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SPECIAL ISSUE ON RECENT RESEARCH CHALLENGES IN BIO-MEDICAL APPLICATIONS

Application of Various Segmentation Algorithms on Diabetic Retinopathy Eye Image

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Diabetic is one the important cost related problems. And also it gives the numerous eye problems for humans like Diabetic retinopathy. In this work a various methods have been proposed to segment the diabetic retinopathy eye. Segmentation is one of the important modules of any image processing technique. In this work we have proposed the Mean Shift Algorithm (MSA), Random Walker Method (RWM) and Ant colony Algorithm (ACA) and to segment the Human eye. The performance of all the proposed techniques has been verified and validated with each technique using MATLAB. Compare all the techniques; Random Walker Method is a novel technique to segment the Diabetic retinopathy eye image. It shows the better and significant results.

Key words: Segmentation, Diabetic Retinopathy, Mean Shift Algorithm, Random Walker Method, Ant Colony Optimization.

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[1]. But over time, diabetic retinopathy can get worse and cause vision loss. Diabetic retinopathy usually affects both eyes. Diabetic retinopathy has four stages:

1. Mild Nonproliferative Retinopathy. At this earliest stage, micro aneurysms occur. They are small areas of balloon-like swelling in the retina's tiny blood vessels.
2. Moderate Nonproliferative Retinopathy. As the disease progresses, some blood vessels that nourish the retina are blocked.
3. Severe Nonproliferative Retinopathy. Many more blood vessels are blocked, depriving several areas of the retina with their blood supply[2]. These areas of the retina send signals to the body to grow new blood vessels for nourishment.
4. Proliferate Retinopathy. At this advanced stage, the signals sent by the retina for nourishment trigger the growth of new blood vessels. This condition is called proliferate retinopathy. These new blood vessels are abnormal and fragile. They grow along the retina and along the surface of the clear, vitreous gel that fills the inside of the eye. Figure 1 shows the normal eye anatomy.

By themselves, these blood vessels do not cause symptoms or vision loss. However, they have thin, fragile walls. If they leak blood, severe vision loss and even blindness can result. Blood vessels damaged from diabetic retinopathy can cause vision loss in two ways:

1. Fragile, abnormal blood vessels can develop and leak blood into the center of the eye, blurring vision. This is proliferate retinopathy and is the fourth and most advanced stage of the disease.

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2. Fluid can leak into the center of the macula, the part of the eye where sharp, straight-ahead vision occurs. The fluid makes the macula swell, blurring vision. This condition is called macular edema. It can occur at any stage of diabetic retinopathy, although it is more likely to occur as the disease progresses. About half of the people with proliferate retinopathy also has macular edema.

Proposed work sequence

The Block diagram of the proposed system of Segmentation of diabetic retinopathy is shown in Figure 2. The different process sequence is involved in this process is also given in below. The Original image is obtained from the image center and then it will be incorporated by using a preprocessing algorithm using density and magnitude. The proposed method flow diagram is shown in Figure 2 in a sequential manner.

Pre-processing

Step 1: Calculate the average magnitude

$$\mathbf{M}(1,2) = \frac{1}{M}\sum_{(1,2)}^{n}\sqrt{\mathbf{Mx}(1,2)^2 + \mathbf{My}(1,2)^2} \quad ...(1)$$

Step 2: Calculate the density of the edge length. The density of the edge length is calculated from

$$\mathbf{L}(1,2) = \frac{C(1,2)}{\max \mathbf{C}(1,2)} \quad ...(2)$$

Where C(i,j) is the number of connected pixels at each position of pixel.

Step 3: Calculate the Initial position of the map from summation of the density of edge Length and average magnitude.

