ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 2, Issue 4, April 2016

Efficient Vessel Segmentation and Vessel Classification of Retinal Image to Identify the Cardio Vascular Diseases

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***Abstract*— A retinal image provides a snapshot of what is happening inside the human body. In particular, the state of the retinal vessels has been shown to reflect the cardiovascular condition of the body. Retinal images provide considerable information on pathological changes caused by local ocular disease which reveals diabetes, hypertension, arteriosclerosis, cardiovascular disease and stroke. Computer-aided analysis of retinal image plays a central role in diagnostic procedures. However, automatic retinal segmentation is complicated by the fact that retinal images are often noisy, poorly contrasted, and the vessel widths can vary from very large to very small. Implement automate segmentation approach based on active contour method to provide regional information using Lebesgue measure. Model the segmented vascular structure as a vessel segment graph and formulate the problem of identifying vessels as one of finding the blood vessels in the graph given a set of constraints such as CRAE and CRVE. These measurements are found to have good correlation with hypertension, coronary heart disease, and stroke. However, the accurate extraction of distinct vessels from a retinal image. A method to solve this optimization problem and evaluate it on a large real-world dataset of retinal images.**

***Index Terms*— Pre-Processing, Vessel Segmentation, Vessel Classification, Central Retinal Artery and Vein Equivalent, Disease Prediction.**

I. Introduction

Retinal imaging is a recent technological advancement in eye care. It enables optometrist to capture a digital image of the retina, blood vessels and optic nerve located at the back of eyes. This aids in the early detection and management of diseases that can affect both eyes and overall health. This includes glaucoma, macular degeneration, diabetes and hypertension. With retinal imaging technology, the most subtle changes to the structures at the back of eyes can be detected. Vascular Diseases are often life-critical for individuals, and present a challenging public health problem for society. The drive for better understanding and management of these conditions naturally motivates the need for improved imaging techniques. Eye fundus is the interior surface of the eye, opposite to the lens and includes the retina, optic disc, macula and fovea and posterior pole. It is the only part of the human body where the micro circulation can be observed directly. It can be examined by ophthalmoscope or fundus photography.

In a new unsupervised fuzzy algorithm for vessel tracking that is applied to the detection of the ocular fundus vessels. It overcomes the problems of initialization and vessel profile modeling that are encountered in the literature and automatically tracks fundus vessels using linguistic descriptions like "vessel" and "non-vessel." The main tool for determining vessel and non-vessel regions along a vessel profile is the fuzzy C-means clustering algorithm that is fed with properly preprocessed data. Additional procedures for checking the validity of the detected vessels and handling junctions and forks are also presented. And then implemented a semi-automatic method to measure and quantify geometrical and topological properties of continuous vascular trees in clinical fundus images is described.

Measurements are made from binary images obtained with a previously described segmentation process. The skeletons of the segmented trees are produced by thinning, branch and crossing points are identified and segments of the trees are labeled and stored as a chain code.

The operator selects a tree to be measured and decides if it is an arterial or venous tree. An automatic process then measures the lengths, areas and angles of the individual segments of the tree. Geometrical data and the connectivity information between branches from continuous retinal vessel trees are tabulated. A number of geometrical properties and topological indexes are derived.

Implement automate segmentation approach based on active contour method to provide regional information using Lebesgue measure.

The segmented vascular structure as a vessel segment graph and formulate the problem of identifying vessels as one of finding the blood vessels in the graph given a set of constraints such as CRAE and CRVE. These measurements are found to have good correlation with hypertension, coronary heart disease, and stroke. However, they require the accurate extraction of distinct vessels from a retinal image. To

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solve this optimization problem and evaluate it on a large real-world dataset of retinal images.

II. Related Works

First review some Enhancement technique, Feature based classifiers, active contour for vessel segmentation applications in the literature, and then briefly introduces some typical filters for vesselness enhancement and classification.

