

## **An Automated Algorithm to Quantify Cardiothoracic Ratio (CTR) in Tele Chest X-Rays**

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In radiography, analysis of tele chest radiographs and measurement of the Cardio Thoracic Ratio (CTR) help to evaluate cardiac enlargement. Usually, CTR values are measured manually using either normal rulers or digitized rulers which are vulnerable to technical errors. Hence, our aim of this research is to introduce an automated algorithm to measure CTR using digital image processing techniques. First, the automated algorithm preprocesses the X-Ray image using histogram equalization and median filtering. Second, the image is segmented with an advanced region-growing algorithm using two seed points in the lungs and the segmented image is fine-tuned using shrink and reconstruct morphological operations to extract the area of the heart and lungs. Finally, the transverse diameter of the thorax and the widest length of the heart are calculated from the segmented binary image for the CTR calculation. 200 digital tele chest radiographs were obtained from patients who are between the age of 18 and 65. For each radiograph, the CTR value was calculated using both the automated algorithm and the manual method using digital rulers. Manually calculated CTR was assessed by a radiologist. Two CTR values were compared statistically. For that, the heart area of each X-Ray image was assessed as normal or abnormal and compared against the radiologist's assessment of the same. An accuracy rate of 83.5% was achieved for the diagnosis of the abnormal size of the heart. Higher accuracy was reported for calculation of the transverse diameter of the thorax compared to the calculation of the widest length of the heart. One limitation of the algorithm is the inconsistency in the segmentation of the lower heart border due to the soft tissues in the lower part of the heart and lung pathology. Overall the results show that the proposed image processing based CTR calculation algorithm could be effectively applied for the diagnosis of the enlargement of the heart.

**Keywords:** Cardiac enlargement, Tele Chest X-ray, Cardio Thoracic Ratio, Image segmentation, Morphological operations