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Automated Segmentation Method for Disease Identification and Fovea Detection Using GLCM and ELM

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Abstract: Retinal image analysis is extremely important in medical image processing. Diabetic Retinopathy (DR) is an eye disease that can lead to complete loss of visual capacity, if left undiagnosed at the initial stage. In India DR is the 3rd cause of blindness. Diabetic retinopathy is obtained automatically. A computer has used to predict the qualitative research and emerging knowledge about retina using extreme learning machine classifier. The fundus image analysis developed to assist ophthalmologist's diagnosis and also functions as an automatic tool for the mass screening of diabetic. In this method, extreme learning machine is used to detect the abnormal image. Texture features are extracted by using Gray Level Co-occurrence matrix (GLCM). Fovea is one of the important feature of a fundus retinal image. During the last 30 years, people are trying to extract the different features like blood vessels, optic disk, macula, fovea automatically from retinal image. The retinal image of a person, processing and pattern recognition can be performed. It can differentiate the bright region (optic disc) and dark region (fovea). While, compares the similarity or dissimilarity between regions can detect fovea region. The architecture gets the retinal image acquired from fundus camera and pre-process the image using histogram equalization, performs the segmentation algorithm for detecting the blood vessels, optic disk and fovea.

Key words: Retinal Fundus Images, Automatic segmentation, GLCM, ELM, Diabetic retinopathy, Fovea

INTRODUCTION

The fovea is the most important part of the eye, located in the centre part of the retina. The fovea is responsible for sharp central vision which is necessary for human activities. Fovea size is relatively very small compared to the rest of retina but fovea is the only area of the retina where 20/20 vision is attainable and very important for seeing fine detail and colour. Usually this fovea zone is approximated to a circle of radius 200 μ (Samanta *et al*., 2013). The fundus images are most commonly used by the ophthalmologist to monitor the progression of the disease. They are recorded accurately by device called ophthalmoscopes. Normally these images are manually sorted by trained clinicians a typical retinal fundus image with its features labelled is shown in Fig. 1. The central region called the macula. A small depression in the centre of the macula is called fovea. The optic disc is the entry and exit site of blood vessels and the fibers are responsible for transmitting electrical impulses from retina to the brain. The optic disc can be seen as the elliptical shape in the fundus eye image. Its size varies from one person to another, between 1/10 and 1/5th of the image. In colour image, it appears as the bright yellowish region as the exudates. Diabetic retinopathy The visions of many people in the world are threatened by the diabetic retinopathy. Diabetic retinopathy is the eye disease that causes the blindness or blurs the visions

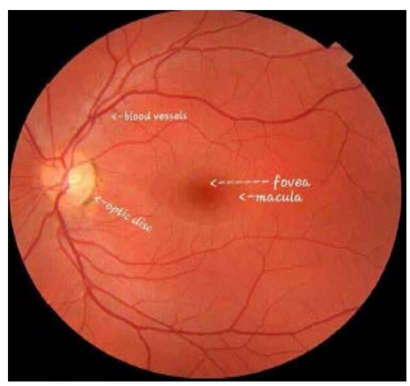

Fig. 1: Retinal fundus image

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(Nandhini and Malathi, 2014). It arises due to cells stop responding to the insulin that is produced so that glucose in the blood cannot be absorbed into the cells of the body. According to the research, the laboratory tests of diabetic retinopathy can reduce the exposure to danger of blindness by half. Therefore, early detection could limit the severity of the disease and treating the disease in best possible manner. The optic disc detection is an important step to identify the other fundus features. The optic disc is the normal feature of the image but the lesions are the abnormal case. Detection the optic disc can be used to decrease the false positive in the detection of the lesions. Manual detection of blood vessels is difficult since the appearance of blood vessel in a retinal image consisting of many different and connected parts and having low contrast. Diabetic Retinopathy is a serious of visual problems due to diabetics by chronic hypoglycemia and the leading cause of visual impairment to people all over the world. Blood vessels that originate from the optic disc may leak fluid which leads to diseases (DR). Diabetic Retinopathy may cause various forms of retinal lesion. The initial stage of retinopathy is the micro aneurysm.

