International Journal of
Clinical & Medical Imaging

Pulmonary edema detection in chest x-ray using machine learning

Atul Kumar[1,2], Yen-Yu Wang[1,2,3], Kai Che Liu[1,2], I-Chen Tsai[1,2], Ching-Chun Huang[4], Nguyen Hung[5]
[1]IRCAD-Taiwan, [2]Chang Bing Show Chwan Memorial Hospital, Taiwan, [3]National Changhua University of Education, Taiwan, [4]National Chung Cheng University Taiwan, [5]National Kaohsiung University of Applied Sciences , Taiwan

Abstract

- Pulmonary edema is a common manifestation of various clinical conditions. A computer aided evaluation of pulmonary edema will be helpful for physicians in determining the course of management for the condition. This study presents a texture analysis of chest x-ray to automatically detect pulmonary edema in chest x-ray.

Objective

- To automatically distinguish chest x-ray with evidence of pulmonary edema from normal chest x-ray.

Methods

- Forty normal radiographs and 40 with the evidence of pulmonary edema were retrieved from the image archive of Show Chwan Memorial Hospital, Changhua, Taiwan.
- Image enhancement : The images were resampled and enhanced by sequentially applying median filter (3x3 pixels) , contrast stretching and contrast limited adaptive histogram equalization (CLAHE) (Fig.1).
- Segmentation: Lung region s in the images were manually segmented.
- Gabor image and features: A two-dimensional (2D) Gabor filter captures visual properties such as spatial localization and orientation selectivity [1]. Gabor filter , with different directionality, were applied to the enhanced images (Fig.2). Statistical features such as mean, median, standard deviation, kurtosis, entropy, and skewness were calculated for the lung regions in the image.
- SVM model: With the different features, classifier models were trained using Support Vector Machine (SVM). SVM models allow the classification of individual data into distinct classes based on data in high-dimensional space.
- SVM model evaluation : The SVM model prediction was evaluated by calculating its accuracy and area under the curve (AUC) of ROC (Receiver Operating Characteristic) plot (Fig.3).

Results

- The model of the SVM was evaluated on 20 normal images and 20 images with pulmonary edema.

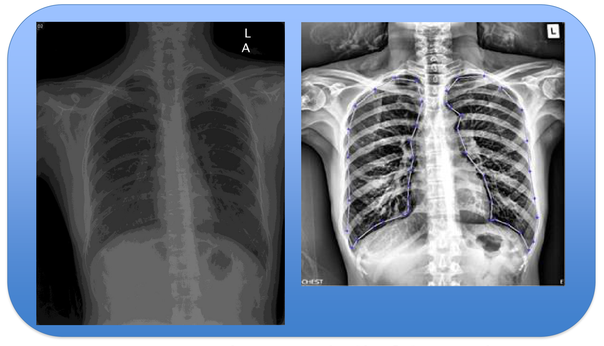

Figure 1: Unenhanced (left), and resampled and enhanced (right) images

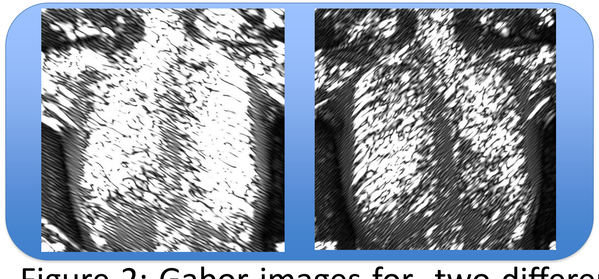

Figure 2: Gabor images for two different directions.

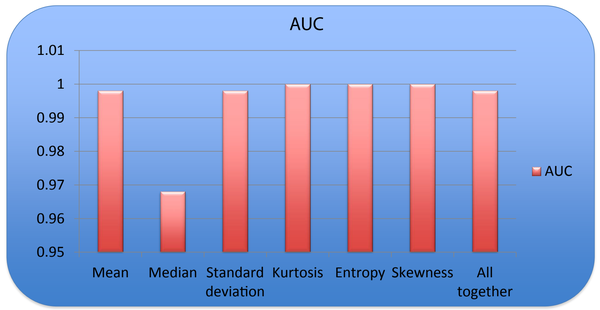

Figure 3: AUC of ROC plot for different features

Conclusions

- To our knowledge, this is the first study for the pulmonary edema where machine learning is used for differentiating normal lung image from the pulmonary edema lung image.

References

1. Grigorescu et.al. “Comparison of texture features based on Gabor filters” Image Process. IEEE Trans, 2002.