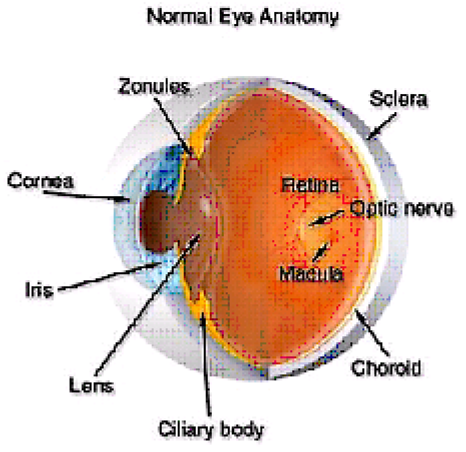

Fig. 1. Normal Eye Anatomy

$$\mathbf{P}(1,2) = \frac{1}{2(M(1,2) + L(1,2))} \quad ...(3)$$

Step 4: Calculate the thresholding of the initial position map. If

$$P(1,2) > T_{max} \quad ...(4)$$

Then P (1, 2) is the initial position of the edge following. And then we obtained the initial position by setting T_{max} to 90% of the maximum value.

Mean shift algorithm

To further evaluate the efficiency of the proposed method in addition to the visual inspection, the proposed boundary segmentation method numerically using the Hausdorff distance and the probability of error in image segmentation. The objects surrounded by the contours obtained using the five snake models and the proposed method are compared with that manually drawn by skilled doctors from the Medical Hospital. Showing the results it shows the Error difference value is very minimal and also negligible. So the proposed techniques produced nearer to the optimal value. Figure 3 shows the schematic diagram of Mean shift, finding and also Figure 4 shows the Mean shift clustering. Fig.5 shows the output results of the proposed technique. As well as figure 6 shows

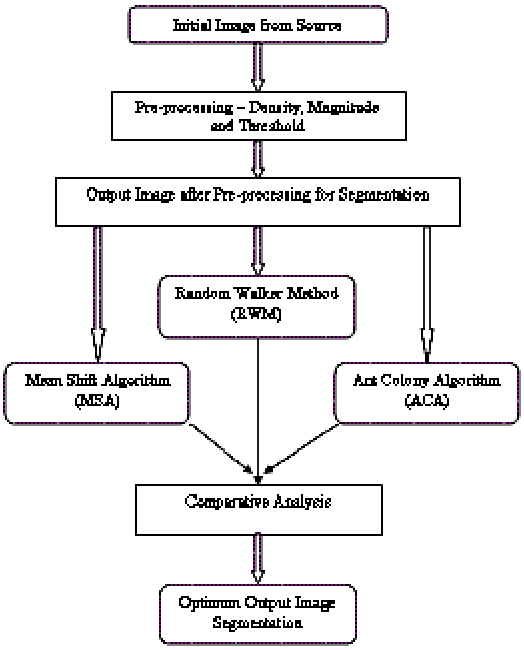

Fig. 2. Work Sequence flow chart

the MATLAB output of fine filtered segmented output. All the coding was done by MATLAB.

Random walker method

The pseudo code for the proposed technique is shown above in the figure 7. The proposed techniques produced nearer to the optimal value. Fig.7 shows the output results of the proposed technique

Pseudo code:

Procedure search (*F, K*)
a Ã randomly chosen truth assignment
for repeat *K* times do
if *a* |= *F* then
return *a*
else
c Ã randomly chosen unsatisfied clause of *F*(*a*)
s Ã randomly chosen atom of *c*
a Ã *a* except the truth value of *s* flipped
end if
end for
return *false*
end procedure

Ant colony optimization

Through any biologist's view, it is quite known that the visual the visual sensory organs of the real world ants are rudimentary by nature and in some cases they are completely blind. Foraging behavior of ant species is also based on the indirect communication possibly done by pheromones. During their walking from the food sources to the nest, the ants are depositing pheromone on the ground, forming in this way, a pheromone trail. The mathematical modeling for segmentation of a diabetic retinopathy eye image using the algorithm is formulated as below.

