International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

A`Implementation of Ant Colony Optimization Technique for Cancer Diagnosis

Varsha Patankar[Á*], Devesh Nawgaje[Ḃ] and Rajendra Kanphade[Ċ]

[Á]M.E. Digital Electronics, S.S.G.M. College of Engineering, Shegaon (MS)-444203 India
[Ḃ]Department of EXTC, S.S.G.M. College of Engineering, Shegaon (MS)-444203 India
[Ċ] Principal, NMIET, Pune-410507, India.

Abstract

In this paper a novel approach for the detection of breast cancer is used. Many imaging techniques are introduced for the breast cancer diagnosis. In this ant colony optimization (ACO) based edge detection technique is used for the diagnosing of breast cancer. This process is used to detect outlines of an object and boundaries between objects present and the background in the image. Experimental result gives the better performance of the proposed method than other techniques.

Keywords: *Ant colony optimization, Breast cancer, Diagnosis, Edge detection, Mammogram.*

1. Introduction

Now-a-days it is found that the cancer is most dangerous disease which is caused by some internal and external factors. The cancer-causing agents can be present in food and water, in the air, and in chemicals and some internal factors like hormones, immune conditions etc (Malcolm R Alison, 2001). According to the World Health Organization (WHO), breast cancer is one of the most deadly cancers than other type of cancer occurs mostly in women (Lukasz Jelen *et al*, 2008). The exact cause of breast cancer is still unknown. There are several methods are introduced for preventing this disease.

In literature many of researchers have found good solution for detection of breast cancer with better accuracy. In (Tobias Christian Cahoon, 2000) authors suggested the approach using segmentation with fuzzy models and classification by crisp k-nearest neighbor (k-nn) for breast cancer. Carlos and Moshe in (Carlos Andres Pena-Reyes *et al*, 1999) uses neural pattern recognition model which is the combination of two methodologies fuzzy systems and evolutionary algorithms, with a success of 97%. Hybrid system for diagnoses of the breast cancer based on FCOSVM improves the accuracy up to 97.34%. Various methods using neural network have introduced in (Devesh D. Nawgaje *et al*, 2012) for diagnosis of breast cancer in which the authors found that by using Jordan and Elman Network has achieved a top result of accuracy 98.03%. Amin Einipour in (Amin Einipour, 2011) combines two methods fuzzy systems and ACO algorithm which automatically produce systems for breast cancer diagnosis which gives better accuracy 98.21%.

This paper presented a new technique for breast cancer detection. In this ant colony optimization (ACO) is used for the cancer diagnosis which gives detection of edges of cancerous tumor from medical images. The nature inspired algorithm ACO is a population based metaheuristic (Anna Veronica Baterina *et al*, 2010, Shweta Agarwal, 2012). Artificial ants are used for the finding best solution path on weighted graph (Anna Veronica Baterina *et al*, 2010). The solution is constructed by pheromone substance which is the set of parameters associated with components of graph such as nodes or edges (Anna Veronica Baterina *et al*, 2010)

2. Edge detection of an image

Edge detection of an image is the detection of boundaries of an object present in that image (Jing Tian *et al*, 2008). This detection is done where the sharp changes in an intensity of an image occurs. To extract the important information from an object various edge detection technique are used.

The techniques such as, canny, prewitt, and sobel etc. are conventional methods, which are more expensive because, each set of operations is conducted for each pixel (Charu Gupta *et al*, 2013). These technique increases the computation time according to the increase in size of the image. ACO based edge detection is used to overcome these problems.

3. Ant colony optimization

ACO is inspired by natural behavior of ants for searching the shortest path from nest to food source (Anna Veronica Baterina *et al*, 2010, A. Amali Asha *et al*, 2011). The main aim of ACO is the discovery of good tour (Charu Gupta *et al*, 2013). When all ants in that colony act as a community they are able to solve complex problems. They communicate through pheromone substance with other members in their colony by depositing some pheromone in their return path. So that it also increases the probability

*Corresponding author: **Varsha Patankar**

that the other ants will follow the same path (Shweta Agarwal, 2012, A. Amali Asha *et al*, 2011). This will become the guidance for other ants to choose the shortest path (A. Amali Asha *et al*, 2011).

In this paper, ACO method is used for the edge detection to extract the information from medical images. The natural behavior of ants is known from the following figures.

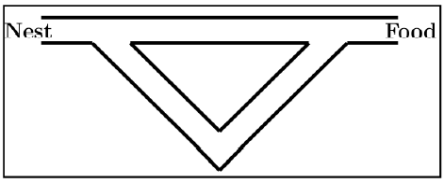

Fig.1 All ants are in the nest. No pheromone in the environment.

