RETINAL BLOOD VESSEL DETECTION AND A/V CLASSIFICATION FROM LOW QUALITY RETINAL IMAGE USING MSERF FEATURE ALGORITHM

[1]Sonali M. Thakur, [2]Amit Pimpalkar, [3]Ashwini Meshram

[1,2,3]Department of Computer Science and Engineering

G.H. Raisoni Academy of Engineering and Technology, Nagpur, (India)

ABSTRACT

Examine the retinal blood vessels can provide helpful information to doctor for early detection of disease such as hypertension, cardio-vascular, diabetic retinopathy. This disease affects retinal blood vessels of thinner veins, thicker arteries. Hence, an abnormal width ratio to artery to vein (AVR) may be assessment of vascular changes and calculation of characteristic signs with different properties such as difference in size, quality and angle. In this paper, we focus to the calculation of characteristics signs with vascular changes are measured and accessing the stages, severity of some retinal conditions. The proposed method classifies the vascular tree deciding on the type of two intersection points (graph nodes) and assigning one of two labels to each vessels segment (graph links). Finally, intensity features of the vessels segments are measured for assigning the final A/V class.

Keywords: Artery/Vein Classification, Artery/Vein Discrimination, AVR, Canny Edge Detector, Graph Links, MSER Feature Algorithm, Retinal Images, Retinal Vasculature, Vessel Segmentation.

I. INTRODUCTION

In recent years, the patients are suffering from several diseases such as heart stroke, hypertension, blood pressure and diabetic retinopathy to show some signs in retinal blood vessels or make alternations to width of arteries and veins in different ways leading to abnormally thicker arteries , thinner veins or vice versa. In digital image processing to allow the examination of a large number of images in minimum time with chipset cost and reduced the current observer-based techniques [1]. Another advantage is to perform automated screening for pathological conditions, such as diabetic retinopathy, cardio-vascular, hypertension and reduce the workload required of trained manual graders. Several works on vessel classification have been proposed, but automated classification of retinal vessels into arteries and veins has received limited attention, and is still an open task in the retinal image analysis field. In recent years, graph-based methods have been used for retinal vessel segmentation, vessel calibre estimation, retinal image registration, and retinal vessel classification. The graphs extracted from the retinal vessels then, decide the intersection points from one node to another node and assigned the labels on each intersection points that are called graph links. Finally, intensity features of the vessel segments are measured for assigning the final artery/vein class.

In A/V classification extract the graph from vessel tree & diagnostic indicators as the Arteriolar-to-venular diameter Ratio (AVR) [3]. The AVR value is used for calculation of blood vessels extraction and detection of the bifurcation point of the vessels like diabetic retinopathy and prematurity. So, in other images processing operations, the AVR requires segmentation, vessel width measurement & artery/vein (A/V) classification [4]. Therefore, the AVR measurement system must identify which vessels are arteries and veins. Retinal vessels are affected by several diseases namely as diabetes, hypertension and vascular disorder.

II. METHODS OF A/V CLASSIFICATION

Several methods for A/V classification from image processing are divided in the following stages: Feature extraction from retinal vessels, A/V classification. In this portion, we will outline the algorithm and techniques found in literature for the different stages of feature extraction from images and classification of which are arteries and veins.

2.1 Feature Extraction From Retinal Vessels

P.Nithiyanantham et al. [3] described the graph trace algorithm. In graph traced algorithm, there was traced the pixel points from the centerline of the vessels and then, classified the vessel features. Finally, there was assigned the result whether it was arteries or veins in retinal images.

An intensity feature algorithm to describe the evaluation of the vessels has been proposed by schrauwen et al. [4]. This evaluation was based on partitioned of each vessels segment and then, combined the number of vessels segment. Finally, there was set the curvature value for identified which were arteries or veins.

