IMPROVEMENT OF CORONARY ANGIOGRAPHY FOR QUANTITATIVE CORONARY ANALYSIS BY USING A COMPUTER VISION TECHNIQUE

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Degree of Master of Philosophy

Department of Information Technology

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Abstract

Coronary cine-angiography is an invasive medical image modality, which is widely used in Interventional Cardiology for the detection of stenosis in Coronary arteries. Quantitative coronary analysis is one of the demanding areas in medical imaging and in this study a semi automated quantitative coronary analysis method has been proposed. Direct coronary cine-angiogram frames are processed in order to obtain the features of lumen such as, vessel boundary, skeleton and luminal diameter along the vessels' skeleton as the results. The proposed method consists of four main implementation phases namely, pre-processing, segmentation, vessel path tracking and quantitative analysis. The visual quality of the input frames is enhanced within the pre-processing phase. The proposed segmentation phase is implemented based on a spatial filtering and region growing approach. A clinically important vessel region is processed to detect the vessel boundary and skeleton, which is required as prior knowledge for quantitative analysis. Moreover, the vessel diameter is computed while tracking the vessel skeleton path starting from a given seed. The proposed segmentation method possesses 93.73% mean segmentation accuracy and 0.053 mean fallout rate. Moreover, the proposed quantitative analysis method has been validated for assessing its' technical supportability using a clinically approved data set. As a result of that, this proposed method computes the vessel diameter along the vessel skeleton in single pixel gap and develops the ability to determine the diameter stenosis as the quantitative analysis results. Additionally, the clinical feasibility of the proposed method has been validated to emphasize the clinical usability. Moreover, this study can be further extended to make clinical decisions on stenosis through the functional significance of the vasculature by using proper medical image modality like biplane angiography.

Key words: motion stabilization, vessel segmentation, vessel tracking, quantitative coronary analysis

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LIST OF ABBREVIATIONS

Abbreviation	Description
AMB	Acute Marginal Branch
AP	Anterior-Posterior
CA	Coronary Artery
CC	Correlation Coefficient
CCA	Coronary Cine-angiogram
CLAHE	Contrast Limited Adaptive Histogram Equalization
CMRI	Cardiac Magnetic Resonance Imaging
CX	Circumflex Artery
DFT	Discrete Fourier Transform
FFR	Fractional Flow Reserve
GMV	Global Motion Vector
HOG	Histogram based Oriented Gradient
IVUS	Intra-vascular Ultrasound
LAD	Left Anterior Descending Artery
LAO	Left Anterior Oblique
LCA	Left Coronary Artery
LMCA	Left Main Coronary Artery
MR	Median Ramus
MSCT	Multi Slice Computer Tomography

NIR	Near-Infrared
OCT	Optical Coherent Tomography
OMB	Obtuse Marginal Branch
PCI	Percutaneous Coronary Intervention
PDA	Posterior Descending Artery
PET	Positron Emission Tomography
PLV	Posterior Left Ventricular
RAO	Right Anterior Oblique
RCA	Right Coronary Artery
SIFT	Scale Invariant Feature Transform
SP	Septal Perforators
SPECT	Single Photon Emission Computed Tomography
SPT	Skeleton Path Tracker
VDC	Vessel Diameter Calculation

LIST OF APPENDICES