Cancer's Probability Assessment from Breast Ultrasonograhys by Using Image Processing

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Abstract. In Indonesia, breast cancer is the first leading cause of death in women. Even data from the WHO, shows that in 2020, from total of 213,000 cancer cases, there are 65,000 cases of breast cancer or about 30% of all cancer cases in women. Breast ultrasonograhy (BUS) is an effective way to detect cancer. In addition, BUS can distinguish benign and malignant, so it can reduce unnecessary biopsy procedure. Cancer's probability assessment is necessary to examine by radiologist. One of the standard assessment is breast imaging-reporting and data system (BI-RADS). Radiologist use this standard from BUS to grade the cancer's probability manually, so the result might be subjective. This research offered a new approach to standardize the system of cancer's probability assessment by image processing. The proposed methods in this research begin with the pre-processing. The BUS images have been improved by image filtering and enhancing. After pre-processing, the cancer's probability part has been segmented by semi-automatic methods. The manual method uses for locate cancer's probability part roughly. The automatic method uses for segment the area of cancer. After that, the feature area of cancer has been extracted. The K-nearest neighbors (KNN) algorithm then used to classify the cancer's probability according the BI-RADS. The proposed method produces 0.79 in Cohen's kappa coefficient. This number indicates the system has substantial agreement with radiologist assessment.

Keywords: image processing · breast ultrasonography · KNN

1 Introduction

In Indonesia, breast cancer is the first leading cause of death in women. Even data from the WHO, shows that in 2020, from total 213,000 cancer cases, there are 65,000 cases of breast cancer or about 30% of all cancer cases in women. This high number indicates the urgency of diagnose program implementing and risk factor controlling. So early detection of breast cancer is needed to reduce death risk from patients. Ultrasound imaging to detect benign or malignant is an effective way to detect them. Breast ultrasonograhy (BUS) has many advantages than the others medical imaging devices. BUS is faster, cheaper, has no radiation, higher sensitivity, and also higher accuracy. In addition, BUS can distinguish benign and malignant, so it can reduce unnecessary biopsy procedure.

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The cancer probability usually graded by radiologist by using BUS imaging. Popular cancer's probability grading is called by breast imaging-reporting and data system (BI-RADS). In this assessment method, there are only 5 grade that can measure with BUS image. These are BI-RADS 1 until BI-RADS 5. The other BI-RADS' measure before BUS examination (BI-RADS 0) and measure as proven malignancy after biopsy (BI-RADS 6). However, this method is very dependent on the operator skill in finding the cancer location. In addition, different radiologist tend to grade the cancer's probability differently using BI-RADS. This study offered a new approach to standardize the system of cancer's probability assessment that can potentially reduce the differences among radiologist by using image processing.

2 Methods

This study offers cancer's probability assessment system from BUS images by using image processing algorithm. In this research, we focused on cancer's probability grading based on data from BUS images as showed in Fig. 1. BUS images were taken by Ultrasound GE Logiq E9. The images resolution are 1024 × 1024. The image processing algorithm is shown in Fig. 2.

2.1 Pre-processing

In this section, the original image was enhanced and improved by pre-processing. The steps in this section are divided into two stages. The first stage is the application of a smoothing/low pass filter. In this filter, artifacts are removed, because the ultrasound image itself produces a lot of artifacts due to the movement of the patient and the probe

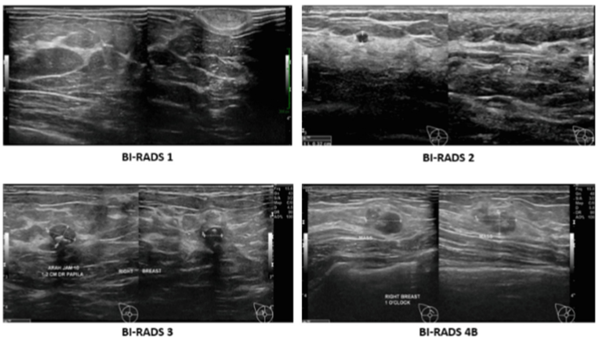

Fig. 1. Typical Cancer's Probability Grading by Using BI-RADS.

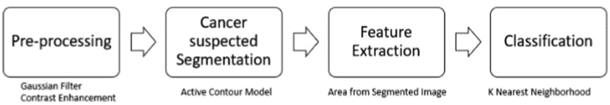

Fig. 2. The Proposed Image Processing Algorithm to Classify The Cancer's Probability

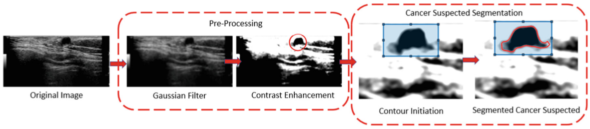

Fig. 3. Image Result in Pre-Processing and Segmentation Steps. The red dashed line indicates steps in this work.

on the ultrasound. In this study, the low pass filter that has been used is Gaussian filter with sigma number is 3.

In the second stage, the filtered image was enhanced by using contrast enhancement. The region of interest (ROI) section, which is the image part that is suspected of being cancer, is made more contrast with the background. Provided that, in the next step, the system will be easily to distinguish ROI with background. The result of pre-processing shown in Fig. 3.

2.2 Cancer Suspected Segmentation

In some previous works, active contour model (ACM) is very effective to segment the cancer suspected part. In this study, we proposed semi-automatic system. In manual part, the initial contour was made by radiologist. Then, the ACM will segment the ROI automatically. In this study, the iterations for ACM is 800.

2.3 Feature Extraction

From the segmented image, the area feature has been extracted by using this equation:

$$Area = \frac{SegmentedAreaTotalPixel}{AllPixelsinImage}(pixel^2) \tag{1}$$

In Eq. (1), the area feature will represent the total pixels in area of cancer suspected. After the area feature extracted, the feature will be programmed into the classification system as a training data.

2.4 Classification

In this work, we used K Nearest Neighborhood (KNN) as a system to classify cancer's probability. K-Nearest neighbor (K-NN) is one of the oldest and most frequently used nearest neighbor (NN) classification methods. KNN has proven to be an algorithm for simple classification with good results. K-NN is included in the supervised learning classification method, which requires first learning on a system by training some data. The working principle of the K-NN classification is to find the closest distance in the test data to the K value of the nearest neighbor in the training data. In this work, we used small K value, because the classification result can be more sensitive. 20 BUS images have used as a training data. Before that, those images have been assessed by radiologist with BI-RADS method, so it can use as a gold standard.

3 Result

The cancer's probability assessment using BI-RADS was performed on 20 new datasets of BUS images. The images were taken at Saiful Anwar General Hospital, Malang. A radiologist has assessed first those images. After that, those training data have assessed by proposed system. The Cohen's kappa used to measure inter-observer agreement between these two assessment (from radiologist and from proposed system). The result is 0.79.

4 Conclusions

This work offered a new approach by computer software to standardize the system of cancer's probability assessment. The area feature was extracted from the BUS image by using image processing algorithm. The KNN algorithm then used to classify the image according the BI-RADS assessment system. The proposed method is 0.79. It indicates the substantial agreement between radiologist and proposed system. Therefore, it potentially used to diagnose the cancer's probability in BUS images.

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