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Analysis of Fetal Development Using Ultrasound Images

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Abstract: *The analysis of fetus behavior is observed using the medical imaging tool called the Ultrasound imaging. The quality of these images tend be low due the presence of noise. Hence, this noise needs to be suppressed or removed. Pre-processing steps are done before the fetal development analysis. The system helps the pregnant women to take care of her health with the suggestion from the expert.*
Keywords: *Denoising, Enhancement, Image Analysis, Ultrasound images*

I. Introduction

The biomedical image processing is a growing field of research in the recent years. There are many types of medical imaging devices like Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Ultrasound, X-ray etc. The internal organs of the body are viewed by using the Ultrasound medical imaging. And the fetal development process is observed using the ultrasound images. Because of the properties like low cost, non invasiveness and real-time imaging the device makes itself more suitable for fetus imaging. The drawback of Ultrasound image is that it encompasses speckle noise. This noise degrades the image quality and makes it unsuitable for further analysis. Thus removal of this noise becomes essential and the image needs to be denoised and enhanced.

II. Methodology

The main aim is to analyze the development of fetus by denoising and enhancing the ultrasound images. Also the movement of fetus observed after the preprocessing step. Fig. 1 shows the block diagram of the system. It has three main stages: the denoising stage, the enhancement stage and the development stage.

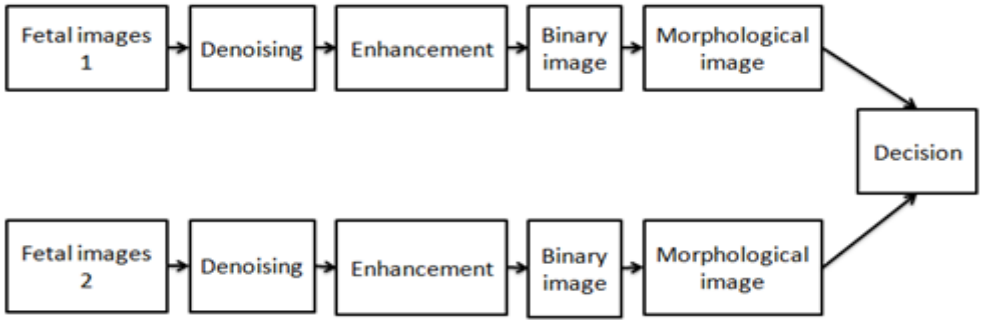

Fig. 1. Block Diagram

1.1 Denoising Stage

The medical imaging devices are affected by different types of noses. While the X-ray images have Poisson's noise and the ultrasound images have speckle noise in them. These images are formed due to the reflections from the body tissues. The presence of speckle degrades the quality of image [1]. And the removal of this noise is essential. Speckle noise is reduced by the method called denoising. Image denoising is a process of eliminating noise in order to strengthen and recover small details that are hidden. It is done by Discrete Wavelet Transform (DWT). The Wavelet Transform technique is proved to be effective in case of removal of noise. The input signals are decomposed into multiple scales, which represent the time frequency of the original signal. Statistical modeling [2-4] and thresholding[5] is performed to remove noise at each scale. Denoisng is accomplished by transforming back the wavelet coefficient into transform domain.
Denoising is achieved by the following steps.

1. Calculate the DWT of the image.
2. Threshold the wavelet coefficient.
3. Compute the Inverse Discrete Wavelet Transform to achieve the denoised estimate.

1.2 Enhancement Stage

Image enhancement is a needed process to improve the overall contrast of the image. This will improve the image quality and makes it suitable to use in other applications. The method adopted to achieve enhancement is the Histogram Equalization method. The overall contrast of the image is improved by this technique and it is usually applied for images with over or under contrast areas. The most frequent intensity values are spread out to accomplish the enhancement process. Histogram Equalization is the traditional enhancement technique and is the popular one due to its simplicity [4]. It is the effective method for almost all type of images.

1.3 Development Stage

Morphological Image Processing unit is considered for the development analysis of the fetus. it is a collection of nonlinear operation that are related to the morphology of the image. Morphology refers to shape of the object. It includes certain operations like erosion and dilation. This method is suitable for processing the binary images because their reliability to relative ordering of the pixels.. Hence the image needs to be converted to the binary form. Here the image is examined by a small shape. The small shape is referred to as structuring element. The structuring elements are compared with neighborhood pixels. The two operations dilation and erosion has opposite effects. Dilation is a process of maximizing any shape with reference shape. It is done so by adding a layer of pixels at the outer and inner boundaries of regions. While erosion is the process of minimizing any shape with the reference shape. Any discontinuous region around the reference shape is removed in the process.

