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A Computational Methodology Towards the Detection of Diabetic Retinopathy

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ABSTRACT

Diabetic retinopathy is an eye-related neurological disorder, the diabetic patient eye damaged by blood vessel in the retina area of the eye. Computational methodology is a proper way for detecting and predicting the diabetic retinopathy disease. The aim is to identify and detect the Diabetic Retinopathy, so this present work focusses on detection of Diabetic Retinopathy. This work proposed the novel WMD-MSVM -Weighted Mahalanobis Distance based Multiclass Support Vector Machine oriented; upon Diabetic Retinopathy diagnosis system for the purpose of feature selection, also ROI extraction method being utilized to fetch features from Diabetic Retinopathy images. From the results, it is clear that the performance of WMD-MSVM on instance selected training dataset yields improved detection accuracy compared with the performance of WMD-MSVM on full-training-dataset. There is an improvement of around 1% of detection accuracy in case instance selected dataset. This proposed work is benefit for diabetic patients to gain the proper treatment by physicians at an early stage for Diabetic Retinopathy. This computational approach to detect the diabetic which results the best solutions for ophthalmology. The diabetic image analysis and machine learning approach considered as a challenging research area that aims to provide a computational approach to assist in the early diagnosis and detection of Diabetic Retinopathy problems.

Keywords—Diabetic Retinopathy, Machine Learning, Classification, Accuracy, Comparison.

I.INTRODUCTION

This research involves the Diabetic retinopathy diagnosis technique merges the proposed algorithm of WMD-MSVM (Weighted Mahalanobis Distance based Multiclass Support Vector Machine) on the basis of max mutual information. Using the ROI extraction method, features can be extracted from the Diabetic retinopathy images. Using the WMD-MSVM classifier, accurate match is being identified among various classes of Diabetic retinopathy image datasets. ROI extracted images are pre-processed thereby computing the contrast, energy, weighted covariance, Weighted Mean, Kurtosis, Weighted Correlation and entropy related to overall ROI extracted images. The newly developed Diabetic retinopathy diagnosis system adopts instance selection which is based on the mutual information and proposed WMD-MSVM classification algorithm. The technique of WMD-MSVM Algorithm presents data based on which Diabetic retinopathy detection can be estimated. In addition to this, a methodology is recommended for conducting cross platform analysis concerning such data. Also by comparing various studies a new vision or perception is presented. The aim is to identify and detect the Diabetic Retinopathy, So this present work focusses on major objectives of this research,

- To study and identify the visual problems in Diabetic Retinopathy and assess their deficits conditions.
- Pre-processing mechanisms to handle noises in the dataset and produce the best accuracy results.
- Training done by machine learning algorithms to measure the best training accuracy.
- Similarly, the testing done to calculate the performance metrics like accuracy.
- Tuning the parameter in the proposed WMD –MSVM to improvise the performance metrics.

