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Ant Colony Optimization Based Exudates Segmentation of Fundus Images

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Abstract
Now a days, Diabetic Retinopathy is a deadly form of disease. Diabetic retinopathy is a complication of diabetes and a leading cause of blindness. It occurs when diabetes damages the tiny blood vessels inside the retina, the light-sensitive tissue at the back of the eye. Exudates of diabetic retinopathy appears as white or yellow in color. Early detection of diabetic retinopathy is not possible as patients are generally asymptomatic. Exudates are frequently observed with microaneurysms. These methods are noise presence, low contrast, uneven illumination, and color variation. Therefore, in order to overcome the above stated issues computer aided diagnosis for exudates segmentation is needed. This proposed system first preprocesses the fundus image of human retina which is followed by image segmentation in which exudates are segmented. Proposed study segments the exudates using Ant Colony optimization Algorithm. The algorithm's performance was evaluated with a dataset available online. Classification is performed on segmented image to classifying the image as Normal retina and diabetic retinopathy retina.

Keywords Ant Colony Optimization, Exudates, Fundus Images, Image Processing.

INTRODUCTION

Diabetic retinopathy (DR) is an eye disease related with long-standing diabetes mellitus, which causes variations from the abnormal in the retina. DR has turned into a genuine general medical issue in many nations, since it is the main source of new visual impairment and vision defects in working-age people. In the underlying phases of DR, patients are large asymptomatic, yet in the further developed stage, they may encounter side effects that incorporate bending and obscured vision. Therefore, early detection of DR is crucial for preventing vision impairment and for effective treatment. The easiest method for analyzing the eye fundus in screening programs for preventing DR is digital color fundus photographs. They create a high-quality record of the fundus for detecting DR early signs and monitoring its progression. However, due to the growing incidence of diabetes in the population, ophthalmologists must examine a huge number of images. Therefore, developing computational tools that can assist diagnoses is of major importance [1].

Exudates are one of the most punctual indications of DR. They show expanded vessel penetrability since they are plasma lipid and protein gatherings in the retina. In fundus pictures, exudates show up as

glossy yellow– white spots with sharp outskirts. Exudates are as often as possible saw with microaneurysms, trademark dim DR sores. The issues in precisely recognizing exudates in fundus pictures are clamor nearness, low complexity, uneven light, and shading variety. A few methodologies have been proposed in the survey this kind of injury from shading fundus photos.

Diabetic retinopathy has primarily 2 stages. To start with is non-proliferative stage and the second is the proliferative stage. Exudates found in the non-proliferative stage are specified as delicate (soft) exudates proliferative stage. Exudates found in the non-proliferative stage are mentioned as soft exudates and exudates in the proliferative stage are called as hard exudates [2]. Fundus image with main characteristics is shows in Fig.1.

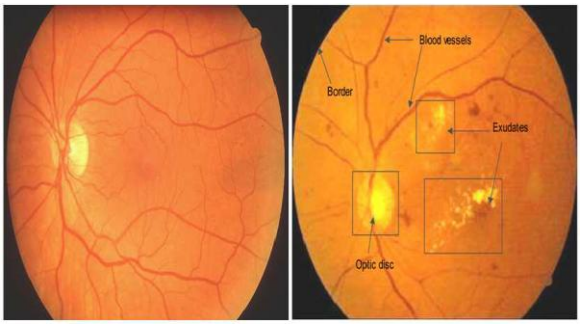

Fig.1: *Retinal Fundus Image and its Main Characteristics*

Diabetic retinopathy is a complication of diabetes and a leading cause of blindness. It occurs when diabetes damages the tiny blood vessels inside the retina, the light-sensitive tissue at the back of the eye. A healthy retina is necessary for good vision. If you have diabetic retinopathy, at first you may notice no changes to your vision. But over time, diabetic retinopathy can get worse and cause vision loss. Diabetic retinopathy usually affects both eyes. Though in the starting stages it can be difficult to notice the changes, carrying out dilated eye test every year will help to look out for any changes to retina [3]. The side effects for a compelling individual will have obscured vision, development of spots which is because of the spillage of liquids by swelled veins. The spots gradually increment giving a conceded vision and making extreme harm retina. In the event that untreated at the privilege time, there are chances that the individual will lose his vision for all time. The individual, social and monetary expenses of diabetes are tremendous and are probably going to antagonistically influence India's monetary advancement throughout the following couple of decades. Unless critical advances are taken to impede this blossoming plague, increasingly youthful and moderately aged Indians will fall prey to diabetes in the prime of their lives. Fig.2. demonstrates the contrast between the typical vision and furthermore diabetic retinopathy vision.