1.4 Movement Detection

A video sequence of ultrasound recording contain fetus imaging is considered to observe any movement of the fetus. Different frames of the video are taken and they are preprocessed, that is denoised and enhanced. The detection of movement is done by applying fuzzy logic which includes correlation, mean and standard deviation. Correlation is the method of finding all the regions that matches the subimage. To find the matches, sum of products is computed. While mean is the average measure of intensity and standard deviation is the measure of average contrast.

III. Experimental Results

The experiment is carried out using the MATLAB tool. Here the images are denoised, enhanced and development of fetus is observed. And the detection of fetus movement is accomplished by considered the ultrasound video sequence.

1.5 Denoisng

Denoising is done by applying Discrete Wavelet Transform method. Here the High frequency component of the image is removed. And the image is reconstructed using the Inverse Discrete Wavelet Transform method. Figure 2 shows the result of denoising.

(a)

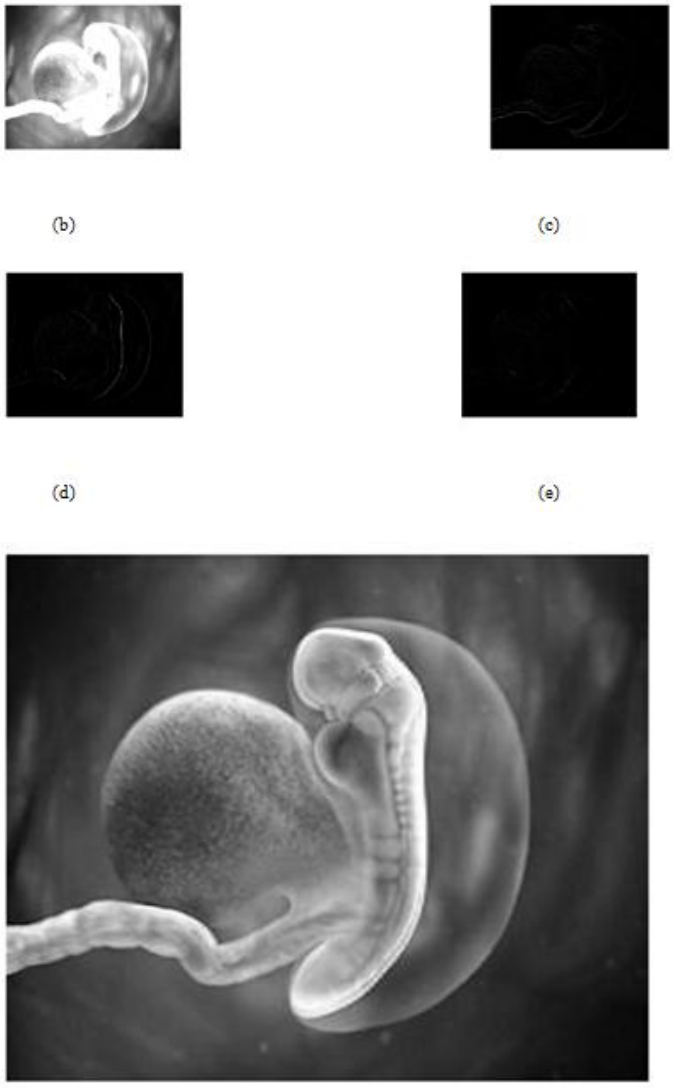

Fig. 2. Result of Denoising:(a)Gray Image of fetus at week 5 (b) LL component of (a) (c) LH component of (a) (d) HL component of (a) (e) HH component of (a) (f) Reconstructed Image of (a)

1.6 Enhancement

Histogram equalization is the method adopted to enhance the image quality. The most frequent intensity values are spread out to enhance the image. Figure 3 shows the result of enhancement.

Fig. 3 Histogram Enhanced Image

1.7 Development Analysis

The fetus image of gestational week-5 to week-8 is analyzed. The images are converted into binary and the erosion is done for analyzing the fetus development process. Fig 4 shows the results of development stage.