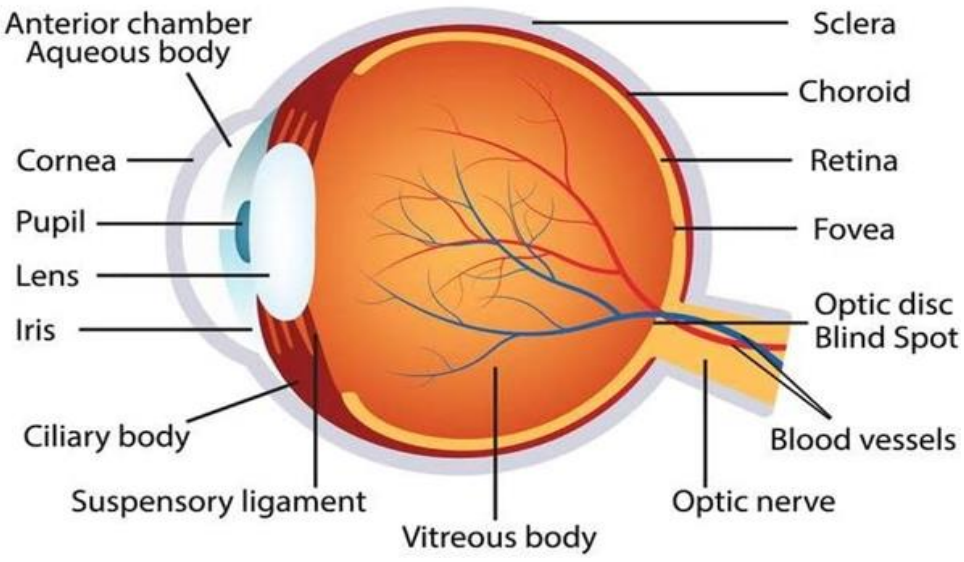

Figure 1. Cross-section of a human eye and its major parts

This work proposed the novel WMD-MSVM -Weighted Mahalanobis Distance based Multiclass Support Vector Machine oriented; upon Diabetic Retinopathy diagnosis system for the purpose of feature selection. From the results, it is clear that the performance of WMD-MSVM on instance selected training dataset yields improved detection accuracy compared with the performance of WMD-MSVM on full-training-dataset. As the results, the improvement of around 1% of detection accuracy in case instance selected dataset. This proposed work is benefit for diabetic patients to gain the proper treatment by physicians at an early stage for Diabetic Retinopathy. This computational approach to detect the diabetic which results the best solutions for ophthalmology.

2. RELATED WORKS

The process of Image processing involves carrying out some operations on the image, to obtain a stronger enhanced image or for extracting significant data/facts. Here the image being the input and resultant output can either be an image or characteristics/functions linked with that particular image. As of now the image processing claims to be one of the speedily emerging technology. It has turned out to be the central research domain in contrast to the disciplines of engineering and computer science technology. The Table 1. Represents the Literature Review – Recent Diabetic Retinopathy related Exudates detection algorithms.

Table 1. Literature Review – Recent Diabetic Retinopathy related Exudates detection algorithms

S.No	Author & Year	Image Processing Techniques	Machine Learning Techniques	No of Samples	Database	Classification Accuracy
1	Habib *et al.* (2017) [1]	Noise reduction and Noise removal is done by Median filter, contrast limited adaptive histogram equalization and Gaussian filter	Tree ensemble	**256**	DIARETDB1 v2.1, MESSIDOR	**92.12%**
2	Kumar *et al.* (2016) [2]	For noise reduction and image enhancement done by Median filter and contrast limited adaptive histogram equalization, the matched filter used for removing blood vessels	Gaussian filtering	**89**	DIARETDB1	**93.41**
3	Sreng *et al.*	A median filter and 2D wavelet transformation	Threshold, Canny edge	**89**	DIARETDB1	**90**

	(2017) [3]	are used for Images resizing, noise removal, and image enhancement				
4	Pereira *et al.* (2014) [4]	The background image of the green part is identified by a Median filter, dark lesions are identified by Gaussian and modified kirsch filters.	Multi-agent model	**36**	LaTIM	**89.89%**
5	Wu *et al.* (2017) [5]	Median filter applied for generating Background ROI image. contrast enhancement done by contrast limited adaptive histogram equalization and Gaussian filter applied to smoothing the edge part of the image	Local features	**198**	ROC & e-option	**91.03%**

3. PROPOSED METHODOLOGY

The Figure 2. Illustrate the Classification of Training &Testing Stages.

