DYNAMIC SEGMENTATION OF THE LIVE ORGANS WITH FAST EDGE DETECTION ALGORITHM

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ABSTRACT

Image processing is a useful subfield of computer science and has been finding use in many different real life solutions. Segmentation is getting digital information from the image to classify the regions on it. We introduce a new method for segmenting the live organs with Laplacian Edge Detection. Our method can be adapted and used for many different applications including medical field such as surgeries with magnetic resonance guided robots. The core method is described in this article. The method is tested for left ventricle of the heart and will be experimented in other organs as well.

INTRODUCTION:

Segmentation is gaining importance due to its wide range of use in medical applications. Several methods have been developed especially for segmenting the left ventricle of the heart for planning cardiovascular surgeries [1-6]. There have been introduced a few robotic devices to help those surgeries as well [5-8]. Here, we present a new algorithm to enable fast segmentation for all the organs. The algorithm is tested in the heart (left ventricle).

ALGORITHM:

Laplace edge detection has many uses in image processing such as face recognition, pattern recognition, medical imaging [9]. Following is the step by step description of how this method is used for medical images of the heart. For every image form the MR machine do the following sequentially:

1 – Read image: Get the image in particular plane. It can be real time or operational in short, long or oblique axes.

2 – Pick a seed point on the area of interest and read its pixel and position value. Get the tracked tip of a catheter, and/or organ biomarker:

$$\text{Seed point: } P_S = (x_S, y_S)$$
$$\text{Pixel intensity } (P_S) = I_S$$

3 – Define a line: Corresponds to the linear projection band through the image as drawn in Figure 1.

Start Point: $P_1 = (x_1, y_1)$

End Point: $P_n = (x_n, y_n)$

Projection line: $L_P = | P_n P_1 |$

Where n is the number of points along the line L_P.

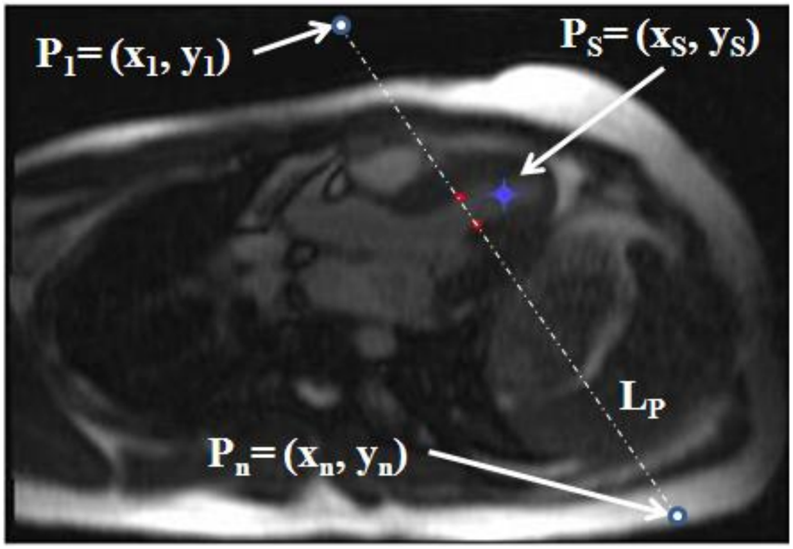


Figure 1: sample image with projection line and the points to be defined.

4 – Get the pixel intensity values along the line:

$I(x_i, y_i)$ is the pixel intensity at the point (x_i, y_i) along the line L_P

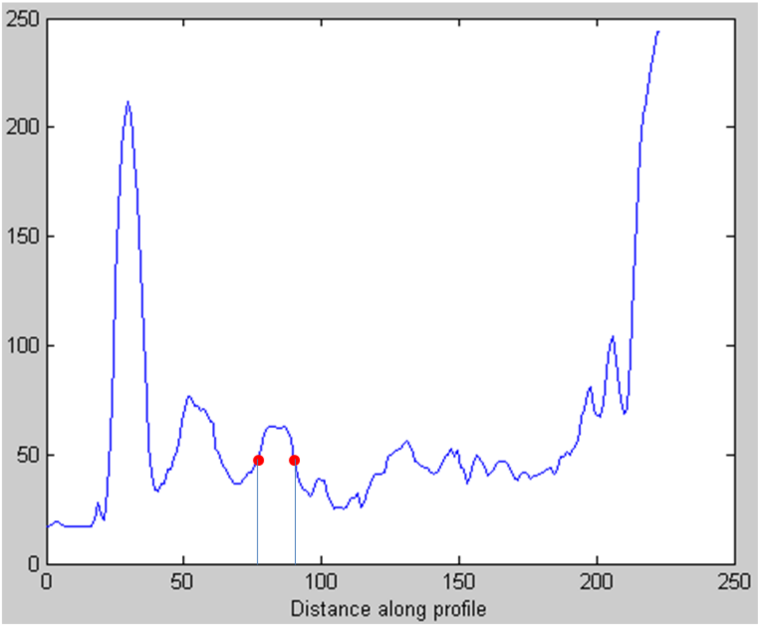


Figure 2: Pixel intensities are plotted.