$$p_{i,j}^{(n)} = \frac{\left(\tau_{i,j}^{(n-1)}\right)^{\alpha}\left(\eta_{i,j}\right)^{\beta}}{\sum_{f\in\Omega_i}\left(\tau_{i,j}^{(n-1)}\right)^{\alpha}\left(\eta_{k,j}\right)^{\beta}}, \text{if } j \in \Omega_i \quad \text{...(5)}$$

Ant colony optimization is a technique for optimization that was introduced in the early 1990's. The inspiring source of ant colony optimization is the foraging behavior of real ant

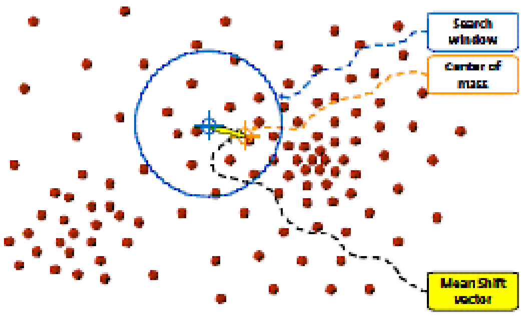

Fig. 3. Mean Shift Finding

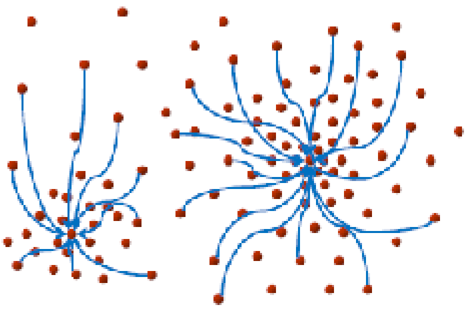

Fig. 4. Mean Shift Clustering

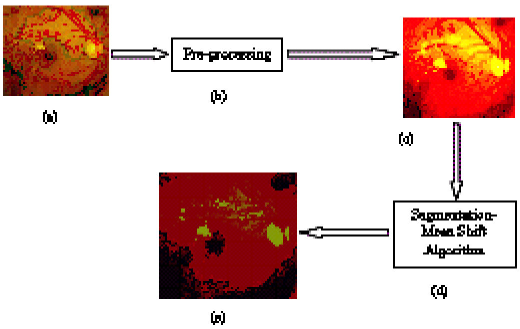

Fig. 5. Output Result (a). Original Image (b). Pre-Processing (c). Output of Pre-Processing ; (d). Segmentation – Mean shift algorithm (e). Segmentation – Output

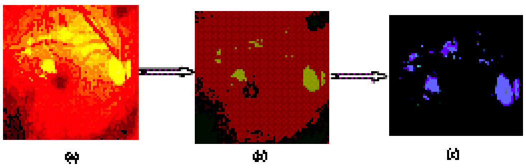

Fig. 6. Mean Shift Algorithm (a). Pre-Processing image output (b). Segmentation Output;(c). Segmentation–Output Fine filtering

colonies. This behavior is exploited in artificial ant colonies for the search of approximate solutions to discrete optimization problems, to continuous optimization problems, and to important problems in telecommunications, such as routing and load balancing. First, we deal with the biological inspiration of ant colony optimization algorithms. Figure 7 shows the model ant roots. Pseudo code also given above the figure 8. Figure 9 shows the MATLAB final segmented output of the diabetic retinopathy eye image.

Pseudo code:

Initialization
Set for every pair (i, j): $\hat{o}_{ij} = \hat{o}\,()$
Set N=1 and define a ς_i, ς_j
While
$\varsigma_i = \varsigma_j$
Build a complete trail
For i = 1 to n, j = 1 to n
Choose the alternate node and pair
Update the equation

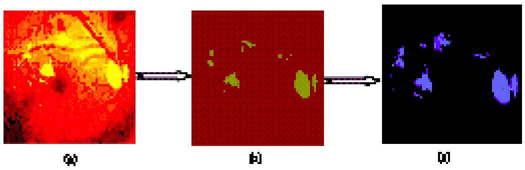

Fig. 7. Random Walker Method Algorithm (a). Pre-Processing image output; (b). Segmentation Output (c). Segmentation– Output Fine filtering

