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Catfish PSO Based Enhancement for Digital Mammogram Images

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Abstract—*In medical field, breast cancer detection at early stage is a cumbersome task. As a first step, the images have to be enhanced, which is the most crucial pre-processing step. Many methods that exist today for image enhancement are based on histogram of the image. In this paper, we propose a novel Catfish Particle swarm Optimization (PSO) algorithm based image enhancement techniques used for image enhancement that can be used for breast cancer image enhancement or mammography enhancement. The results are compared with Classical Histogram Equalization (HE) technique and Particle swarm Optimization (PSO) algorithm. The result proves the superiority of the proposed technique.*

1. INTRODUCTION

One in eight women in United States is said to have chances of breast cancer [1]. It is also said that 70% of breast cancers cancer have no identifiable risk factors [2]. It is not only an alarming disease in developed countries but also in developing countries including India. Owing to the lack of awareness of this disease and in absence of a breast cancer screening program, the majority of breast cancers are diagnosed at a relatively advanced stage [3]. With rising incidence and awareness, breast cancer is the commonest cancer in urban Indian females, and the second commonest in the rural Indian women [4]. So, it is highly important that early cancer detection is essential. In order to detect cancer automatically without human intervention, it is highly important that we have to have a good quality image, which is obtained by enhancement of the image.

One of the classical methods of image enhancement is Histogram Equalization [5]. Being a simplest method, the idea is to uniformly distribute the cumulative density function of the image. The major drawback of HE is that the mean-brightness of the HE image is considered as the middle gray-level and the mean of the image is not considered. As an alternative, Meta-heuristic algorithm based image enhancement is proposed. Meta-heuristic algorithms are a group of stochastic algorithm. The word "Meta-heuristics" means "Good-enough- but still". Some of the metaheuristic algorithms reported for image enhancement are Genetic Algorithm (GA)[6,7], Artificial Bee colony Algorithm(ABC)[8], Particle Swarm Optimization (PSO)[9], Black hole algorithm[10] etc.

In this paper, Catfish PSO based enhancement technique is introduced, which enhances the image without human intervention. For this purpose, an objective function is created and the output images are evaluated against the classical techniques in terms of quality. The paper is organized as follows: Section II provides overview of Catfish PSO algorithm. Section III describes the results of Catfish PSO based enhancement method. In Section IV, Conclusion is drawn.

2. OVERVIEW OF CATFISH PSO BASED IMAGE ENHANCEMENT:

Particle Swarm Optimization (PSO) is a swarm based evolutionary technique that mimics the flock of birds and its search for food[11]. This technique was introduced by Kennedy et al. The first step of the technique is to initialize the bird's position in the search space. Each of the bird is then made to remember its own best position called 'Local best' (pbest) and the best position of the group called 'Global best' (gbest).

Several variants have been proposed and successfully implemented in PSO such New PSO [12], Linearly Decreasing Weighted PSO [13] etc. New PSO introduces the use of Worst particles position, in both local & global level and the bird's next move is made in such a way that, it deviates from the worst position. In linearly decreasing Weight PSO, the exploitation is initially high, making global search more efficient. Then, as the weight is linearly decreased, the local search or exploration is increased toward the end of the algorithm.

The Catfish PSO was first introduced by Chang et al [14]. Then, it was implemented for Economic Dispatch Problem [15]. The nature of Catfish particles to decrease the premature convergence by introducing new particles at the maximum – minimum points makes the algorithm more efficient. The algorithm is used as given in [15]. If the distance between 'gbest' and the surrounding particles is short, each particle is considered a part of the cluster around 'gbest' and will only move a very short distance in the next generation. To avoid this premature convergence, catfish particles are introduced to replace 10% of the original particles with the worst fitness

value of the swarm. This will help the algorithm to stern or drive the entire swarm towards optimal or near- optimal solution.

