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A Novel Framework for Detection of Cervical Cancer

V. Pushpalatha[1], S. Sathiamoorthy[2] and M. Kamarasan[3]
[1]Research Scholar, [2&3]Assistant Professor, Division of Computer and Information Science
Annamalai University, Annamalai Nagar, Tamil Nadu, India
E-Mail: ks_sathia@yahoo.com
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Abstract **- Today, Uterine Cervical Cancer is most general form of cancer for women. Prevention of cervical cancer is possible via various screening courses. Colposcopy images of cervix are analyzed in this study for the recognition of cervical cancer. An innovative framework is suggested to correctly identify cervical cancer by employing effective pre-processing, image enhancement, and image segmentation techniques. This framework comprises of five phases, (i) Dual tree discrete wavelet transform to pre-process the image (ii) Curvelet transform and contour transform to enhance the image (iii) K-means for segmentation (iv) features computation using Gray level co-occurrence matrix (v) classification using adaptive Support vector machine. The experimental results evident that proposed technique is superior to existing methodologies.**
Keywords: **Dual-Tree Discrete Wavelet Transform, Curvelet Transform, Contour Transform, K-Means clustering, Gray Level co-occurance matrix**

I. INTRODUCTION

Cervix is linear part of lower uterus because of that it is defined as a neck of uterus. In USA, cancerous community described that they found of 12,800 new cases with cervical cancer for every year and it leads to 4000 deaths, and also stated that cervical cancer is the highest reason of death among women [1]. It is also evident that cervical cancer lies in the age below 50. Cervical cancer results in uncontrolled growth of cells in cervix and each of them has a precise life time. New cells replace them while they die. However, cancer cells never die and extend to divide. This endless division leads to cancer. Factors that causes cancer are Human papillomavirus virus (HPV), smoking, feeble immune system. Over 100 Human papilloma viruses are found. Among them fifteen roots cancer in human body and remaining HPV is harmless.

The amount of informed patients of cervical cancer is reduced in last 20 years due to periodical screening by women. During screening, cancer is predicted in beginning Phase that can be treated positively [2]. Nowadays women are aware of cancer. So they frequently do the screening test with or without the physician's suggestion.

Because of human errors and time consuming of pap smear result, the pap smear method is not advisable. Thus, automated approach has to be developed that performs the disclosure of unusual cells fast, accurate, and easy.

II. RELATED WORKS

Deep features based convolutional neural network is compared with seven classic classifiers fed with hand crafted pyramid features for classification of cervigram images in [3] and it is determined that convolution neural network outperformed the existing seven classic neural networks for cervigram images.

In [4], Neighborhood concentric filter is used for denoising. From the denoised image, segmentation operation is performed in an enhanced manner using optimal weight updation with Multi-Level set estimates. From segmented region of interest gray level co-occurrence matrix and geometrical features like area, cell size, cell intensity and maximum intensity are calculated and are fed to neural network based RVM classifier intended to classification of abnormal and normal cervical images. In line with this, number of researches [3-15] has been done in the domain of cervical cancer detection.

Recently, energy from Gabor and contourlet wavelets and Gray level co-occurrence matrix is employed for the prediction of cervical cancer detection in MRI images [16].

In [17], discrete wavelet transform based color histogram is employed and segmentation is based on contour approach. Though literature reports number of automated systems for cervical cancer detection, still the accuracy of the cervical cancer detection is limited. It may be because of choosing the appropriate combination of techniques for pre-processing, enhancement, feature calculation and classification. In the suggested system, we used 2D DT-DWT for preprocessing, curvelet and contour transform for image enhancement, gray level co-occurrence matrix for feature extraction and support vector machine for classification, and this combination works well for cervical cancer discovery in digitized colposcopy images.

III. PROPOSED WORK

The framework for revealing of cervical consists of 5 phases and are.

1. *Pre-processing phase:* Dual Tree Discrete Wavelet Transform approach
2. *Image Enhancement phase*: Curvelet and Contour Transformation approaches

3. *Segmentation phase:* K-Means clustering method
4. *Feature extraction phase:* 1st and 2nd order statistics are calculated with Gray level co-occurrence matrix
5. *Classification:* Support vector machine is incorporated for the classification of cervical images captured using colposcopy.