Problem formulation: It is very difficult to detect fovea region because which have thin and more interconnected parts, area very small. Sometimes Computer Aided Diagnosis (CAD) Technique used for detecting diabetic retinopathy is leading in less concrete result. Major problem is prognosis of blindness is difficult, an extremely time-consuming process. Very difficult to identify eye diseases and abnormalities like:

- Retinopathy of Pre-maturity (ROP)
- Exudates
- Microaneurosym (lesions)
- Glaucoma

MATERIALS AND METHODS

The main objective of the proposed work is to identify detection of diabetic retinopathy and to locate the centre of fovea in retinal image. The proposed approach mainly focuses on disease identification using feature extraction method using Gray Level Co-occurrence Matrix (GLCM). Extreme learning classifiers are used to classify normal and abnormal images. Due to diabetic retinopathy leakage of blood and other fluids may occur and cause swelling of retinal tissue and clouding of vision. C Sundar (Sundhar and Archana, 2014). proposed a method for automatic screening of the fundus image for the detection of DR. Proposed system presents a new method that automatically detects the fovea region using automated segmentation method. Image processing technique plays a vital role in this method. Segmentation process is responsible to extract the proto-objects from the retinal image and helps in the concept of foveal attention. The spatial relationship of the optic disk and the macula lutea helps in detecting the fovea region. After locating optic disk, the macula region is identified by the OD radius and which is the centre portion of the fundus image. The centroid of the macula area is marked as the fovea region. The difference in intensity shows the major variation between the fovea and the macular region. The macula has less variation in intensity range when compared to fovea. This identifies the fovea from the macular area in the fundus images.

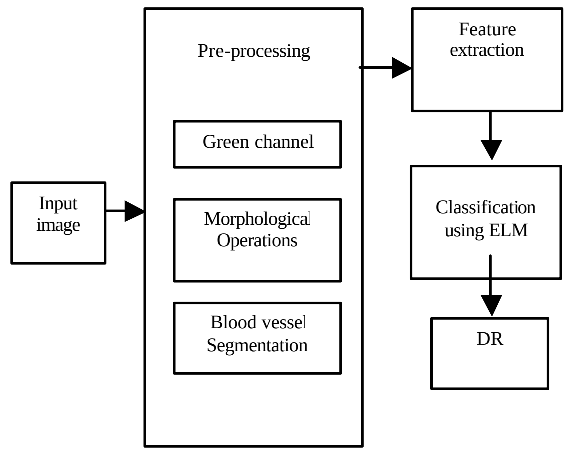

Fig. 2: Overall block diagram for disease identification

This method has been broadly divided into various modules like Micro aneurism detection, Exudates Segmentation, Optic Disc localization, retinal vessel segmentation etc. The architecture gets the retinal image acquired from fundus camera and pre-process the image using histogram equalization, performs the segmentation Algorithm for detecting the Blood vessels, Optic disk and Fovea. M. Usman. Proposed an automated system for accurate detection of MAs using coloured retinal images. A classic 3-stage model is used consisting of candidate region extraction, feature vector formation and classification. The candidate region extraction phase applied mathematical morphology, contrast enhancement technique and Gabor filter bank for the enhancement of MA regions present in fundus image. Blood vessel pixels are eliminated in candidate extraction phase to reduce the number of spurious regions.

Proposed system includes techniques like acquisition, Preprocessing, Optic disc detection, segmentation and fovea detection. Overall block diagram for feature extraction and ELM classification is shown in Fig. 2.

Pre-processing: It is aprogram that processes feed forward mechanism. the input data is pre-processedis then it is given to the next stage of work which is often used by some subsequent programs like compilers. Color fundus images often show important light source efficiency, difference in luminance and noise. In order to reduce these imperfections and generate images more suitable for extracting the pixel features brusquely in the classification step, a preprocessing comprising the following steps is applied) vessel central luminance removal) background to make uniform or similar and) vessel Segmentation (Marin *et al*., 2011).