D. Relan et al. [5] proposed a method to detect the retinal vessels. These vessels were based on color features which combines a GMM+EM (Gaussian Mixture model with Expectation-Maximaization). The GMM+EM classifier used a three parameter such as, Mean, Covariance and Mixture Coefficient. The GMM+EM classifier was divides the cluster into four quadrants and four colour features such as mean of red, mean of green, mean of hue and variance of red. The color features were extracted from the channels and detected the vessels in each quadrant and finally combines the result.

A feature extraction process from two classification methods and two feature extraction methods was classified which were arteries or veins based on neural networks and support vector machines has been proposed by kondermann et al [6]. The classification method was used for feature vector after reduced the dimensionality such as support vector machine and neural network. In support vector machine was compared the result between four kernels such as linear, polynomial, RBF, sigmoid with various parameters.

A semi-automatic method described to vascular tree for extracted skeleton from vascular tree and described topological and geometrical properties of a single vessel and sub-tree. Then, Martinez-Perez et al. [7] was provided a manually labels to the root segment of the vascular tree and searches for unique terminal points such as on starting point to ending point of blood vessels.

In automated method [8] was identified the color images of retinal vessels. These color images converted vessel segmentation into segments map. There was identified the vessel tree by graph search and labeled these vessels tree or branches. The orientation, width and intensity of each vessel segments were utilized to found the optimal graph of vessel segment. These vessel segments were labeled as primary vessels or branches.

S.R. Lesage et al. [9] described the feature extraction algorithm. In feature extraction method they showed preprocessing operations on high resolution images such as diabetes, hypertension and retinopathy of prematurity (ROP). The extraction techniques were took a measurement of blood vessels of the retina and found the bifurcation points of blood vessels.

2.2 A/V Classification

In Rule-based algorithm was provided a manually labels on starting point to ending point of blood vessels and mentioned as a labelled either arteries or veins throughput the vascular tree has been proposed by Rothaus et.al [10].

Vazquez et al. [11] combined a colour-based clustering algorithm with a vessel tracking method. The colour-based clustering algorithm was chose a shortest path. First , there was divides the cluster into four quadrants and four colour features such as mean of red, mean of green, mean of hue and variance of red. The color features were extracted from the channels and detected the vessels in each quadrant and finally combines the result.

A tracking artery/vein classification was exploited the balanced layout of arteries and veins in optic disk centered retinal images has been proposed by Grisan et.al [12]. This algorithm was divides the retinal images into four quadrants and a four color features such as Mean of Red, Mean of Green, Mean of Hue and variance of Red and each quadrants contains similar number of arteries and veins with significant local differences in features.

Niemeijer et.al [13] proposed an automatic method for classified retinal vessels into arteries and veins. In automatic method, there was used a centerline features and k-nearest neighbor (KNN) classifier were extracted features from vessel tree and label was assigned to each centerline pixel. These centerline pixels indicated of its being veins pixels. Then, find the average of the labels of connected centerline pixel to each centerline pixel. Finally, tested different classifier and found k-nearest neighbor classifier.

In piecewise guassian model [14] to give an intensity distribution of retinal vessels considered with minimum distance classifier. The performance of these techniques was dependent on acquisition of retinal images such as mean of red, mean of green, mean of hue, variance of red and detected the vessels in each quadrants. Finally, combines the each quadrant.

The feature-based model was partitioned into each vessel in segment and combined these numbers of segments for reduced the dimensionality such as support vector machine and neural network has been proposed by K. Gaun et.al [15]. Then, determined each skeleton in orthogonal direction of vessel at regions of interest around centerline position and draw a line across a line on the vessels.

In ridge based method [16] was automated segmentation of vessels in two dimensional color images of the retina for computer analysis of retinal images. The ridge of retinal vessels was extracted ridges from retinal images which coincide with centerline vessels and partitioned into patches then, assigned an each patches in each image pixels.

A.S.Newbaur et al. [17] described the feature extraction algorithm. In feature extraction method they showed changes in retinal blood vessels structure and progression of diseases such as diabetes, hypertension and retinopathy of prematurity (ROP). After, retinal vessel was extracted such as, morphological structure was used to remove the vessel thinner than three pixels. Then, bifurcation and cross-over points were discarded from vessel skeleton after extraction of centerline pixels of vessels. There was indicated where two vessels pass each other or a vessels branches into two thinner vessels.