A. Wang .Y, Ji .G, Lin .P, and Trucco .E, (7)

A novel vessel enhancement technique based on the matched filters with multi wavelet kernels MFMK and it identifies multi wavelet kernels separating vessels from clutter edges and bright, localized features. For noise attenuation and vessel localization, a multi scale hierarchical decomposition, which particularly effective for the normalized enhanced image. This process performs an iterative segmentation at increasing image resolutions, locating smaller and smaller vessels. A single scale parameter controls the level of detail included in the vessel map. Then show a necessary condition to achieve the optimal decomposition, deriving a rule to identify the optimal number of the hierarchical decomposition. This method does not require preprocessing and training it can therefore be used directly on images with different characteristics. In addition, it relies on adaptive thresholding so that no numerical parameter is tuned manually to obtain a binary mask. Multi-scale hierarchical decomposition performs an iterative segmentation at varying image resolutions, locating smaller and smaller vessels. Reduce the interference of large bright areas like the optic disc or bright lesions. Fragmentation is limited and large vessels are the least affected. Difficult to analyze different parts of the same vessel must be of the same type.

B. Lupascu. C, Tegolo .D, and Trucco .E,(5)

Feature-based Ada-Boost classifier FABC, a supervised method, which trains a classifier with manually labeled images. The feature vector is a rich collection of measurements at different spatial scales, including the output of various filters Gaussian and derivatives of Gaussian filters, matched filters, and Gabor wavelet transform, and the likelihood of structures like edges and ridges via numerical estimation of the differential properties of the intensity surface principal and mean curvatures, principal directions, and root mean square gradient. This feature vector encodes a rich description of vessel-related image properties, namely local pixel's intensity and Hessian-based measures, spatial the gray-level profile of the cross section of a vessel can be approximated by a Gaussian curve and structural vessels are geometrical structures, which can be seen as tubular. Our combination of features embeds redundancy in the feature vector deliberately, to cover the widest possible spectrum of situations. This rich combination of features is used in retinal vessel detection for the first time. Efficient method for automated vessel segmentation in retinal images by classifying pixels as vessel or non vessel. The limitation of this approach is it does not include a post-processing stage for improving the vessel mask obtained by the pixel-based classifier which means connecting broken vessels and resolving local ambiguities due to the convergence of multiple and variously bent vessels design constraint is that improvements must impinge minimally on computation times.

C. Sun .K and Jiang .S,(4)

Active contour model for automatic vascular segmentation on 2-D angiogram, where the local morphology feature is integrated into the region-based deformable model. Compared to it applies directional measure substituting isotropic one in data fitting term. Different fitting formulation, maximum fuzzy opening, and minimum fuzzy opening are used for object and background, respectively. They can be computed before evolution without need to update in each contour evolution. Therefore, achieves a robust evolution of level set against initial condition. Besides, the scale used in local image information extraction is detected with an adaptive process instead of predefined ones adopted in. The local region associated to curve is also used to confine the energy of level set. It involves and extends methods that have been presented earlier at a conference. Able to segment angiogram with intensity in-homogeneity and it is robust against the initialization for the selective fitting term used for vessel and background. Limitation is little influence on the accuracy, but influence the computational cost.

D. Fraz .M, Remagnino .P , A. Hoppe, B. Uyyanonvara, A. R. Rudnicka, C. G. Owen, and S. A. Barman,[8]

Retinal vessel segmentation and delineation of morphological attributes of retinal blood vessels, such as length, width, tortuosity branching pattern and angles are utilized for diagnosis, screening, treatment, and evaluation of various cardiovascular and ophthalmologic diseases such as diabetes, hypertension, arteriosclerosis and cordial revascularization. This survey is unique in that it particularly focuses on the algorithms and methodologies for the segmentation of blood vessels in two dimensional colored retinal images acquired from a fundus camera and no such review exists to the knowledge. The objectives are to review the retinal vessel segmentation methodologies, to provide a detailed resource of the algorithms employed for vessel segmentation to researchers for ready reference, to discuss the advantages and disadvantages of the various approaches, to discuss the current trends and future directions and summarize the open problems. Developed faster, more accurate 3D segmentation techniques, particularly focusing on retinal images. Accuracy and robustness of the segmentation process are low in this survey.

