A Fully Automatic Retinal vessels segmentations based on Hybrid optimization and SVM

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Abstract— automated analysis of retinal images is a challenging research area that aims to provide automated methods to help in the early detection and diagnosis of many eye diseases such as diabetic retinopathy and age-related macular degeneration (AMD). Blood vessels act as a landmark for localizing the retinal structures like optic disc (OD), fovea and hard exudates (HE) (disease lesions). The blood vessels can have measurable abnormalities in diameter, color and tortuosity due to systemic or local ocular disease. Retinal images are used in the diagnoses of eye diseases by ophthalmologist. Retina images of human are taken using fundus camera, then analyzing retina images using image processing and pattern recognition techniques to make specific diagnoses decision. Color fundus image forms the basis for manual assessment in screening. Such manual assessment however is not scalable in large-scale screening scenario, particularly in developing countries like India either due to the scarcity of skilled manpower or unavailability of high end imaging equipment at the point of care. For such large-scale screening we need automated image processing algorithms for assessment and detection of eye disease. Segmentation of blood vessels in retinal images is an important part in retinal image analysis for diagnosis and treatment of eye diseases for large screening systems. The task of automatic segmentation of blood vessels is challenging due to their abrupt variations in branching patterns. This task becomes even more challenging due the presence of noisy background and tortuosity. The research work has been focused on the basis on deep learning a neural network for blood vessel segmentation. Further, the vessel segmentation has been applied as a multi-label inference which is learnt by joint loss function. In this way, we have dealt about the class label dependencies of neighboring pixels which play an important role in segmentation of anatomical structures. The proposed hybrid (Lion Optimization and Bat Optimization) optimization technique has been applied further for the optimization of the selected features and to improve the accuracy. The performance of the system has also been evaluated on the basis of various parameters such as precision, sensitivity, specificity and accuracy. The proposed approach has shown the better results as compared with the existing methods..

Keywords— *Lion Optimization; Bat Optimization; fuzzy logic; neural network.*

I. INTRODUCTION

A. Medical image analysis

In diagnosis, treatment and care of various diseases the medical image processing has become an important domain in current medical research. There is availability of fundus imaging; computed tomography, ultrasound, computed tomography and X-ray like different medical imaging modalities assist clinicians in the procedure of their diagnosis. The acquired images finer details can be attained by the advances in field of medical imaging. The use of traditional visual inspection techniques is become unable to process image data effectively due to medical image analysis based computer development. The physicians' intensive interest gets currently attracted by fast escalating research advancement in analysis of medical images. The medical images clinically relevant information is extracted by mainly focusing on computational algorithm design. The medical image analysis paves a way to visualise and also facilitate the interpretation of several critical pathologies and anatomical structures. The various existing diseases appropriate treatment and prompt diagnosis task has become essential. There can be vision loss and blindness due to diabetes widespread complication by eye disease diabetic retinopathy if it is not diagnosed at an early stage. There is worldwide increase in number of diabetes affected people that also results in increase of DR automated detection methods. The photoreceptors light sensitive cells exist in interior surface of the eye tissue lining of retina. The light is converted into neural signals by photoreceptors and through optic nerves it is carried to the brain. The fundus images retina image is obtained to record the retina condition. The retina images are captured using retinal microscope fundus camera system. Retinal image contains essential diagnostic information which assists in determining whether the retina is healthy or unhealthy.

In medical society both non-vascular and vascular pathology diagnosing is done using retinal images. The retinal vascular structure changes information is provided by retinal images which are common in occlusion, cardiovascular, hypertension, stroke and glaucoma like diseases. The blood vessels patterns, tortuosity and reflectivity get changed by these diseases. The vessels tortuosity or branching angle changed by hypertension and new blood vessels development like neovascularilization occur by diabetic retinopathy. The blindness or sight degradation takes place if these medical

conditions are not treated. There can be prevention of major vision loss and preventive measure occurrence changes are important to be exposed in early time.

The Figure 1 gives a complete illustration of vessel network. Vessels which can be seen in (A) are large vessels including arteries and veins; those in (B) are arterioles and venules, they connect to the capillaries, deliver oxygen and nutrition to the tissue, as illustrated in (C). In retinal circulation the venules and arterioles diameter is less than 20 micrometer and less than 6 micrometer in case of capillaries. The identification of microcirculatory vessel is more importantly done with their physical characteristics instead of their diameter. The blood flow or some diseases can take place by change in their diameter. In Table 1, the microcirculation vessels relevant diameters are listed.

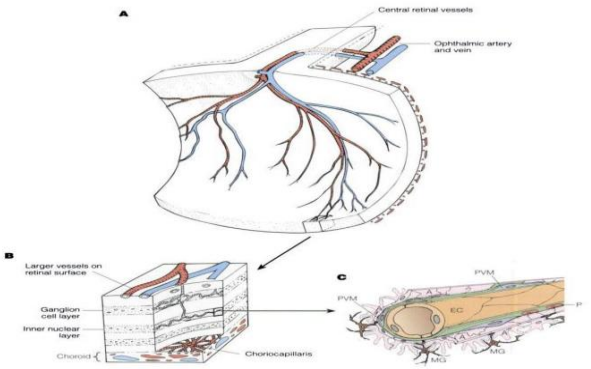

Figure 1: Blood vessels in retinal images. [5]

Table 1: Relevant vessel diameters of the retina

Vessel	Diameter
Central Retinal Artery (Retinal Circulation)	.3mm
Arterioles (Retinal Circulation)	<20mm
Venules (Retinal Circulation)	<20mm
Capillaries (Retinal Circulation)	<6mm

The structure change and vascular anomalies related several retinal implications are included in muscular degeneration, retinal artery occlusion, glaucoma and diabetic retinopathy. In retina blood supply get disturbed by those implications that results in increase of visual impairment risk. In medical diagnostics, it is powerful tool for a retinal blood vessels automatic segmentation from retinal images. The used segmentation method should be reliable and accurate to be used in this purpose. The image or background and object of interest differentiation is the main aim of segmentation.

