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# Image Segmentation Using Modified Spatial Fuzzy c-Means

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## ABSTRACT

*Disease diagnosis based on ultrasound imaging is popular because of its non-invasive nature. However, ultrasound imaging system produces low quality images due to the presence of spackle noise and wave interferences. This shortcoming requires a considerable effort from experts to diagnose a disease from the fetal ultrasound images. Image segmentation is one of the techniques, which can help efficiently in diagnosing a disease from the ultrasound images. Most of the pixels in an image are highly correlated. Considering the spatial information of surrounding pixels in the process of image segmentation may further improve the results. When data is highly correlated, one pixel may belong to more than one cluster with different degree of membership. This paper deals with an image segmentation technique namely improved spatial fuzzy c-means and an ensemble clustering approach for the fetal ultrasound images to identify the abnormal organ development. Spatial, wavelets and gray level co-occurrence matrix (GLCM) features are extracted from fetal ultrasound images. Redundant and less important features are removed from the features set using genetic search process. Finally, segmentation process is performed on optimal or reduced features. Ensemble clustering with reduced feature set provides segmentation time as well as clustering accuracy. Parameters are measured from the images that are segmented. Based on the values, Multi-Layer Back-Propagation Neural Networks (MLBPNN) is used to classify the images into normal or abnormal. Experimental results show the learning capability of MLBPNN classifier. This paper deals with the segmentation and classification of fetal ultrasound images that are very useful for detection of normal or abnormal organ development.*

**KEYWORDS : Fuzzy c-means, Genetic search, Ensemble clustering, Neural Networks**

## Introduction

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image.

Image processing basically includes the following three steps. At first, the image is imported with optical scanner or by digital photography. Second step is to analyze and manipulate the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs. Then output is the last stage in which result can be altered image or report that is based on image analysis. Image segmentation is the image processing technique. It is the process of partitioning a digital image into multiple segments (sets of pixels).

## Techniques

sFCM method is based on fuzzy c-means and spatial information of neighboring pixels around pixel under consideration. In sFCM technique, all neighboring pixels are equally treated irrespective of the cluster it may belong. Even though, neighboring pixels around a pixel under consideration are located at various distances. We have considered pixels in close vicinity of pixel under consideration contribute more in deciding its fate compared to the distant located pixels. Taking into account this scenario, we have modified the sFCM by assigning more weightage to spatial information of neighboring pixels lying very close to the pixel under consideration and vice versa, and say it as spatial fuzzy c-means modified (sFCMM). An ensemble scheme of majority voting for segmentation of fetal ultrasound images based on the fuzzy c-means (FCM).

There are four stages used namely, preprocessing, features extraction and selection, segmentation and post-processing operation applied at segmented images, and classification of segmented images into normal or abnormal by using Multi-Layer Back-Propagation Neural Networks (MLBPNN). Fig. 1 shows the block diagram of the proposed scheme.

## Image preprocessing

In ultrasound images, spackle noise and wave interferences are usually present. In addition, they have relatively low contrast. Spackle noise and wave interference needs to be filtered out in pre-processing stage for better segmentation. Therefore, median filter is used for noise removal. To detect the important information hidden in the dark and bright regions, histogram equalization technique is applied. Furthermore, histogram equalization increases the dynamic range and contrast of the fetal ultrasound images.

## Feature extraction

The main objective of this stage is to formulate the feature vector for every pixel. These features are then used for classification or clustering. Three types of features namely: intensity histogram, continuous wavelet transform, and gray level co-occurrence matrix (GLCM) are extracted from the ultrasound image. These extracted features are combined and used for segmentation. The features of MGH, 2D-CWT, and GCLM have advantages to represent the texture in medical images.

Moments of gray level histogram (MGH): A frequently used technique for texture analysis of an image is based on statistical properties of intensity histogram. The moments of gray level histogram (MGH) is to calculate mean, standard deviation, smoothness from the fetal ultrasound images.