III. Proposed Design

Examination of blood vessels in the eye allows detection of eye diseases such as glaucoma and diabetic retinopathy. Traditionally, the vascular network is mapped by hand in a time-consuming process that requires both training and skill.

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Automating the process allows consistency, and most importantly, frees up the time that a skilled technician or doctor would normally use for manual screening. Implement automatic process to examine the blood vessels to identify the cardio vascular diseases in retinal images.

It utilizes the concept of active contours to remove noise, enhance the image, track the edges of the vessels, calculate the perimeter of vessels and identify the cardio diseases. Implement infinite perimeter active contour with hybrid region information IPACHI model to segment blood vessels and calculate perimeter of the blood vessels.

An efficient and effective infinite perimeter active contour model with hybrid region terms for vessel segmentation with good performance. This will be a powerful tool for analyzing vasculature for better management of a wide spectrum of vascular-related diseases. Retinal vascular caliber CRAE and CRVE was analyzed as continuous variables. Analysis of covariance to estimate mean retinal vascular caliber associated with the presence versus absence of categorical variables or increasing quartiles of continuous variables to predict the cardio vascular diseases.

A. *Getting Input Image*

To acquire a digital image. Retinal images of humans play an important role in the detection and diagnosis of cardiovascular diseases that including stroke, diabetes, arterio sclerosis, cardiovascular diseases and hypertension. Vascular diseases are often life critical for individuals, and present a challenging public health problem for society.

The detection for retinal images is necessary and among them the detection of blood vessels is most important. The alterations about blood vessels such as length, width and branching pattern, can not only provide information on pathological changes but can also help to grade diseases severity or automatically diagnose the diseases. Upload the retinal images.

The fundus of the eye is the interior surface of the eye, opposite the lens, and includes the retina, optic disc, macula and fovea, and posterior pole. The fundus can be examined by ophthalmoscope or fundus photography. The retina is a layered structure with several layers of neurons interconnected by synapses. In retina we can identify the vessels. Blood vessels show abnormalities at early stages also blood vessel alterations. Generalized arteriolar and venular narrowing which is related to the higher blood pressure levels, which is generally expressed by the Arteriolar to Venular diameter ratio.,

It constructed a dataset of images for the training and evaluation of our proposed method. This image dataset was acquired from publically available datasets such as DRIVE and STAR. Each image was captured using 24 bit per pixel (standard RGB) at 760 x 570 pixels.

First, tested against normal images which are easier to distinguish. Second, some level of success with abnormal vessel appearances must be established to recommend clinical usage. As can be seen, a normal image consists of blood vessels, optic disc, fovea and the background, but the abnormal image also has multiple artifacts of distinct shapes and colors caused by different diseases.

B. *Pre Processing the Image*

To improve the image in ways that increases the chances for success of the other processes. The gray scale conversion operation to identify black and white illumination. Noise in colored retinal image is normally due to noise pixels and pixels whose color is distorted so implement sharpening filter can be used to enhance and sharpen the vascular pattern for preprocessing and blood vessel segmentation of retinal images performing well in preprocessing, enhancing and segmenting the retinal image and vascular pattern.

Human perception is highly sensitive to edges and fine details of an image, and since they are composed primarily by high frequency components, the visual quality of an image can be enormously degraded if the high frequencies are attenuated or completed removed. In contrast, enhancing the high frequency components of an image leads to an improvement in the visual quality. Image sharpening refers to any enhancement technique that highlights edges and fine details in an image. Image sharpening is widely used in printing and photographic industries for increasing the local contrast and sharpening the images. In principle, image sharpening consists of adding to the original image a signal that is proportional to a high-pass filtered version of the original image. In this filter, the original image is first filtered by a high-pass filter that extracts the high-frequency components, and then a scaled version of the high-pass filter output is added to the original image, thus producing a sharpened image of the original. Note that the homogeneous regions of the signal, i.e., where the signal is constant, remain unchanged.