Green channel: Color digital images are made ofpixels. The pixels are made of combinations of primary colors. Channelin this context is the grayscale image of the same as a color image, made of just one of these primary colors. A gray scale image has just one channel. 24 bit is presented in RGB image, each channel has 8 bits, (R,Y, Z),15 or 16 bit color is called as high color, 24 bit color is called true color 30-36 or 48 bit color is called as deep color. The image is composed of three images where each image can store discrete pixels with STANDARDl brightness intensities between 0 and 255. If the RGB image is 48 bit each channel is made of 16-bit images.

Morphological operations: Morphology is a covering a large number of image processing operations that process images based on external form. Morphological operations apply a Building element to an input image, creating an output image of the same size. The two operations are dilation and erosion. Dilation adds pixels, while erosion removes pixels on object boundaries. The number of pixels added or removed from the structure of an image; depend on size and shape of the element used to process the image. The state of any given pixel in the output image is obtained by applying a rule to the analogous pixel and its neighbors in the input image performing both operations. The rules of the dilation or erosion operation are listed Table 1.

Feature extraction method: In machine learning, in image processing, feature extraction starts from an initial set of measured data and builds derived values (features) intended to be providing use full and not comparable. Main features are the area of blood vessels, area of exudates, homogeneity, correlation, energy, eccentricity, area, aspect ratio, identification of MAs entropy value etc. Feature extraction can be optically discerned as a special kind of data reduction. The aim is to is to find a subset of informative variables predicated on image data. Feature extraction is essential step for segmentation to be prosperous. Feature extraction is with an expedient for simplifying segmentation. Several types of features are available among which the textural features are found to be more suitable to medical field. Apart from textural features, they can also be extracted from the anatomical structures of the retinal image. Objective of feature extraction is to extract the vessels, Microaneurysms and exudate present in the pre-processed image. Microaneurysms and exudate appear as isolated patterns and are disconnected from the vessels. The features of microaneurysms and exudate can be extracted based on shape, size and intensity level. Microaneurysm size ranges from 14-136 μm. Microaneurysms are dark reddish in colour, Exudates are yellow-white patches of varying sizes and shapes (Sundhar and Archana, 2014). The extracted features should provide the characteristics of the input type to the classifier by more concentrated description of the relevant properties of the image into a feature space of specific dimension (n). Area of blood vessels is determined by finding the total number of white (vessel) pixels in the vessel-segmented image. The exudates and MA are determined by finding the number of white pixels (Gowthaman, 2014). The total number of pixels in candidate region is called as Area. The ratio of the distance between foci of ellipse and its major axis length and it is equal to 0 for a circular region is called as Eccentricity. The ratio of major axis length to minor axis length of the candidate region is called as Aspect Ratio. Entropy is the measure of molecular disorder. Energy is the measure of information. The retinal image of the patients affected by this disease is captured intially. Those images are subjected first for pre processing because they may be in low resolution and noisy. Then from pre processed image the features are extracted for the identification. Feature extraction is an important technique which only helps for perfect identification. From those features they are finally given for the identification and classification of MAs of DA (Gowthaman, 2014). The proposed algorithm for the candidate region extraction works in three phases. In phase 1, Using mathematical morphological operations, improves the contrast of dark regions, contrast nor-malization and filter banks. Phase 2 enhancement of blood vessel. The last phase of candidate region extraction eliminates all blood vessel pixels from candi-date pixels in order to reduce the spurious regions and to increase the accuracy of classifier (Akram *et al*., 2013).