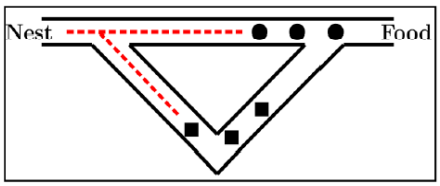

Fig.2 Foraging starts. Some ants take the short . path, some ants take the long path to the food source.

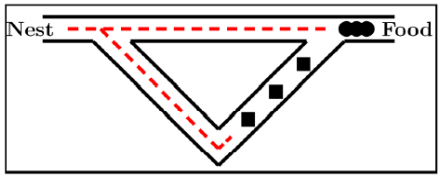

Fig. 3 The ants that have taken short path have arrived earlier at the food source. Therefore, while returning, the probability to take again short path is higher.

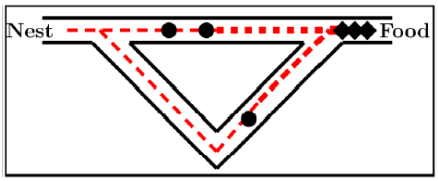

Fig.4 The pheromone trail on the short path receives, in probability, a stronger reinforcement and the probability to take this path grows.

4. ACO algorithm for edge detection

ACO algorithm artificial ants are distributed over the image for shortest route construction (Anna Veronica Baterina *et al*, 2010). Edge detection of an image is the identifying the pixels that are correspond to the edges. A 2-dimensional image is used with the pixel value as its elements (Charu Gupta *et al*, 2013).

Randomly artificial ants are distributed over the image on each pixel value for extraction of edges (Anna Veronica Baterina *et al*, 2010). Ants move from one pixel to another between the pair of nodes in an image. A 2-dimensional matrix is shown with its pixel value.

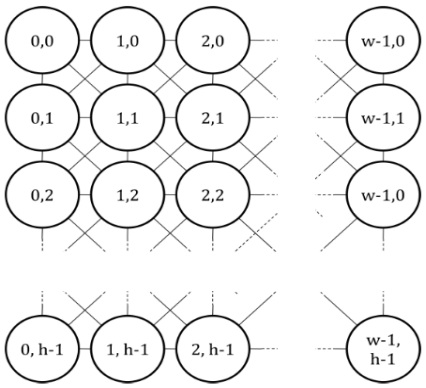

Fig. 5 Matrix representation of an image

In the graph the connection is between the adjacent pixels or elements of an image. This connection is only in the form of 4-connectivity or in 8-connectivity. The ants move with this pattern to construct the final pheromone matrix.

4.1 Initialization Process

Initially K numbers of ant are placed in random for each pixel value with an image of size M1 × M2. In this M1 is the length of an image and M2 is the width of an image. Here the parameters α and β are initialized and heuristic information is set. The initial value of each component of the pheromone matrix is set to be a constant τ (init).

4.2 Construction Process

In this process the K number of ant is randomly moving for L construction steps on image from node i to node j. Ants probabilistically choose one of their 8 neighborhood pixel by using transition probability rule according to equation (1).

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

Where, τ(i,j) is the pheromone information value on edge i,j,
α is a parameter to control the influence of τ(i,j),
η(i,j) represents the heuristic information of edge i,j,
β is a parameter to control the influence of η(i,j),
Ωi is the neighboring nodes of (i,j).

There are two fundamental concerns in the construction process. The main concern is with the determination of heuristic information η (i,j) which can be determined by the pixel location (i,j) as,

$$(i,j) = c\, I(i,j)/Z \tag{2}$$

Where, Z is the normalization factor and is defined as,

$$\sum i=1{:}M1 \sum j=1{:}M2\ Vc\ I(i,j) \tag{3}$$

Where, Ii,j represents the intensity value of the pixel (i, j) of image I. The value of function Vc (Ii,) depends on changes in pixel intensity values which is defined as,

$$Vc\,(i, j) = f|(\,I(i-1, j) - I(i+1, j)| + |(i-1, j-1) - I(i-1, \quad j+1)| + |(i-1, j-1) - I(i+1, j+1)| + |(i, j-1) - I(i, j+1)| \qquad (4)$$

In order to change the respective shapes the function in equation (4) is modified mathematically. Four functions are taken (Flat, Quadratic, Sine and Wave) for computing the heuristic function.

$$f(x) = \lambda x, \quad \text{for } x \geq 0,$$

$$f(x) = \lambda x^2, \quad \text{for } x \geq 0,$$

$$f(x) = \begin{cases} \sin(\pi x / 2\lambda) & 0 \leq x \leq \lambda; \\ 0 & \text{else.} \end{cases}$$

$$f(x) = \begin{cases} (\pi x \sin((\pi x/\lambda))/\lambda & 0 \leq x \leq \lambda; \\ 0 & \text{else} \end{cases} \qquad (5)$$

The parameter λ in above functions adjusts the respective shape.

