AUTOMATIC ABDOMINAL ORGANS SEGMENTATION WITH MATHEMATICAL MORPHOLOGY IN MR IMAGES

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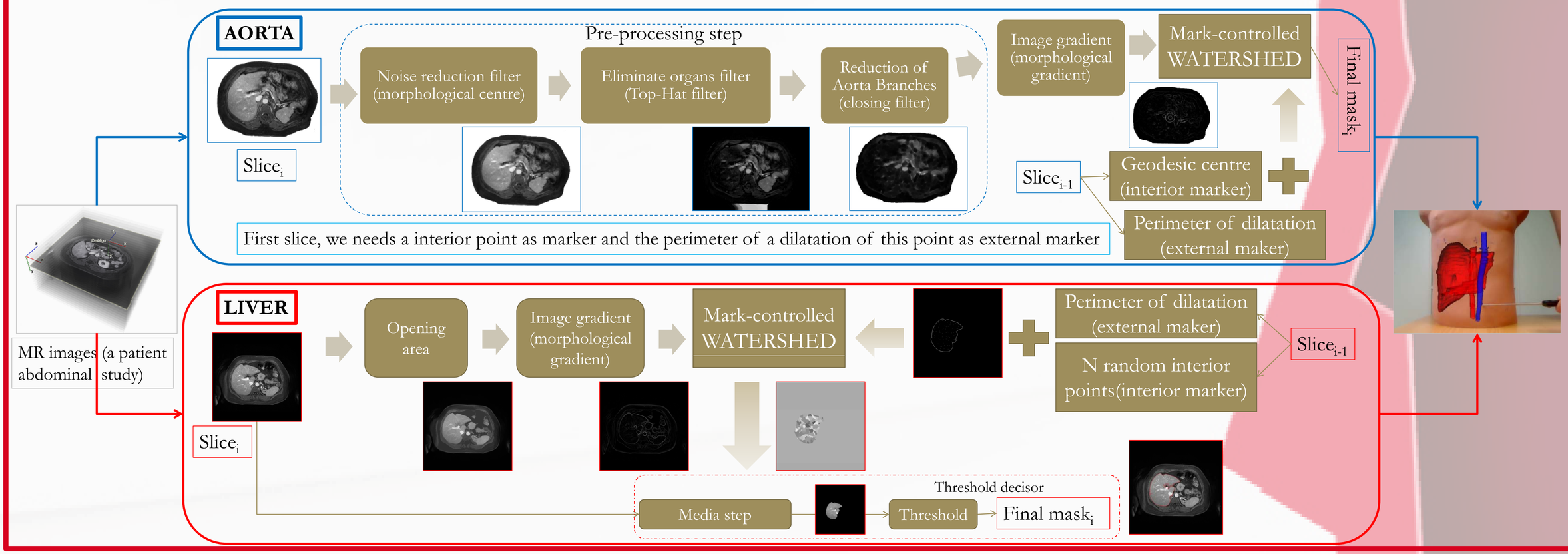
Abstract

This work proposes an automatic segmentation method based on the watershed transformation. This method is tested in magnetic resonance datasets and focused on the segmentation of the aorta artery [1] and the liver. After this segmentation process, a 3D model is created with the purpose of projecting it over the patient to help the surgeon in the trocar placement in laparoscopy surgery [2].

The watershed algorithm is a robust segmentation method if the input image has well-defined boundaries and if the image minima represent relevant objects. In abdominal MR images these hypotheses are two problems and for this reason a pre-processing step is required. The problem of the necessity well-defined boundaries are solved in the case of the aorta artery with the gradient image and different morphological filters to eliminate structures with similar grayscale values. In the case of the liver this step is more complex and the gradient is obtained applying an opening area operator.

The problems of the minima are solved with a variant of the watershed transformation called marked-controlled watershed, which consists of using a set of markers to modify the gradient image. These markers will be the new minima of the image and they prevent the over-segmentation, typical in the basic watershed algorithm. In the case of the aorta artery two markers are defined, an internal marker obtained as the geodesic centre of the adjacent slice (in the z axis) and an external marker obtained as the perimeter of the dilatation of the adjacent slice (in the z axis). In the liver, the external marker is obtained as in the aorta artery (the perimeter of a dilatation of the adjacent slice) but in the case of internal markers, several internal markers are calculated to prevent the break of the liver and the possibility of the hepatic tree isolates some parts of the liver. Finally a threshold decided if a region is liver or not.

Segmentation Algorithm



Results and conclusions

AORTA

Study	Own	Theshold decisor	Region Growing	K-means Classificator
1 (N images)	0.84	0.61	0.81	0.73
2 (N images)	0.8	0.64	0.77	0.73
3 (N images)	0.79	0.47	0.75	0.62
4 (N images)	0.82	0.59	0.76	0.62

Table 1. Comparison with other methods. The coefficient calculated is the Jaccad index.

Jaccard coefficient is calculated for different methods. The Threshold algorithm is base in a multi-Otsu thresholder. In the region growing method a pixel is added at the region if it has a level of gray between "m $\pm f$*sd", where "m" and "sd" are the media and standard deviation of the region and "f =3" (extracted empirically). Finally the number of clusters of the k-means method, that obtains the best results is 5 or 7 (obtained empirically, dependent of each study).

CONCLUSIONS: An automatic method for abdominal organ segmentation in MR images is proposed. Watershed method has the main problem of the over-segmentation, but the mark-controlled Watershed algorithm solves it. To obtain a good segmentation a well-defined gradient image of the organ of interest and a good set of external markers and internal markers are needed (solved in our method with anatomic knowledge). In the case of the Aorta Algorithm the results are promised (JC = 0.8107 ± 0.02) [1] and in the case of the liver the main problem is when it is broken in an image, in other images the results seem very good.

LIVER

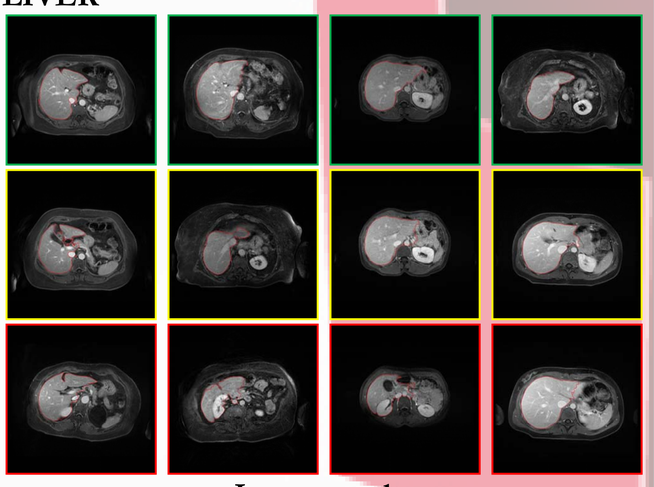


Image results

References

[1] *López-Mir Fernando., Naranjo Valery., Angulo Jesús., Villanueva Eliseo., Alcañiz Mariano., López-Celada Susana.,* AORTA SEGMENTATION USING THEWATERSHED ALGORITHM FOR AN AUGMENTED REALITY SYSTEM IN LAPAROSCOPIC SURGERY, in IEEE International conference on image processing (ICIP 2011)

[2] Fuertes *Juan José., López-Mir Fernando., Naranjo Valery., Ortega Mario., Villanueva Eliseo., Alcañiz Mariano.,* AUGMENTED REALITY SYSTEM FOR KEYHOLE SURGERY: PERFORMANCE AND ACCURACY VALIDATION, in International Conference on Computer Graphics Theory and Applications (GRAPP 2011)

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