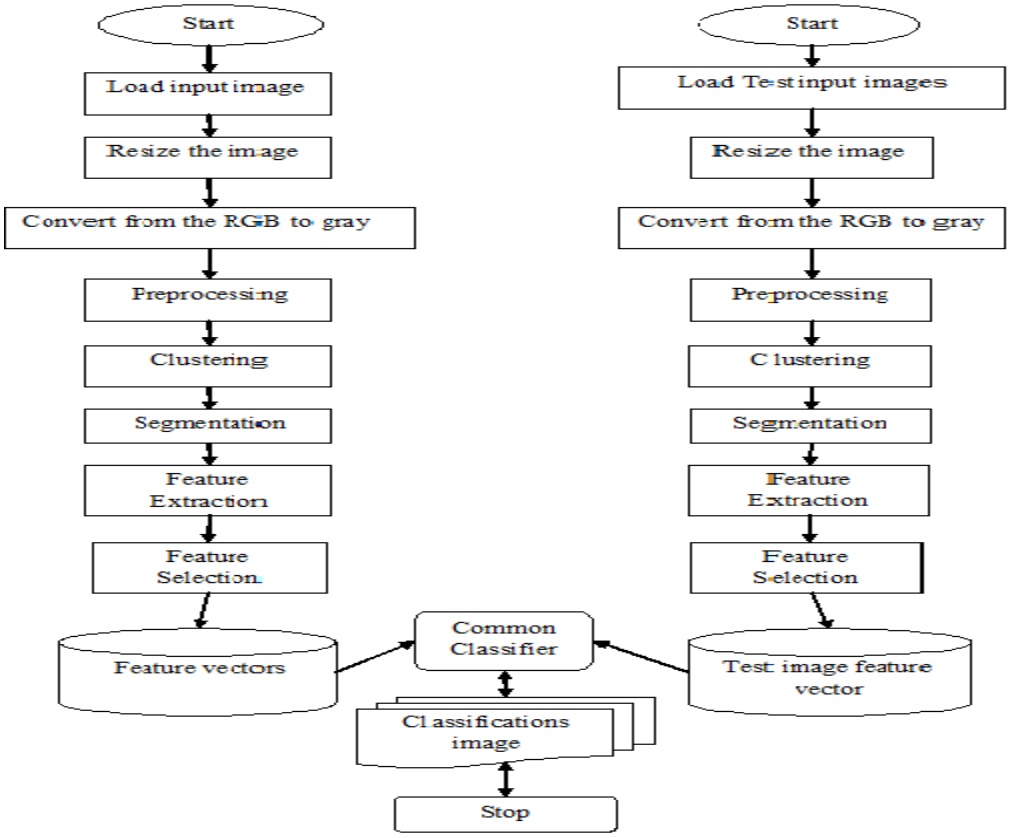

Figure 2. Classification of Training &Testing Stages

3.1 Proposed WMD-MSVM Algorithm

The technique of WMD-MSVM Algorithm presents data based on which Diabetic retinopathy detection can be estimated.

Input: Input Training dataset (NMDS oral dataset / Image database)

Output: Result dataset (Classified data)

Step: 1 *Choose any two initial cluster centers by algorithm search m.*

Step: 2 *Import a new class C.*

Step: 3 *Calculate the distance between two classes using Weighted Mahalanobis distance metric*

Step: 4 *if the distance between class A and B is greater than distance between class A and C, then*

Step: 5 *Data / image C is same as the original data / image.*

Step: 6 *Else*

Step: 7 *C is a different data/image.*

Step: 8 *find the minimum, maximum and average distance of every class in the cluster.*

Step: 9 *if the distance between class A and C is less than the threshold limit of the distance, then*

Step: 10 *create a new cluster (sub-cluster) and this is the center of the new cluster.*

Step: 11 *Else*

Step: 12 *C is assigned as a new category.*

Step: 13 *repeat the operation until reduced the difference between the classes.*

Figure 3. illustrate the Proposed Framework to predict diabetic retinopathy using WMD- MSVM machine learning techniques. Figure 4. Demonstrate the Correlation matrix comprising of all the features in the dataset.

