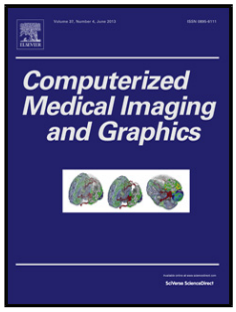

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Enhanced coronary calcium visualization and detection from dual energy chest x-rays with sliding organ registration

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Highlights

- We propose an image processing method to create a bone-image-like, coronary calcium image using dual energy (DE) chest radiography to detect this excellent biomarker for atherosclerotic disease with chest x-ray
- Our processing method includes automatic heart silhouette segmentation, sliding organ registration and scatter removal to reduce motion artifacts and improve calcium conspicuity in DE chest radiography
- Experimental results show that, compared to standard, clinically available DE processing, our method significantly reduces misregistration error, improves image quality ($p<0.0001$) and increases AUC performance ($p=0.0095$) for coronary calcium reading in DE chest radiography

Abstract. We have developed a technique to image coronary calcium, an excellent biomarker for atherosclerotic disease, using low cost, low radiation dual energy (DE) chest radiography, with potential for widespread screening from an already ordered exam. Our dual energy coronary calcium (DECC) processing method included automatic heart silhouette segmentation, sliding organ registration and scatter removal to create a bone-image-like, coronary calcium image with significant reduction in motion artifacts and improved calcium conspicuity compared to standard, clinically available DE processing. Experiments with a physical dynamic cardiac phantom showed that DECC processing reduced 73% of misregistration error caused by cardiac motion over a wide range of heart rates and x-ray radiation exposures. Using the functional measurement test (FMT), we determined significant image quality improvement in clinical images with DECC processing ($p<0.0001$), where DECC images were chosen best in 94% of human readings. Comparing DECC images to registered and projected CT calcium images, we found good correspondence between the size and location of calcification signals. In a very preliminary coronary calcium ROC study, we used CT Agatston calcium score >50 as the gold standard for an actual positive test result. AUC performance was significantly improved from 0.73±0.14 with standard DE to 0.87±0.10 with DECC ($p=0.0095$) for this limited set of surgical patient data biased towards heavy calcifications. The proposed DECC processing shows good potential for coronary calcium detection in DE chest radiography, giving impetus for a larger clinical evaluation.

Keywords: Coronary artery calcification, dual energy chest radiography, image processing, sliding organ registration, ROC

1. Introduction

Several large studies have shown that coronary calcium, as assessed with CT calcium score, is an important biomarker for coronary artery disease, much better than lipids, C-reactive protein, and