B. Anatomy of human eye

The camera similar visual system receptor organ is human eye. Light that comes in through the cornea passes through the iris and is focused onto the retina through a lens. The brain optic nerve is used to transmit visual information and encodes it and incoming light is reacted by camera film like retina. Figure 2, illustrates the cross sectional view of a human eye which emphasizes its principal components.

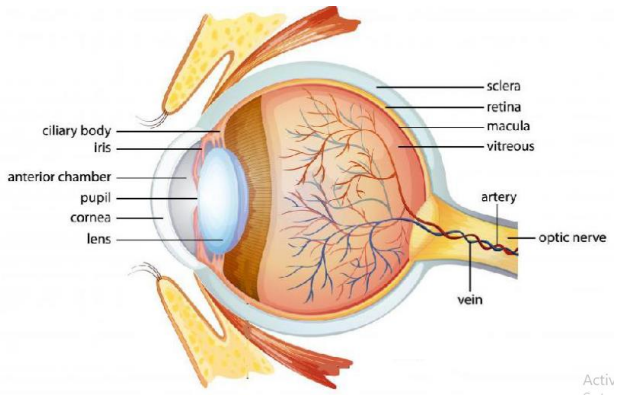

Figure 2: Illustrates the cross sectional view of a human eye

In DR diagnosis an important role is played by retina and by its examination the DR caused vascular unambiguous changes are detected. The retina is a thin layer of photosensitive neural cells, which lines the inside back wall of the eye and these photosensitive neurons are not uniformly distributed over the retina. The cones and rods are two types of retina photoreceptors. The rods are normally spread all over the peripheral retina and are responsible for peripheral vision and for light and dark contrast perception. In macula, cones are located and in detail colour perception or central vision is provided by it and in case of bright light it function in a best way. Macula is a round area present in the central region of the retina which is responsible for central vision. The highest cones concentration is contain by small dispersion fovea a center of the macula and utmost visual perception is its responsibility. Due to DR progression if macular area gets affected then there will be more vision loss risk. The light is converted into electrical impulses by photosensitive neurons after the reception of light rays and optic nerves are used to convey them to the brain where image is perceived. The optic disk is the optic nerve head and any photosensitive cells are not contained by it that is the eye blind spot. The retinal blood vessels exit site and entry is the act of optic disk. The blood vessels, derived from the central retinal artery and vein, stream into the retina to vascularise the retinal layers and neurons.

C. Retinal and related diabetic diseases

The abnormal high blood sugar and chaotic metabolism characterized life threatening, persistent disease is Diabetes mellitus (DM) and known as hyperglycaemia. The hormone insulin low levels results in it that can be without or with anomalous resistance to those effects. The nervous system and vision get affected by several complication of DM that also result in kidneys, heart and other organs affected. The people aged between twenty to seventy years are mostly resulted in blindness which is the diabetes primary reason.

1) Diabetic Retinopathy

In working age people, prime ophthalmic pathological blindness cause is diabetic retinopathy (DR). The glaucoma, cataracts and eye inside blood vessels damage is more significantly caused by long term diabetes that also results in such patient's eye sights affected. This state is known as DR, which is a critical eye disease and deemed to be the symptom of diabetes on the retina. The immediate vision impairment

does not engross diabetes complications due to which after diabetes fifteen years vision degradation takes place.

The major reason of DR is blood glucose anomalous elevation that results in vessel endothelium harms and retinal vessel permeability is also get increased by it. The microaneurysms called minute capillary dilations formation is the DR initial sign. The macular edema, hemorrhages, neovascularisation development is lead of DR progression and retinal detachment is also takes place at severe stage. The use of laser photocoagulation at earlier stages can prevent severe vision loss in DR detection.

2) Diabetic Macular Edema

The DR visual complication is Diabetic macular edema (DME) and it is the most common cause of blindness and eye sight loss. In diabetic patient's retina swellings is the characterised of DME. The leakage of fluid from microaneurysms within a central macula is the main reason of its occurrence which appears as chronic damage consequence due to elevated blood sugar levels. In laser treatment instigation, the DME clisnically significant presence is an imperative sign. The retina thickness is one of the other DME features and use of only single 2D image is unable to identify it directly. In this type of imaging technique, there is lackness of acquired depth information. As an alternate solution, ophthalmologists can diagnose the presence of the fluid that causes the thickening of retina from images, by detecting the presence of associated lipid deposits.

3) Age-related Macular Degeneration

A different retinal disease that has analogous consequence to diabetic retinopathy, but an additional cause is the age-related macular degeneration (AMD).The eye disease degenerative form is AMD by which retina central portion or muscular gets affected. The soft drusen presence is the most important early AMD characteristics. The person has macular degeneration is not confirmed by drusen presence but a strong correlation between two is there and risk of muscular degeneration development is raised by it. The wet and dry AMD are two distinct forms make a late AMD and any serum or blood leakage is not engross by macular degeneration dry form. But there can be still occurrence of vision loss and fluctuating vision, not able to engross any serum or blood leakage like extensive functional limitations symptoms are there in AMD dry form patients. Due to poor illumination conditions like limited vision at night and their limited central vision area causes a difficulty in reading. Under the macular region and retina a abnormal blood vessels growth, macular degeneration of wet form can be noticed. In this severe condition, the patients may lose at least a part of their central vision.