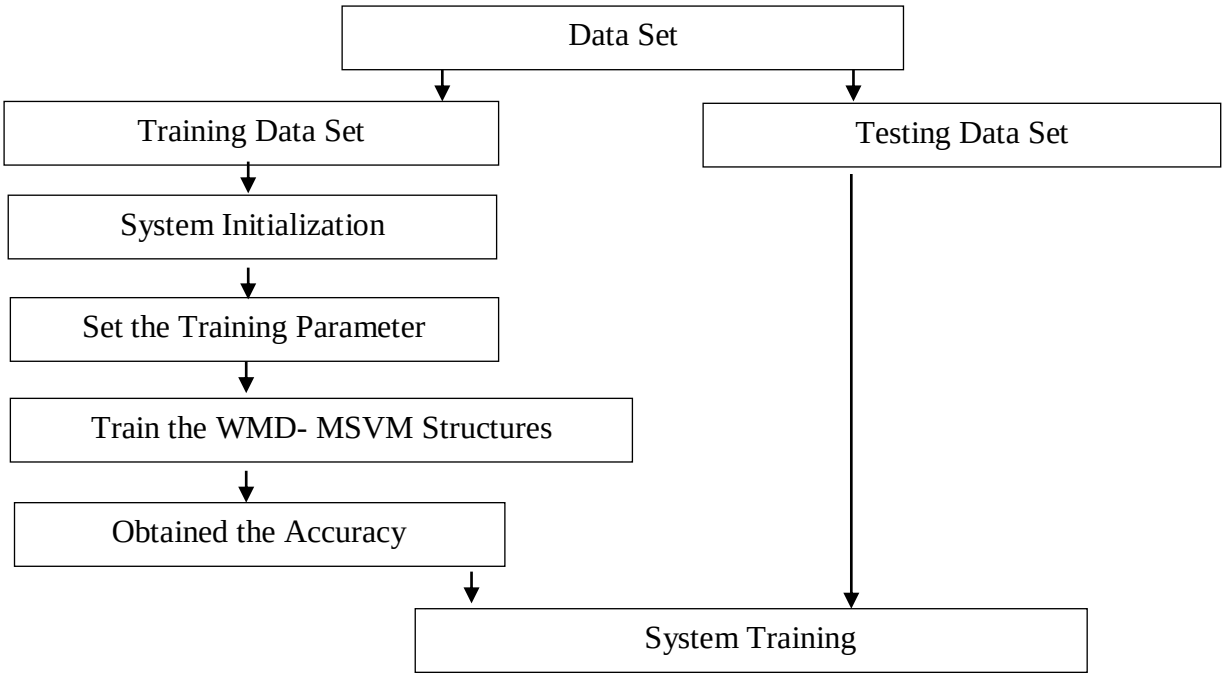

Figure 3. Proposed Framework to predict diabetic retinopathy using WMD- MSVM machine learning techniques.

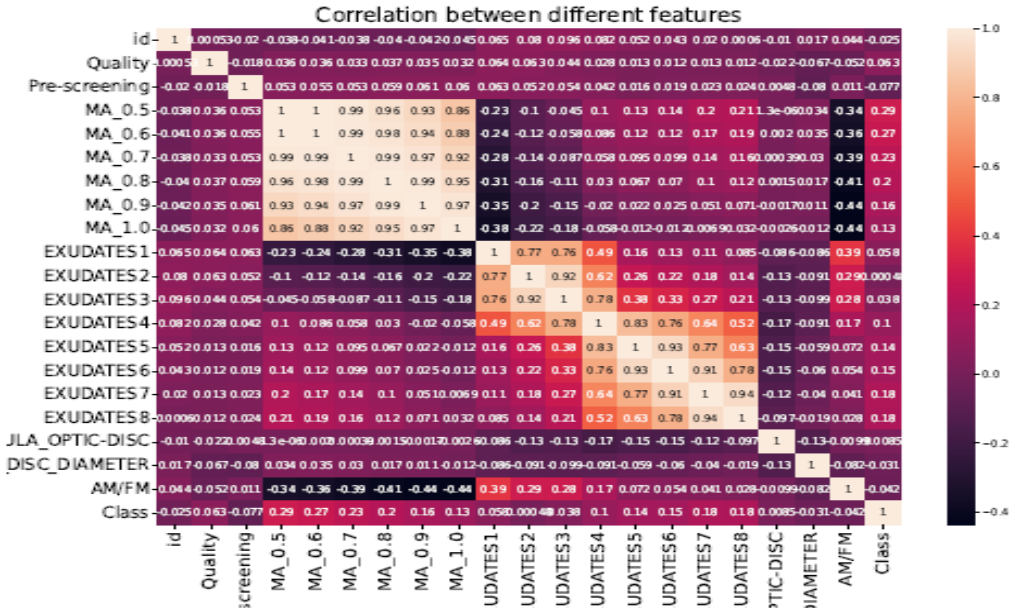

Figure 4. Correlation matrix comprising of all the features in the dataset.

4. EXPERIMENTAL RESULTS

Using the mentioned configuration, experiments were carried out: OS - windows 7, Processor - G2020, Intel Pentium (R) and CPU speed of 2.90 GHz. The proposed scheme is highly accurate. The RGB color model helps in enhancing the pixel intensity and hence is a significant function [6, 7, 8].

Comparative analysis of MSVM and other Classifiers–For the evaluation of the proposed MSVM algorithm multiple experiments were carried out by employing the diabetic retinopathy dataset. Table 2. depicts MSVM algorithm's performance by making use of diabetic retinopathy dataset in various partitions like 70-30%, 80-20% and 90-10% Training-Testing records. Referring these partitioned dataset, a total of 5 experiments were carried out thereby gaining varied output.