The adaptive threshold technique [18] was based on diversity and the intensity of each region to drive the binary image. Then, grey level images converted into binary images and located the objects on retinal images and found boundaries in images. Finally, they were assigned a label to every pixel on images.

III. PROPOSED METHOD

The introduction of the methodologies and the algorithms used in the project are given in this session.

3.1 MSER Feature Algorithm

The maximally stable external regions (MSER) are used as a method of blob detection in images. The MSER features are to find image elements from two images with different viewpoints. This method is extracting a number of corresponding image elements contributes to the matching elements and it has led to better stereo matching and object recognition algorithms. The advantages of MSER features is the regions are defined the intensity function in the region and the outer border and mentioned a key characteristics of the regions which make useful.

Detect MSER Features (I, varargin)

The MSER feature to extract the feature from images using regions detect MSER Features(I). This function is returns to MSER regions object then, containing region pixel list and other information about MSER feature is detected from 2-D grayscale image I. The function is specified the regions = detect MSER Features (I,Name,Value)specifies additional name-value pair arguments are described as follows:

- Threshold Delta:

This value specifies the step size between intensity threshold levels used in selecting external regions Typical values range from 0.6 to 4.

- Region Area Range:

The region contain a two-element vector [minArea maxArea], which specifies the size of the regions in pixels. This value allows the selection of regions containing pixels between minArea and maxArea.

- Max Area Variation:

The Positive scalar is increase the value and then, returns a greater number of regions at the cost of their stability. The stable regions are very similar in size over varying intensity thresholds. Typical values range from 0.1 to 1.

- ROI :

A vector of the format [X Y WIDTH HEIGHT], specifying a rectangular region in which corners will be detected and [X Y] is the upper left corner of the region.

3.2 Canny Edge Detector

The Canny edge detector is an edge detection operator that uses to detect a wide range of edges in images. Edge detection technique has been applied to extract the useful structural information from different objects and reduced the amount of data to be processed.

canny_edges(max_thresh, min_thresh,sigma):

The canny edge detector method to detect the wide range edges of an image. To set the minimum threshold value and maximum threshold value for image segmentation. If the image intensity I_{ij} is less than some fixed constant T (that is $I_{ij} < T$), or a white pixel if the image intensity is greater than that constant value. It is necessary for the computer to automatically select the threshold T.

3.3 System Architecture of Artery/Vein Classification of Retinal Images

The System architecture of artery vein classification of retinal image described as follows:

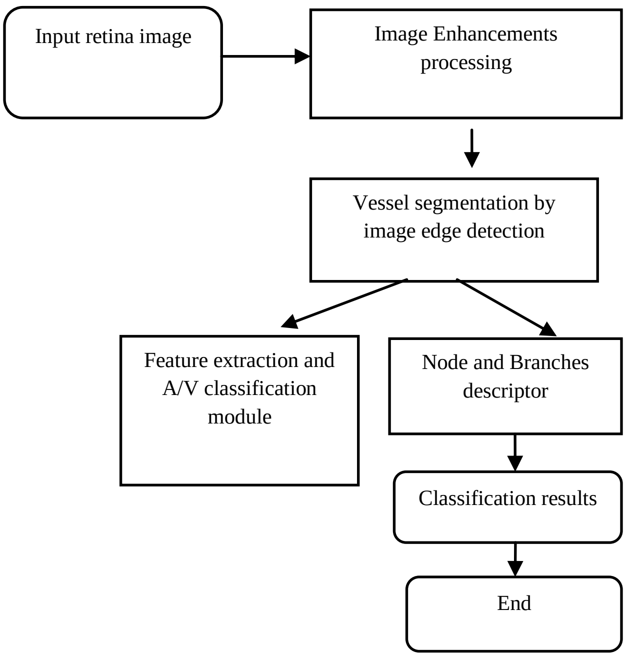

Figure 3.4: System Architecture of Artery/Vein Classification of Retinal Images.