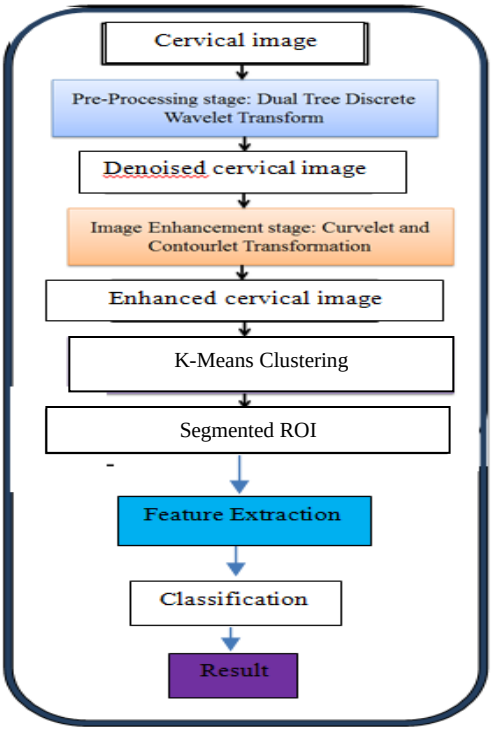

Fig. 1 An innovative Framework for cervical cancer identification

A. Pre-Processing Stage by DT-DWT

The Discrete Wavelet Transform [18] has advantages like better compression of signal energy, flawless reconstruction using short support filters, very less computation and no redundancy. DT-DWT is also used as fuzzy denoising technique and it offers shiftable sub-bands and worthy directional selectivity. The 2D DT-DWT applied image can be work with two critically sampled separable 2D-DWT in parallel. The benefits of 2D DT-DWT over separable 2D DWT are that it is used to adopt 2D wavelet transforms that are highly discriminating with respect to orientation.

B. Image Enhancement Phase

1. Curvelet Transform

Curvelet transform [19] centered enhancement deals with exciting phenomena that arises along curved contour in 2D image. Curvelet transform is suitable to images that contains contour. Thus, it is worthy for contour enhancement. Curvelet transform also has properties like scaling law and new pyramid.

2. Contour Transform

The Contour transform [19] combines Laplacian Pyramid with Directional Filter Bank. The first one is used for capturing point discontinuities and later is used to connect point discontinuities to linear structures. Laplacian Pyramid decomposes image into numeral radial subbands and Directional Filter Bank decomposes each LP sub-band into any power of 2's number of directional sub-bands. The contour coefficient is characterized in a quad-tree arrangement.

C. Image Segmentation Phase by K-Means Algorithm

K-Means [20] approach partitions the data into K mutually exclusive groups. K-Means used to cluster objects using its attributes into K number of groups. Here, K is +Ve integer number. Clustering is carried out by decreasing sum of squares of distances between data and relevant cluster centroid. This algorithm is suitable to cluster huge quantity of data. It generates single level of clusters, unlike the hierarchical clustering method's tree structure arrangement.

Observations in data are treated as object taking location in a space and a partition is found. Objects of each cluster are very close with each other as probable and as distant from objects within other clusters as probable. Selection of distance measure is imperative step in clustering process. Distance metric defines the resemblance of two elements. It greatly influences shape of clusters. So, the correlation distance measure is selected which is used to provide the correlation between various data features.

D. Gray Level Co-Occurrence Matrix

Since GLCM [16] captures spatial relationship of pixels in an image. Hence, called as gray level spatial dependence matrix. GLCM computes the frequency of a pairs of pixel with specific values horizontally (0^0), vertically (90^0) or diagonally (45^0 and 135^0) and in specified spatial relationship. From the computed GLCM, first and second order statistical features like mean, standard deviation, correlation, contrast, energy and homogeneity are computed. The second order statistics measures local variations, joint probability occurrences of specified pair of pixel, uniformity and closeness of distribution of an elements respectively.

E. Classification

In the literature artificial neural network has been suggested broadly for classification of images more effectively The adaptive SVM [21] based on statistical learning theory has been used more frequently by the researchers for nonlinear and non-separable problems in various areas of research due to its high accuracy in classification problem.

Since in the proposed framework adaptive SVM [21] is employed for classification of cervical images using the features found from GLCM. In the proposed framework, RBF kernel function is used to maps data from input space to a higher. Tenfold cross-validation is accomplished for training and testing the SVM.

IV. RESULTS AND DISCUSSION

For the experiments, we have collected various classes of 450 colposcopy images with ground truth from various hospitals and the images are in various sizes. In the proposed system we used the following evaluation metrics for the evaluation of preprocessing and enhancement Phases of proposed work. The images in the database are preprocessed using the dual tree discrete wavelet transformation, enhanced using curvelet and contour transformation then k-means clustering approach is used for segmentation.

The efficacy of proposed framework can be evaluated by using the metrics like Mean Squared Error (MSE), Peak Signal-to-Noise Ratio (PSNR) and Execution Time.