C. *Vessel Segmentation*

Partitions an input retinal image in to its constituent parts or objects. Feature extraction and vessel segmentation steps using IPACHI model. It can create vascular network using active contour with Lebesgue measure with γ neighborhood function. It can extract the map is a representation of the vascular network, where each node denotes an intersection point in the vascular tree, and each link corresponds to a vessel segment between two intersection points. For generating the graph, we have used active contour method. The nodes are extracted from the centerline image by finding the bifurcation points which are detected by considering pixels with more than two neighbors and the endpoints or terminal points by pixels having just one neighbor. In order to find the links between nodes vessel segments, all the bifurcation points and their neighbors are removed from the centerline image and as result we get an image with separate components which are the vessel segments. On the other hand, any given link can only connect two. Vessels segmentation binary mask is created by detecting vessels edges from sharpened image. The blood vessels are marked by the masking procedure which assigns one to all those pixels which belong to blood vessels and zero to non vessels

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IJARMATE
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pixels. Final refined vessel segmentation mask is created by active contour model. An active contour model is also called snakes, is a framework in computer vision for delineating an object outline from the possibly noisy two dimensional image. In this approach, a snake is an energy minimizing, deformable spline influenced by constraint and image forces that pull it towards object contours and internal forces that resist deformation. Snakes may be understood as a special case of the general technique of matching a deformable model to an image by means of energy minimization. In two dimensions, the active shape model represents a discrete version of this approach, taking advantage of the point distribution model to restrict the shape range to an explicit domain learned from a training set. Finally provide the segmentation mask for preprocessed retinal images.

D. Vessel classification

The segmented vessels are classified into arteries and veins. Correct classification of vessels is vital, because heart diseases affect arteries and veins differently. The alterations in veins and arteries cannot be analyzed without distinguishing them. Segmented vessels are classified by the supervised method Support Vector Machine. After extraction of blood vessels, feature vector is formed based on properties of artery and veins. The features get extracted on the basis of centerline extracted image and a label is assigned to each centerline, indicating the artery and vein pixel. Based on these labeling phase, the final goal is now to assign one of the labels with the artery class (A), and the other with vein class (V). In order to allow the final classification between A/V classes along with vessel intensity information the structural information and are also used. This can be done using SVM classification. The trained classifier is used for assigning the A/V classes to each one of the sub graph labels. First, each centerline pixel is classified into A or V classes, then for each label (Ci j , j = 1, 2) in sub graph i, he probability of its being an artery is calculated based on the number of associated centerline pixels classified by LDA to be an artery or a vein. The probability of label Ci j to be an artery is

$$Pa(Ci\,j) = na\,Ci\,j / (na\,Ci\,j + nvCi)$$

Where na Ci j is the number of centerline pixels of a label classified as an artery and nv Ci j is the number of centerline pixels classified as a vein. For each pair of labels in each sub graph, the label with higher artery probability will be assigned as an artery class, and the other as a vein class. Finally, to prevent a wrong classification as a result of a wrong graph analysis, we calculate the probability of being an artery or a vein for each link individually.

E. Disease Prediction

Diagnosis the diseases using AVR ratio based on CRAE and CRVE measurements. The vessel measurements CRAE, CRVE have been found to be correlated with risks factors of cardiovascular diseases and are positive real numbers. The major systemic determinant for smaller CRAE is higher blood pressure whereas wider CRVE is mainly due to current cigarette smoking, higher blood pressure, systemic inflammation and obesity. Those with higher blood pressure 75th percentile had on average 4.8 microns smaller CRAE and 2.6 microns wider CRVE than those with lower blood pressure 25th percentile. A more recent study found a strong negative correlation between renal function and retinal parameters (CRAE and CRVE) in a cohort of eighty healthy individuals which suggests a common determinant in pre-clinical target organ damage. This is in support of earlier studies examining the association between retinal vascular signs and incident hypertension providing evidence that a decrease in CRAE is indeed an antecedent to clinical onset of hypertension and occurs prior to other signs of target organ damage. Besides the value of CRAE in predicting hypertension, it also shows great potential in other pathologies including stroke and diabetes. Generalized arteriolar narrowing as reflected by a decrease in CRAE is associated with an increased risk of stroke with odds ratios reported between 1.1 and 3.0.15,22,23 While in diabetes, an increase of CRVE is associated with increased incidence of diabetic retinopathy DR, progression of DR, progression to proliferative DR and macular oedema, but is unrelated to CRAE.

