Computer aided diagnosis (CAD) for thorax radiography children patient with segmentation deformable models method

To cite this article: R Sefina et al 2018 IOP Conf. Ser.: Mater. Sci. Eng. 432 012054

View the article online for updates and enhancements.
Computer aided diagnosis (CAD) for thorax radiography children patient with segmentation deformable models method

R Seftina¹, Prawito¹, D S Soejoko¹
¹ Department of Physics, Faculty of Mathematics and Natural sciences, University of Indonesia, Depok, West Java 16332, Indonesia
rahmiseftina@gmail.com

Abstract. This study developed a correlation test Computer Aided Diagnosis (CAD) radiographic of children pulmonary using segmentation Deformable Models method to detect abnormalities. Deformable Models method searched abnormalities by value of the image pixel. Deformable models method used two variations, namely deformable models with median filter and deformable models with wiener filter. Abnormal result lung pixel values of segmentation wiener deformable models with wiener filter is 186-255 and deformable models with median filter is 190-255. Deformable Models used wiener filter have ROC result relatively higher than Deformable models used median filter with value of accuracy 78.5%, sensitivity 74.5%, specificity 80.0%, precision 90.0% and overall error of 21.0%. ROC result of segmentation using Deformable models method evince that Deformable models method can separated normal and abnormal tissue from radiographic of children pulmonary. However, Deformable models method can not definitively determine lung infection from radiographic of children pulmonary but this method can help radiologist to separated normal and abnormal tissue automatically with computer.

1. Introduction
Computed radiography (CR) is an imaging modality with digital system that widely used for the examination of the thorax and abdomen. Contrast and brightness from image of CR can be modified, so the image of CR becomes more clear and sharp. In addition, dose effect of CR is lower than CT so as not to endanger patients with unfavorable conditions and also patients who are still too young or too old. Sometime the abnormalities on thorax examination using CR, covered by other anatomic structures or the brightness of nodules is similar with background (normal tissue) and that’s make difficult to see abnormalities direct from the image [1]. Especially in lung examinations of children who have dimensions of small lung size and fewer number of alveoli. Because of that, in this study Computer Aided Diagnosis (CAD) used to detection of abnormalities by separated normal and abnormal tissue on image from CR. The success of such a separation will be easier to read, so it can be an additional input for radiologists in the detection automatically with computer [2].

Medical image segmentation with CAD is one of the most challenging research topics in image processing and computer vision. A variety of different methods have been proposed [5]. Segmentation method widely used in CAD is Markov Random Field (MRF) models, thresholding approaches, region growing approaches, artificial neural network, atlas-guide approaches, and Deformable Models [6]. In
this study, CAD for radiography of children pulmonary with segmentation deformable models method is used to detect child’s lung abnormalities with infection trend. This is because Deformable Models have brought tremendous impact to classical problems in image processing such as providing ways to devise efficient computational algorithms for automatic segmentation. Other than that, the segmentation result provides by Deformable Models are usually dependent on the contour initialization and can provide partial objects boundaries [7].

2. Experimental method

This study was conducted by CR image of pediatric lung, 1-15 years old, from Rumah Sakit Anak dan Bunda Harapan Kita. The image was taken from November 2014 until January 2016 with inspection standard PA, AP, and supine. There was 136 image was equipped with a physician evaluation result used in this study. From 136 images, 66 abnormal images used as the model data and 70 images with 20 normal image and 50 abnormal image used as test data.

CAD program developed used MatLab 2016 with some commands like the active contour, filter, Fuzzy Clustering Means (FCM) segmentation and deformable models segmentation. CAD development of children CR lung is divided into preparation, image segmentation, and evaluation. The preparation is done by change format of sample images from DICOM to TIFF, grouping sample images be normal and abnormal image, proceed image with normalization, and image cropping. Image segmentation is done by Fuzzy Clustering Means (FCM) segmentation and deformable models segmentation with two methods of deformable models, namely deformable models with median filter and deformable models with wiener filter. Evaluation is performed by calculating the success rate is expressed by the ROC (Receiver Operating Characteristics).

Sample images are used in this study have different kV and mAs. Variation of kV and mAs produces sample images have different contrast and brightness levels for each image. Other than that, sample images also have sections that can interfere with segmentation process. Therefore, on the preparation performed normalization and image cropping. Normalization aims to equalize contrast and brightness levels of sample image with range pixel value 0-255. Image cropping aims to remove unwanted part of image, so the time required to run segmentation become shorter.

