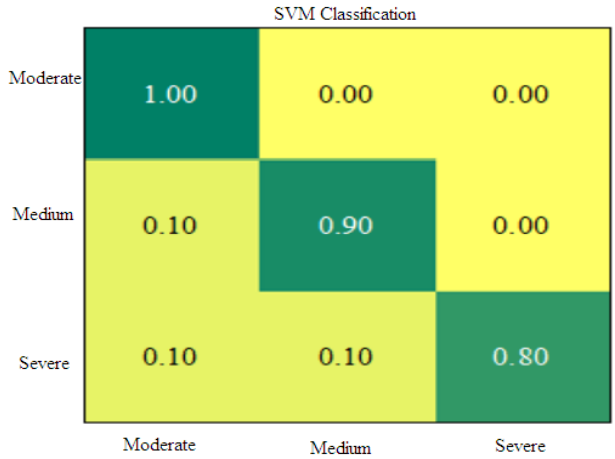


Fig. 12. Confusion Matrix of SVM Classifier

The accuracy of SVM classifier is displayed on the command window of the MATLAB. Here 30 samples of Diabetic Retinopathy images are taken for testing purpose. The accuracy obtained is 90.00%. This proposed model is helpful for earlier detection of diabetic retinopathy.

IV. CONCLUSION

In the proposed system the various stages of Diabetic Retinopathy are classified. In general, the process is carried out in three stages. First, various preprocessing methods such as median filter, morphological operation and histogram equalization are applied in the fundus images and the results are presented. Then, optic disc blood vessels, microaneurysms segmentation is carried out. Finally, the Diabetic Retinopathy stages like mild, moderate and severe stages are classified using the proposed classifiers.

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