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A Novel Framework for Detection of Cervical Cancer

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***Abstract* - In Worldwide, Uterine Cervical Cancer is the most common forms of cancer in women. Most Cervical Cancer (CC) can be prevented through screening programs pointed at identifying precancerous sores.Meanwhile Digital Colposcopy, colposcopiccervigrams or images have procured in raw form.In this paper, a novel framework has intended to detect cervical cancer by applying Pre-processing step, Image enhancement, and Image Segmentation. This framework is formed of three stages, (i)Dual Tree Discrete Wavelet Transform(DTDWT) for pre-processing, (ii) Curvelet transform and ContourTransform(CC) for Image enhancement, and (iii) K-means clustering for Segmentation.**
***Keywords:* Image Processing, Cervical cancer, Dual-Tree Discrete Wavelet Transform (DTDWT), Curvelet Transform, Contour Transform, K-Means clustering**

I. INTRODUCTION

Cervix is the linear portion of the lower uterus. That is why it has described the neck of the uterus. The cancerous community of the USA provides a view for cervical cancer (CC) that there is a analysis of 12,800 new cases of CC that leads to 4000 deaths which are growing the usual maximum cause of death amongst women [1]. In most illustrations reported of CC lie in the age group under 50. CC is a result of an uncontrolled increase of the cervical cells. Each cell has a particular span of life. New cells replace them while they die. However, cancer cells do not die and extend to divide. This endless division leads to cancer. Some determinants alleviate cancer similar to the Human papillomavirus (HPV) virus in which a sexually transferred virus, smoking, and a weak immune scheme. More than 100 Human papillomavirus viruses are beyond out of which fifteen causes cancer in the body, and other 85 are harmless.

The number of reported cases of CC has been decreased in the past 20 years because of the useful screening test described pap smear test as cancer if identified at an initial stage can be managed successfully [2]. Women now knowledgeable of cancer frequently do the pap smear test as physicians suggest that Human papillomavirus test and pap smear test should be handled at the corresponding time. Cervical screening not only identifies cancer but also monitors for the aberrations in the cell that is if the nucleus grows larger in size. If the unnatural cells are not handled, they become transformed into the malignant cancerous cell. Because of human mistakes and lack of time of result of pap smear test, the pap smear tests are not perpetually accurate. Therefore, an electronic method has to be devised that performs the disclosure of unusual cells fast, accurate, and easy.

II. RELATED WORKS

Table I gives the related work done on the detection of cervical cancer by using Image Processing techniques.

TABLE I RELATED WORK ON THE DETECTION OF CERVICAL CANCER BY IMAGE PROCESSING TECHNIQUES

Author name	**Description**	**Methods used**
Xu, Tao, *et al* [3]	This paper introduced a new image datas*et al*ong with expert annotated diagnoses for evaluating image-based cervical disease classification algorithms.	Histogram of Local Binary Pattern, Convolutional Neural Network
Taneja, Arti, PriyaRanjan, and AmitUjlayan [4]	This paper enhances the performance of single-cell segmentation with the integrated feature vectors of geometrical (area, cell size, cell intensity and the maximum intensity) and Gray Level Co-occurrence Matrix (GLCM) to improve the abnormality level prediction	Gray level co-occurrence matrix, Neighborhood-Concentric filtering, Neural network-relevance vector Machine
Selvathi, D., W. RehanSharmila, and P. ShenbagaSankari [5]	The proposed method used two levels of classification using the deep learning technique, followed by a support vector machine (SVM) to tackle the overlapping cell issues.	Deep learning, Support Vector Machine, Convolutional Neural Network (CNN)
Bora, Kangkana, *et al* [6]	In this paper a new segmentation technique has also been proposed for extracting shape features. Ripplet Type I transform, Histogram first order statistics and Gray Level Co-	Ripplet Type I transform, Histogram first order statistics and Gray Level Co-occurrence Matrix