(i) Image Enhancements:

In image enhancements we extract the green channel of image which shows the more probability of veins of retina image. Retina image is rgb (red green blue). After that we enhance the extract image by using histograms adjustment algorithm to improve the image quality.

(ii) Vessel Segmentation:

After improve the retinal image we apply the canny edge detector to finding the edges from image for classification of A/V.

(iii) Feature Extraction and A/V (Artery/Vein) Classification:

Feature extraction module contain SVM (state vector machine) module which is used to train the project for detection the feature points in image.

(iv) Node and Branches Descriptor:

Node and branches descriptor used to finding the cross section points of edges in image to classify the vein and artery by using graph method with the help of BFS (breath first search) to traverse a graph.

(v) Classification Result

This module classifies the input image by basic of training of feature detection and node descriptor module and shows calculate the result.

IV. RESULT ANALYSIS

In result analysis, covers the output of the project and also includes the analysis of the project.

4.1 Image Enhancement Processing

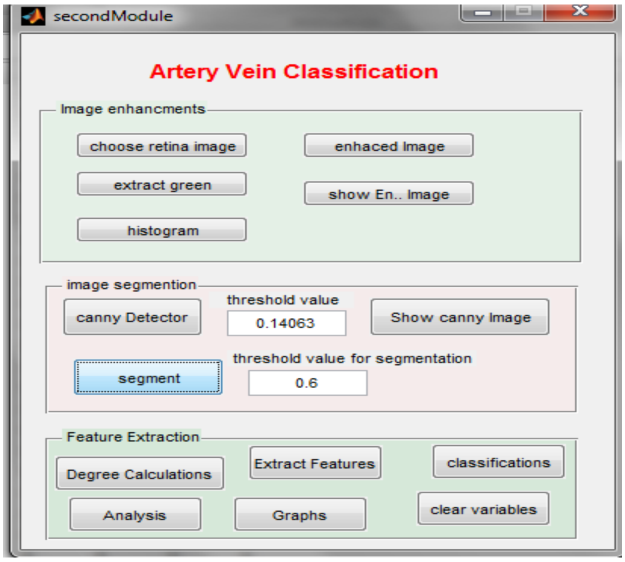

Figure 4.1: Main Form of Image Enhancement Processing

The above figure 4.1 shows the main form of image enhancement processing on different images which convert that color image into grey scale image. Next, click on histogram option then display histogram on green image and histogram on enhance green image. After applying image enhancement processing on A/V images which is discussed in previous chapter. Then, select the retinal images from test data. In test data contain images of several diseases such as diabetic retinopathy, hypertension, cardiovascular. Then, select any images from test data and display this form.

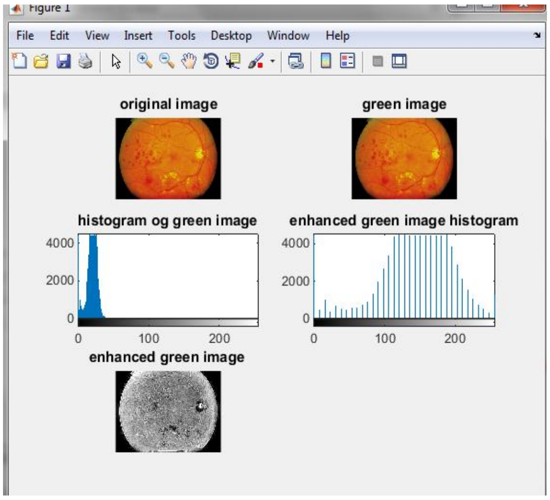

Figure 4.2: Snapshot of Image Enhancement Processing

The above figure 4.2 shows an image enhancement on different images which convert that color image into grey scale image. Next, click on histogram option then display histogram on green image and histogram on enhance green image. After applying image enhancement processing on A/V images.

