International Journal of Soft Computing 3 (3): 220-223, 2008
ISSN: 1816-9503

Hybrid Particle Swarm Optimization for Automatically Detect the Breast Border and Nipple Position to Identify the Suspicious Regions on Digital Mammograms Based on Asymmetries

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Abstract: The presence of microcalcifications in breast tissue is one of the most important signs considered by radiologist for an early diagnosis of breast cancer, which is one of the most common forms of cancer among women. In this study, the Genetic Algorithm (GA) hybrid with Particle Swarm Optimization (PSO) is proposed to automatically detect the breast border and nipple position to identify the suspicious regions on digital mammograms based on asymmetries between left and right breast image. The basic idea of the asymmetry approach is corresponding left and right images are subtracted to extract the suspicious region. The proposed system consists of 2 steps: first, the mammogram images are enhanced using median filter, normalized the image, pectoral muscle region is removed and the border of the mammogram is detected for both left and right images from the binary image. Further, PSO is applied to enhance the detected border. The figure of merit is calculated to evaluate whether the detected border is exact or not. And the nipple position is identified using ACS. The performance is compared with the existing methods. Second, using the border points and nipple position as the reference the mammogram images are aligned and subtracted to extract the suspicious region. The algorithms are tested on 114 abnormal digitized mammograms from MIAS database.

Key words: Genetic Algorithm (GA), Particle Swarm Optimization (PSO) , microcalcifications

INTRODUCTION

Cancer involves the uncontrolled growth of abnormal cells that have mutated from normal tissues. This growth can kill when these cells prevent the normal functioning of vital organs or spread throughout the body damaging essential systems. The term benign refers to a condition, tumor or growth that is not cancerous. This means that it does not spread to other parts of the body or invade and destroy nearby tissue. Benign tumors usually grow slowly. In general, benign tumor or condition is not harmful. However, this is not always the case. If a benign tumor is big enough, its size and weight can press on nearby blood vessels, nerves, organs or otherwise cause problems. Breast cancer, also known as carcinoma, is a malignant growth that begins in the tissues of the breast. There are several types of breast cancer. Ductal carcinoma begins in the cells lining the ducts that bring milk to the nipple and accounts for more than 75% of breast cancers 20% of lobular carcinoma begins in the milk-secreting glands of the breast but otherwise fairly similar in its behavior to ductal carcinoma; 5% of other varieties of breast cancer can arise from the skin, fat, connective tissues and other cells present in the breast.

ENCHANCEMENT

Image preprocessing and enhancement methods inquire about how to improve the visual appearance of mammograms. This study deals with preprocessing and enhancement activities such as removal of film artifacts and labels, filtering the image, normalization and removal of pectoral muscle region. The enhancement method consists of four processing steps. In the first step, the given images are identified as left or right breast image and the film artifacts such as labels and X-ray marks are removed from the mammogram. In the second step, the high frequency components are removed using median filtering. In the third step, the mammogram images are normalized to avoid the difference in brightness and contrast between the mammograms caused by the recording procedure. In the fourth step, the pectoral muscle region is removed from the breast region to increase the reliability of the segmentation and classification of microcalcifications (Karnan *et al*., 2006).

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SEGMENTATION OF SUSPICIOUS REGION

The suspicious region or microcalcifications is segmented using Bilateral Subtraction for a pair of images. Thangavel *et al.* (2006) and Cheng *et al.* (2003) have presented a study on methods of various stages of automatic detection of microcalcification in digital mammograms. It is to be noted that researchers have not used GA and PSO to analyze the mammograms in the recent past. In this study, metaheuristic algorithms such as GA and PSO are implemented to extract the suspicious region based on the asymmetry approach.

In bilateral subtraction, the asymmetries between corresponding left and right breast images are considered for extracting the suspicious region from the background tissue. The breast border and the nipple position are used as reference points for alignment of mammograms. The Genetic Operators such as reproduction crossover and mutations are used to detect breast border and using a novel method called Particle Swarm Optimization algorithm is used to identify the nipple position.

Detection of the breast border: A histogram-based thresholding technique is used to generate a binary image to separate the breast and the non-breast region. The GA enhances the breast border. Border detectors detect the edges in the binary images, where each pixel takes on either the intensity value zero for a non-border pixel or one for a border pixel. Each pixel in the binary map corresponds to an underlying pixel in the original image. In this proposed system, kernel is extracted from the border points as a neighborhood array of pixels of the size of 3×3 window of binary image. The binary kernels are considered population strings for GA.

The corresponding kernels are extracted from gray level mammogram image using spatial coordinate points and the sum of the intensity values are considered as the fitness value. After identifying the initial population and the fitness value, the genetic operators can be applied to generate the new population. Reproduction operator produces a new string for crossover. Reproduction is implemented as linear search through roulette wheel with slots weighted in proportion to kernel fitness values. In this function, a random number multiplies the sum of the population fitness called as the stopping point.