The image enhancement being an optimization problem, the intensity of each and every pixels of the input image is altered so that image is enhanced. The transformation function is used as in [9]. The four constants '*a, b, c and k*', produce a large variation in output image. The transformation function may be summarized as

$$g(i,j) = K(i,j)[\, f(i,j) - cXm(i,j)] + m(i,j)^a$$ Where,

$$\mathrm{K(i,j)} = \frac{\mathrm{k\ D}}{\sigma(\mathrm{i,j}) + \mathrm{b}}$$

The objective function is defined in [9].The paper uses metrics such as entropy, number of edges, edge intensity etc. as parameters for evaluation. There are so many edge detector algorithms such as Laplacian, Sobel, Canny and so on. Here in this study, Sobel edge detector on account of its simplicity has been used [5]. Thus the final objective function may be defined as

$$Max.F(I_e) = \log(\log(E(I_s)))X\ \frac{n_{edgels}}{MXN}\ XH(I_e)$$

Where,

$E(I_s)$ is the sum of all *M X N* pixel intensities

n_edgels is the number of edges above the threshold intensity

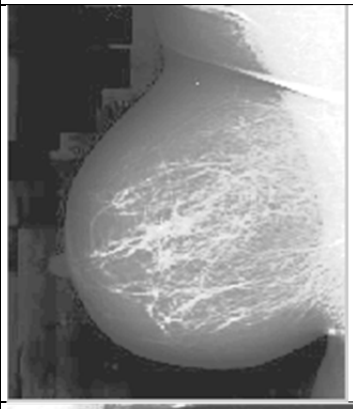
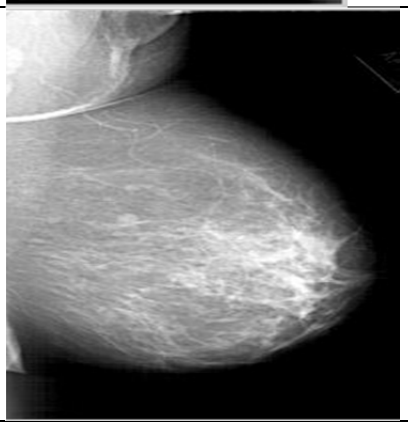
$\mathrm{H(I_\varepsilon)}$ is the entropy of the output function.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed method is tested on many mammograms taken from DDSM and Mini-MIAS database [16]. The number of particles or birds is 20 and the maximum number of iterations is 10. Then, if two consecutive iterations produce the same results or fitness value then worst 10% (i.e. two particles) are removed and new particles are initialized at the extremities.

Due to space limitations, three distinct mammograms (i.e. Normal, Cancerous and Benign) are presented here to prove the superiority of the algorithm. Table 1 presents the visual results of original image compared against Histogram Equalization and the proposed Catfish PSO algorithm. It can be seen that proposed method produces better results than classical HE.

Table 1: Visual Results of images

Image	Original Image	HE	Catfish PSO Based Image enhancement
Normal			
Cancerous			

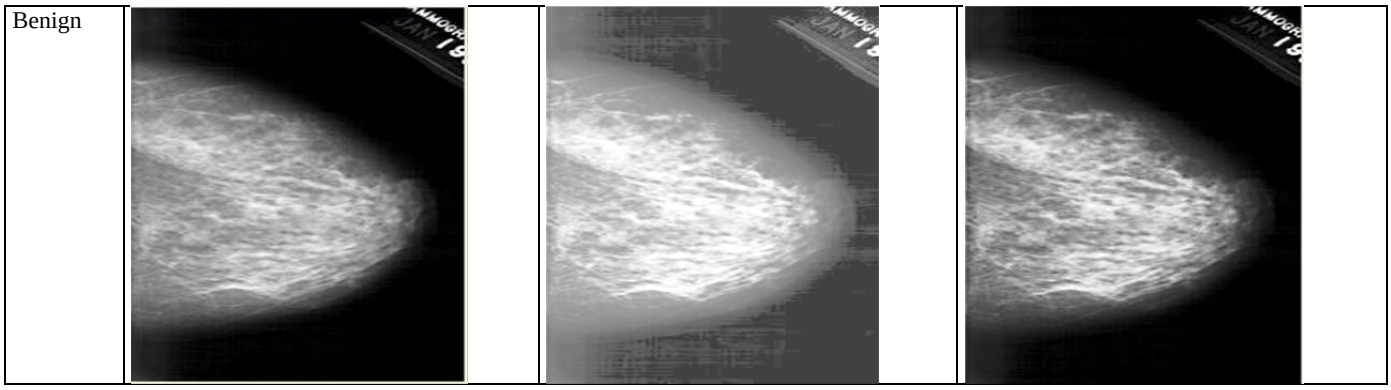


Table-2 Presents the results of fitness or objective function. From the table, it can be clearly seen that Catfish PSO based images produces enhanced results than HE technique and PSO algorithm. The Catfish PSO outperforms PSO because it avoids premature convergence by introduction of Catfish Particles.