Table 1: Rules for dilation and erosion

Operation	Rule
Dilation	Output pixel value is the maximum Pixel values is 1, the output pixel is
Erosion	Output pixel value is the minimum. Pixels value is 0, the output pixel is 0

Textural features can be extracted with the help of Gray Level Co-occurrence Matrix (GLCM). GLCM considers the spatial relationship of pixels. it is characterize the texture of an image by calculating how often pairs of pixel with specific values and in a spatial relationship occur in an image, Splat and GLCM feature are extracted to ameliorate the relegation precision. In order to relegate the given input images, different classes must be represented utilizing pertinent and consequential features with the avail of cull method. Finally classification accuracy is compared with K-Nearest Neighbour (KNN) classifier. Extracted splat and GLCM features to classify the images into haemorrhage affected retina. The feature vector used for classification of segmentation of retinal structures and texture analysis. The features are blood vessels, MA, etc.

ELM classification: ELM has strong potential for large-scale computing and machine learning. Extreme Learning Machine is used to classify the image (a normal or abnormal). If the image is found to be abnormal Segmentation is done using clustering algorithm to find the approximate position of the abnormality in the retinal blood vessels (Varalakshmi and Janardhan, 2014). ELM includes training and testing mode, training mode includes ELM train and testing mode includes ELM predict. In testing mode, it includes many iterations to check the image whether it is normal or not. The activation function like sine, Gaussian, sigmoid etc., can be selected for neuron layer and linear activation functions for the output neurons. It is a Multi-class relegation where number of output neurons will be automatically set identical to number of classes. This ELM model is given for the testing features of MAs to the classifier. And testing image features, to find out the candidate lesions (Gowthaman, 2014). ELM can approximate any target perpetual function and relegate any disjoint regions (Huang *et al*., 2012). ELM inclines to have better scalability and achieve homogeneous or much better generalization performance at much more expeditious learning speed.

Automated segmentation method for fovea detection: Segmentation is the process of constituent elements into distinct independent parts. a digital image into multiple segments with the help of pixel. It includes Gradient-regularized area function; Gradient regularized length function, Gradient information function for maintaining uniform intensity and for maintaining the length of the boundary and to handle the problems with weak boundaries. Arturo Aquino introduces a new methodology for OD segmentation that obtains a circular

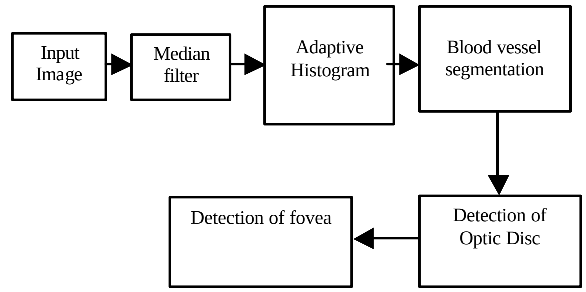

Fig. 3: Block diagram of automated segmentation method for fovea detection

boundary approximation. It needs as initial information the coordinates of a pixel located within the OD. To this effect, the treatment of segmentation methodology is very simple but consistently good in quality or performance. Very fast OD location methodology is also proposed to obtain the required OD pixel. The retinal image consists of a network of blood vessels. These vessels originate from the optic disk. Based on the database from which the image is obtained, decides the location of optic disk. Initially the blood vessels of the disk are found. Based on the adaptive mathematical morphology, the origin of optic disk is identified. The fovea is located at a distance of 2.5 times the diameter of optic disk from its centre.

Median filter: Noise can cause the problems in the detection of disease. The noise contains in the image is reduced by using the method such as median filter. This filter is a non-linear filter type and it is often used to reduce the effect of noise without blurring the sharp edge. Median filtering is mainly used for image smoothing and noise reduction. Median filter works by moving through the image pixel by pixel and is used to reduce noise in the images. Unlike low pass filtering, median filtering preserves edges while removing noise and can smooth a few pixels. It concentrates on contrast, intensity, symmetry, orientation and roundness. Segmentation helps to increase accuracy and speed. It includes Gradient-regularized area function; Gradient regularized length function, Gradient information function for maintaining uniform intensity and for maintaining the length of the boundary and to handle the problems with weak boundaries

The Overall Block Diagram for Fovea Detection is shown in Fig. 3. It includes Median Filter, Adaptive Histogram Equalization, Blood Vessel Segmentation, Optic Disc Detection and Detection of Fovea.

