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Globally Supported Radial Basis Function based Collocation Method for Evolution of Level Set in Mass Segmentation using Mammograms

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Abstract
Computer-aided detection system plays an important role for the detection of breast abnormalities using mammograms. Global segmentation of mass in mammograms is a complex process due to low contrast mammogram images, irregular shape of mass, speculated margins, and the presence of intensity variations of pixels. This work presents a new approach for mass detection in mammograms, which is based on the variational level set function. Mesh-free based radial basis function (RBF) collocation approach is employed for the evolution of level set function for segmentation of breast as well as suspicious mass region. The mesh-based finite difference method (FDM) is used in literature for evolution of level set function. This work also showcases a comparative study of mesh-free and mesh-based approaches. An anisotropic diffusion filter is employed for enhancement of mammograms. The performance of mass segmentation is analyzed by computing statistical measures. Binarized statistical image features (BSIF) and variants of local binary pattern (LBP) are computed from the segmented suspicious mass regions. These features are given as input to the supervised support vector machine (SVM) classifier to classify suspicious mass region as mass (abnormal) or non-mass (normal) region. Validation of the proposed algorithm is done on sample mammograms taken from publicly available Mini-mammographic image analysis society (MIAS) and Digital Database for Screening Mammography (DDSM) datasets. Highest 97.12% sensitivity, 92.43% specificity, and 98% AUC with 5.12 FP/I on DDSM dataset; and 95.12% sensitivity, 92.41% specificity, and 95% AUC with 4.01FP/I is achieved on MIAS dataset with Combined BSIF features.

***Keywords*—Mammography, Mesh-free based radial basis function, Finite difference method, Binarized statistical image features, Local Binary Pattern**

1. Introduction

Early detection of breast abnormalities plays a vital role to diagnose and control breast cancer. Breast abnormalities can be detected by using various image modalities such as mammograms, ultrasound, MRI, PET, CT, and SPECT. Mammograms are effective imaging technique for visualization of soft tissues and breast abnormalities. Therefore, several semi-automatic and fully automatic Computer-Aided Detection (CAD) systems are evolved to detect the breast lesions for digital mammograms [1-3]. Fully automatic CAD systems for breast abnormality detection are still under development. Various types of breast abnormalities such as mass, micro-calcifications, bilateral asymmetry, and architectural distortion can be seen in the mammograms. CAD system includes segmentation of micro-calcification and masses, feature extraction from segmented suspicious regions, and classification. However, global segmentation of mass is a challenging task due to (a) variability in the appearance of mass, (b) irregular and speculated margins, (c) occlusion of masses by dense breast tissues, and (d) low contrast mammogram images. Radiologists use CAD system as the second reader based on the features computed from the segmented mass region. Mass segmentation plays a significant role in mass detection using mammograms. The