4.2 Image Segmentation

Image enhancement processing is done then, next module is image segmentation. In image segmentation define a canny edge detector and image segmentation. In figure 4.3, we are use canny edge detector for wide range of edges in retinal images. After a canny edge detector is done then next step is image segmentation. Image segmentation is use for partitioning digital images into multiple segments and locates the object and boundaries. Then, perform a thresholding for create binary images.

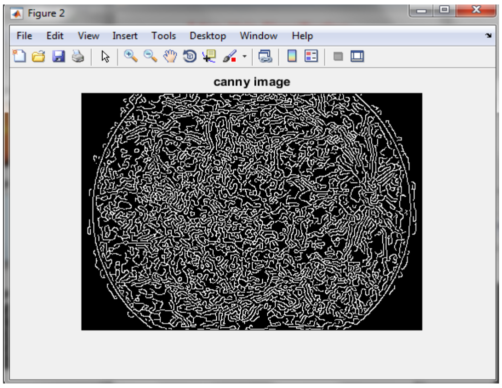

Figure 4.3: Snapshot of Canny Edge Detector

Image segmentation is the process of partitioning a digital image into multiple segments. In figure 4.4 is locate objects and boundaries in images and assigning a label to every pixel in an image.

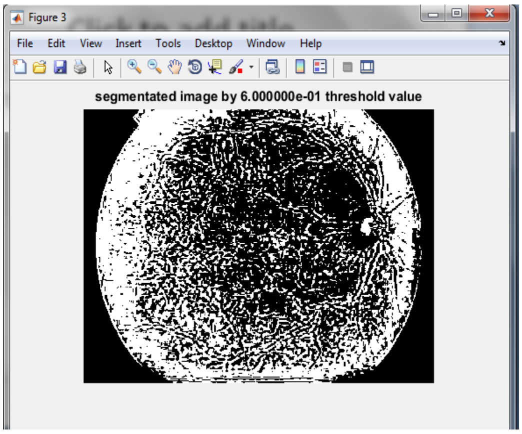

Figure 4.4: Snapshot of Image Segmentation

4.3 Feature Extraction

Image segmentation processing is done then, next module is feature extraction. In feature extraction, mention a degree calculation of nodes, A/V classification, Analysis, Graph with MSER Features.

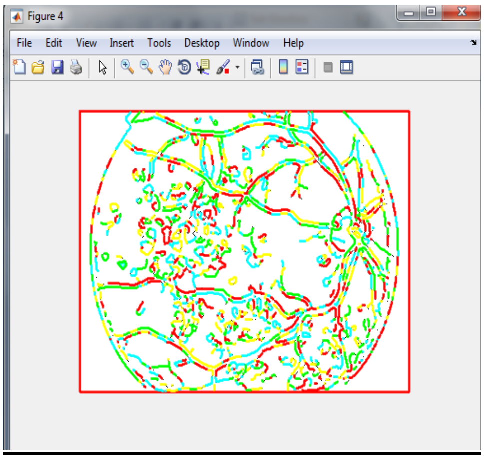

Figure 4.5: Snapshot of Combine a Degree of Nodes

The above figure 4.5 shows the node analysis. The node analysis is divided into four different cases depending on the node degree. Nodes of degree 2 represent in green colour, nodes of degree 3 represent in red colour, nodes of degree 4 represent in yellow and nodes of degree 5 in blue colour. Then, combine all degree of nodes.

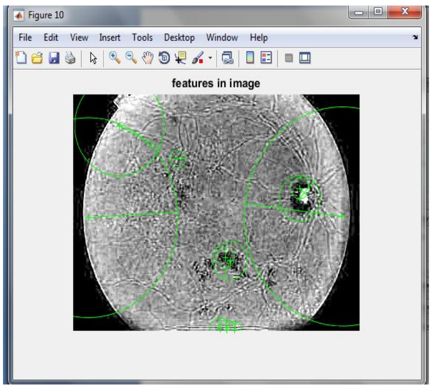

Figure 4.6: Snapshot of Feature Extraction

The above figure 4.6 shows feature extraction. In feature extraction to extract a feature from retinal image and only considering a strongest points then, this strongest points compare with store image in database.

