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Classification of Normal and Cardiomegaly Conditions in Chest Radiographs Using Cardio-Mediastinal Features

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Abstract. In this study, an attempt has been made to differentiate normal and cardiomegaly using cardio-mediastinal ratiometric features and machine learning approaches. A total of 60 chest radiographs including normal and cardiomegaly subjects are considered from a public dataset. The images are preprocessed using edge aware contrast enhancement technique to improve the edge contrast of lung boundaries. The mediastinal, cardiac and thoracic widths and their ratiometric indices are computed to characterize the morphological variations. The features are fed to three different classifiers for the differentiation of normal and cardiomegaly. Results show that the Linear discriminant analysis classifier is found to perform better with average values of recall 88.7%, precision 88.8%, and area under the curve 91.9%. Hence, the proposed computer aided diagnostic approach appears to be clinically significant to distinguish normal and cardiomegaly especially in remote and resource - poor settings.

Keywords. Cardiomegaly, Cardio-Mediastinal features, Machine learning

1. Introduction

Cardiomegaly is a medical condition that affects the cardiovascular system, specifically involving the enlargement of heart. This signature results from hosts of other diseases and strongly associated with congestive heart failure. Mediastinum region in the chest is considered as one of the substantial anatomical regions for the gross diagnosis of cardiovascular abnormalities. Early detection with mass screening approaches are crucial to prevent such condition, particularly in remote and resource-poor settings. Chest radiographs (CXRs) have been widely used for this purpose due to their non-invasiveness, and portability. Conventional image processing methods applied on CXRs fail to characterize the condition and differentiate them from normal subjects.

2. Methods

The frontal CXRs of 60 subjects (Normal- 30, Cardiomegaly-30) are obtained from Chest X-ray14 publicly available dataset. The images are in grayscale with a resolution

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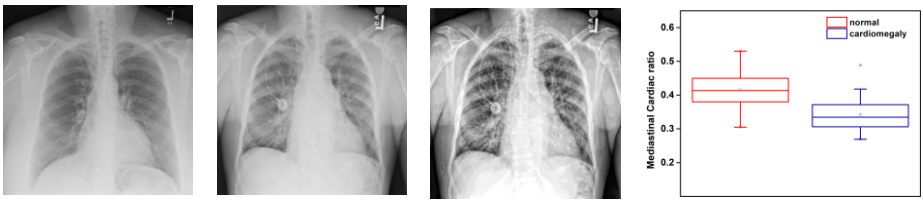
of 1024*1024. The images are subjected to edge aware contrast enhancement technique. It is used to enhance the contrast in smaller sub-regions of the image by retaining the edge information [1]. This method uses local Laplacian filtering based on Gaussian to distinguish edges from details. Sharpness measure is used to validate the edge contrast enhancement of lung boundaries.

Left mediastinal width and mediastinal width [2], cardiac width and thoracic width features are extracted, and their corresponding ratiometric indices such as Mediastinal width ratio, Cardiothoracic ratio [3], Mediastinal cardiac ratio (Mcr) and Mediastinal thoracic ratio are derived for all the subjects. All the features are provided to Linear Discriminant Analysis (LDA), Naïve Bayes (NB) and Support Vector Machine (SVM) classifiers. Ten-fold cross validation is performed and the performance measures are evaluated.

3. Results and Discussion



(a) (b) (c)

Figure 1. Representative images (a) normal and cardiomegaly (b) preprocessed (c) Mcr plot

From Figure 1, it is seen that the original images have poor edge contrast especially along lung boundaries at significant anatomical landmarks and the adopted preprocessing method is found to enhance the edge contrast locally. Significant distinction is observed between normal (0.3-0.55) and cardiomegaly (0.28-0.42) using Mcr plot.

The performance comparison of classifiers is shown in table 1. It is found that LDA performs better than NB and SVM with average values greater than 88% for recall, precision and F-measure and AUC of 91.9%. Large number of input images would be considered for future work.

Table 1. Performance of classifiers using all the features

Classifiers	Recall (%)	Precision (%)	F-measure (%)	AUC (%)
LDA	88.7	88.8	88.7	91.9
NB	82.3	82.4	82.4	88.4
SVM	85.5	85.5	85.5	86.0

References

[1] X.Y. Li, Y. Gu, S.M. Hu, and R.R. Martin, Mixed-domain edge-aware image manipulation, *IEEE Transactions on Image Processing* **22** (2013), 1915-1925.

[2] V. Lai, W.K. Tsang, W.C. Chan, and T.W. Yeung, Diagnostic accuracy of mediastinal width measurement on posteroanterior and anteroposterior chest radiographs in the depiction of acute nontraumatic thoracic aortic dissection, *Emergency Radiology* **19** (2012), 309-15.

[3] M.A. Hasan, S.L. Lee, D.H. Kim, and M.K. Lim, Automatic evaluation of cardiac hypertrophy using cardiothoracic area ratio in chest radiograph images, *Computer Methods and Programs in Biomedicine* **105** (2012), 95-108.