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Computer Aided Segmentation of Breast Ultrasound Images Using Scale Invariant Feature Transform (SIFT) and Bag Of Features

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Abstract

Automatic and precise segmentation of breast ultrasound (BUS) image is a challenging task. The proposed method successfully implemented a segmentation algorithm by region growing from a seed point based on texture features generated by Gray Level Co-occurrence Matrix (GLCM). The seed points generated by canny edge detection and wavelet modulus maxima methods are refined by Support Vector Machine (SVM) trained by Scale Invariant Feature Transform (SIFT). The segmented images are compared with ground truth images and True Positive Rate (TPR) of 90.1% and average SI (Similarity Index) of 0.85 demonstrates that the proposed method can segment the tumor regions efficiently and accurately.

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Keywords: Bag of features;Scale Invariant Feature Transform;Modulus Maxima;Support Vector Machine

1. Introduction

Cancer is one of the most deadly diseases in which cells grow out of control. According to world cancer statistics the most common cancers are breast, lung, prostate etc[1]. According to the Indian Council of Medical Research (ICMR) in 2016 the total numbers of new cancer cases are around 14.5 lakh and the figure is likely to reach nearly

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17.3 lakh in 2020. Occurring in high frequencies, breast cancer is one of the leading causes of mortality among females worldwide [2] .

Until recently mammography has been effectively used for detecting and diagnosing breast cancer. However, due to the low specificity of mammography, many cases lead to unnecessary biopsy operations. Ultrasound (US) imaging is an important adjunct to mammography. Ultrasonography has been considered as one of the most powerful techniques for imaging organs and soft tissue structures in human body[2]. Breast ultrasound (BUS) imaging is superior to mammography in the following ways[2]. (1) It requires no radiation; (2) accuracy rate of BUS imaging in the diagnosis of simple cysts is much higher. US imaging has thus become one of the most important diagnostic tools for breast cancer detection.

Recent advances in computing technology have motivated the development of computer aided diagnosis (CAD) tools to assists radiologists with classifying breast tumors in ultrasound images as benign or malignant. Segmentation is one of the most significant components for a computer-aided diagnosis (CAD) system. Due to the nature of ultrasound imaging, the images always suffer from the low quality caused by speckle noise, poor contrast, blurred edge and shadow effect[7]. Therefore manual segmentation requires many laborious hours and suffers from great individual variability.

Many existing methods of BUS image segmentation follows model based methods like level set, active contours and Markov random fields (MRF)[12]. In most model based approach, segmentation is considered as finding maximum or minimum of the energy function. Therefore calculating energy functions and reformulating the models are always time-consuming, especially for complicated BUS images. Also, the pre-labeled regions-of-interest (ROI) or manually initialized contours are required by most model-based methods.

A novel method for automatic segmentation of tumor regions in BUS images is proposed in this paper. The proposed tumor segmentation technique is scale and rotation invariant and does not require a user defined region of interest (ROI). Seeds representing the tumor regions are first obtained by identifying the homogeneous regions in the BUS image. SIFT (Scale Invariant Feature Transform) features are then extracted to form Bag of features (BoF) to discriminate mass regions from the nonmass regions. An SVM classifier trained by above mentioned features are used to find final candidate seeds. Using gray level co-occurrence matrix, a single seed that best represent the actual tumor region is then retained. The tumor regions are then segmented by using a region growing algorithm.

2. Proposed Method

Detailed block diagram of the proposed method is shown in the Fig.1. The following section describes the details of the proposed method.

2.1. Preprocessing

Due to constructive and destructive interference of back scattered echoes from the scatters that are typically much smaller than the wavelength of an ultrasound wave, a speckle pattern is formed in medical ultrasound image. The task of image preprocessing is to reduce speckle without destroying the important features of BUS images for diagnosis. Shearlet transform provides sparse representation for the objects[7]. Also there is no limitation in the number of the directions for the shearing and shear matrix used to perform the direction filtering. Shearlet was found to have a better speckle reduction capability and therefore was selected for speckle reduction. After speckle reduction, histogram equalization was employed to enhance contrast and sharpness of edges.