Blood vessel segmentation: The blood vessels in the retina may leak fluid in the vascular region. The leakage occurs due to damage in the blood vessels caused by high glucose level in blood. The fluid that leaks in a vascular region are seems to be yellow or white lesions. Various techniques are used to obtain the vascular tree to find the abnormal vessels in the retina. One of the methods, Kirsch's template is generated to extract the main blood vessels from the retina to identify the vascular region. This template uses size of 3×3 matrixes to extract the blood vessel and the operator is used to calculate the maximum magnitude of the edge in all directions. The vascular tree in the retina is considered as the foreground image which is separated by resetting the threshold value. Blood vessels appear as networks that originate at the middle of optic disk and were of progressively diminishing width. Since our aim is to locate the fovea region, need to achieve success in detecting blood vessels.

Optic disc detection: In order to extract the features of the optic disc, Morphological operation is applied to the gray scale retinal image and binary retinal image is obtained. Morphological operation uses dilation and erosion method in processing the image based on shapes. To obtain a binary image, the intensity values are added to the boundaries of an object using dilation. The maximum value of neighbourhood pixel in the binary form of retinal image represents the value of the output pixel. In a binary image, the optic disc region is obtained by removing the intensity value on the boundaries of an image using erosion. The minimum value of the neighbourhood pixel in the region represents the output pixel value. If any of the pixel value is zero then the erosion process output for the corresponding pixel is set to zero. The output of an input image is obtained with the same size by applying structuring element. The values 0 and 1 forms a matrix which represents the structuring element may have any shape and size. The disc shaped structuring element of size 5 is applied to eliminate the region that is wrongly located as an optic disc region. The lowest mean intensity value in the image represents the region of interest, (i.e.,) Optic Disc (OD). The region of interest is mapped in the original retinal image and bounding box is drawn to locate the OD region

Detection of fovea: The fovea centre is located using the automated segmentation method. In India automation field is highly developing (Paintamilselvi, 2012). The Extracted vascular tree image shows the a vascular region in the fundus image. This helps to locate the fovea region from the optic disc. The fovea is located 2.5 times the diameter of the optic disc. Exhaustive experimental study shows that automated segmentation method helps in detecting curvature of the main blood vessel. The main blood vessel is obtained as the thickest and largest blood vessel emanating from the optic disk. The main blood vessel is obtained by looking for its continuity from the optic disk. This vessel is modelled as a parabola. The vertex of the parabola is taken as the pixel on the main blood vessel that is closest to the centre of the optic disk circular mask. The fovea is located approximately between 2-3 Optical Disk Diameters (ODD) distances from the vertexes, along the main axis of the modelled parabola and is taken as the darkest pixel in this region. The region of the fovea is taken to be 1 optic disk diameter of the detected fovea location and detection of micro aneurysms in this region is suppressed. Technological advances in medical imaging and analysis have expanded the clinical and research applications of fluorescein angiography. Progression of disease, treatment decisions as well as guidance during laser treatment, often are based on fluorescein angiography.

RESULTS AND DISCUSSION

To evaluate the proposed work for the identification of diabetic retinopathy and detection of fovea is performed using the mat lab software. Dataset images contain varieties of images. They are selected for detailed evaluation. This work mainly concentrates on two sections. In first part Disease identification has done, Texture features are extracted by using Gray Level Co-occurrence Matrix (GLCM). Extracted features by feature extraction method can be given to Extreme learning machine classifier as an input to classify the images into Disease affected images (DR). Extreme learning machine classifier includes training and testing section to classify the images and to detect the disease.