4) Glaucoma

The eye optic nerve gets damaged or worse over time by form of eye disease name as glaucoma. The ganglion cells and their axons get damaged by this as whole retina gets affected by it. This disease is characterised by an increased pressure on the optic nerve and as a result, the optic nerve slowly gets affected and thereby it leads to peripheral visual field loss. The anterior chamber is a small space that is present in the eye front portion and there is in and out of apparent liquid flows from it. The patient who has glaucoma the fluid does not drain properly and it drains too slowly eye and nearby tissues bathes are nourishes by fluid. There is intraocular pressure which is the rise in pressure inside the eye and fluid level gets increased by it. There is damaged of eye optic nerve and their other parts unless that pressure is not brought controlled after bringing it to down level. If this damage to the optic nerve that happens due to high eye pressure continues, glaucoma will cause permanent loss of vision. Within a few years there can be total permanent blindness caused by glaucoma if it is not cured by treatment. Glaucoma can be diagnosed in its early stages by examining the exact shape of the optic nerve and few methods have been presented to accomplish this task with fundus and OCT images.

D. Datasets

The Data sets can be partitioned and sequential:

• In a sequential data set, records are data items that are stored consecutively.

• A partitioned data set consists of a directory and members. The directory holds the address of each member and thus makes it possible to access each member directly. Each member consists of sequentially stored records.

The libraries are partitioned data sets and in libraries data set name by convention there is presence of LIB letters. Within a library, there are separate libraries on which procedures, programs and convention are stored and partitioned data set procedure or program is stored in separate number.

Data sets can be permanent or temporary:

• Most permanent data sets exist before a job starts and persist after a job step completes. Some permanent data sets are created during a job step and persist after the job completes.

• Temporary data sets generally are used to pass data from one job step to another, and exist only during the life cycle of the job.

Data sets can be cataloged, which permits the data set to be referred to by name without specifying where the data set is stored. A catalog describes data set attributes and indicates the devices on which a data set is located. In z/OS, the master catalog and user catalogs store the locations of data sets.

1) Datasets and evaluation metrics:

There are mainly three publically available datasets that has been introduced in this section. In testing of their own segmentation algorithms number of researchers have used these datasets.

There are mainly STARE, CHASE DB1 and DRIVE three standard datasets. DRIVE1 consists of 40 fundus images obtained from a screening program in the Netherlands. The canon non-mydriatic 3-CCD camera CR5 is used to capture those images and camera is at 45 degree field of view (FOV) and 584x565 pixels is each image size. The test set and training set are the two sets on which DRIVE dataset is divided and in each set there are 20 fundus images. The two independent human observers are used for annotating test set and two observers are used for annotating training set. There are 20

fundus images in STARE2 and at 35 degree FOV TopCon TRV-50 fundus camera is used to capture these images and 605x700 pixels is each image size. Out of 20 ten images are normal and rest of the ten contain pathology. The two independent observers are used to annotate STARE dataset.

There are 28 fundus images in CHASE DB13 that is acquired from multiethnic school children. At 30 degree FOV a hand-held Nidek NM-200-D fundus camera is used to captute those images and 960x999 pixels is each image size. The two independent observers is used to annotate CHASE DB1. For the DRIVE, STARE and CHASE DB1 datasets, the manual segmentations of the first observer are used in this work, which is a common choice for these datasets.

E. Fuzzy logic

Fuzzy logic is a form of many-valued logic; it deals with reasoning that is approximate rather than fixed and exact. Compared to traditional binary sets (where variables may take on true or false values), fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. The partial truth concept handling is extended in fuzzy logic and either completely true or false is the range of truth value. The specific functions are used to manage degree by the use of linguistic variables. The fuzzjective is the terms that described irrational.

The fuzzy set theory proposed fuzzy logic introduced by Lotfi A. Zadeh. There are different fields that are used to apply fuzzy logic to artificial intelligence from control theory. Fuzzy logics had, however, been studied since the 1920s, as infinite-valued logics - notably by Łukasiewicz and Tarski.

1) Applying truth values

The continuous variable subranges are characterized by basic application. For instance, a temperature measurement for anti-lock brakes might have several separate membership functions defining particular temperature ranges needed to control the brakes properly. The range 0 to 1 is used to map same temperature value by each function. The brakes controlling is used to determine truth values.

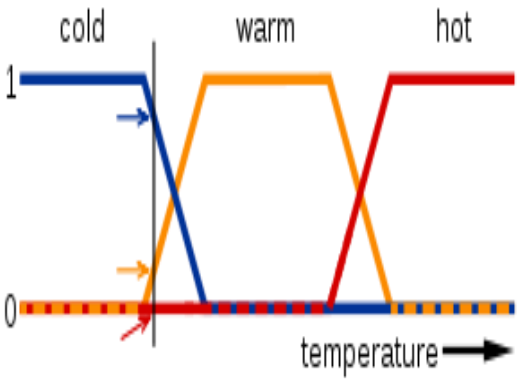

Figure 3: Fuzzy logic temperatures

The cold, hot and warm expressions meaning in this image are represented by temperature scale mapping functions. There are three truth values for each point on that scale and one for each of the three functions. The three arrows gauge has one particular temperature that is used to represent image vertical line. Since the red arrow points to zero, this temperature may be interpreted as "not hot". The orange arrow (pointing at 0.2) may describe it as "slightly warm" and the blue arrow (pointing at 0.8) "fairly cold".