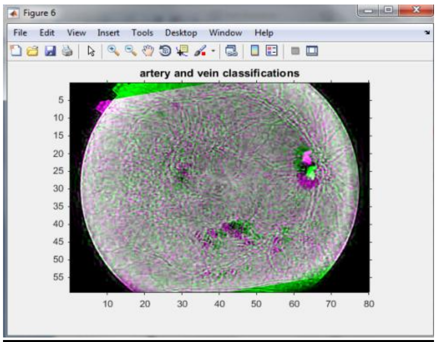

Figure 4.7: Snapshot of A/V Classification

The above figure 4.7 shows classifies the input image by basic of training of feature detection and node descriptor module and shows which are arteries and veins. So, red is arteries and green is veins.

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calling boundries
ending boundries
color green nodes of degree 1 total nodes 3.264000e+02
color red nodes of degree 2 total nodes 2.863000e+02
color yellow nodes of degree 3 total nodes 2.448000e+02
color blue nodes of degree 4 total nodes 3.264000e+02
calling boundries
ending boundries
color green nodes of degree 1 total nodes 3.264000e+02
color red nodes of degree 2 total nodes 2.863000e+02
color yellow nodes of degree 3 total nodes 2.448000e+02
color blue nodes of degree 4 total nodes 3.264000e+02
diabetes, it may be a silent disease in its \n early stages, and the delay in diagnosis and in the institution of appropriate
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Figure.4.8: Snapshot of Analysis of Disease

The above figure 4.8 shows analysis of disease. To detect the problems occur in certain diseases like diabetic retinopathy, cardiovascular and hypertension then display the messages on screen.

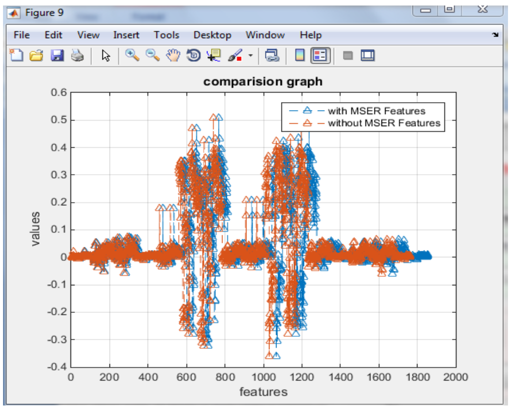

Figure 4.9: Graph represent with and without MSER Feature

The above figure 4.9 shows the graph represent with and without MSER Features. The MSER Features find correspondence between image elements from two images with different viewpoints. Blue is representing with MSER feature and Red is representing without MSER features.

V. RESULT ANALYSIS

For analysis the result of project, first we create a database of Images and saved with different categories. In a database number of Images stored with a different category after that pass the new image for classify, it display the best matching category name. Precision also called positive predictive value is the fraction of retrieved instances that are relevant, while Recall is the fraction of relevant instances that are retrieved.

Formulae are as follow:

Precision = TP/ (TP+FP)

Recall = TP/ (TP+FN)

Where,

TP= the no. of items are correctly labelled as belonging to the positive class

FP= which are items are incorrectly labelled as belonging to the class

FN= which items not labelled as belonging to the positive class

Following table 5.1 shows the classification of Image by using Intensity features algorithm. In that Saved the Images in a different category and then pass the Images of all category but they are different with saved images in a database. After that find the Precision and recall by using TP (True positive) and TN (True negative) value. The graph of result is shown at figure 5.1**.**

Database	PI	TP	FN	Precision	Recall	Accuracy
Diabetes	10	7	3	0.47	0.7	70
Cardio-vascular	10	8	2	0.53	0.8	80
Hyper-tension	10	8	2	0.53	0.8	80

TABLE 5.1: Result Analysis (Without MSER Features)