Red dot they are highly visual in green plane, thus from the smoothed image only green channel image is extracted from the RGB Image which used for further processing is shown in Fig. 4. Morphological opening and

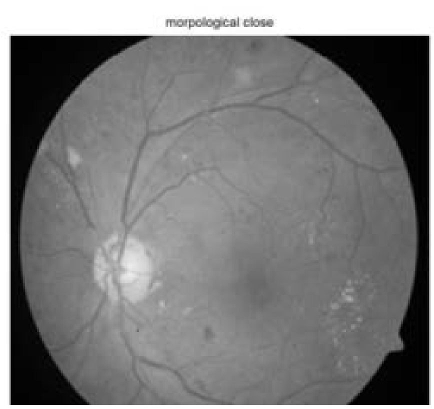

Fig. 4: Green channel

Fig. 5: Morphological open

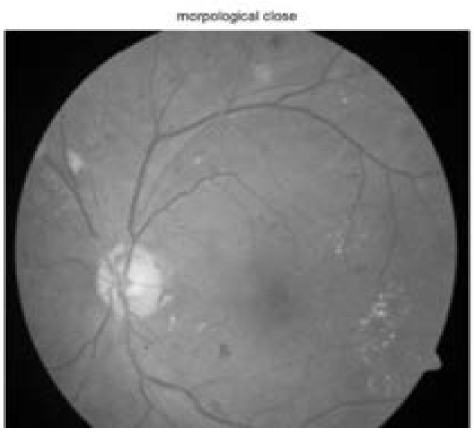

Fig. 6: Morphological close

closing is shown in Fig. 5 and 6. Blood vessels in the image makes difficult to identify the lesions clearly. Blood vessel segmentation has been done for the diagnosis or evaluation of ocular or systemic diseases are shown in Fig. 7. It offers much information however for easy detection of pathological lesions like exudates or micro aneurysms it must be excluded. The identification or presence of candidate lesions in the images should be detected and is shown in Fig. 8. The abnormal images are differentiated or classified with the help of ELM classifier.

Automated segmentation method is used for fovea detection. Input image is given to median filter which helps to remove the unwanted noises and for smoothing the images is shown in Fig. 9. Adaptive histogram equalization has done to improve the contrast of the image is shown in Fig. 10 Contrast of the image should be enhanced for the detection of candidate lesions. Blood vessels in the image makes difficult to identify the lesions clearly.

Fig. 7: Vessel segmentation

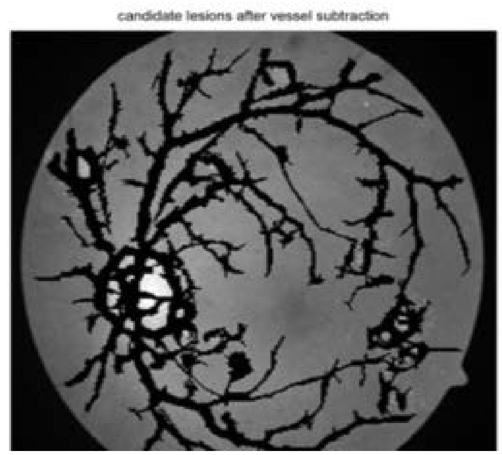

Fig. 8: Candidate lesion

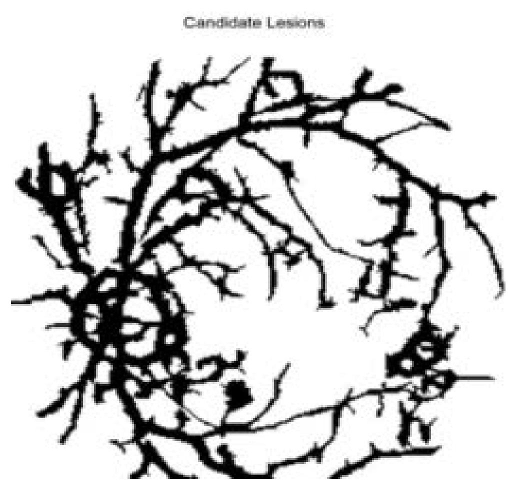

Fig. 9: Lesions after vessel subtraction (DR)

Automated segmentation method is used for fovea detection, utilized to locate objects and boundaries in