	occurrence Matrix have been used for color and texture features respectively.	
Iliyasu, Abdullah M., and ChastineFatichah [7]	A quantum hybrid (QH) intelligent approach that blends the adaptive search capability of the quantum-behaved particle swarm optimisation (QPSO) method with the intuitionistic rationality of traditional fuzzy k-nearest neighbours (Fuzzy k-NN) algorithm (known simply as the Q-Fuzzy approach) is proposed for efficient feature selection and classification of cells in cervical smeared (CS) images.	quantum machine learning, Fuzzy k-NN, quantum-behaved PSO
Singh, Sanjay Kumar, and Anjali Goyal [8]	This paper presented an approach for segmentation of nuclei of uterine cervix pap smear cells using watershed segmentation.	Watershed segmentation, Morphological operations, Thresholding
William, Wasswa, *et al* [9]	The survey reviews publications on applications of image analysis and machine learning in automated diagnosis and classification of cervical cancer from pap-smear images spanning 15 years. The survey reviews 30 journal papers obtained electronically through four scientific databases (Google Scholar, Scopus, IEEE and Science Direct) searched using three sets of keywords: (1) segmentation, classification, cervical Cancer; (2) medical imaging, machine learning, pap-smear; (3) automated system, classification, pap-smear.	K-Nearest-Neighbors, Support Vector Machine
Sornapudi, Sudhir, *et al* [10]	In this study, a deep learning (DL)-based nuclei segmentation approach is investigated based on gathering localized information through the generation of superpixels using a simple linear iterative clustering algorithm and training with a convolutional neural network	convolutional neural network, Deep Learning
Zhao, Lili, *et al* [11]	This paper proposed an efficient abnormal cervical cell detection system based on multi-instance extreme learning machine.	multi-instance extreme learning machine
Manogaran, Gunasekaran, *et al* [12]	Bayesian hidden Markov model (HMM) with Gaussian Mixture (GM) Clustering approach to model the DNA copy number change across the genome	Bayesian hidden Markov model, Gaussian mixture clustering
Bhargava, Ashmita, *et al* [13]	In this paper, a method is proposed that helps in detection and classification of the cancer using HOG feature extraction and classifying it by the help of support vector machine (SVM), k-nearest neighboring (KNN), artificial neural network (ANN).	Artificial Neural Network, Support Vector Machine, KNN
Hemalatha, K., and K. Usha Rani [14]	In this paper, an improved Edge detection method with the Fuzzy approach is proposed to segment Cervical Pap Smear Images into Nucleus and Cytoplasm.	Fuzzy Approach, Edge Detection Fuzzy Inference System
Zhao, Lili, *et al* [15]	In this paper, a novel unsupervised segmentation method without needing the training data for overlapping cervical smear images is proposed.	K-Means, Max-flow/min cut algorithm, Voronoi –based dump division

III. PROPOSED FRAMEWORK FOR DETECTION OF CERVICAL CANCER BY USING IMAGE PROCESSING

The novel framework for the detection of cervical cancer by image processing is composed of three important stages. The first stage is Pre-processing, the second stage is Image enhancement and the third stage is Segmentation.

1. *Stage 1:* Pre-processing: Dual Tree Discrete Wavelet Transform approach

2. *Stage 2:* Image Enhancement: Curvelet and Contour Transformation approaches
3. *Stage 3:* Segmentation: K-Means clustering method

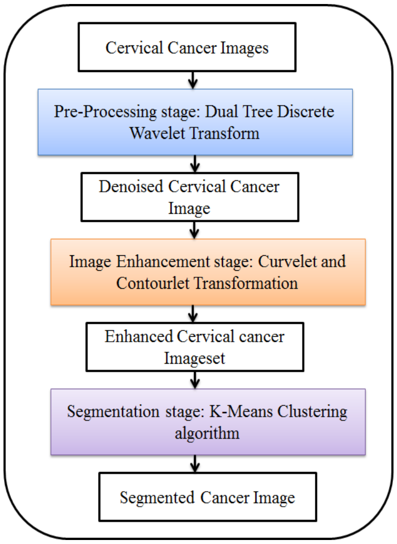

Fig. 1 A Novel Framework for Detection of Cervical cancer by using Image Processing

A. Pre-Processing Stage by DT-DWT

The Discrete Wavelet Transform (DWT) has properties such as good compression of signal energy, perfect reconstruction with short support filters, no redundancy and very low computation. Dual Tree Discrete Wavelet Transform (DT-DWT) is used as a fuzzy denoising algorithm which provides both shiftable sub-bands and good directional selectivity and low redundancy.

The 2D Dual-Tree Discrete Wavelet Transform (DT-DWT) of an image can be employed using two critically-sampled separable 2D DWT in parallel. The advantages of the Dual-Tree DWT (DT-DWT) over separable 2D DWT are that it can be used to employ 2D wavelet transforms which are more selective with respect to orientation.