2) Neural network

The animal's central nervous systems inspired computational models artificial neural networks (ANNs) in related fields and machine learning. Which is capable of recognition of pattern and animals central nervous systems?. Artificial neural networks are generally presented as systems of interconnected "neurons" which can compute values from inputs. The set of input neurons is used to defined handwriting recognition neural network in example and input image pixels is used to activate input neurons set. After being weighted and transformed by a function (determined by the network's designer), the activations of these neurons are then passed on to other neurons. This process is repeated until finally, an output neuron is activated. Which character was read is determined by this and number of tasks is solved by data neural networks to learn using other machine learning methods. The speech recognitions, computer vision and ordinary rule based programming is used to solve it.

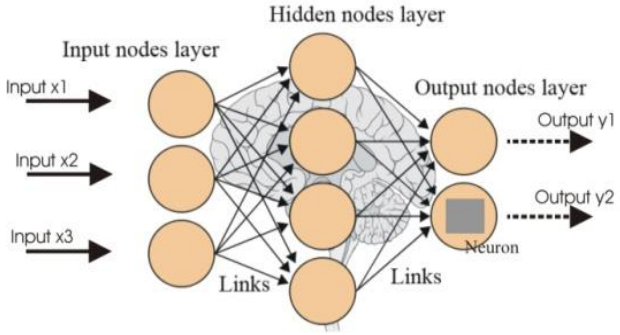

Figure 4: Example or concept of ANN

The neural networks inspired concept is the inspiration of human central nervous system examinations. In an Artificial Neural Network, simple artificial nodes, known as "neurons", "neurodes", "processing elements" or "units", are connected together to form a network which mimics a biological neural network.

There is no single formal definition of what an artificial neural network is. The Neural is the common statistical models class if below given characteristics are possessed by it.

- consist of sets of adaptive weights, i.e. numerical parameters that are tuned by a learning algorithm, and
- are capable of approximating non-linear functions of their inputs.

The adaptive weights are conceptually connection strengths between neurons, which are activated during training and prediction.

Neural networks are similar to biological neural networks in performing functions collectively and in parallel by the units, rather than there being a clear delineation of subtasks to which various units are assigned. The term "neural network" usually refers to models employed in statistics, cognitive psychology and artificial intelligence. Neural network models which emulate the central nervous system are part of theoretical neuroscience and computational neuroscience.

In modern software implementations of artificial neural networks, the approach inspired by biology has been largely abandoned for a more practical approach based on statistics and signal processing. In some of these systems, neural networks or parts of neural networks (like artificial neurons) form components in larger systems that combine both adaptive and non-adaptive elements. While the more general approach of such systems is more suitable for real-world problem solving, it has little to do with the traditional artificial intelligence connectionist models. What they do have in common, however, is the principle of non-linear, distributed, parallel and local processing and adaptation. Historically, the use of neural networks models marked a paradigm shift in the late eighties from high-level (symbolic) artificial intelligence, characterized by expert systems with knowledge embodied in if-then rules, to low-level (sub-symbolic) machine learning, characterized by knowledge embodied in the parameters of a dynamical system.

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones. This is true of ANNs as well.

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyse. This expert can then be used to provide projections given new situations of interest and answer

"what if" questions.

Other advantages include:

- Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
- Self-Organisation: An ANN can create its own organisation or representation of the information it receives during learning time.
- Real Time Operation: ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
- Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

II. LITERATURE REVIEW

Toufique.A.Soomro, et al., (2018), has performed eye vessels accurate and quick segmentation using proposed method of automatic retinal vessel segmentation. Te different eye diseases analysis becomes possible using such method. The segmentation process performance is undermined using varying low contrast retinal fundus images. The ICA1 and ICA2 are two architectures and Independent Component Analysis (ICA) helps in removal of noise. The improved contrast values are provided and selected one of the ICA architectures by validating their effect on retinal color fundus images. As compared to ICA1, ICA2 architecture performs better for retinal fundus as in terms of compensating the low values of contrast it is more effective. The existing state of art methods are compared with the proposed one by conducting different experiments on it that shows it is better than existing one. The STARE and DRIVE publically available databases are used for assessing the proposed segmentation model impact. The achieved segmentation accuracy is 96% using DRIVE database and there is increase of 3% from 72 to 75% in its sensitivity.

Hanung Adi Nugroho, et.al., (2017), have concluded that one of the most important task is analysing retinal vessels structural changes that helps in detecting and diagnosing hypertension, arteriosclerotic, diabetic retinopathy and age-related macular degeneration (AMD) like diseases related to detecting retinal. The morphological reconstruction and frangi filter based a new method is presented for retinal fundus image segmenting retinal vessels. The STARE and DRIVE datasets is used for evaluating colour fundus images using proposed method. The average of sensitivity of 72.13% is achieved using DRIVE dataset and by evaluating proposed method performance and 94.50%, 96.65% of accuracy, specificity is achieved respectively. The 75.50% of sensitivity, 88.76% of accuracy and 90.38% od specificity is achieved in case of STARE dataset. In fundus images, a successfully retinal vessels segment is indicated from the achieved results using proposed method.