On the image segmentation, each image was processed by FCM segmentation and deformable models segmentation. FCM segmentation was done with the minimum point search method histogram automatically. The minimum point of the histogram is used to find the number of regions/clusters contained in the image and determine the threshold value [3]. In this study deformable models was done with active contour model driven by Globally Signed Region Pressure Force (GSRPF). GSRPF is done in this study because GSRPF is robust to contour initialization and has the ability to stop the curve evolution close to evenill-defined (weak) edges [4]. Parameter deformable models used in this study are iterations and sigma to control the smoothness of the level set function in each iterations.

Figure 1. The segmentation result of deformable models (a) iterations 10, (b) iterations 80, (c) iteration 140, (d) iteration 200, and (e) final result of deformable models.
Evaluation was done by calculating the ROC (Receiver Operating Characteristics) image segmentation methods against a reference image from physician evaluation results. ROC counts is the accuracy, sensitivity, specificity, precision, and overall error. ROC uncertainty calculation is repeated five times by crossing data/cross validation. Cross validation is useful to determine the stability of the method.

3. Results and discussion

Medical image segmentation is the process of labeling each voxel in a medical image data set to indicate its tissue type and provide information about the anatomical structure. The various confrontations in medical image segmentation are poorly defined boundaries, blur or weak edges, intensity inhomogeneity, inconsistency in image quality while doing a scan and variable object shapes in medical images [10, 12]. Because of that, using segmentation method can be useful to detection of abnormalities by separated normal and abnormal tissue.

In other research, MRF segmentation method used to detection abnormalities from radiographic of children pulmonary. MRF is a probabilistic which captures such contextual constraints. Like as in Deformable models method, MRF method search abnormalities by value of the image pixel. In that research, MRF method used four variations like MRF without a filter, median filter+MRF, wiener filter+MRF, and adaphisteq filter+MRF. ROC segmentation result wiener filter relative higher than others. ROC wiener filter results show the value of accuracy 81.4%, sensitivity 82.0%, specificity 80.0%, precision 91.1% and overall error of 18.6% [3].

Like as in MRF method research, in this study Deformable Models method use to detection abnormalities from radiographic of children pulmonary. Deformable Models are curves or surfaces that deform two-dimensional (2D) or three-dimensional (3D) digital images under the influence of both internal and external forces and user defined constrains [13]. In this study, Deformable Models method used to detection abnormalities from radiographic of children pulmonary by separate normal and abnormal tissue.

Lung image has a lot of noise. Noise the most disturbing is the ribs. To reduce the influence of the ribs to the image of the lung treated with FCM segmentations and various filter. FCM segmentation used to reduce ribs from the lung image and to clarify the cluster to distinguish between bone and abnormalities. The difference result of deformable models segmentation with FCM and deformable models segmentation without FCM can be seen in Figure 2.

![Figure 2](image-url)

**Figure 2.** FCM segmentation image result (a) Original image, (b) Deformable models without FCM, (c) Deformable models with FCM

To reduce influence of the ribs and another noise in lung image was done with various filters including a gaussian filter, median filter, a standard deviation filter, wiener filter, histeq filter, histeq + wiener filter, adaphisteq filter and adaphisteq + wiener filter. Criteria of filter used in this study is a filter that can reduce noise without creating a blurry image and can keep the details of the sharpness of the corners of the object. Figure 3 show result of deformable models segmentation with various filter. From Figure 3 median filter and wiener filter can meet criteria of filter that used in this study.

Abnormal cluster search done by looking at cluster pixel values from segmentation result of 66 abnormal images that used as the model data. Through the observation of 66 abnormal image, the
range of values obtained abnormal image pixel in the image that is subsequently used as the pixel value of data models. Pixel value of model data will be compared to pixel value of the test data obtained to determine the normal and abnormal image based on the pixel value. Table 1 is a cluster of range pixel values obtained by averaging the pixel values of the image.

![Figure 3. X-ray image with several treatment filter](image)

### Table 1. Range pixel value of the model data used as a reference for the test data.

| Method                              | Range of pixel value |
|-------------------------------------|----------------------|
| Median filter + Deformable models   | 190-255              |
| Wiener filter + Deformable models   | 185-255              |

Normal and abnormal images based on pixel values will be compared with doctors' evaluation results to determine whether the image is segmented in accordance with the results of the physician's evaluation. Based on the results of the evaluation that has been done, then calculated ROC value shown in Table 2.

