International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-1, October 2018

Computer-Aided Diagnosis of Digital Mammograms using Gabor Wavelets

Umar S. Alqasemi, Ahmed A. Qashgari, Mukhtar M. Alansari

Abstract*: Digital mammogram X-ray is commonly used for breast cancer diagnosis, where computer aided diagnosis (CADx) algorithms are used to help the radiologists process the large volume of data with more accurate diagnosis. In this study, we developed a new CADx algorithm applied and tested on digital X-ray mammogram images from a standard test database from the Mammographic Image Analysis Society (MIAS). The algorithm starts by extracting features using Gabor wavelet transform of different level of orientation and wavelengths. After that, the dimension of the extracted features is reduced through Principal Component Analysis (PCA) followed by Support Vector Machine (SVM) classifier of Gaussian kernel. The model perfectly fitted the training data with 100% accuracy, sensitivity, and specificity in detecting malignant cases versus benign ones. Furthermore, the model performed well on testing set with 90% accuracy, 100% sensitivity, and 89% specificity.

Keywords: Computer-Aided Diagnosis, Digital Mammogram, Gabor Wavelets Feature, Support Vector Machines, Classification.

I. INTRODUCTION

Breast cancer is one of the top disease have death impact to who sufferer, the best medical equipment dedicated of breast cancer with accurate result is the x-ray devices through mammogram equipment modality because of higher specification available on it [1].

Specially, the high intensities density is the main player of characteristic specification on mammographic image with covering breast region, because of the fast technology movement with discovering a new methods and technique to increase the accuracy rate to diagnostic the tumor from early stage to give the physicians move to proactive and preventive treatment mode through dedicate the class type of tissue normal as majority of result scanning, benign tumor, or malign tumor to keep a space to the physicians to take right treatment through give them the high accuracy result after segmentation and microclassification using computer aided diagnostic [2].

Manuscript published on 30 October 2018.
***** Correspondence Author (s)
Umar S. Alqasemi, Department of Biomedical Engineering, King Abdul-Aziz University, Jeddah, Saudi Arabia, E-mail: ualqasemi@kau.edu.sa
Ahmed A. Qashgari, Department of Biomedical Engineering, King Abdul-Aziz University, Jeddah, Saudi Arabia, E-mail: ahmed.q@drayaa.com
Mukhtar M. Alansari, Department of Biomedical Engineering, King Abdul-Aziz University, Jeddah, Saudi Arabia, E-mail: mukhtar.rad@gmail.com

Sun et al. [3] Regional Analysis in this research paper and previous papers came as first stage to defined the region of interest from the database to start forward on the computer aided diagnosis program, and the 2D quincunx wavelet transform used to developed the multiresolution of decomposition of normal and abnormal image based on features extraction. There are several features can use related about the methodology and there are common features such as mean, stander division, and entropy to enhance the accuracy with more out about from image to get more accurate diagnoses, in this paper we are using the gabor wavelet transform, for wavelet transform have multiscale, the one-dimensional modulus maxima wavelet transform, and the two-dimensional to multi-scale product. M. Salmeri et al. Multiscale wavelet developed the processing image through dyadic wavelet and applied on more images databases to enhance the algorithm with got great output from it [4].

Mascio et al. developed algorithm is one of other criteria to enhance the CADx result on digital image mammograms with focusing on gray-scale morphology and microclassification to get better output in false negative -FN [5]. Karssemeijer et al. to moving in automated detection concept is great with the medical equipment come more faster with high accuracy output to the user, need to work on the database to get a labeling to check the performance of the output and algorithm with using the learning data then test data as statistical methods for classification on digital mammogram image [6]. Elshinawy, Mona et al. performance evaluation is a KPI in most of researcher to get stage of the CAD and where can improved to increase the accuracy and be more sensitivity on the false negative rate for each features applied in the CADx ti can adding and removing the steps of the methodology form the researcher mind [7]. Performances evaluation are the main key of result to take the decision on the patient and CADx is moving in the right direction or not with check the error rate, accuracy, sensitivity, and specificity. Sensitivity is a proportion of positive number with the disease subject, leading with true positive, false negatives rate [8]. One of perfect technique to developed the computer vision application for medical imaging modelling is the 2D Gobar wavelet with very fit on it as function depending on orientation, texture analysis, and image retrieval [9]. Challenges in most of CAD research in the classification is the mass detection because of high characteristic on tissue density, so that there are four categories classified, which starting with structural followed by statistical after that the modelling tell reach to final categories stage on transformation on texture features [10].