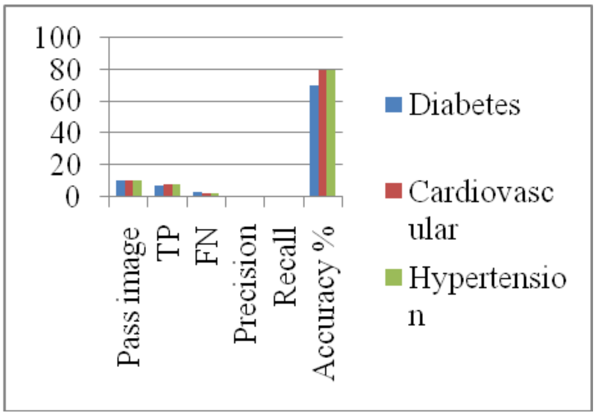

Figure 5.1: Graph of Result Analysis (Without MSER features)

In above figure 5.1 shows the graph of result of classification using Intensity features algorithm. Here in a graph find a precision, Accuracy, recall of existing system.

In table 5.2 shows the classification of image using MSER features (with MSER feature algorithm) and the graph of result are shown in figure 5.2. By using the accuracy is more than the accuracy find in a without MSER features algorithm (Intensity features algorithm).

Database	PI	TP	FN	Precision	Recall	Accuracy
Diabetes	10	10	0	0.66	1	100
Cardio-vascular	10	9	1	0.60	0.9	90
Hyper-tension	10	9	1	0.60	0.9	90

TABLE 5.2: Result Analysis (With MSER Features)

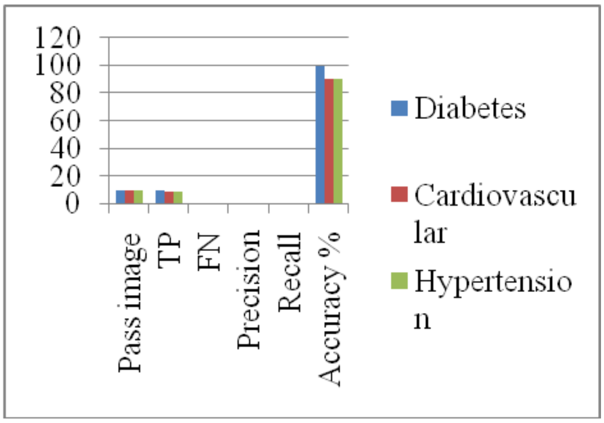

Figure 5.2: Graph of Result Analysis (with MSER Features)

In this chapter we discussed output of our project. In that we perform A/V classification with MSER feature and without MSER feature algorithm and comparison shown in the result analysis table.

Figure 5.1 AND Figure 5.2 shows the experimental results vary depending on the different data sets. In existing system, contain a 3 database such as Diabetes, Cardiovascular, and Hypertension. They achieved a recall 70% and Precision 80%. Here, we are used 3 test data such as Diabetes, Cardiovascular, and Hypertension. Then use MSER features algorithm for improves the accuracy. Then, we have achieved a recall 90% and precision 100%. We conclude that the MSER feature is providing more accuracy than Intensity feature.

IV. CONCLUSION

As describe throughout the paper, many technologies exists for classification of arteries & veins in retinal image and calculation of changes in blood vessels. In existing methods that use intensity features to discriminate between arteries and veins. The retinal images are non-uniformly illuminated and exhibit local luminosity and contrast variability which affect performance of intensity-based A/V classification method. Hence, to overcome this problem our system using a graph-based method which can be use additional structural information extracted from a graph representation of the vascular network. Further work can be extended by an advanced GTM algorithm which can uses for dealing with high rates of outlying matches of arteries and veins and easy to identify an A/V classification.

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Authors Biography

Name: Sonali M. Thakur

Department of Computer Science and Engineering

G.H. Raisoni Academy of Engineering and Technology, Nagpur

Name: Prof. Amit pimpalkar

Department of Computer Science and Engineering

G.H. Raisoni Academy of Engineering and Technology, Nagpur

Name: Prof.AshwiniMeshram

Department of Computer Science and Engineering

G.H. Raisoni Academy of Engineering and Technology, Nagpur