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SEGMENTATION OF VESSELS IMAGES ON ANGIOGRAMS IN SPACE OF TRANSFORMATION COEFFICIENTS WITH COMMON WAVELET FUNCTIONS

Marina Polyakova

Odessa National Polytechnic University,
1, Shevchenko Avenue, Odessa, 65044, Ukraine,
marina_polyakova@rambler.ru

Abstract: *The method of vessel segmentation on angiogram is elaborated. It includes the analysis of own values of Hessian for every pixel of image. The elements of Hessian calculated from the image convolution by the common wavelet functions with a compact support. This decreases the conputational complexity of method of segmentation of angiograms due to replacement of a few levels of data processing by one.*

Keywords: *segmentation of images, wavelet transform, angiogram.*

Basic fractions among a general death rate in Ukraine make the heart diseases. For the vessel state diagnostics the angiographic research of coronary arteries is actively used in a cardiology. It is necessary for diagnosis of ischemic heart disease and localization of stenosis of vascular structures.

One of base procedures of angiographic research is segmentation of vessel tree on angiograms. The method of segmentation of angiograms is used on one of the stages of reconstruction of spatial structure of coronary artery (CA) [1]. The spatial model of heart vessels allows the estimating of their geometrical characteristics and visualizing the spatial structure of vessels. Result of reconstruction of CA spatial structure used in the cases when the vessel stenosis is present on angiogram in one projection, while on an angiogram in other projection that vessel in a norm [1].

For the segmentation of angiographic images the tree of vessel is localized on an angiogram and then the angiographic image is transformed to binary image. Further the binary image of angiogram is analyzed [2]. For example, the method of paper [3] localizes a vessel tree by the analysis of eigen values of Hessian in every point of image. At the calculation of this matrix was taken into account that the width of vessel changed on all of its extent. Therefore for the processing of fragments of vessel of different width the scale-space representation of angiographic image [4] was used and analysis of Hessian eigen values on the fixed set of scale values was applied. For each of values of scale the partial derivatives of image were calculated by the convolution of an image with the derivative of Gaussian.

It is known that double differentiation increases the noise level. Therefore the convolution of an image with the derivative of Gaussian at the calculation of partial derivatives of image is applied. Although at multiscale image processing the time of processing is decreased, it still dissatisfies limitations of methods of angiogram segmentation. To reduce the complexity of the angiogram segmentation method is possible by application developed in [5] the distribution wavelets with a compact support which replacing a few levels of processing by one. The last is due to that convolution with the distribution wavelets with a compact support analogical applying of the set of band-pass filters. An application of the distribution wavelets provides quality of localization of vessel tree on an angiogram which is necessary for diagnostic.

The aim of the paper is reducing of the angiogram processing time by application of the distribution wavelets with a compact support for localization of vessel tree.

In this paper the method of segmentation of images of vessels on angiograms in space of transform with distribution wavelet is elaborated and the results of segmentation are analyzed. The calculation complexity and robustness of the elaborated method on angiograms is investigated.

For modification of method of [3] it is applied the distribution wavelets with a compact support. At the construction of these functions a cascade algorithm [6] is used. After application of this algorithm we get discrete sequence $\{\psi_n\}_{n=0}^{N}$ where N it is an amount of coefficients of sequence. This sequence is used as coefficients of filter for processing of images [6]. For example, on a fig. 1 the impulse response of the filter $\{\psi_n\}_{n=0}^{N}$ which got by application of 3th iterations of cascade algorithm [8] to two-scale difference equation with scaled to unit coefficients

$$\left\{-\frac{1}{2^{3+\alpha}}, \frac{1}{2^{2+\alpha}}, -\frac{1}{2^{1+\alpha}}, 1, 1, -\frac{1}{2}, \frac{1}{2^{2+\alpha}}, -\frac{1}{2^{3+\alpha}}\right\},$$

where $\alpha = 0{,}7$.

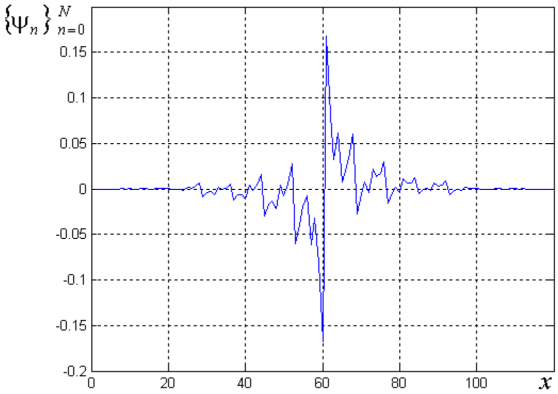

Fig. 1 — Impulse responce of filter $\{\psi_n\}_{n=0}^{N}$

Application of the distribution wavelets with a compact support as analyzing wavelets for implementation of underlining transform for the detection of vessels on angiograms (fig. 2) preferably to the Gaussian derivatives. The characteristics of localization of vessels are estimated on angiograms before and after the skeleton calculation. Analysis of experimental results shows that a method using the distribution wavelets with a compact support decreased the time of image processing on 43 percent and quality of processing is not worsened. Characteristics of robustness changed as follows: probability of false positive was decreased on 21,5 percent, and probability of false negative increased on 14 percent.

As direction of further researches it is assumed to apply the distribution wavelets with a compact support at reconstruction of vessel tree on 3D computer tomography images [7].

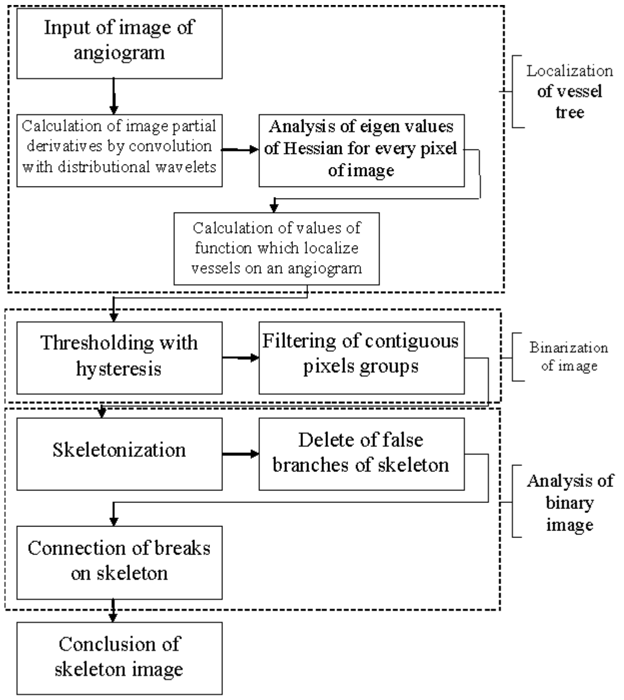

Fig. 2 — Functional diagram of the method of the angiogram segmentation in the space of transform with the distribution wavelets and analysis of segmentation results

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