Table I provides MSE values acquired by DT-DWT and median filter for given four sample cervical cancer images. Table II gives the PSNR values obtained by DT-DWT and median filter for given four sample cervical cancer images. median Table III gives the comparison of curvelet and contour transform and histogram equalization using mean square error method and Table IV illustrates the comparison of curvelet and contour transform and histogram equalization using PSNR method. From the results it is observed that the proposed dual tree discrete wavelet and the combination of curvelet and contour transform performs better than the conventional median filter and histogram equalization respectively.

TABLE I COMPARISON OF THE MEAN SQUARED ERROR VALUES FOR THE DUAL TREE DISCRETE WAVELET TRANSFORMATION AND MEDIAN FILTER APPROACHES IN THE PROPOSED FRAMEWORK

Transformation Techniques	**Mean Squared Error (MSE)**			
	Image 1	**Image 2**	**Image 3**	**Image 4**
Dual Tree Discrete Wavelet Transform	16.521	16.412	16.501	16.536
Median Filter [22]	24.531	26.432	24.678	24.512

TABLE II COMPARISON OF THE NOISE TO RATIO VALUES FOR THE DUAL TREE DISCRETE WAVELET TRANSFORMATION AND MEDIAN FILTER APPROACHES IN THE PROPOSED FRAMEWORK

Transformation Techniques	**Peak Signal to Noise Ratio**			
	Image 1	**Image 2**	**Image 3**	**Image 4**
Dual Tree Discrete Wavelet Transform	27.6843	28.7932	28.8821	28.7713
Median Filter [22]	37.884	38.789	36.995	37.113

TABLE III COMPARISON OF THE MEAN SQUARED ERROR VALUES FOR THE CURVELET AND CONTOUR TRANSFORM AND HISTOGRAM EQUALIZATION APPROACHES IN THE PROPOSED FRAMEWORK

Transformation Techniques	**Mean Squared Error (MSE)**			
	Image 1	**Image 2**	**Image 3**	**Image 4**
Curvelet and Contour Transform	14.928	14.8715	14.9755	14.926
Histogram Equalization [23]	25.431	24.632	25.984	26.541

TABLE IV COMPARISON OF THE PSNR VALUES FOR THE CURVELET AND CONTOUR TRANSFORM AND HISTOGRAM EQUALIZATION APPROACHES IN THE PROPOSED FRAMEWORK

Transformation Techniques	Peak Signal to Noise Ratio			
	Image 1	Image 2	Image 3	Image 4
Curvelet and Contour Transform	36.8347	36.6328	36.9317	36.8216
Histogram Equalization [23]	45.8823	46.9852	45.9972	46.6663

Sensitivity and specificity measures are used to measure the efficacy of proposed and existing system [24, 25]. The sensitive measures true positive rate and is demarcated as proportion of real positives which are properly identified. Whereas specificity is true negative rate which is proportion of actual negatives which are correctly identified.

From the ROC curve it is very clear that the proposed approach performs very well and attains higher classification rate then the existing approaches [24, 25] and it is because of the better preprocessed and enhanced output of proposed approach.

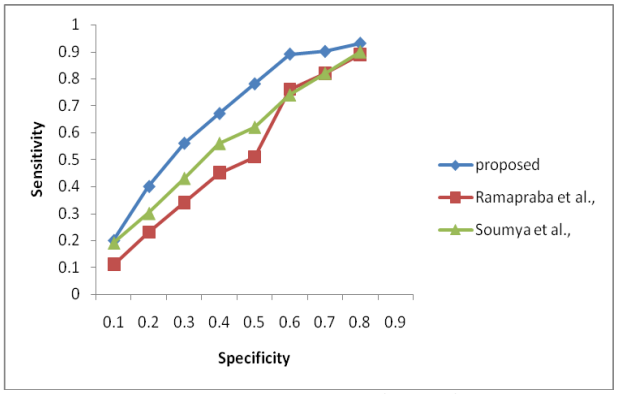

Fig. 1 ROC curves obtained in the classification for the proposed approach, Ramapraba *et al.*, and Soumya *et al.*, approach.

TABLE V ASSESSMENT OF THE PROPOSED AND EXISTING FRAMEWORK IN TERMS OF ACCURACY AND TIME COMPLEXITY

Method	Time in seconds	Accuracy
Proposed	4.17	93.42
Ramapraba *et al.*,	4.22	92.11
Soumya *et al.*,	4.11	89.02

V. CONCLUSION

This study introduced an innovative framework to the disclosure of cervical cancer using wavelet techniques has been presented. Dual Tree Discrete Wavelet Transform, Contour Transform, Curvelet Transform is done in the pre-processing Phase and image enhancement Phases. K-Means clustering has utilized for image segmentation. Gray Level co-occurrence matrix is used for computing the 1st and 2nd order statistical features and is classified using the adaptive support vector machine. From the experimental results it is very clear that proposed system is significantly better than the existing approach.

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