F. System Architecture

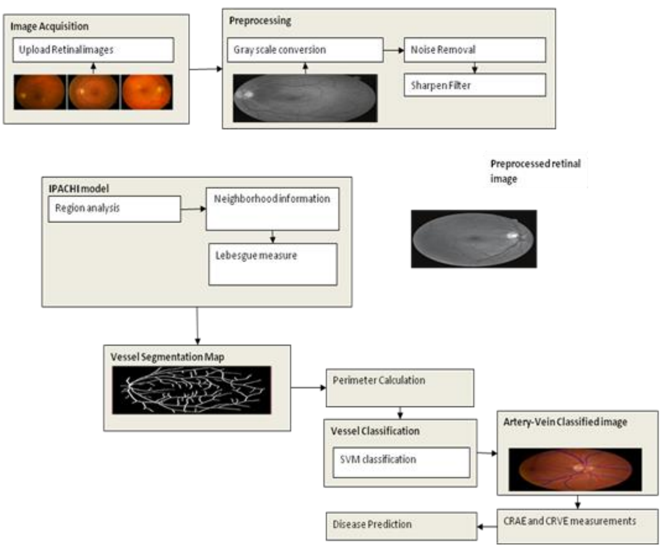

Fig 1: Architecture overview

Acquire a digital image and improve the input image by preprocessing. Colored image is converted in to gray scale for easily identify the noise. Gray scale is a range of shades of gray without apparent color. The darkest possible shade is black is the total absence of transmitted or reflected light. The lightest possible shade is white the total transmission of light at all visible wavelength. Intermediate shades of gray5n of light at all visible wavelength. Intermediate shades of gray are represented by equal brightness levels of the three primary color (Red,Blue,Green) for transmitted light or equal amounts

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of the three primary pigments (Cyan,Magenta,Yellow) for reflected light. The converted gray scale image is filtered by sharpen filter. Filtering is the operation of applying a transform on a image in order to enhance it. Enhancing the high frequency components of an image leads to an improvement in the visual quality. Image sharpening refers to any enhancement technique that highlights edges and fine details in an image. After preprocessing the preprocessed image is segmented by the contour method which is a improved segmentation approach. Finally we get the segmentation mask and calculate the perimeter of the vessel.

After segmentation process vessel classification is done by Support vector Machine. The CRAE and CRVE measurements are calculated. Using this measurement we predict the heart disease.