Table 2: Results obtained in terms of Fitness function

Image Name/Type	Fitness of Original Image	Fitness of HE	Fitness of PSO	Fitness of Catfish PSO
Normal	0.0695	0.1045	0.1654	**0.1784**
Cancer	0.1966	0.4296	0.5531	**0.5897**
Benign	0.1199	0.2584	0.5043	**0.5126**

4. CONCLUSION

In this paper, Catfish PSO based automatic image enhancement technique for breast cancer images have been implemented. Results of the proposed technique are compared with PSO and with Histogram Equalization (HE) .It is observed that Both PSO and Catfish PSO give better results when compared to HE. Catfish PSO outperforms PSO in terms of solution quality, because it avoids pre-mature convergence leading to a wider global search. In future work a study to classify features of masses to identify the benign or malignant patients for early detection of breast cancer is to be carried out.

REFERENCES

[1] "US Breast Cancer Statistics", American Cancer Society.http://www.breastcancer.org/symptoms/understand_bc/statistics

[2] Agarwal G, Ramakant P. Breast Cancer Care in India: The Current Scenario and the Challenges for the Future. *Breast Care*. 2008; 3(1):21-27. Doi:10.1159/000115288.

[3] National Cancer Registry Program. Ten year consolidated report of the Hospital Based Cancer Registries, 1984–1993, an assessment of the burden and care of cancer patients. New Delhi: Indian Council of Medical Research; 2001.

[4] Angela Lanfranchi, "Decades of Hope", Speech in Somerville, New Jersey on Courthouse Steps for Somerset County Cancer Coalition and Freeholders.

[5] Gonzalez, R. C., & Woods, R. E. (2002). Digital image processing.

[6] Hashemi, S., Kiani, S., Noroozi, N., & Moghaddam, M. E. (2010). An image contrast enhancement method based on genetic algorithm. *Pattern Recognition Letters*, *31*(13), 1816-1824.

[7] Verma, A., Goel, S., & Kumar, N. (2013, February). Gray level enhancement to emphasize less dynamic region within image using genetic algorithm. In*Advance Computing Conference (IACC), 2013 IEEE 3rd International* (pp. 1171-1176). IEEE.

[8] Draa, A., & Bouaziz, A. (2014). An artificial bee colony algorithm for image contrast enhancement. *Swarm and Evolutionary Computation*, *16*, 69-84.

[9] Gorai, A., & Ghosh, A. (2009, December). Gray-level image enhancement by particle swarm optimization. In *Nature & Biologically Inspired Computing, 2009. NaBIC 2009. World Congress on* (pp. 72-77). IEEE.

[10] Yaghoobi, S., Hemayat, S., & Mojallali, H. (2015, March). Image gray-level enhancement using Black Hole algorithm. In *Pattern Recognition and Image Analysis (IPRIA), 2015 2nd International Conference on* (pp. 1-5). IEEE.

[11] Eberhart, R. C., & Kennedy, J. (1995, October). A new optimizer using particle swarm theory. In *Proceedings of the sixth international symposium on micro machine and human science* (Vol. 1, pp. 39-43).

[12] Selvakumar A I, Thanushkodi K. A new particle swarm optimization solution to nonconvex economic dispatch problems. IEEE Transactions on Power Systems, 2007, 22(1): 42–51

[13] Shi, Yuhui, and Russell Eberhart. "A modified particle swarm optimizer."*Evolutionary Computation Proceedings, 1998. IEEE World Congress on Computational Intelligence., The 1998 IEEE International Conference on*. IEEE, 1998.

[14] Chuang L Y, Tsai S W, Yang C H. Catfish particle swarm optimization. In: 2008 IEEE Swarm Intelligence Symposium. Missouri, USA, 2008, 1–5

[15] Murali, K., and T. Jayabarathi. "Solution to economic dispatch problem with valve-point loading effect by using catfish PSO algorithm." *Frontiers in Energy* 8.3 (2014): 290-296.

[16] Michal Health, Kevin Bowyer, Daniel Kopans, Richard Moore and W. Philip Kegelmeyer, in Proceedings of the Fifth International Workshop on Digital Mammography, M.J.Yaffe ed., 212-218, Medical Physics Publishing, 2001. ISBN 1-930524-00-5.