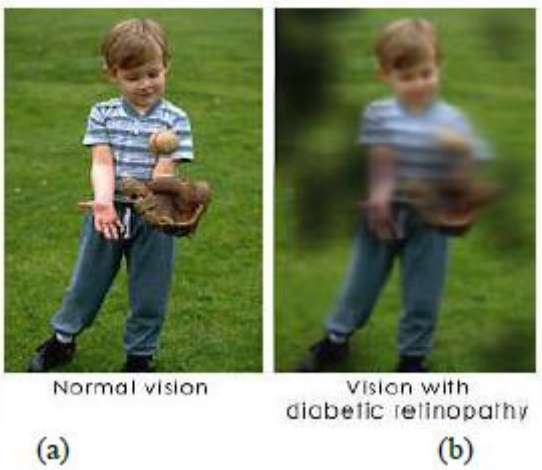

Fig.2: *(a) Normal Vision (b) Vision with Diabetic Retinopathy*

Exudates have been distinguished by various diverse techniques like portioning the picture by region based segmentation, morphological process, markovain segmentation model, genetic algorithm, ant colony optimization and so forth. For the guess of the diabetic-related segmentation it is vital to discover the exudates. Exudates can be recognized by various distinctive approaches like dividing the photo by watershed division,

unadulterated part technique and versatile. If there should arise an occurrence of dim injuries like exudates this undertaking is troublesome in light of these reasons: First, on account of closeness of anatomical structures like vessels, optic circle that have comparable data of force, surface with those of the injuries, second the light changeability cause imaging effect and third the eye dvancement and difference in head positions. There is electronic methodology which perceives the diabetic retinopathy by recognize exudates through morphological technique in shading fundus retinal pictures and afterward portions these injuries or exudates.

Paper is organized as follows; Section II gives literature survey of ant colony optimization based segmentation of fundus images for diabetic retinopathy. Section III provides the proposed system for the exudates segmentation. Section IV gives Algorithm explanation. Section V concludes the paper.

Literature Survey

A lot number of research in the field of Diabetic Retinopathy exudates detection. Research have been made from last few years which covers a wide range of computer vision and image processing techniques. Image preprocessing, Segmentation, Feature Extraction and classification of images are the most used techniques which is found in the literature.
The first paper is Exudates Segmentation in fundus images using as ant colony optimization approach. This paper first preprocess the fundus image by using image preprocessing technique. Ant colony optimization based segmentation is applied for exudates segmentation [1].

The second paper is Ant Colony Optimization based method for optic cube Segmentation in retinal images. Image Processing is used for preprocessing. Ant colony optimization based segmentation is applied for optic cube segmentation [4].

The third paper is Identification and Analysis of Macula in Retinal Images using Ant Colony Optimization based Hybrid Method. In this paper hybrid approach to analyses optic disc and macula to characterize the normal and abnormal status of the retina is proposed. Otsu method used for to further analyses [5].

The fourth paper is Retinal blood vessels segmentation using ant colony optimization. This paper first preprocess the image by using morphological preprocessing technique. Feature extraction is done using line detector. Ant colony optimization based segmentation is applied for blood vessels segmentation [6].

The fifth paper is Segmentation of Diabetic Retinopathy Retinal Eye Image Using Ant Colony Optimization Algorithm. This paper first preprocess the image by using density and thresholding preprocessing technique. Ant colony optimization based segmentation is applied for exudates segmentation of fundus diabetic retinopathy image [3].

Proposed System

The work flow of the proposed system of Segmentation of diabetic retinopathy is shown in Fig.3. The Original image is obtained from the database DRIVE which is available online. Then it will be incorporated by using preprocessing Algorithm using switch median filter. Filter image is used for the segmentation of exudates. Then segmented image is classify to analyze that retinal fundus image is of diabetic patient image or non-diabetic patient image.