Zengqiang Yan, et.al., (2017), have recommended that pixel to pixel matching based accuracy, specificity and sensitivity are retinal vessel segmentation most commonly used quality assessment evaluation metrics. The vessel segmentation results evaluation is restricted due to variation is pixel to pixel, thickness and location matching as vessels are annotated by different observers due to problem of inter observer. The source vessel and reference segmentation maps generated skeleton maps are compared by constructing a proposed skeletal similarity metric by them. In the reference to skeleton

map each skeleton segment is assigned adaptively instead of pixel to pixel matching strategy use that helps in addressing problem of inter observer. They have also used a vessel thickness based searching range method whose radius and determined their radius. The similarity calculation is done by selecting a searching range within located source pixels in skeleton maps using curve similarity exist in skeletal similarity and source or reference vessel segmentation between thickness consistency us measured using thickness similarity, source skeleton maps. The true negative, true positive, false negative and false positive definitions are modified by authors in respect to overall performance provided global score by other metrics. The objective measurements like accuracy, specificity, sensitivity and etc are constructed based on the similarity of skeletal.

Toufique A. Soomro, et.al., (2017), has analyzed that mainly for retinal images vessels segmentation and even for different applications of medical images task of accurate vessel segmentation is tough. The eye diseases progress is analysed using computerised algorithm. In case of narrow low contrast vessels, a low sensitivity is achieved using almost all of the existing proposed method of computerized retinal segmentation. The issue of low sensitivity has been considered by them and a new retinal vessel segmentation algorithm is proposed. The post processing, pre-processing and deep learning model is used in newly proposed method introduced by them. The uneven illuminations issue is handled using pre-processing. The fine vessels observation is achieved by training a designed fully Convolutional Neural Network (CNN). The good segmented vessels are achieved by removing background noise pixels using post-processing step. In terms of tiny vessels detection, good segmented images are achieved using proposed segmentation method. The STARE and DRIVE publically available databases are used for evaluating our method. The higher sensitivity of 75% leads to proper detection of tiny vessels with an accuracy of 94.7%.

Neha Gupta, et.al., (2016), have analyzed that images can be break down into different parts using the procedure of image segmentation. In order to attain images essential characteristics there is need to use it. In traffic controlling, weather forecasting, satellite imagery, etc like different utilizes the segmentation but in diagnosis different diseases in medical filed it has been mostly used. Though manual segmentation provides with good results but automated analysis of retinal images is more promising as it reduces time and effort required by the experts. Diabetic Retinopathy is such a disorder of an eye which can be mostly seen in a person suffering from diabetes. There can be complete blindness caused to a person if this disease has not been recognized in early time. Although various techniques have been proposed to detect the blood vessels and diagnose the disorders but the main issue of noise has not been considered greatly. They have proposed two filters hybrid combination that helps in getting beter results as compared to existing methods. In case of addition of noise in colored retina image it is prove to be good that has been tested using DRIVE database.

Chengzhang Zhu, et.al., (2015), have proposed an improved supervised method based on Extreme Learning Machine (ELM) mainly for retinal vessel segmentation. Firstly vector fields divergence, morphological features and local features consist of fundus images each pixel are extracted using 36-D feature vector. Then ELM input will be the constructed manual segmentation and feature vector training set of pixels matrix. In the last retinal vessels segment is obtained by classifier. The DRIVE dataset is used to evaluate the proposed method that results in 0.9581 of average accuracy. The use of ELM is also helps in reducing running time that makes it applicable for disease screening and computer-aided diagnosis.

III. RESEARCH PROBLEM FORMULATION

A. Problem formulation

Segmentation and localization of retinal blood vessels serve as an important cue for the diagnosis of ophthalmological diseases such as diabetes, hypertension, microaneurysms and arteriosclerosis. However, manual segmentation of blood vessels is both tedious and time consuming. Thus, the focus of the proposed work is on automatic segmentation of retinal blood vessels from fundus images. The task of automatic segmentation of blood vessels is challenging due to their abrupt variations in branching patterns. This task becomes even more challenging due the presence of noisy background and tortuosity. The propose work will be based on SVM for blood vessel segmentation. Further, the vessel segmentation problem will formulate as a multi-label inference problem which is learnt by joint loss function. In this way, we can learn about the class label dependencies of neighboring pixels which play an important role in segmentation of anatomical structures. The proposed hybrid (Lion Optimization and Bat Optimization) optimization technique will be applied further for the optimization of the selected features and to improve the accuracy. The performance of the system will be evaluated on the basis of various parameters such as precision, sensitivity, specificity and accuracy.

B. Research Objectives

The research work presents a technique for automatic segmentation of retinal blood vessels from fundus images.

The objective of the research includes:

1) To study and understand the existing retinal vessels segmentation techniques.

2) To propose and implement proposed hybrid (Lion Optimization and Bat Optimization Algorithm) optimization technique for the optimization of the proposed work.

3) To apply the SVM approach for feature classification of the improvement of the results.

4) To analyze the performance of the proposed work on the basis of parameters such as sensitivity, specificity, Precision, and Accuracy.