![Normal and abnormal images](image)
Figure 4. ROC result of abnormal image used deformable models segmentations with median (a) normal image segmented as normal image (TN), (b) abnormal image segmented as abnormal image (TP), (c) abnormal image segmented as normal image (FN), and (d) normal image segmented as abnormal image (FP).

Figure 5. ROC result of abnormal image used deformable models segmentations with wiener filter (a) abnormal image segmented as abnormal image (TP), (b) abnormal image segmented as normal image (FN), (c) normal image segmented as normal image (TN), and (d) normal image segmented as abnormal image (FP).

Table 2. ROC value of Deformable models method with median filter and Wiener filter.

| ROC     | Median filter   | Wiener filter  |
|---------|-----------------|----------------|
| Accuracy| 70.0% ± 2.8%    | 78.5% ± 3.1%   |
| Sensitivity | 66.0% ± 4.2%    | 74.5% ± 4.1%   |
| Specificity | 80.0% ± 0.0%    | 80.0% ± 0.0%   |
| Precision | 89.2% ± 2.1%    | 90.0% ± 2.8%   |
| Overall Error | 30.0% ± 2.9%    | 21.0% ± 3.0%   |

ROC segmentation results wiener filter is relatively higher than median filter. ROC wiener filter results show the value of accuracy 78.5%, sensitivity 74.5%, specificity 80.0%, precision 90.0% and
overall error of 21.0%. However, differences of ROC for any kind of success rate is not more than 5% that means Deformable Models can be implemented to detect abnormalities.

4. Conclusion
Deformable models method searched abnormalities by value of the image pixel. Deformable models method used two variations, namely median filter + Deformable Models and Wiener filter + Deformable Models. Abnormal result lung pixel values with segmentation Wiener filter + Deformable models was 186-255 and median filter + Deformable Models was 190-255. Wiener filter + Deformable models method showed ROC result relatively higher than median filter + Deformable models with value of accuracy 78.5%, sensitivity 74.5%, specificity 80.0%, precision 90.0% and overall error of 21.0%. Differences of ROC value using Deformable Models method was not more than 5% that means Deformable models could be implemented to detect abnormalities. However, Deformable models method cannot definitively determine lung infection from radiographic of children pulmonary.

Acknowledgment
At the outset we would to thank Rumah Sakit Anak dan Bunda Harapan Kita for allowed to use the data of CR image of children patient from Rumah Sakit Anak dan Bunda Harapan Kita as the research sample in this study. The acknowledgment would be incomplete without thanking Septia Ardiani who get data from Rumah Sakit Anak dan Bunda Harapan Kita.

References
[1] Shiraiishi J Li Q Suzuki K Engelmann R and Doi K 2006 Med Phys. 33 2642-53
[2] van Ginneken B 2012 5th Int. Workshop on Pulmonary Image Analysis 9-21
[3] Adiani S Prawito Soeharso D 2017 Proc. of The 7th Annual Basic Sci. Int. Conf. 132-5
[4] Abdelsamea MM and Tsaftaris SA 2013 18th Int. Conf. on Dig. Sign. Proces. (DSP)
[5] Zhang S Wang L Jiang L and Liu S 2010 3rd Int. Cong. on Image and Signal Proces. (CISP2010)
[6] Dzung Xu L C & Jerry L 2000 Current Methods in Medical Image Segmentation Baltimore; Departement of Electrical and Computer Engineering Johns Hopkins University
[7] Yang B 2005 Geometric Deformable Models Using the Level Set Method Canada
[8] Demirkaya O Asyali M S and Sahoo P K 2009 Image Proc. with MATLAB, App. in Medicine and Biology London: CRC Press Taylor & Francis Group
[9] Dougherty G 2011 Medical Image Proces, Tech. and App. NewYork: Springer
[10] Jayadevappa D Kumar S S and Murty D S 2009 Int. J. of Comp. Sci. 36(3)
[11] Liu Brian and Ashish R 2013 Hindawi Pub. Corporat. Comput. and Math. Methods in Medicine
[12] McInerney T Terzopoulos D 1996 Medical Image Analysis 1(2) 91 – 108
[13] Kass M Witkin A and Terzopoulos D 1988 Int. J. Comp. Vision 1 312-33