Table 2. Performance Analysis of the proposed MSVM

Exp. No	70-30% Training test partition	80-20% Training test partition	90-10% Training test partition
1	98.53	99.02	99.51
2	98.24	98.53	99.23
3	98.32	98.69	99.32
4	97.91	98.12	98.73
5	98.73	99.45	99.62

Table 2, illustrates that the performance of the proposed algorithm being superior compared with the rest of the partitions falling under 90-10% Training-Testing. High accuracy of nearly 99.62% is gained in the partition (90-10%) Training and Testing of the available input oral cancer dataset.

Table 3 Performance Analysis of the proposed MSVM with instance selection

Exp. No	70-30% Training-Test partition	80-20% training-test partition	90-10% training-test partition
1	98.73	99.26	99.71
2	98.43	98.72	99.43
3	98.51	98.85	99.56
4	98.06	98.34	98.93
5	98.96	99.67	99.83

Table 3 represents the performance of the proposed MSVM algorithm with instance selection by making use of the oral cancer dataset in various partitions like 70-30%, 80-20%, and 90-10% Training-Testing records. Referring these partitioned dataset, a total of 5 experiments were carried out thereby gaining varied output. Table 3, illustrates the performance of the proposed algorithm being superior compared with the rest of the

partitions falling under 90-10% Training-Testing. High accuracy of nearly 99.62% is gained in the partition (90-10%) Training and Testing of the available input diabetic retinopathy dataset.

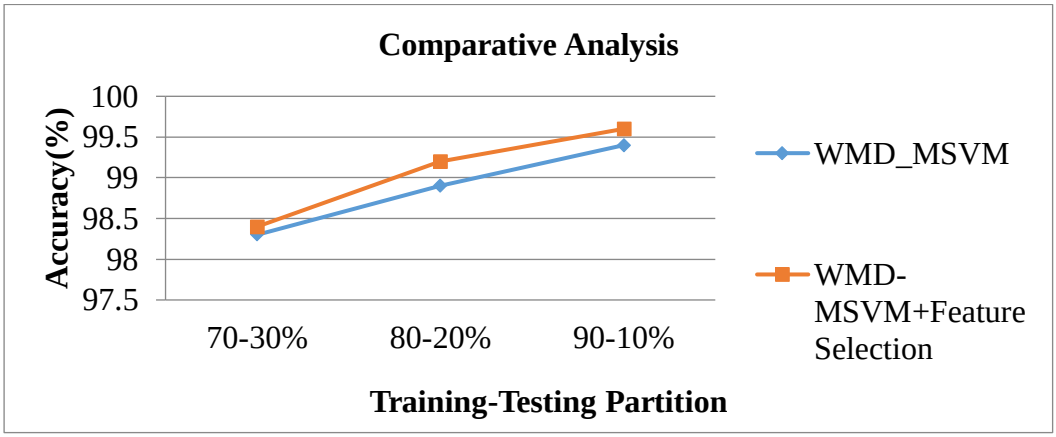

Figure 5 Comparative Analysis of MSVM with and without feature selection

Figure 5 illustrates a comparative analysis of the proposed algorithm of MSVM with full-training-dataset and WMD-MSVM with instance-selected-training-dataset which is fed as input to the proposed method. Mutual information based instance selection method is implemented on diabetic retinopathy dataset to enhance the detection accuracy of the recommended classification algorithm. From fig. 5, it is clear that the performance of MSVM on instance selected training dataset yields improved detection accuracy compared with the performance of MSVM on full-training-dataset. There is an improvement of around 1% of detection accuracy in case instance selected dataset.