Next, the mutation operator, flipping bits at random carries it out, with some small probability values. When mutation occurs on a bit string representation, a random bit is either flipped or flopped, i.e., its value is changed from zero to one or vice versa (Goldberg, 1989). After mutation, the kernels are considered a new population.

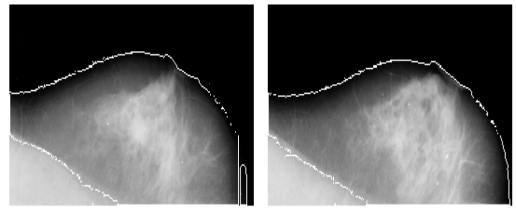

Fig. 1: Border detection using GA

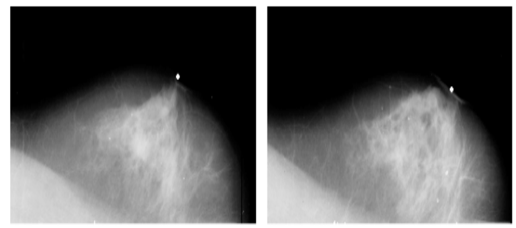

Fig. 2: Nipple identification

This procedure is performed until the size of the new population is equal to the initial population. Then the old population is assigned the new population value and the same procedure is performed again to generate the next population. Finally, the kernels in the latest population are the enhanced border points. In the binary image, the spatial coordinates of the border points are mapped with the original mammogram image (Karnan *et al.*, 2006). Figure 1 and 2 show the breast border detection using Genetic Algorithm and nipple identification using PSO.

Identification of the nipple position: The nipple may appear either in profile or not in profile. The nipple is located on the mammogram close to where the rate of change among gray levels is larger than in the rest of the breast. This study presents Particle Swarm Optimization (PSO) for identifying the nipple position. PSO is a recent heuristic search method whose mechanics are inspired by the swarming or collaborative behavior of biological populations. In other words, PSO move from a set of points (population) to another set of points in a single iteration with likely improvement using a combination of deterministic and probabilistic rules. The major objective of this study is to extracting suspicious region from back ground tissue or mammogram.

The PSO algorithm consists of three steps, namely, generating particles, positions and velocities, velocity update and finally, position update. Here, a particle refers to a kernel in the entire mammogram image that changes its position from one move (iteration) to another based on velocity updates.

Table 1: Performance analysis

Authors	Methods	Detection rate (%)
Ferrari and Rangayyan, 2001	Directional Filtering with Gabor wavelets	74.40
Lau and Bischof, 1991	Asymmetry Measures	85.00
Sallam and Bowyer,1999	Unwarping Technique	86.60
The proposed Approach	Bilateral Subtraction using PSO	92.60

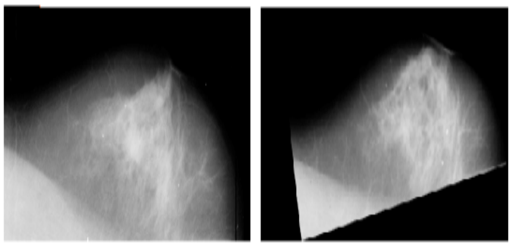

Fig. 3: Alignment of mamograms

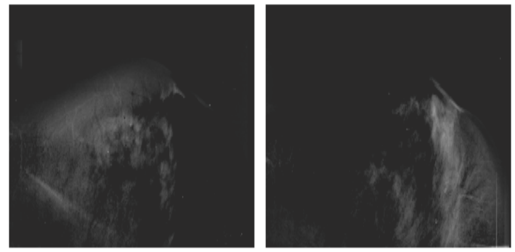

Fig. 4: Asymmetry image

Initially all the flag values are set to 0 and the velocity values are assigned with V_0. At the initial step, all the birds are assigned with the border points and their velocity values are updated. Select the bird, which generate the global best and change the position of the bird to the next pixel which is unvisited. Change the position of the remaining birds in the direction of the bird which generates global optimum. Repeat the procedure all the pixels have been visited by all the birds. The kernel, which generates the *Gmax,* is traced and the spatial co-ordinate of the center pixel is stored. This procedure is repeated till all the birds have visited the kernels. The entire procedure can be repeated for Number of times (NI). At the final iteration, the spatial co-ordinate of the center pixel is considered as nipple position.

Alignment of mammograms: Right and left breast images must be aligned prior to subtraction (Karnan *et al*., 2006; Mendez *et al*., 1996). Alignment involves the selection of border points and nipple position for transforming the coordinates of one image in order to align the left and the right images. In Fig. 3 the right breast image is always transformed. The right mammogram is displaced and rotated to align the images and the coordinates of the detected nipples of both the images are used to determine the displacement.