B. Image Enhancement Stage

1. Curvelet Transform

Curvelet transform based image enhancement deals with interesting phenomena which occur along curved edges in a 2D image. The Curvelet transform is suited for images to contain edges, so it is good for edge enhancement. Curvelet transform has new features like the scaling law, in other words, the spatial domain related with scale by parabolic curving. Also, it has a new pyramid.

2. Contour Transform

The Contour transform is an extension of wavelet transform in two dimensions, which combines Laplacian Pyramid (LP) with a Directional Filter Bank (DFB). The Laplacian pyramid is used to capture the point discontinuities and is then followed by a directional filter bank to link point discontinuities into linear structures. The Laplacian Pyramid (LP) is used to decompose an image into a number of radial subbands and Directional Filter Banks (DFB) decompose each LP detail subband into any power of two's number of directional subbands. The Contour coefficient can be represented in a quad-tree structure. Each coefficient in the coarsest level has four children in the next higher subband and each of the children has four children in the next higher subband and a quadtree will emerge.

C. Image Segmentation Stage by K-Means Clustering Algorithm

K-Means clustering method partitions the experimental data into K mutually exclusive clusters. K-Means clustering is an algorithm to classify or to group the objects based on attributes/features into K number of groups. Here, K is a positive integer number. Grouping is done by minimizing the sum of squares of distances between data and the corresponding cluster centroid. The purpose of K-Means clustering is to classify the data. This algorithm is suitable to cluster large amounts of data. It creates a single level of clusters, unlike the hierarchical clustering method's tree structure arrangement.

Each observation in the data is treated as an object having a location in space and a partition is found in which objects within each cluster are as close to each other as probable, and as far from objects in other clusters as possible. Selection of distance measure is an important step in the clustering process. Distance measure determines the similarity of two elements. It greatly influences the shape of the clusters, as some elements may be close to one another according to distance and further away according to another. So, the correlation distance measure is selected which is used to provide the correlation between various data features.

IV. RESULT AND DISCUSSION

A. Evaluation Metrics

The performance of the 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 COMPARISON OF THE MEAN SQUARED ERROR (MSE) VALUES FOR THE TRANSFORMATION APPROACHED 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
Curvelet Transform	15.642	15.521	15.589	15.601
Contour Transform	14.214	14.222	14.362	14.251

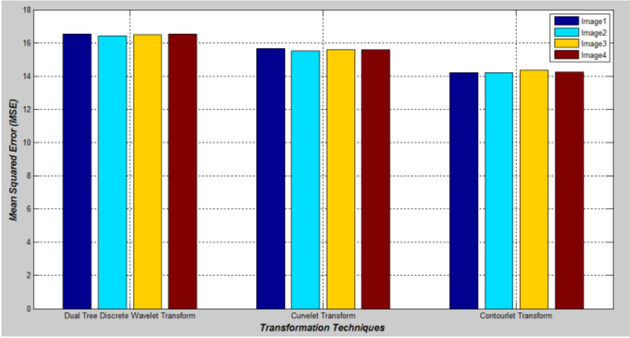

Fig. 2 Performance analysis of the transformation techniques like Dual Tree Discrete Wavelet Transform, Curvelet Transform, and Contour Transform against Mean Squared Error (MSE)

Table I gives the MSE values obtained by three transform techniques like DT-DWT, Curvelet transforms, Contour transforms for given four cervical cancer images. Figure 2 depicts the graphical representation of the transform techniques for given four images.

TABLE II COMPARISON OF THE PEAK SIGNAL TO NOISE RATIO (PSNR) VALUES FOR THE TRANSFORMATION APPROACHED 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
Curvelet Transform	35.7952	35.6784	35.8863	35.7772
Contour Transform	37.8743	37.5873	37.9772	37.8661