5 – Calculate the local mean intensities (expected intensity values) along the line for every consecutive 7 points:

$\forall j \in [4, n-3]$

$E[I_j] = \frac{1}{7}\sum_{i=j-3}^{j+3} I(x_i, y_i)$

6 – Calculate the local variances:

$\mu_j = E[I_j]$

$Var(I_j) = E[(I_j - \mu_j)^2]$

$$Var(I_j) = \frac{1}{7}\sum_{i=j-3}^{j+3} (I(x_i, y_i) - \mu_j)^2$$

Load the $Var(I_j)$values into an array, i.e., Local Variances Array: LVA, of size n-6.

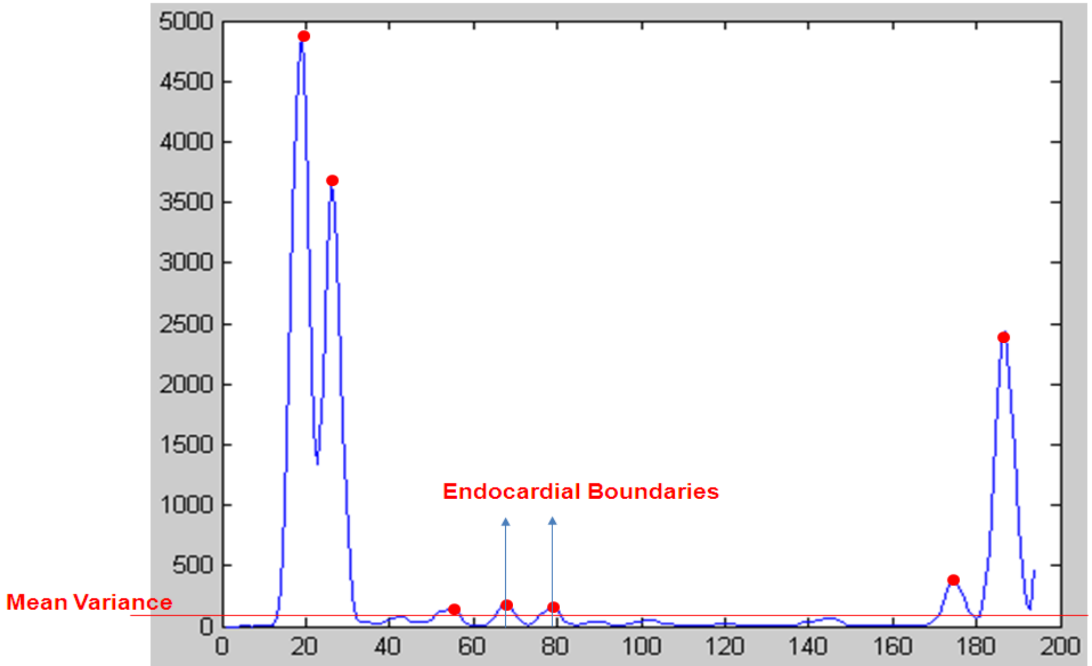
7 – Find the mean variance which is to be used as the threshold:

$$M = \frac{1}{n-6}\sum_{j=1}^{n-6} Var(I_j)$$

8 – Find the variances in LVA which are bigger than the mean variance and create Bigger Variances array, BVA:

$BVA = \{Var(I_j) | Var(I_j) > M \text{ and } 1 \leq j \leq n-6\}$

9 – Determine the local maximas of BVA and create Maximal Variances Array MVA. These are the strongest candidates to be the edges.



10 – Find the midpoints and the corresponding pixel intensities of the every consecutive local maximum pairs,

11-Determine the two local maximas which are nearest to the seed point and have the midpoint with similar intensity to seed point`s.

12 – Mark this specific couple since they are the endocardium boundary points.

After applying this algorithm along several lines and connecting the edges we have a full segmentation to be used for surgical guidance. Our next step is to test the accuracy of the segmentation and use it for other organs.

Conclusion:

This algorithm can be adapted for planning surgical operations in heart and the other organs [8, 10-13]. Further testing is necessary for quantitatively measuring the accuracy of the algorithm.

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