Generating the asymmetry image: After the images are aligned, bilateral subtraction will be performed by subtracting the digital matrix of the left and right breast image (Muttarak *et al*., 2004). Microcalcifications in the right breast image have positive pixel values in the image obtained after subtraction, while microcalcifications in the left breast image have negative pixel values in the subtracted image. As a result, 2 new images are generated: One with positive values and the other with negative values. The most common gray value is zero, which indicates no difference between the left and the right images. The asymmetry image can be threshold to extract suspicious regions also shown in Fig. 4. To generate the ROC curve, the asymmetry image is threshold using ten different intensity values ranging from 50-150 (Karnan *et al*., 2006a, b; Karnan, 2006; Karnan and Thangavel, 2007; Thangavel *et al*., 2005a, b; Thangavel and Karnan, 2005a; Thangavel and Karnan, 2005b). GA was used to detect the border and PSO was used to find the nipple position. The experimental results show in Table 1 that the bilateral approach produces 0.926 as Az value (Karnan *et al*., 2006). It was observed that the PSO hybrid with GA is performed well. The effectiveness of the proposed technique is determined by extracting the suspicious region from the mammogram image using bilateral subtraction. The true positive detection rate and the number of false positive detection rate at various thresholds of the asymmetry images are used to measure the algorithm's performance.

REFERENCES

Cheng, H.D., X. Cai, X.W. Chen, L. Hu and X. Lou, 2003. Computer Aided Detection and Classification of Microcalcifications in Mammograms: A Survey. Pattern Recognition, 36: 2967-2991.

Ferrari, R.J., R.M. Rangayyan, J.E.L. Desautels and A.F. Frere, 2001. Analysis of Asymmetry in Mammograms via Directional Filtering With Gabor Wavelets. IEEE. Trans. Med. Imaging, 20: 953-964.

Goldberg, D.E., 1989. Genetic Algorithms in Search, Optimization and Learning. NY, Addison Wesley.

Karnan, M., K. Thangavel, K. Thanushkodi and K. Geetha, 2006a. Differential Geometry and Topology in the Perspective of Modern Trends. DGTPMT-2006, Dayalbagh Educational Institute, Agra, Pushpak Publications (In Press).

Karnan, M., K. Thangavel, K. Thanushkodi and K. Geetha, 2006b. Enchancement of Micrcalcifications in Digital Mammograms, GCEVISION. Proceedings Thirunelveli, pp: 363-370.

Karnan, M., K. Thangavel, K. Thanushkodi and K. Geetha, 2006c. Patrcle swarm optimization for mammogram Image analysis. Lecture notes on Engineers and computer scientists IMCES-Hongkong, pp: 115-120.

Karnan, M., K. Thangavel, K. Thanuskodi and K. Geetha, 2006d. Automatic Detection of Suspicious Regions on Digital Mammograms using Genetic Algorithm. DGTPMT-2006, Dayalbagh Educational Institute, Agra, Pushpak Publications (In Press).

Karnan, M., K. Thangavel, K. Geetha, K. Thanushkodi and R. Sivakumar, 2006e. Particle Swarm Optimization for Automatic Detection of the Suspicious Regions on Digital Mammograms. Algorithm International Conference on Intelligent Systems and Controls, Karpagam College of Engineering. Coimbatore, pp: 9-11.

Karnan, M., 2006. Intelligent System For Mammogram Image Analysis. PhD Dissrtation, Gandhigram Rural University, Tamilnadu, India.

Karnan, M. and K. Thangavel, 2007. Automatic Detection of the Breast Border and Nipple Position on Digital Mammograms Using Genetic Algorithm. Int. J. Comput. Methods and Programs in Biomed. (Elsvier), 87: 12-20.

Lau, T.K. and W.F. Bischof, 1991. Automated detection of breast tumors using the asymmetry approach. Comput. Biomed. Res., 24: 273-295.

Mendez, A.J., P.G. Tahocesb, M.J. Lado, M. Souto, J.L. Correa and J.J. Vidal, 1996. Automatic Detection of Breast Border and Nipple in Digital Mammograms. Comput. Methods and Programs Biomed., 49: 253-262.

Muttarak, M., G. Peh and B. Chaiwun, 2004. Malignant germ cell tumors of undescended testes: Imaging features with pathological correlation. Clin. Radiol., 59: 198-204. 2004.

Sallam, M.Y. and K.W. Bowyer, 1999. Registration and difference analysis of corresponding mammogram images. Med. Image Anal., 3: 103-118.

Thangavel, K., M. Karnan, Siva R. Kumar and A. Kaja Mohideen, 2005. Automatic Detection of Microcalcification in Mammograms-A Review. Int. J. Graphics Vision and Image Processing, 5: 31-61.

Thangavel, K., M. Karnan, R. Siva Kumar and A. Kaja Mohideen, 2005. Segmentation and Classification of Microcalcification in Mammograms Using the Ant Colony System. Int. J. Artificial Intelligence and Machine Learning, 5: 29-40.

Thangavel, K. and M. Karnan, 2005. Computer Aided Diagnosis in Digital Mammograms: Detection of Microcalcifications by Meta Heuristic Algorithms. Int. J. Graphics Vision and Image Proc., 5: 41-55.

Thangavel, K. and M. Karnan, 2005. Automatic Detection of Asymmetries in Mammograms Using Genetic Algorithm. Int. J. Artificial Intelligence and Machine Learning, 5: 55-62.