IV. Experimental Analysis

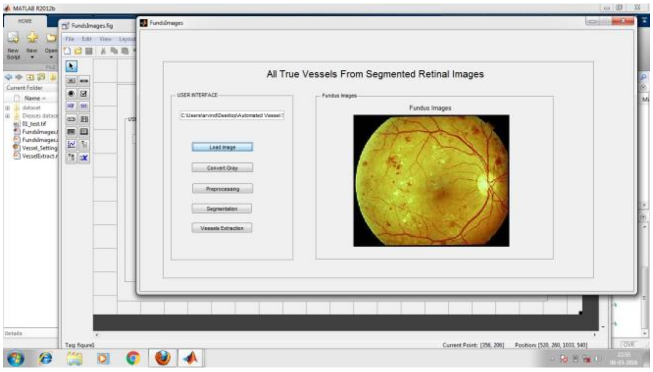

Fig 2: Image Acquisition

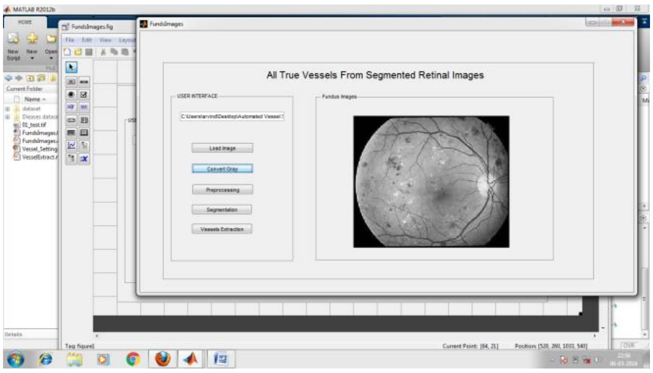

Fig 3: Gray Scale Conversion

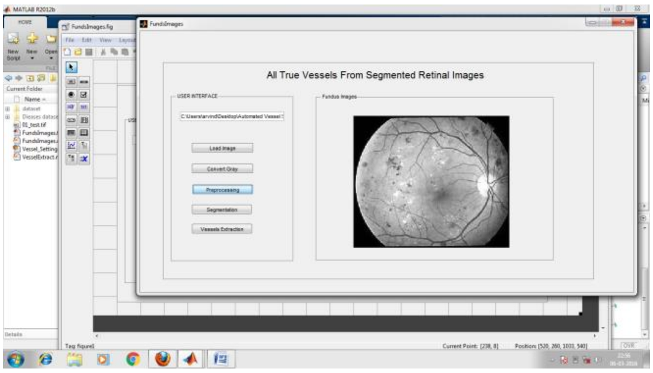

Fig 4: Pre Processing

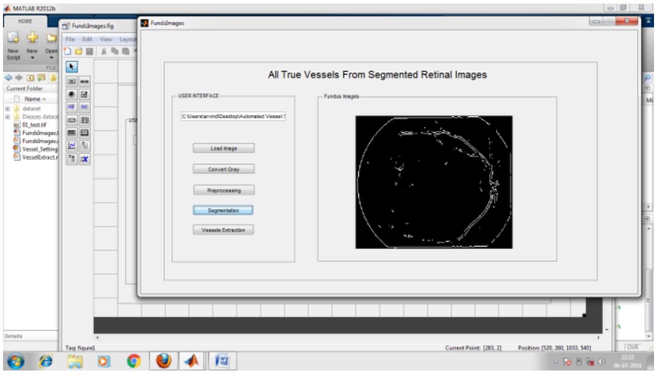

Fig 5: Segmentation

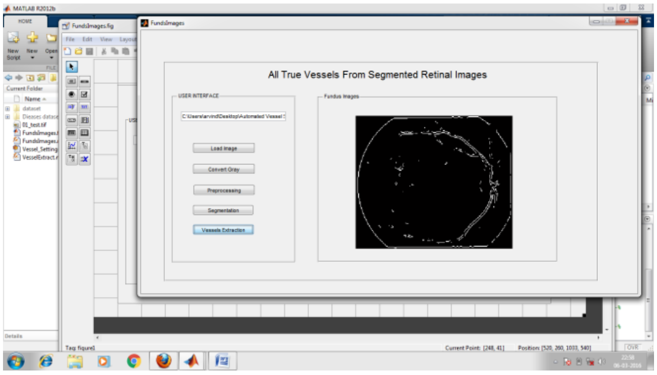

Fig 6: Vessel Extraction

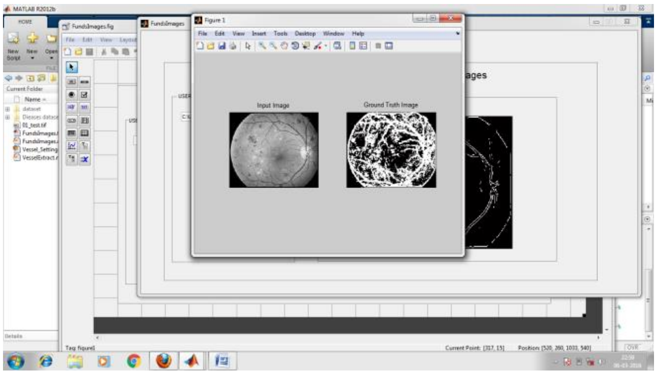

Fig 7: Extraction

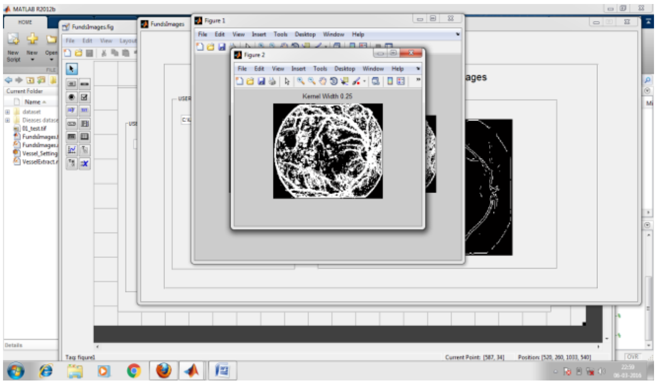

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Fig 8: Extraction (width 0.25)

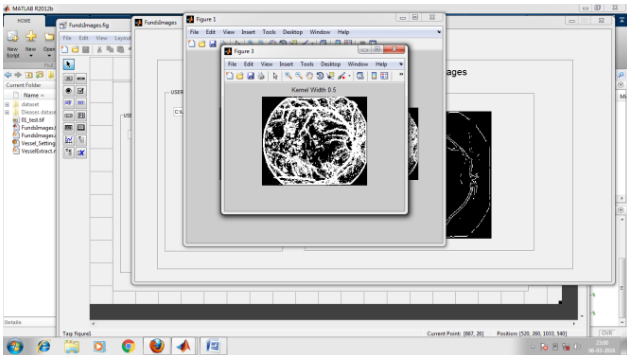

Fig 9: Extraction (width 0.5)

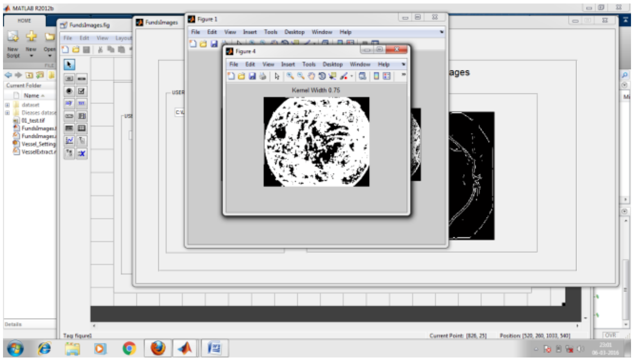

Fig 10: Extraction (width 0.75)