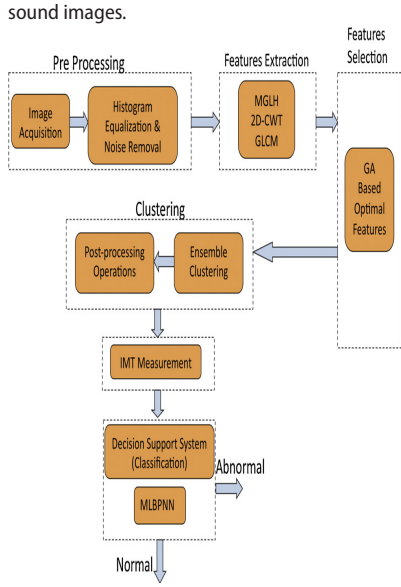


**Fig. 1 block diagram of the proposed scheme.**

2D-continuous wavelet transforms (2D-CWT): Continuous wavelet transform is convenient for non stationary signals. In

pattern analysis, 2D-CWT technique provides robust processing. To deal with the problem of computational time and speed up the 2D-CWT analysis is used.

**Features selection**
Features optimization is being used to reduce the feature space which improves the accuracy and computational time. It is achieved by omitting irrelevant, redundant, and noisy features. High dimensionality data required more computational time and resources. Some features may be removed to achieve better performance of system in terms of accuracy and computational time. The features are optimized using genetic search approach. These selected or optimized features are then given as input to the algorithm for segmentation (clustering).

**Segmentation (clustering)**
We have used different clustering algorithms for image pixel classification. The detail for each algorithm is given as below.

Fuzzy c-means (FCM): Fuzzy c-means clustering (FCM) is an unsupervised technique that have been successfully applied to clustering, features analysis and classifier designing in fields such as image segmentation, medical imaging, astronomy, and geology. FCM algorithm is used to group similar data points into a same cluster. The clustering is achieved iteratively, minimizing the cost function, to decide the fate of pixel to which cluster the pixel may belong.

Spatial fuzzy c-means modified (sFCMM): In sFCMM, more detailed spatial information of every pixel in the sub-window is utilized to decide the pixel under consideration, compared to sFCM.

**Ensemble clustering technique**
The ensemble clustering technique is used to combine several individual classifiers in order to obtain a classifier that outperforms every individual. Ensemble technique offers many advantages: first, it reduces the risk of picking the wrong classifier; second, it also reduces the risk of staying stacked in local optima; third, one may not able to obtain the optimal classifier, so combining several classifiers.

**Morphological operations**
Some isolated pixels may remain in the segmented image and requires to be removed from the final segmented image. Morphological operations have been used to remove the isolated pixels in segmented image.

**Conclusions**
In this paper, we have used a scheme for segmenting the fetal ultrasound images. In this paper, different features based on the moments of gray level histogram (MGH), 2D-continuous wavelet transform (2D-CWT), and gray level co-occurrence matrix (GLCM) are extracted from the fetal ultrasound images. As working with the large feature space there may be different effects at classification. Considering the time and resources, classification of high dimensional feature space significantly affects time and resources. There may be many features which do not have significant contribution in the classification. The redundant features may reduce the classification accuracy and needs more computational time and resources. To save the resources and maintain the accuracy of classification the features are then optimized using genetic algorithm search method. The main purpose of the features optimization is to reduce the feature space which results in low computational cost and higher accuracy. The fetal ultrasound image is then segmented by FCM, sFCM, sFCMM. Ensemble clustering of majority voting is used to select the pixels which have classified into same clusters by three or more techniques. The modified sFCM and ensemble clustering shows the best performance than other schemes. The ultrasound images segmented efficiently by using the sFCMM and from resultant images it can be observed that the region of interest (ROI) is efficiently separated from background area. Ensemble clustering with reduced feature set outperforms with respect to classification time as well as clustering accuracy. MLBPNN is employed to classify the segmented images into normal or abnormal.

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