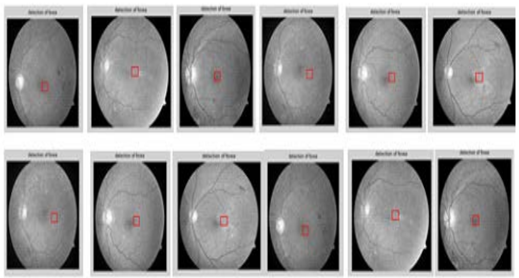

Fig. 10: Fovea detection for a set of image: a) Input data and b) Output data

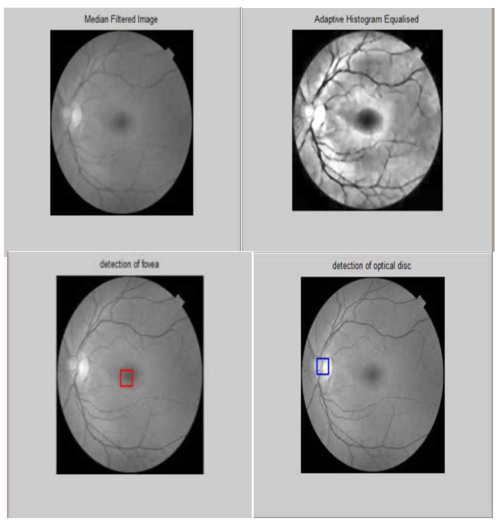

Fig. 11: Input image; median filtered; adaptive histogram; detection of optic disc; detection of fovea

images and it is the process of assigning a label to every pixel in an image. Each pixel can be differentiated based on textural features. Segmentation method is mainly depends on pixel values and produces better results with less complexity and time. After segmentation of blood vessel. Detection of optic disc is mainly done with the help of morphological operation is explained in Fig. 11.

Detection of fovea region by segmentation method is illustrated in Fig. 12. Segmentation is the process of partitioning a digital image into multiple segments with the help of pixel. It includes Gradient-regularized area function; Gradient regularized length function, gradient information function for maintaining uniform intensity and for maintaining the length of the boundary and to handle the problems with weak boundaries.

Table 1 compares both existing k-means and automated segmentation method. It mainly concentrates on accuracy, specificity, sensitivity and entropy values.