IV. RESULT AND DISCUSSION

The important information for eye care specialists is provided through structure of retinal vessels whose changes indicate different diseases. The arteriosclerosis, hypertension, diabetes, cardio vascular disease, and stroke diseases can be

detected through retinal vessels extracted information. In overall the world, most of working ages people are affected by blindness through diabetic retinopathy that mainly occur due to blood vessel structure changes. We can utilize attributes of retinal blood vessels like length, width, tortuosity, angles and branching pattern. The retinal vessels automated segmentation is considered as a first step for ophthalmic disorder in computer aided diagnosis system development. The diabetic retinopathy, vessel diameter measurement in relation with diagnosis of hypertension, computer assisted laser surgery and etc are screening programs. They are implemented by analysis and automatic detection of the vasculature. A large number of death and visual loss has been occurred due to spreads of diabetes on retina. In most of the cases the loss of major vision has been lost by periodic screening with early recognition of retinal vessel. So, for diagnosis of subsequent retinal disease a accurate retinal vessel segmentation is required. The process of retinal vessels segmentation is not an easy task there are different challenges that have been faced as with retinal vessels there are optic disc, fovea structures that are present in retinal image. Secondly the detection of objects has become hard due to wide range of widths and lower contrast of thin vessels in retinal vessels. The use of automated analysis of optic fundus based on computer is one of the possible solutions for above mentioned measurements. This computer based analysis helps in detecting blood flow, vessel distribution and extra vessel growth changes that shows it's widely acceptance by medical community. The optic nerve is proving to be most important organs in anatomy of human retina.

The complete work is divided into different sections. Firstly fundus images are used for testing purpose. The retinal images are divided into three sections one is for normal images, on eis for abnormal images and one folder is made for testing purpose in which few of both normal and abnormal images are added. Firstly we will train the system for both types of images then we will test it to know the performance of proposed approach. In Training learning process human will interact with machine. In this there are two individual pushbutton for both normal and abnormal category we can select either of one for pre-processing purpose. In this part image will be selected from normal images contain in normal category folder and pre-processed. Then the hybrid approach of BAT and LION optimization algorithm is used for feature optimization purpose that gives best results from all extracted features. Support vector machine (SVM) is used for testing purpose.

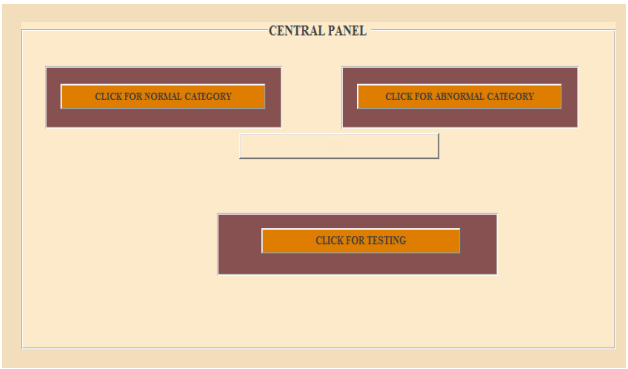

Figure 5: Main panel

The above figure 5 shows the main panel in which the GUI interface is made using user interface controls such as pushbuttons, edit texts and static texts. These are used for user interface and are made in the MATLAB environment. The above fig shows the panel which covers the training and testing process of both normal and abnormal images.

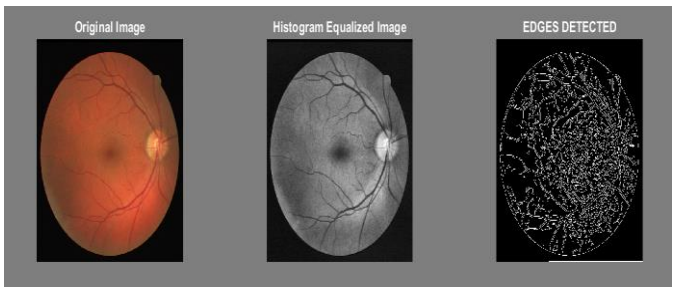

Figure 6: Normal category Samples

The above figure 6 shows the normal category samples extracted from normal images. Along with original image histogram equalized image and edge detected image is also shown that is extracted from original images. In this firstly the contrast limiting is formed by pre-processing done using histogram equalization. Then the edges of images are detected that will help in further processing.

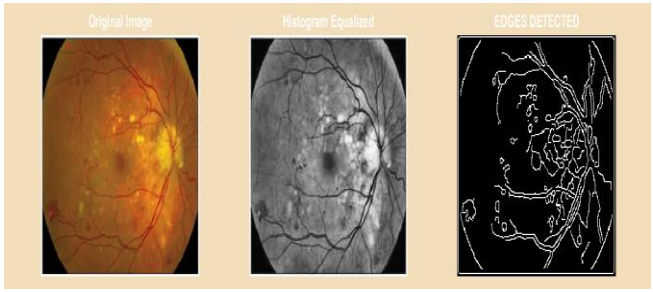

Figure 7: Abnormal category Samples

The figure 7 shows the abnormal category panel which shows the abnormal blood vessel sample. Along with original abnormal image its histogram equalized and edges detected image is also shown. As in normal category image in this also the selected image is pre-processed using Histogram equalized and edge detector. There are large numbers of techniques available for detecting an image that helps in locating sharp discontinuities after identifying an image. The boundaries are characterized by detecting abrupt changes in pixel density that is called discontinuities.