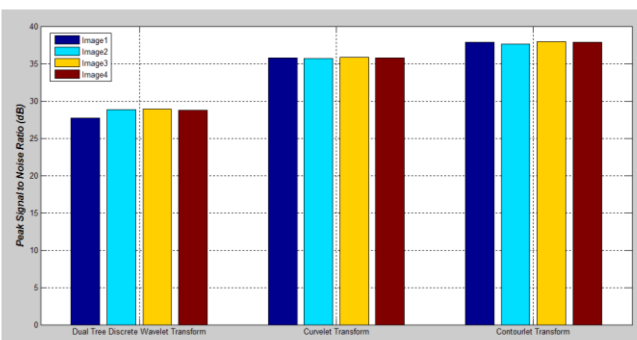

Fig. 3 Performance analysis of the transformation techniques like Dual Tree Discrete Wavelet Transform, Curvelet Transform and Contour Transform against Peak Signal to Noise Ratio (PSNR) value

Table II gives the PSNR values obtained by three transform techniques like DT-DWT, Curvelet transforms, Contour transforms for given four cervical cancer images. Figure 2 depicts the graphical representation of the transform techniques for given four images against PSNR values.

Table III gives the comparison of the three different transform techniques by using K-Means clustering algorithm has used in the segmentation process against execution time. Figure 4a gives the graphical representation of the K-Means segmentation algorithm by using different transform techniques against execution time.

TABLE III COMPARISON OF THE EXECUTION TIME FOR THE TRANSFORMATION APPROACHED IN THE PROPOSED FRAMEWORK

Transformation Techniques	**K-Means clustering**			
	Image 1	**Image 2**	**Image 3**	**Image 4**
Dual Tree Discrete Wavelet Transform	15.254	15.365	15.478	15.632
Curvelet Transform	14.362	14.852	14.745	14.698
Contour Transform	14.147	14.789	14.689	14.986

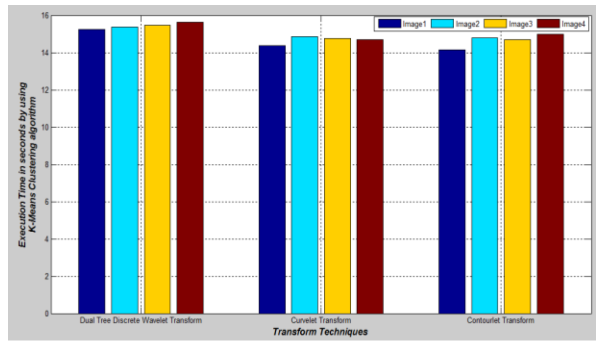

Fig. 4 Performance analysis of the K-means segmentation algorithm by using different transform techniques against execution time

TABLE IV COMPARISON OF THE EXECUTION TIME FOR THE TRANSFORMATION APPROACHED IN THE PROPOSED FRAMEWORK

Transformation Techniques	**EM (Expectation-Maximization) clustering**			
	Image 1	**Image 2**	**Image 3**	**Image 4**
Dual Tree Discrete Wavelet Transform	111.788	112.852	112.763	111.884
Curvelet Transform	112.897	112.542	111.563	111.323
Contour Transform	110.986	110.745	110.632	110.521

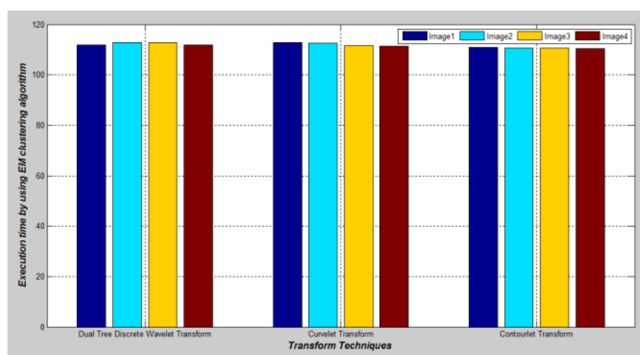

Fig. 5 Performance analysis of the EM Clustering segmentation algorithm by using different transform techniques against execution time

Table IV gives the comparison of the three different transform techniques by using Expectation-Maximization (EM) clustering algorithm has used in the segmentation process against execution time. Figure 4a gives the graphical representation of the EM clustering segmentation algorithm by using different transform techniques against execution time.

V. CONCLUSION

In this paper, a novel framework for the disclosure of Cervical Cancer (CC) by using Image processing techniques has presented. Dual Tree Discrete Wavelet Transform (DT-DWT), Contour Transform, Curvelet Transform is done in the pre-processing stage and image enhancement stages. K-Means clustering has utilized for image segmentation. From the experimental result reached by three stages, it is clear that K-Means gives the result in less time than the EM clustering is utilized in the segmentation process.

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