Concept of principal component analysis – PCA focused on dataset transformation variables to can processing easily through it, with reduce the dimensionality of dataset images to patch images [11]. Support vector machine is providing the learning methods on programming software in MATLAB and it is successful in kernel rule (Gaussian) methods and procedure in theory of statistical learning [12], with having two main categories in origin of arises, the first one is the nonlinear way through mapping in features vector, and the second one is to find hyperplane to separate the database to training and testing then applying the CADx program on it to check the classifier performance with consider the error rate, and this is on of the aim of SVM [13].

This paper implemented a new CADx program algorithm using Gabor wavelets features reduced the error rate with increase the sensitivity and specificity and we used PCA in programming code to make the process easily, then fed to Support Vector Machine classifier, which shows promising accuracy for aiding diagnosis of calcifications in digital X-ray mammograms. Additional in SVM classifier aim is to reduce the false positive region % from diagnosis to increase the accuracy to show it to the physicians [13].

II. MATERIALS AND METHODOLOGY

A. Database Source

The source of data images was from the international reference society (MIAS) of the mammogram images used in this scientific study, including 322 samples labelled with categories (normal, benign, and malignant), 1024 × 1024 is pixels of images database. Additional the abnormality cases in database were divide to six categories as follow: first one is micro-calcification, followed by circumscribed-masses, then speculated-masses, and ill-defined-masses, after that architectural-distortion, finally asymmetry. 110 samples are used in this study with 8 × 8 pixels region of interest (ROI) for each image. Most of previous research have used the same source of database because of more credibility and accurate result from real patient with applying several methodology and technique depend on the researcher thinking to approving their methods and comparing result with others, even in this research we used the same source and applied our methodology and comparison with previous scientist.

B. Feature Extraction

C. Beside PCA, we used two feature selection methods to screen the non-useful features further, by using the 2 type of evolution the feature, t-test if the P-Value < 0.05 will be useful feature and other evolution is correlation coefficient > 0.5 will be useful feature.

C. Classification

Fit a classification SVM was project classifier use a Gaussian kernel, with applied it in the learning set, and then applied it in testing set. A fitc SVM is learning models supervision with algorithms analyzes data to use a classification parameter and regression analysis. SVMs have a complex algorithm to solve and deal with several problems to developing and provide a solution such as a non-linear classification using kernel trick and other features can applied on.

III. RESULTS AND DISCUSSION

First step in the result, we are showing the normal and abnormal (benign and malignant) mammogram image with patch of 128x128 pixel of original extracted from database by 1024×1024 pixels images, as shown in figure 1.

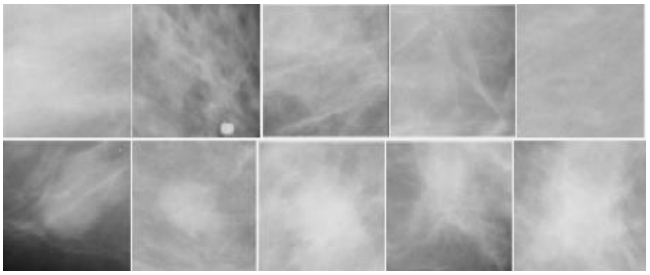

Figure 1. Mammographic Image extracted from the CADx program in MATLAB to Patches of 128×128 pixels. The top row from the figure is represents 5 samples as normal case, and bottom row from the figure is represents 5 samples as abnormal case (Benign and Malignant).

After import 322-sample image in MATLAB program from database source, we started to select from the 110 samples as randomly, with create ROIs 8x8 pixels with loading ROIs in one data file. Then we created learning and testing set with 50% from 110 samples to be 55 samples for each set to run the code on it. The evaluation features result using t-test experiment was 66 useful feature out of 66, mean feature, standard deviation feature, and 64 feature in Gabor wavelets because 8x8 pixels. The coefficient correlation the relation between each features, we got 65 features out of 66. The outcome of performance evaluation for the training set is 100% for all parameters (accuracy, sensitivity, and specificity) and the outcome for the testing set as shown in below table.1 with found the result of orientation zero degree is equal 45 degree, and 90 degree equal 135 degree outcome implemented in classifier FIT SVM (‘Gaussian kernel’).

Table.1 The Performance Evaluation for Testing Set

Orientation	Sensitivity	Specificity	Accuracy
45 degree	100.00%	83.30%	90.00%
90 degree	97.78%	83.08%	89.09%

IV. CONCLUSIONS

This scientific paper study designed a CADx system to enhance the accuracy for learning and testing set in digital mammogram image with using the MATLAB software to select and test the useful of Gabor wavelets and check the performance evaluation in Fit SVM Gaussian kernel classifier, with achieve the result of accuracy 100% in learning set. This is the CAD program will increase the productivity in accuracy in diagnostic dieses for banging and malignant for breast cancer, and will be good tools for the radiologist to take the decision for the treatment process. We compared the result with the previous work loan Buciu,

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Alexanderu Gacsadi [1] as shown in below table.2, the compression was a good indication for our study to enhance the sensitivity, specificity and accuracy in CADx program using Gabor wavelet, with miner increase the percentage in sensitivity to difference by 2.44% and 22.44% on specificity which was a great result and enhanced the program accuracy of a diagnostic.