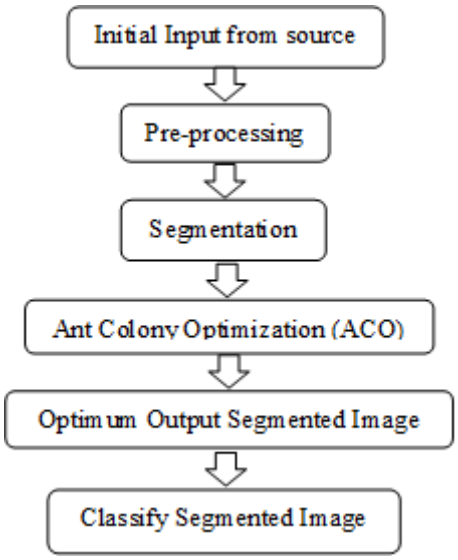

Fig.3: *Proposed System work Flow*

The intra- and inter-image variability of fundus images, mainly due to retinal pigmentation and the acquisition process, affects automatic segmentation of exudates. Therefore, a preprocessing step for normalizing images is very important to improve the algorithm capacity for generalizing [1]. In proposed system retinal fundus image is preprocess and hen segmentation if done on that image. Finally segmented image is classify for diabetic or non-diabetic image. This optimal image flow is as shown in Fig.4.

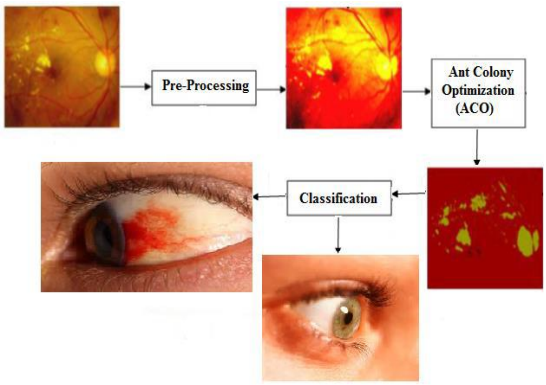

Fig.4: *Optimal Image Flow of Proposed System*

The whole architecture of the proposed system is as shown is Fig.5. The original image is obtain from the database which is available online DRIVE database. Image is preprocess, to preprocess original image first channel extraction is done on image. From channel extraction green channel image is extracted. Green channel image used for the next processing part because background intensity is low in green channel image. After channel extraction green channel image is filter using switch median filter. Filtered image further take into consideration for the segmentation of the exudates. Exudates segmentation can be based on features of exudates, such as color, boarder, and edge. Segmented image is finally classify using suitable classifier.

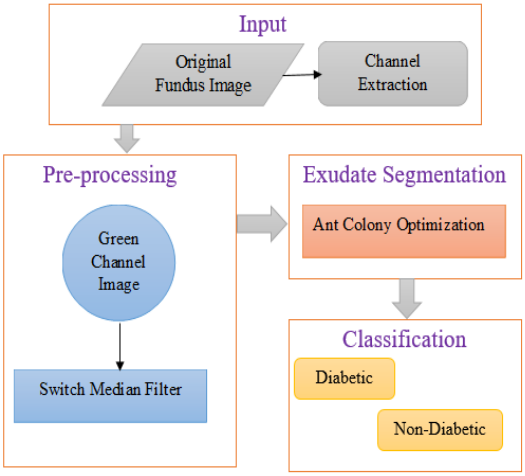

Fig.5: *Proposed System Architecture*

Methodology-Ant Colony Optimization

The ACO algorithm was first introduced and formalized as a meta-heuristic by Dorigo et al. The observation of foraging behavior of ant species inspired the ACO technique development as a stochastic local search method. For example, ants find the most limited way between the insect settlement and a sustenance source by trading data about the course that ought to be taken after. At the point when the ants stroll to and from the sustenance source, they leave pheromones on the ground; this pheromone trail is utilized by ants to speak with each other. Ants probabilistically prefer to follow a direction proportional to the quantity of

pheromone. Using simple reactive agents allows the transition from the natural to artificial ant colony. These agents cooperate by exchanging information through environment modifications. That is, artificial ants communicate indirectly via artificial pheromone trails [1].