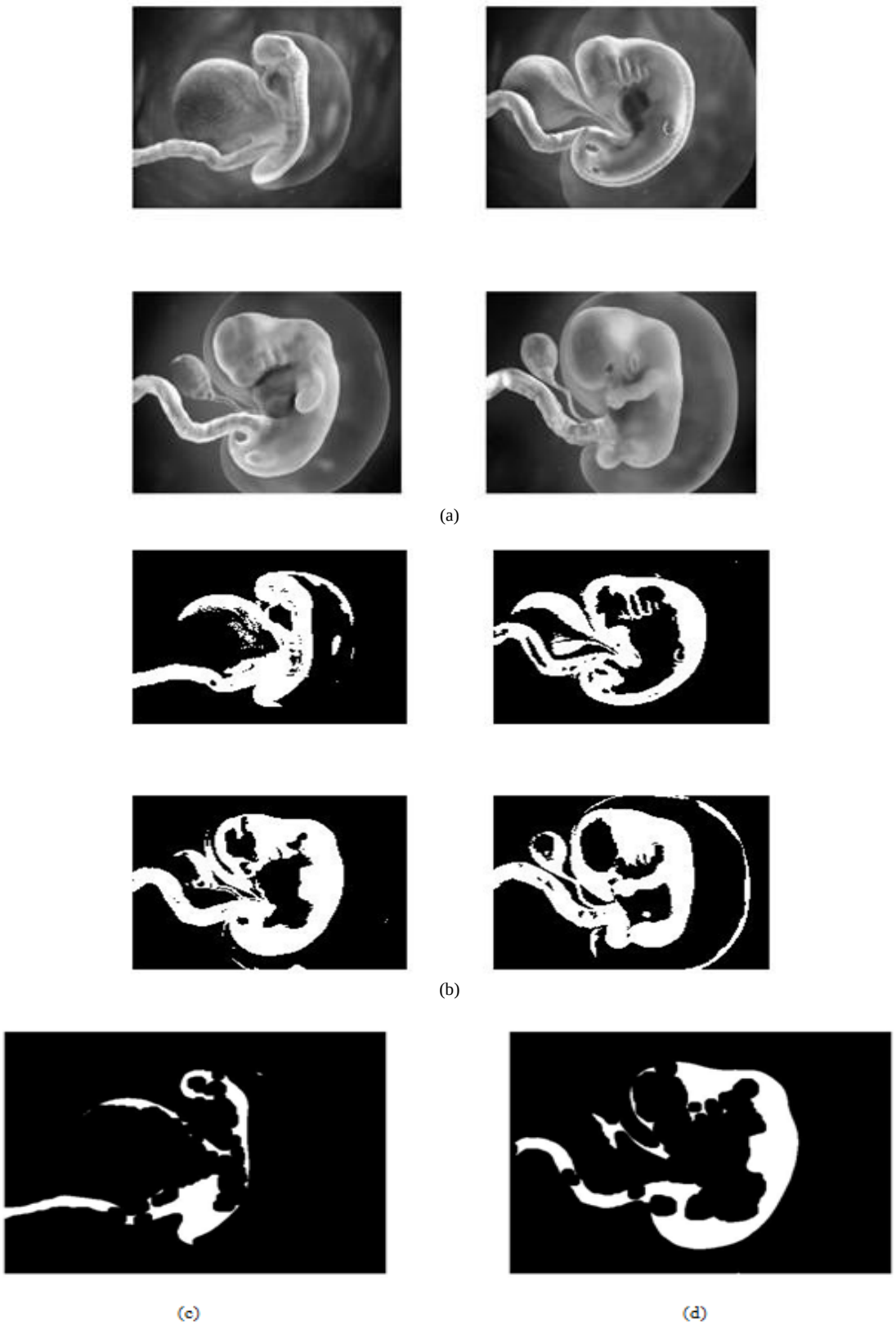

Fig.4.(a) Gray Image of Fetus from Week-5 to week-7 (b) Binary image of (a) (c) Erosion of week-5 (d) Erosion of wee

1.8 Movement Detection

Ultrasound video sequence is considered for the detection of movement. The preprocessing steps like denoising and enhancement are done. Fig 5 shows the denolised and enhanced images of two random frames of the video. Correlation, mean and standard deviation are performed for these frames and the movement is observed if there is any.

(a)

(b)

(c)

(d)

(e)

Fig.5.(a) First Frame of Video (b) Denoised First Frame (c) Enhanced First Frame (d) Denoised Second Frame (e) Enhanced Second Frame

IV. Conclusion

The development analysis is done by morphological image processing method for the preprocessed images. And the movement of the fetus is observed by the fuzzy logic method once the video frames are preprocessed. The system conveys information about any movement stage by stage and the development of fetus is observed.

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