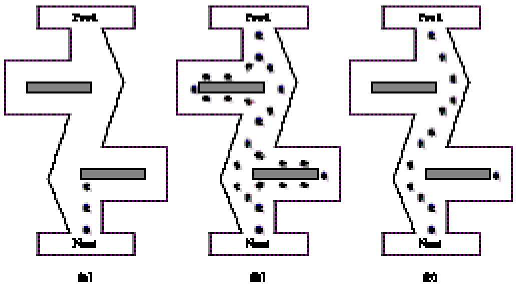

Fig. 8. Three different roots of ants form Nest to Food

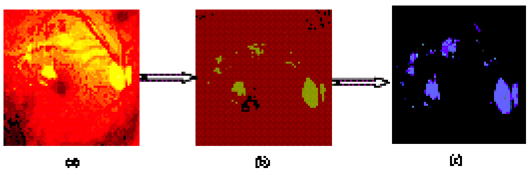

Fig. 9. Ant Colony Algorithm (a). Pre-Processing image output ; (b). Segmentation Output (c). Segmentation– Output Fine filtering

Update the tabu list
Analyze the problem
For i = n-1, j = n-1
Compute the performance
Update the equation
End

RESULTS AND DISCUSSION

The graphical analysis also made to study, compare and analyse all the algorithms with each other. Figure 10. (a) to (c) shows the MATLAB signal noise ratio of all the algorithms respectively. In this figure 10 (b) shows the less noise ratio

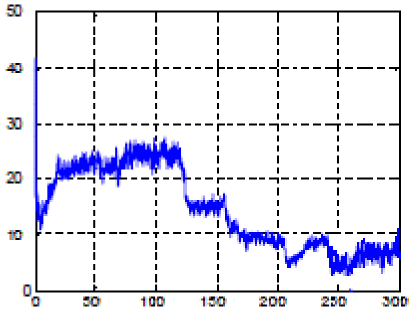

Fig. 10 (a). Mean Shift Algorithm

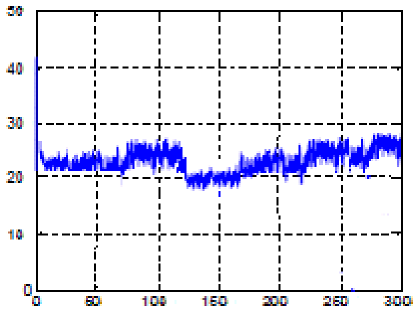

Fig. 10 (b). Random Walker Method

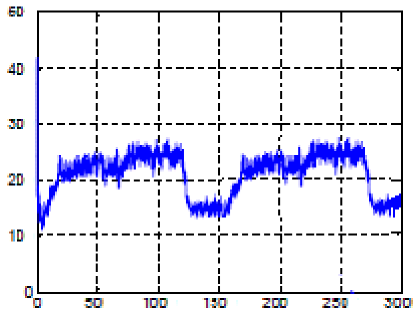

Fig. 10 (c). Ant Colony Optimization Algorithm compares than other two graphs. So, Random walker method is the novel techniques for this problem.

CONCLUSION

Segmentation is one of the important modules of any image processing technique. In this work we have proposed the Mean shift algorithm, Random walker method and also Ant Colony Optimization Algorithm to segment the diabetic retinopathy Human eye. The performance of the each proposed algorithm has been compared with each other. Out of the all the techniques the noise signal graph shows that Random walker method shown the better results compare than other two methods like mean shift algorithm and also Ant colony optimization algorithm. This technique is a novel technique to segment the eye and also shows significant results and compared with the other conventional techniques. In future we have a proposal to implement other hybrid cluster algorithms to segment the same eye image and also to compare with the results of each other.

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