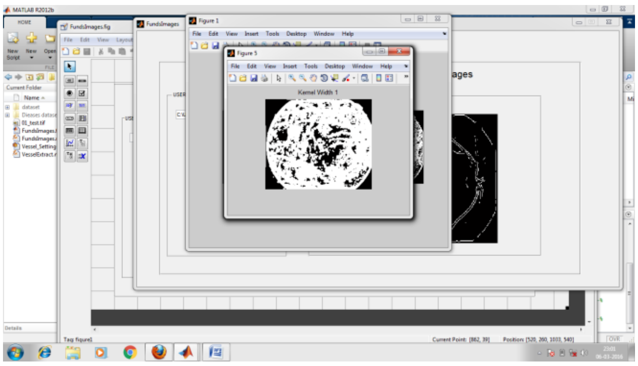

Fig 11: Extraction (width 1)

V. Conclusion

It implemented successfully with accurate identification of true vessels to obtain correct retinal ophthalmology measurements. The IPACHI based method with SVM outperforms the accuracy of the SVM classifier by means of intensity features, which shows the significance of using structural information for A/V classification. In future, it can employ filter to compute the maximum response of vessel likeness function for each pixel. Extend approach to segment optic disc and cup segmentation using ellipse fitting method for analyzing glaucoma diseases.

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