computing@computingonline.net
www.computingonline.net

ISSN 1727-6209
International Journal of Computing

EXTRACTION OF LEFT VENTRICULAR CONTOURS FROM VENTRICULOGRAMS WITH LABELING OF IMAGE PIXELS BY ACTIVE CONTOURS

Marina Polyakova

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

Abstract: *The method of the extraction of left ventricular contours is developed for ventriculograms which obtained by radiological research of heart with the angiographic system. The proposed method includes the underlining of left ventricular contours through the repagular wavelet transform and labeling the pixels of image by active contours that reduced the error of detection of the edge and the area of left ventricle.*

Keywords: *wavelet transform, left ventriculogram, active contours.*

For diagnostics of diseases of vessels the radiographics reseach is actively used in a cardiology. It is directed on verification of diagnosis of ischemic heart disease, clarification of localization of stenosis of vascular river-bed, determination of tactic of medical treatment. At the coronaroangiography, as a rule, the left ventriculography is included. This procedure allows to estimate the systole function of the left ventricle with gemodynamical indexes (end-systole and end-diastole volume of left ventricle, cardiac index, shock index and other).

For the calculation of gemodynamical indexes the left ventricular (LV) contours is extracted from ventriculograms in one of projections at end-systole and at end-diastole. The results of this procedure influence on the error of assessment of cardiac function of heart and, consequently, determine accuracy of diagnosis. A fearture of angiographic images is in that the improvement of quality of extraction of LV contours even on a few percents cans consederably increasing the accuracy of diagnosis.

The perspective way for the improvement of quality of extraction of LV contours is application of the active contours or shakes [1] and the repagular wavelet transform (WT) developed by author [2]. Therefore the aim of this paper is elaboration and research of method of extraction of LV contours with the use of active contours and the repagular WT for increasing of the quality of this procedure in control automatic system of ventriculogram analysis and recognition.

The vector field convolution (VFC) shakes is used for labeling of ventriculogram pixels in modification proposed in [3]. The multistep shakes acccordantly to terminology [4] further will name this modification. An initial problem is decided by this method througth a few optimization sub-problems.

The extraction of LV contours from ventriculograms developed in this paper is based on a functional diagram from a fig. 1 [5]. On the stage of underlining transform according to [2] repagular WT was used with the parameter of a=0,25. This allows choosing the level of scale-space representation of image in accordance with the aims of processing and provides necessary robustness and permissible error of segmentation result.

Multistep VFC snakes applied at labeling of ventriculogram pixels realized in two stages.

On the first stage of the method an underlined image was resulted by weigthed adding of image $r(x,y)$ got from uderlining transform and an image $f_n(x,y)$ formed as a result of neural network generalization. Then from the initial approach of contour as a circle the VFC snakes is started. Parameters values are chosen as R=1, γ=0, ε=0. Such parameters results in the special case of VFC which is the gradient vector flow. The use of it is expediently on this stage as an underlined image is not noised. Therefore this method extracts the LV contours with the low error.

On the secong stage of multistep VFC snakes for the extraction of LV contours from ventriculograms

a contour got on the first stage of method is improved. For this purpose the result of gomomorphic filtering of initial image is processed by repagular WT. Parameter of repagular WT on this stage is a=1 for ventriculograms at end-diastole and a=0,25 for ventriculograms at end-systole.