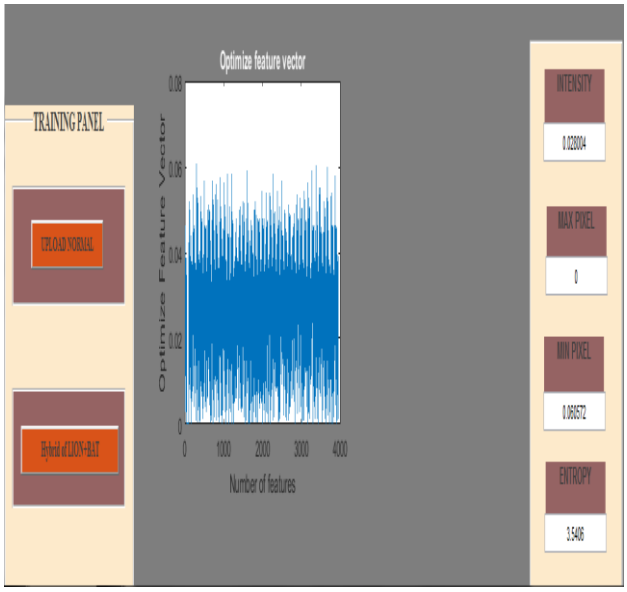

Figure 8: Feature Extraction of normal image samples

The pre-processing task has been done by enhancing contrast after that edges has been detected then extracted a features which comes under a second step of framework. The next step after pre-processing is to optimize extracted features using different available algorithms. The above figure 8 shows the optimize feature values which is done using hybrid BAT and LION approach which shows with respect to the vector length in which the feature vector is saved. There is large number of available algorithms that can be used to perform this task in our case we have used three different algorithms BAT and Lion algorithms. These features are also considered as the characteristic values.

BAT optimization approach:

In 2010, Bat algorithm is developed by Xin-She. There are three rules that is used in it are:

1. The distance is sense using echolocation by all bats and difference between background barriers and prey is also known by them

2. They fly randomly with specific velocity, position, frequency and wavelength should be varying. The loudness factor is also consider for searching prey.

3. The variation is loudness should vary from large positive value to minimum value.

Initially a uniform form frequency is assigned to each bat hats why it is consider as frequency tuning algorithm. Both exploration and exploitation balanced combination is provided in it. An automatic control and auto zooming mechanism into region is also provided by loudness and pulse emission rates with promising solutions.

Pseudo code of BAT algorithm:

Objective function (x), $x = [x1, x2,...,] T$

Initialize the bat population ($i = 1, 2, \ldots, n$) and Vi

Define pulse frequency fi at xi Initialize pulse rates ri and the loudness Ai

While (t < Max number of iterations)

Generate new solutions by adjusting frequency,

and updating velocities and locations/solutions

if (rand > ri)

Select a solution among the best solutions

Generate a local solution around the selected best solution

end if

Generate a new solution by flying randomly

if (rand < Ai & $f(xi) < f(x*)$)

Accept the new solutions

Increase ri and reduce Ai

end if

Rank the bats and find the current best $x*$

end while

Post process results and visualization.

LION Optimization Algorithm:

Raja Kumar and Wang have presented the LION Optimization Algorithm Meta heuristic algorithm. In each run of problem different solutions can be generated by meta heuristic algorithms. In the world LION is considered as strongest mammal due to their unique social behaviour. Lions live in group called pride, in which resident females and males are attending to give birth. The territory is a area in which pride live and there are nomadic lion who try to attack pride. Lions and cubs need to be defended from them and if territorial lion is dealed by nomadic lion then nomadic lion will kill or drive out the territorial lion, and to be territorial lion it will kill the cubs of lost lion, then force the female lion to estrus and copulate for its offspring.

Residents and nomads are two types of lions social behaviour and its type of social organization can be switch. On the basis of two lions behaviour optimal solutions are searched by LION optimization algorithm.

Pseudo code of LION Optimization Algorithm

Input: A network G = (N, E).

Output: Community membership for input nodes.

Procedure: INITIALIZE THE PARAMETERS:

%N omadic, %Resident = 1- % Nomadic, Agemat, Max_Iteration and number_of_trails.

Randomly initialize the position of resident and nomadic lions ? and calculate its fitness.

Find the best lion and assume it as the elite (detennined optimum).

Repeat

Memorize the best solution.

for each lion do

Calculate the fitness.

end for

for each lion do

Try Mating behavior.

if no improvement in fitness value then

Try Territorial Defense behavior

if no improvement in fitness value then

Try Territorial Takeover behavior

end if

end if

end for

t +- t + l.

Until t > Max_Iteration.

return The best solution.

end procedure

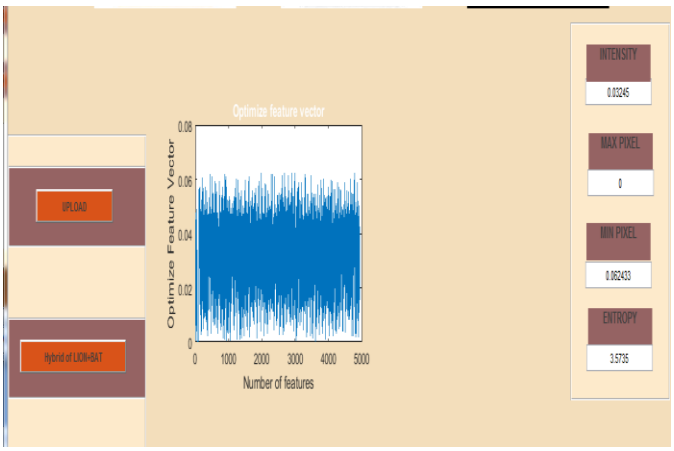

Figure 9: Feature Extraction of abnormal image samples

The above figure shows the feature extraction in an optimized manner for the abnormal category and shows the intensity, pixel both minimum, maximum and entropy value extracted and shows the graphical representation of the feature vector with respect to the length of the feature vector. There are number of optimization algorithm that can be used for feature optimization purpose. In our case we have used hybridization of both BAT and LION optimization algorithm. As mention above in case of LOA each solution has specific gender and each gender has its own searching strategy that assists it to look for optimal point. The general aim in using several prides is that each pride focuses on a specific region and balance between exploration and exploitation. Its character increases capability of it to fit for the optimization on multi-modal problems.