4.3 Update Process

The update process is performed two times for the pheromone updating. The first update is performed after the movement of each ant and second update is performed after the movement of all ants.

The update process, which updates the pheromone matrix after each ant is moved given by,

$$\tau_{i,j}^{n-1} = \begin{cases} (1-\rho).\tau_{i,j}^{n-1} + \rho.\Delta_{i,j}^{(k)} & \text{if (i,j)is visited by the kth ant} \\ \tau_{i,j}^{n-1} & \text{otherwise} \end{cases} \qquad (6)$$

Where, ρ is evaporation constant, Δi,j(k) is determined by the heuristic matrix,

$$\Delta i,j(k) = \eta(i,j) \qquad (7)$$

The pheromone matrix is again updated after all the ants move in each construction step. This is done according to equation (8)

$$\tau\,(n) = (1-\psi)\cdot\tau\,(n-1) + \psi\cdot\tau\,(0) \qquad (8)$$

ψ being a decay constant.

4.4 Decision Process

A binary decision is made in this process at each pixel location to determine whether it is an edge or not, by applying threshold T on final pheromone matrix Ƭ (N). In this the above-mentioned T is proposed to be adaptively computed based on the method developed in.

Result

The proposed approach of this research project has been executed in MATLAB. The resultant output of mammogram image with edge detection is as given,

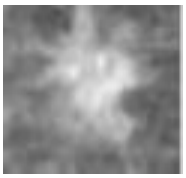

Fig. 6 Original mammogram image

Fig.7 Edge detection image having parameters λ=20, α=20, β=1

Fig.8 Edge detection image having parameters λ=10, α=10, β=1

Conclusion

The image edge detection for medical images using ACO algorithm has an advantage over conventional edge detection techniques. By varying some parameters like λ, α, and β gives the improvement in image edge detection. Experimental results show the feasibility of the approach in identifying edges in an image. With suitable parameter values, the algorithm was able to successfully identify edges.

References

Malcolm R Alison (2001), Cancer, Imperial College School of Medicine, London, UK, Encyclopedia of Life Sciences Nature Publishing Group.

Lukasz Jelen, Thomas Fevens, Adam Krzy˙ Ak (2008), Classification of Breast Cancer Malignancy Using Cytology Images of Fine Needle Aspiration Biopsis, *Int. J. Appl. Math. Comput. Sci.*, Vol. 18, No. 1, 75–83.

Tobias Christian Cahoon (2000), Breast Cancer Detection Using Image Processing Techniques, *IEEE*

Carlos Andres Pena-Reyes, Moshe Sipper (1999), A fuzzy-genetic approach to breast cancer diagnosis *Artificial Intelligence in Medicine*, vol.17, pp. 131-155.

Devesh D. Nawgaje and Dr. Rajendra D. Kanphade (2012), Comparision of Various Neural Networks For Diagnosis of Breast Cancer, *International Transactions on Electrical, Electronics and Communication Engineering*, Vol. 2, No.3

Amin Einipour (2011), A Fuzzy-ACO Method for Detect Breast Cancer, *Global Journal of Health Science* Vol. 3, No. 2

Anna Veronica Baterina, Carlos Oppus (2010), Image Edge Detection Using Ant Colony Optimization, *ISSN*: 1790-5052, Issue 2, Volume 6.

Shweta Agarwal (2012), A Review Paper of Edge Detection Using Ant Colony Optimization Techniques, *International Journal of Latest Research in Science and Technology ISSN (Online)*:2278-5299 Vol.1,Issue 2 :Page No.120-123

Charu Gupta, Sunanda Gupta (2013), Edge Detection of an Image based on Ant Colony Optimization Technique, *International Journal of Science and Research (IJSR)*, India Online ISSN: 2319-7064, Volume 2 Issue 6.

Jing Tian, Weiyu Yu, and Shengli Xie (2008), An Ant Colony Optimization Algorithm For Image Edge Detection, *IEEE*

A. Amali Asha, S.P. Victor, A. Lourdusamy (2011), Feature Extraction in Medical Image using Ant Colony Optimization : A Study, *International Journal on Computer Science and Engineering (IJCSE), ISSN :* 0975-3397 Vol. 3 No. 2.