Chapter 2
An Efficient Coronary Disease Diagnosis System Using Dual-Phase Multi-Objective Optimization and Embedded Feature Selection

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ABSTRACT

Developments in healthcare technologies have significantly enhanced spatial resolution and improved contrast resolution, permitting analysis of additional subtle structures than formerly attainable. An approach for Automatic recognition and quantification of calcifications from arteries in computed tomography (CT) scans is developed which is a key necessity in planning the treatment of individuals with suspected coronary artery disease. First, a Dual-Phase Multi-_objective Optimization approach using an Active Contour Model-based region-growing technique is developed. Second, an embedded feature selection method is developed with an expert classifier to detect calcified objects in the segmented artery with great accuracy. Finally, the Agatston scoring method is utilized to quantify the level of coronary artery calcium plaque. Coronary CT images from the AS+CT scanner with a slice thickness of 3 mm were obtained from clinical practice. Experimental results demonstrate that our proposed method improves the accuracy of lesion detection for better treatment planning.

INTRODUCTION

Cardiac disease would likely be the number 1 reason behind loss of life, globally, with more and more people dying every year from cardiac disease than from any other cause. An approximated 17.5 million individuals died from cardiac disease in 2012, symbolizing 31% of all deaths worldwide. Of such deaths, an estimated 7.4 million have been as a result of coronary heart problems, and 6.7 million because of

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stroke. More than three-quarters of cardiac disease deaths take place in low- and middle-income nations around the world. From the 16 million deaths below the age of 70 as a result of non-communicable diseases, 82% are in low- and middle-income nations and 37% due to cardiac disease. Individuals with heart problems, or are likely to be at substantial cardiovascular risk because of the existence of one or more risk factors - like hypertension, diabetes, hyperlipidaemia or previously-recognized diseases - require early detection and management with counselling and medicines, as suitable (World Health Organization, 2011).

Sources of Multimodal health data include Clinical data in the form of structured EHR, Unstructured EHR, Medical Images, genomic data in the form of DNA sequences, behavioural data which include mobile sensor and social network data. Clinical data include lab results (Structured EHR), Clinical notes (Unstructured EHR) and Medical Images. EHRs contain patient medical history. Medical Imaging plays an important role in modern day health care. Due to immense capability in high quality images of anatomical structures in human beings, efficiently analysing these images can be useful for clinicians & medical researchers since it can aid disease monitoring. Imaging modalities such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET) is commonly used for detecting the bio-markers for diagnosing coronary disease. A biomarker is a perceptible substance in the body that stipulates a particular disease state, organ function or other aspects of health.

Mining disease patterns from health records is difficult due to diversity of medical information sources. Hence algorithms need to be developed, that can automatically extract disease patterns from multi modal clinical data which provides a way for early detection of disease by extracting the complete knowledge about the disease patterns. Physicians and researchers use biomarkers (or) disease patterns to help predict, diagnose and treat a variety of disease states. Mining disease patterns finds it applications such as Image-guided surgery and intervention Therapy planning and guidance etc.

Cardiovascular diseases may be a category of diseases that include the heart or blood vessels. The heart muscle, like every other organ or tissue in the body, needs oxygen-rich blood to survive. The Coronary Arteries are the blood vessels that provide blood to the heart. They branch off of the artery at its base. The right coronary artery, the left main coronary, the left anterior descending, and the left circumflex artery, are the four major coronary arteries.

Arteries are blood vessels that carry blood from the heart throughout the body. They are lined by a skinny layer of cells known as the endothelium. The endothelium works to keep the inside of arteries toned and smooth, that blood keeps flowing. The Dissolvable Cholesterol in the blood and transported through bloodstream by carriers called lipoproteins made up of lipid and proteins. The two forms of lipoproteins that carry cholesterol are lipoprotein (LDL) and high-density lipoprotein (HDL). One more harmful fat which is formulated due to the consumption of food with excessive calories. The total cholesterol level is determined using the LDL, HDL and one fifth of triglyceride level in the blood. Excess amounts of triglycerides in the blood initiates the growth of atherosclerosis. There are several factors related to roughening the arteries like smoking, high blood pressure, high cholesterol levels, diabetes and exercise that affects endothelium. When LDL crosses the broken endothelium, the cholesterol enters the wall of the artery.

Over a long period of deposition plaques will harden and rupture which results to narrow down the coronary arteries. Abnormal narrowing of the coronary arteries reduces the blood flow that causes the chest pain called as angina. Further blood clot will be formed on the rupture surface of plaque which block the blood flow through a coronary artery. Generally, the excess amount of calcium presented in the blood stream accumulates at the coronary plaques, incorporated in the progressive plaque layers and