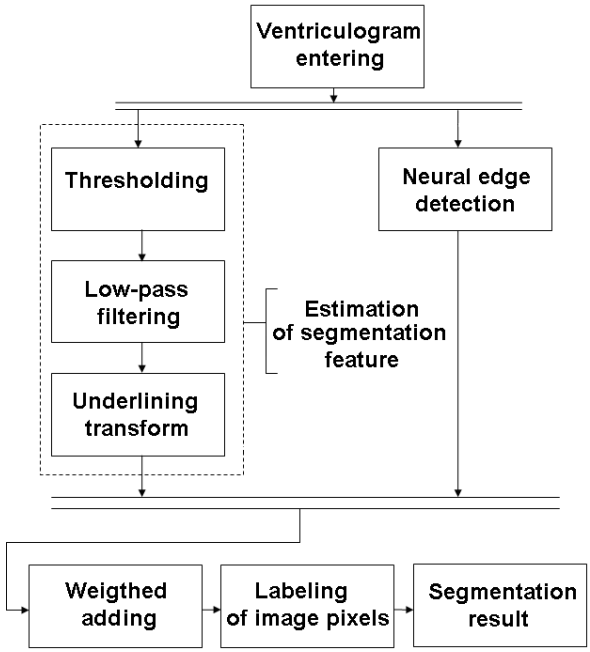
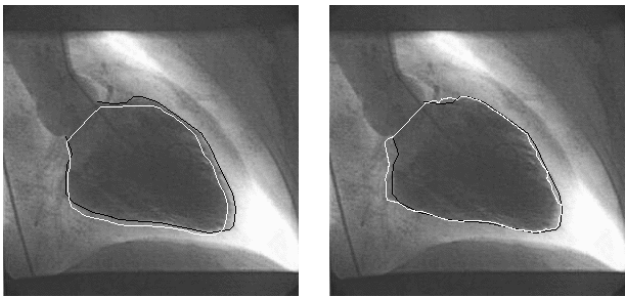


Fig. 1 – Functional diagram of method of extraction of LV contours from ventriculograms

Then VFC snakes is started with the parameters R=32; γ=2,2; $\varepsilon=10^{-8}$. As an initial approach of contour on this stage the resulting contour on the first stage of the extraction of LV contours from ventriculograms was used. To the LV contours gdot on the second stage of the method the dilatation was used in order to smooth small defects.

Results of the extraction of LV contours form ventriculogram at end-diastole with the use of multistep VFC snakes is shown on a fig. 2. By a black line is marked a contour traced a cardiologist.



a b

Fig. 2 – Result of the first stage of multistep VFC snakes (a); second stage of multistep VFC snakes for ventriculogram at end-diastole (b)

The results of extraction of LV contours were calculated for 56 ventriculograms. If the method of the paper [2] is applied with a=0,25 a mean contour error is 7,05% and an area error is 4,31% for ventriculograms at end-diastole. It means that application of multistep VFC snakes decreased contour error on 0,5% and an area error in 5,2 times. Analogical errors for ventriculograms at end-systole at the use of method of [2] were 13,19% and 6,64% (a=0,25). Applying of multistep VFC snakes reduced a contour error on 2,1% and an area error in 3 times. A difference in ejection fractions after applying of repagular WT with a=1 was 0,75% that on 0,8% below what at the use of multistep VFC snakes.

Let's compare the results of multistep VFC snakes for the extraction of LV contours from ventriculograms at end-diastole with results of paper [1]. Application of classification method [1] is resulted in contour error 5,97% that on 0,7% less than contour error of elaborated method. A difference in ejection fractions was 3,71% which in 4,3 times higher than for developed method.

Thus application of multistep VFC snakes for the extraction of LV contours from ventriculograms preferably than tracing. On the first stage of this method an image is processed on the small scale resulted as anisotropic diffusion when the contours of interesting us object (the left ventricle) are stored on ventriculogram and contours of objects into it (sending wire and catheter) and surrounding structures such as the ribs smoothed. On the second stage of method the initial image is processed with a large scale in order to save robustness of result of the extraction of LV contours on the previos stage of the method.

REFERENCES

[1] A. Bravo, M. Vera, R. Medina, Edge detection in ventriculograms using support vector machine classifiers and deformable models, *Lecture Notes in Computer Science,* 4756 (2007). p. 793-802.

[2] M. V. Polyakova, V. N. Krylov, N. A. Gulyaeva, T. V. Pruschak, Control automatic system of analysis and recognition of ventriculograms on a base of the repagular wavelet transform, *International Journal of Computing,* (9) 4 (2010). p. 335-344. (in Russian)

[3] C. Rogab, S. Itzerott, B. U. Schneider, H. Kaufmann, R. F. Huttl, Edge segmentation by alternating vector field convolution snake, *Internation J. of Computer Science and Network Security,* (9) 8 (2009). p. 123-131.

[4] A. F. Izmailov, M. V. Solodov, *Numeral methods of optimization,* Moscow, 2003. 300 p. (in Russian)

[5] K. Suzuki, I. Horiba, N. Sugie, M. Nanki, Extraction of left ventricular contours from left ventriculograms by means of a neural edge detector, *IEEE Transactions on Medical Imaging,* (23) 3 (2004). p. 330-339.