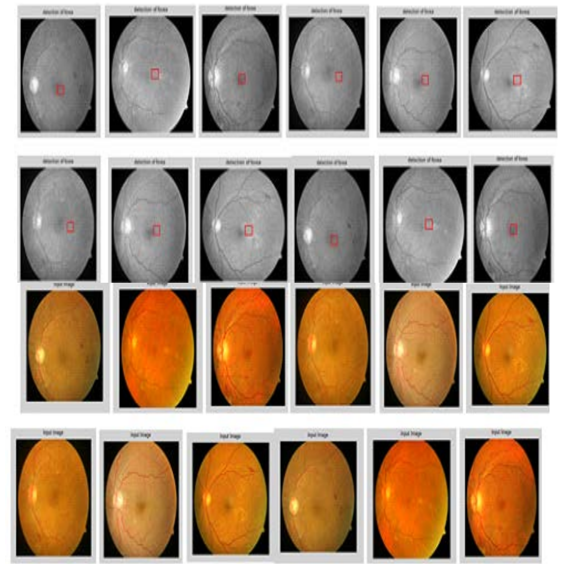

Fig. 12: Fovea detection for a set of image: a) Input data and b) output data

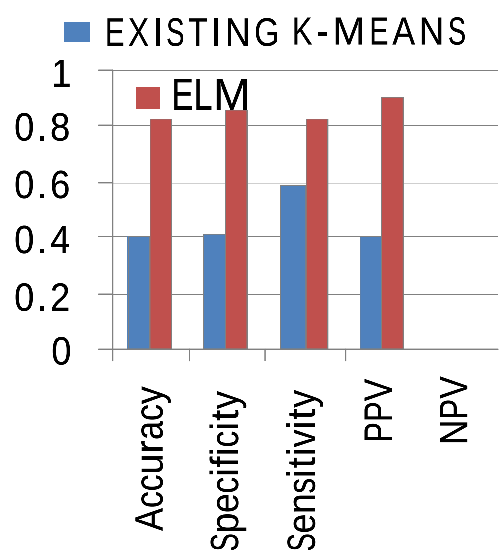

Fig. 13: Comparison graph

Automated segmentation is more accurate compared to k-means algorithm. Accuracy of proposed method is 83%. Proposed method combines both feature extraction method and automated segmentation method so the accuracy is more compared to the existing method. Specificity and sensitivity also mentioned in the comparison table. Specificity and sensitivity is comparatively high compared to previous method. the comparison chart is shown in Table 1. Fovea detection for a set of images is shown in Fig. 13.

Table 2: Comparison between existing and automated segmentation method

Measures	Existing K-Means method	Automated segmentation method
Accuracy	0.4032	0.8302
Specificity	0.4167	0.8562
Sensitivity	0.5832	0.8232
PPV	0.4009	0.9050
NPV	0.4050	0.9095

Table 3: Omparsion existing k-means and automated segmentation method

Name	Age	Sex	Duration of diabetes	Symptoms
Sundaram	65	M	12	Head ache
Ravi	45	M	10	Red vision
Palanisamy	26	M	3	Eye pain
Muthusamy	65	M	8	Blured vision
Rajesh	54	M	5	Decreased vision
Rajeswari	42	F	6	Loss day vision
Ramalingam	48	M	8	Decreased vision
Moideen	56	M	10	Gradual loss
Rukmani	55	F	16	Decreased vision
Saraswati	54	F	10	Blured vision

Hospital survey: A hospital survey on Diabetic Retinopathy is carried out by collecting demographic data of diabetic retinopathy patients. The demographic data were collected from LOTUS EYE HOSPITAL. It was started on March 14, 1997 under the Companies Act, 1956 vide Certificate of Incorporation issued by the Registrar of Companies, Tamil Nadu, Coimbatore. The name of the Company was changed to 'Lotus Eye Care Hospital Pvt. Ltd. on January 23, 2006 and subsequently to 'Lotus Eye Care Hospital Limited' upon conversion into Public Limited Company on October 16, 2007 and a fresh certificate of incorporation has been obtained from Registrar of Companies, Tamil Nadu, Coimbatore.

Table 2 shows demographic data of diabetic retinopathy patients are given below. The data collected from the lotus eye hospital, Coimbatore and the survey is prepared with the help of efficient and experienced doctors. The helpful data given us a good aware of diabetic retinopathy and its cause also other eye diseases.

Table 3 explained about symptoms of diabetic retinopathy and the duration of disease affected by each person. Details of each patient with their ages are mentioned in Table 2 various symptoms like headache, red vision, eye pain, blurred vision, decreased vision.

CONCLUSION

This method mainly concentrates on disease identification and fovea detection. Feature extraction method and ELM classification is used for disease identification. Textural features can be extracted with the help of Gray Level Co-occurrence Matrix (GLCM). GLCM considers the spatial relationship of pixels. The GLCM functions characterize the texture of an image. Splat and GLCM feature are extracted to ameliorate the relegation precision. In order to relegate the given input images, different classes must be represented utilizing pertinent and consequential features with the avail of cull method. Finally disease affected retina is detected by ELM classifier. Extracted splat and GLCM features to classify the images into disease affected retina and normal retinal images.

After disease identification concentrates on fovea detection.. In this method, automated segmentation method is used to obtain the fovea region and the centre of fovea. It is also used to find the blindness of eye due to diabetic retinopathy.

RECOMMENDATIONS

This research can be extended to detect the type of abnormalities like Age related macular Degeneration (AMD) and some other diseases of the patients of abnormalities in retina. Future scope of this project is to detect many eye diseases leading to blindness with higher efficiency.

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