Improving Automated Diagnostics Of Coronary Artery Disease By Utilizing Synthetic Scintigraphic Attributes

Matjaž KUKAR a,1, Claudia DIAS b, Luka ŠAJN a and Ciril GROŠELJ c

a Faculty of Computer and Information Science, University of Ljubljana, Slovenia, 
b Faculty of Economics, University of Porto

c Nuclear Medicine Department, University Medical Centre Ljubljana, Slovenia

Keywords: Image Processing, Data analysis-extraction tools, Decision support, Cardiovascular, Diagnosis related

Coronary artery disease (CAD) is one of the world's main causes of early mortality, and there is an ongoing research for improving diagnostic procedures. The usual clinical process of coronary artery disease diagnostics consists of four diagnostic steps (levels): (1) evaluation of signs and symptoms of the disease and ECG (electrocardiogram) at rest; (2) ECG testing during the controlled exercise; (3) stress myocardial scintigraphy; and (4) coronary angiography. In this process, the fourth diagnostic level is considered as the "gold standard" reference method. As coronary angiography is invasive, expensive, and potentially dangerous for the patients, there is a tendency to improve diagnostic performance and reliability of earlier diagnostic levels, especially of myocardial scintigraphy. Related work for this problem includes applications of neural networks, expert systems, subgroup mining, statistical techniques, and rule-based approaches. In our study we use a population of 278 patients (66 females, 212 males, avg. age 60 years) with all four diagnostic levels completed, who were admitted to the Nuclear Medicine Department, University Clinical Centre in Ljubljana between 2001 and 2004 due to suspected CAD. In 149 cases the disease was angiographically confirmed and in 129 cases it was excluded. We focus on myocardial scintigraphy that results in a series of medical images taken both during rest and a controlled exercise. Images are provided in DICOM format by respective SPECT cameras. In clinical practice, expert physicians use their knowledge and experience as well as various imaging software to manually describe (parameterize) and evaluated the images. We utilize an innovative alternative to manual image evaluation - automatic multi-resolution image parameterization (ARES), coupled with principal component analysis (PCA), and image evaluation with machine learning methods [1]. Our approach significantly outperforms physicians in terms of diagnostic quality of image parameters as well as overall diagnostic accuracy, specificity and sensitivity. From the practical use of described approaches two-fold improvements of the diagnostic procedure can be expected. Higher diagnostic accuracy (up to 15%) is by itself a very considerable gain. Due to higher specificity of tests (up to 12%), fewer patients without the disease would have to be examined with the invasive and more dangerous coronary angiography. Together with higher sensitivity this would save money and shorten the waiting lists. 


Corresponding Author: Matjaž KUKAR, University of Ljubljana, Faculty of Computer and Information Science, Tržaška 25, SI-1001 Ljubljana, Slovenia. E-mail: matjaz.kukar@fri.uni-lj.si.