Table.2 Comparison of Different Performance Measurement for Classifying.

Study	Techniques		Evaluation Performance %			
	Classifier	Features	Sensitivity	Specificity	Accuracy	AUC
[1]	SVM	(PCA) and Gabor wavelet	97.56	60.86		0.79
Study Predict	Fit-SVM	Gabor Wavelet and PCA	100	83.3	90	0.9

ACKNOWLEDGMENT

Authors acknowledge their sincere thanks to Dr. Yasser kadah, Associate Professor, Department of biomedical engineering, king Abdul-Aziz University for his valuable comments and suggestion.

REFERENCES

1. Zaiane OR, Antonie ML, Coman A. Mammography classification by an association rule-based classifier. In Proceedings of the Third International Conference on Multimedia Data Mining 2002 Jul 23 (pp. 62-69). Springer-Verlag.
2. Ioan Buciu, Alexandru Gacsadi, Directional features for automatic tumor classification of mammogram images, Biomedical Signal Processing and Control 6 (2011) 370–378.
3. Y. Sun, C.F. Babbs, E.J. Delp, Normal Mammogram Classification based on Regional Analysis, The 2002 45th Midwest Symposium on Circuits and Systems 2 (2002) 375–378.
4. Mencattini, M. Salmeri, R. Lojacono, Mammographic image enhancement and denoising for breast cancer detection using dyadic wavelet analysis, IEEE Trans. Med. Image, 7 (57) (2008) 1422-1431. B. Smith, “An approach to graphs of linear forms (Unpublished work style),” unpublished.
5. L. Mascio, M. Hernandez, L. Clinton, Automated analysis for microcalcifications in high-resolution digital mammograms, Proc. Spie-Int Soc. Opt. Eng. 1898 (1993) 472-479.
6. N. Karssemeijer, Stochastic model for automatic detection of calcifications in digital mammograms, in: Proceedings of 12th international conference on Information Processing in Medical Imaging, Wye, U.K., (1991).
7. M. Y. Elshinawy, W. W. Abdelmageed, A. H. A. Badawy, and M. F. Chouikha, "Pre-CAD system for normal mammogram detection using local binary pattern features," in Computer-Based Medical Systems (CBMS), 2010 IEEE 23rd International Symposium on, 2010, pp. 352-357.
8. Sardanelli F, Di Leo G. Biostatistics for radiologists: planning, performing, and writing a radiologic study. Springer Science & Business Media; 2009 Mar 31.
9. T. Lee, Image Representation using 2d Gabor Wavelets, IEEE Trans. Pattern Analysis and Machine Intelligence vol.18 (10) (1996) 959–971.
10. AbuBaker A. Mass lesion detection using wavelet decomposition transform and support vector machine. International Journal of Computer Science & Information Technology. 2012 Apr 1;4(2):33.
11. I.T. Jolliffe, Principal Component Analysis Series: Springer Series on Statistics, 2nd Ed., Springer, NY, 2002.
12. V. Vapnik, Statistical Learning Theory. New York: Wiley, 1998.
13. Wei L, Yang Y, Nishikawa RM, Jiang Y. A study on several machine-learning methods for classification of malignant and benign clustered microcalcifications. IEEE transactions on medical imaging. 2005 Mar;24(3):371-80.

AUTHOR PROFILE

Umar S. Alqasemi, Assistant Professor of Biomedical Engineering at King Abdul-Aziz University, research on biomedical engineering application, having more than twenty published papers, more than fifteen papers review and auditor, interested on photoacoustic imaging, CAD imaging, signal processing and more, guider on real life of biomedical business sector at KAU.

Ahmed A. Qashgari MSc. Electrical and Biomedical Engineering, two scientific paper and ten articles, worked on several research on test equipment calibration of biomedical engineering and CAD system of medical imaging, board members on Saudi scientific society of biomedical engineering, two applied research executed in real market with GE healthcare and Saudi government hospitals, interested on biomedical engineering application sectors.

Mukhtar M. Alansari MSc. Electrical and Biomedical Engineering, three published papers, research on biomedical signals and imaging processing, brain computer interface and tissue engineering, co-founder of nanoparticle manufacturing