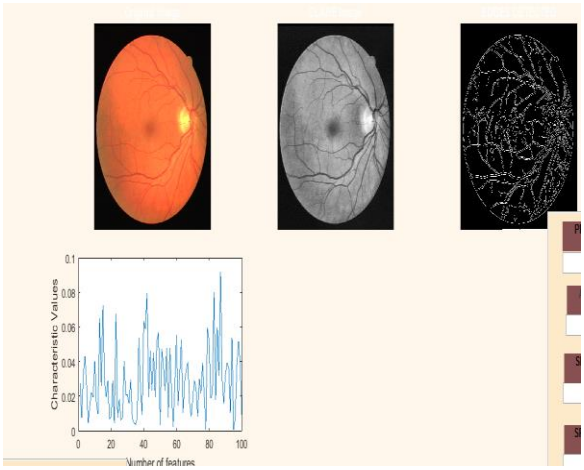

Figure 10: Testing panel

The figure 10 shows the testing process which deals with the random upload of the normal and abnormal lung cancer images and shows that the feature extraction of the test image sample on the basis of which the classification will be done using support vector machine.

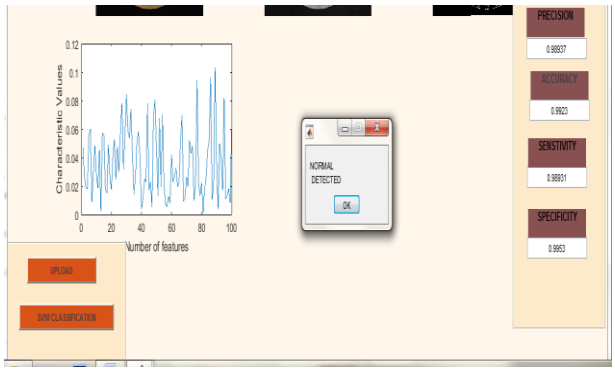

Figure 11: Performance evaluation and Classification

After the feature 11 optimization process, the test images will be classified as normal and abnormal images using classification process using Support Vector Machine. The reason behind using SVM rather than other classifiers is its use and obtained results by different researchers for diabetic retinopathy. The image processing and support vector machine (SVM) techniques have been used for analyzing an image that helps in achieving a high accuracy, Sensitivity, specificity and Precision.

Table 2: Comparison results

Method	Precision	Sensitivity	Specificity	Accuracy
Orlando et al.	0.7854	0.7897	0.9684	NA
Lahiri et al.	NA	0.7500	0.9800	0.9480
Maji et al.	NA	NA	NA	0.9470
Fu et al.	NA	0.7294	NA	NA
Dai et al.	NA	0.7359	0.9720	0.9418

Soares et al.	NA	0.7283	0.9788	0.9466
Zhang et al.	NA	0.7120	0.9724	0.7120
Niemeijer et al.	NA	0.6793	0.9725	0.9416
Base paper	0.8498	0.7691	0.9801	0.9533
Proposed method	0.98937	0.9923	0.98931	0.9953

The results are compared in terms of Precision, Sensitivity, Specificity and Accuracy. Where, specificity is defined as true negative rate that measures the appropriately identified quantity of rejections. On other hand true positive rate and also the probability of true detections measures the quantity of positives that are properly recognised defined sensitivity. The probability that deals with the positive screening test closest to the true values defines a precision. And accuracy is defined as the quality of being accurate and precise. This evaluation must be high with less error rates. The comparison table shows that the results obtained using proposed method is better than existing methods in terms of all Precision, Sensitivity, Specificity and Accuracy. So, a proposed method is proving to be efficient for use in retinal blood vessel segmentation.

CONLUSIONS AND FUTURE SCOPE

Segmentation of blood vessels in retinal images used for the early diagnosis of retinal diseases such as hypertension, diabetes and glaucoma. The high resolution, variability in vessel width, brightness and low contrast make vessel segmentation as difficult task. There exist several methods for segmenting blood vessels from retinal images. However, most of these methods fail to segment high resolution (large in size) images, very few methods provide solution for such a high resolution images but it require lengthy elapsed time and the accuracy of these methods is not completely satisfactory. Automatic segmentation of retinal blood vessels from fundus images plays an important role in the computer aided diagnosis of retinal diseases. The task of blood vessel segmentation is challenging due to the extreme variations in morphology of the vessels against noisy background. The task of automatic segmentation of blood vessels is challenging due to their abrupt variations in branching patterns. This task becomes even more challenging due the presence of noisy background and tortuosity. The research work has been focused on the basis on deep learning a neural network for blood vessel segmentation. Further, the vessel segmentation has been applied as a multi-label inference which is learnt by joint loss function. In this way, we have dealt about the class label dependencies of neighboring pixels which play an important role in segmentation of anatomical structures.

The proposed hybrid (Lion Optimization and Bat Optimization) optimization technique has been applied further for the optimization of the selected features and to improve the accuracy. The performance of the system has also been tested by using the various parameters such as precision, sensitivity, specificity and accuracy.

The retinal vessel segmentation technique gives the knowledge about the location of vessels which paves a way for the screening of diabetic retinopathy. In future, performance of these segmentation based algorithms can be improved based on performance evaluation parameters. Although the performance of the proposed method (sensitivity, specificity, and accuracy) is good in Drive dataset, we can also apply other datasets for the Blood vessel segmentation in future. The other optimizations also can be applied to the proposed work for the improvement of the results.

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