

Chapter 2.9

Angiographic Images Segmentation Techniques

Francisco J. Nóvoa

University of A Coruña, Spain

Alberto Curra

University of A Coruña, Spain

M. Gloria López

University of A Coruña, Spain

Virginia Mato

University of A Coruña, Spain

INTRODUCTION

Heart-related pathologies are among the most frequent health problems in western society. Symptoms that point towards cardiovascular diseases are usually diagnosed with angiographies, which allow the medical expert to observe the bloodflow in the coronary arteries and detect severe narrowing (stenosis). According to the severity, extension, and location of these narrowings, the expert pronounces a diagnosis, defines a treatment, and establishes a prognosis.

DOI: 10.4018/978-1-60960-561-2.ch209

The current *modus operandi* is for clinical experts to observe the image sequences and take decisions on the basis of their empirical knowledge. Various techniques and segmentation strategies now aim at objectivizing this process by extracting quantitative and qualitative information from the angiographies.

BACKGROUND

Segmentation is the process that divides an image in its constituting parts or objects. In the present context, it consists in separating the pixels that

compose the coronary tree from the remaining “background” pixels.

None of the currently applied segmentation methods is able to completely and perfectly extract the vasculature of the heart, because the images present complex morphologies and their background is inhomogeneous due to the presence of other anatomic elements and artifacts such as catheters.

The literature presents a wide array of coronary tree extraction methods: some apply pattern recognition techniques based on pure intensity, such as thresholding followed by an analysis of connected components, whereas others apply explicit vessel models to extract the vessel contours.

Depending on the quality and noise of the image, some segmentation methods may require image preprocessing prior to the segmentation algorithm; others may need postprocessing operations to eliminate the effects of a possible oversegmentation.

The techniques and algorithms for vascular segmentation could be categorized as follows (Kirbas, Quek, 2004):

1. Techniques for “pattern-matching” or pattern recognition
2. Techniques based on models
3. Techniques based on tracking
4. Techniques based on artificial intelligence
5. Main Focus

This section describes the main features of the most commonly accepted coronary tree segmentation techniques. These techniques automatically detect objects and their characteristics, which is an easy and immediate task for humans, but an extremely complex process for artificial computational systems.

Techniques Based on Pattern Recognition

The pattern recognition approaches can be classified into four major categories:

Multiscale Methods

The multiscale method extracts the vessel method by means of images of varying resolutions. The main advantage of this technique resides in its high speed. Larger structures such as main arteries are extracted by segmenting low resolution images, whereas smaller structures are obtained through high resolution images.

Methods Based on Skeletons

The purpose of these methods is to obtain a *skeleton* of the coronary tree: a structure of smaller dimensions than the original that preserves the topological properties and the general shape of the detected object. Skeletons based on curves are generally used to reconstruct vascular structures (Nyström, Sanniti di Baja & Svensson, 2001). Skeletonizing algorithms are also called “thinning algorithms”.

The first step of the process is to detect the central axis of the vessels or “centerline”. This axis is an imaginary line that follows each vessel in its central axis, i.e. two normal segments that cross the axis in opposite sense should present the same distance from the vessel’s edges. The total of these lines constitutes the skeleton of the coronary tree. The methods that are used to detect the central axes can be classified into three categories:

Methods Based on Crests

One of the first methods to segment angiographic images on the basis of crests was proposed by Guo and Richardson (Guo & Richardson, 1998). This method treats angiographies as topographic maps in which the detected crests constitute the central axes of the vessels.

The image is preprocessed by means of a median filter and smoothed with non-linear diffusion. The region of interest is then selected through thresholding, a process that eliminates

7 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/angiographic-images-segmentation-techniques/53595

Related Content

Management and Analysis of Time-Related Data in Internet-Based Healthcare Delivery

Chris D. Nugent and Juan C. Augusto (2005). *Clinical Knowledge Management: Opportunities and Challenges* (pp. 33-51).

www.irma-international.org/chapter/management-analysis-time-related-data/6576

Finite Element Analysis and its Application in Dental Implant Research

Antonios Zampelis and George Tsamasphyros (2009). *Dental Computing and Applications: Advanced Techniques for Clinical Dentistry* (pp. 170-189).

www.irma-international.org/chapter/finite-element-analysis-its-application/8092

Communication and Nursing Relationships

Kyung Rim Shin, Dukyoo Jung and Su Jin Shin (2011). *Evidence-Based Practice in Nursing Informatics: Concepts and Applications* (pp. 25-39).

www.irma-international.org/chapter/communication-nursing-relationships/48920

Predicting Ambulance Diversion

Abey Kuruvilla and Suraj M. Alexander (2011). *Clinical Technologies: Concepts, Methodologies, Tools and Applications* (pp. 1393-1402).

www.irma-international.org/chapter/predicting-ambulance-diversion/53655

Quantitative Analysis of Hysteroscopy Imaging in Gynecological Cancer

Marios Neofytou, Constantinos Pattichis, Vasilios Tanos, Marios Pattichis and Eftyvoulos Kyriacou (2011). *Clinical Technologies: Concepts, Methodologies, Tools and Applications* (pp. 949-964).

www.irma-international.org/chapter/quantitative-analysis-hysteroscopy-imaging-gynecological/53630