To apply ACO, the optimization problem is transformed into the problem of finding the best path on a weighted graph. The artificial ants (hereafter ants) incrementally build solutions by moving on the graph. The solution construction process is stochastic and is biased by a pheromone model, that is, a set of parameters associated with graph components (either nodes or edges) whose values are modified at runtime by the ants. In ACO, artificial ants build a solution to a combinatorial optimization problem by traversing a fully connected construction graph.

Ant Behavior

Ants communicate to one another by laying down pheromones along their trails, so where ants go within and around their ant colony is a stigmergic system. In many ant species, ants walking from or to a food source, deposit on the ground a substance called pheromone. Different ants can notice this pheromone, and its essence impacts the decision of their way, that is, they have a tendency to take after solid pheromone fixations. The pheromone kept on the ground shapes a pheromone trail, which enables the ants to discover great wellsprings of sustenance that have been beforehand distinguished by different ants. Ant behavior is shown in Fig. 6. Using random walks and pheromones within a ground containing one nest and one food source, the ants will leave the nest, find the food and come back to the nest. After some time, the way being used by the ants will converge to the shortest path [7].

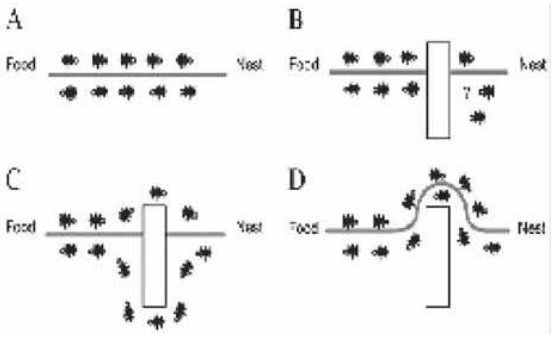

Fig. 6: *Ant Behavior*

- Ants in a pheromone trail between nest and food;
- An obstacle interrupts the trail;
- Ants find two paths to go around the obstacle;
- A new pheromone trail is formed along the shorter

The proposed approach uses a specific number of ants moving on the image driven by the local image intensity values variation. This variation establishes a pheromone matrix, with the same size image, which represents the edge information at each image pixel location. Due to the large image size and to reduce computation time, the ACO algorithm described below was independently applied on non-overlapping 128 X 128 image windows. ACO is an iterative algorithm. At each iteration, a number of artificial ants are considered. Each builds a solution over the solution space through their movements and by updating pheromone information. The process starts with an initialization stage, and then runs for N iterations to construct the pheromone matrix by iteratively performing construction and update processes [1].

Suppose that K ants are used to find the optimal solution (image edges) in a space v; that is, in a sub-image I with size
M1 X M2, and where each pixel can be viewed as a node, the ACO algorithm implemented could be summarized as follows:

1. Determine the heuristic information and initialize the resultant image Ires = 0
2. For each original 128 _ 128 image window
a. Randomly initialize the positions of the K ants and the pheromone matrix s(0).
b. For the construction step index n = 1:N
i. For the ant index k = 1:K
1. Consecutively move the kth ant for L steps, according to the probabilistic transition matrix p(n) (with a size of M1M2 X M1M2).
2. Local update of the pheromone matrix
ii. End For
iii. Global update of the pheromone matrix
c. End For
3. Assign pheromone matrix s(N) to the correspondent window on the resultant image
4. End For

To reduce the number of false positives that usually appear close to blood vessels, the segmented vasculature map obtained was used to eliminate the blood vessels' edges found by the ACO algorithm. Then, to evaluate the final output, the following thresholds used.

CONCLUSION

Segmentation is one of the important modules of any image processing technique. In this paper, a new algorithm based on ACO is described for detecting exudates in color fundus images. The Ant Colony Optimization Algorithm is used in this paper as the edge detector. The Ant Colony Optimization Algorithm segment the exudates in retina.
The performance of the proposed approach will be evaluate using a dataset available online.

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