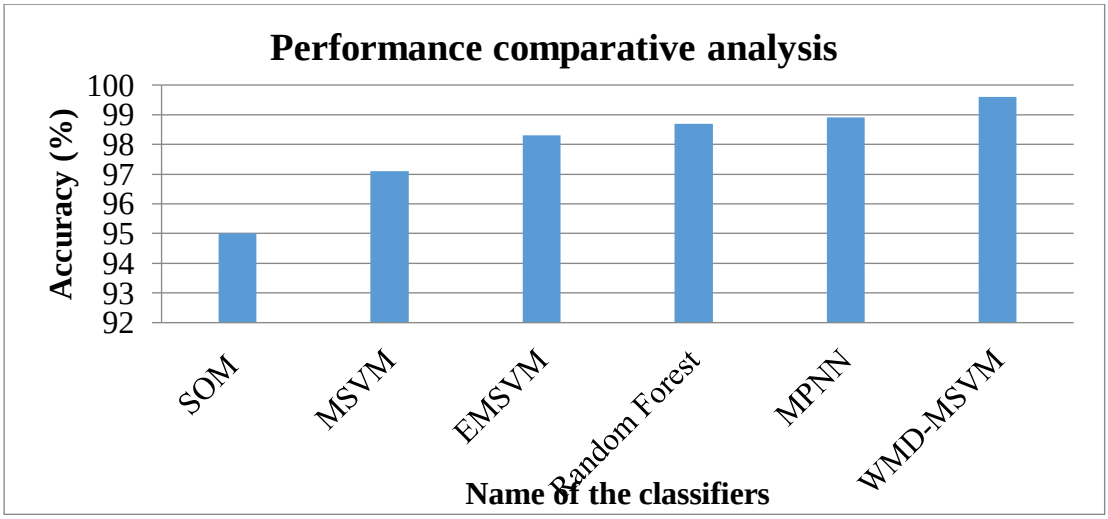

Figure 6 Comparative analysis of MSVM and other Classifiers on diabetic retinopathy Dataset

Figure 6 shows that the comparative analysis between the proposed WMD (Weighted Mahalanobis distance) –MSVM (Weighted Mahalanobis Distance (WMD) based (MSVC) Multiclass Support Vector Machine) algorithm and the existing classifiers, namely SOM, MSVM, EMSVM, Random Forest and MPNN. From the results, it is clear that the performance of WMD-MSVM on instance selected training dataset yields improved detection accuracy compared with the performance of WMD-MSVM on full-training-dataset.

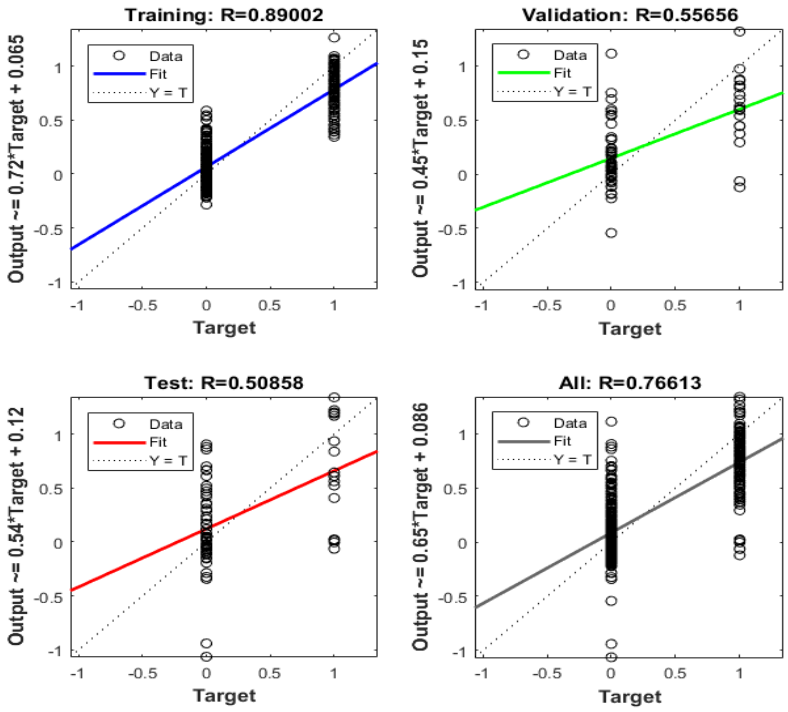

Figure 7 WMD- MSVM Regression Analysis

5. CONCLUSION

This research concluded that to determine the presence of diabetic retinopathy contribute towards diabetic patients and provide the better solutions for biomedical research. This work can be extended to minimize the computational overhead. This work proposed the novel WMD-MSVM -Weighted Mahalanobis Distance based Multiclass Support Vector Machine oriented; upon Diabetic Retinopathy diagnosis system for the purpose of feature selection. From the results, it is clear that the performance of WMD-MSVM on instance selected training dataset yields improved detection accuracy compared with the performance of WMD-MSVM on full-training-dataset. As the results, the improvement of around 1% of detection accuracy in case instance selected dataset. This proposed work is benefit for diabetic patients to gain the proper treatment by physicians at an early stage for Diabetic Retinopathy. This computational approach to detect the diabetic which results the best solutions for ophthalmology. The diabetic image analysis and machine learning approach considered as a challenging research area that aims to provide a computational approach to assist in the early diagnosis and detection of Diabetic Retinopathy problems.

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