Development of a Semiautomatic Segmentation Algorithm for the Measurement of Pancreatic Cancer Liver Metastases in Ultrasound Images

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Introduction

Ultrasound (US) is the most commonly used liver imaging modality worldwide. Due to its low cost, it is increasingly used in the follow-up of cancer patients with metastases localized in the liver. In this contribution, we present the development of an interactive segmentation approach for liver metastases in US acquisitions. A (semi-)automatic segmentation is still very challenging because of the low image quality and the low contrast between the metastasis and the surrounding liver tissue. Thus, the state of the art in clinical practice is still manual measurement and outlining of the metastases in the US images.

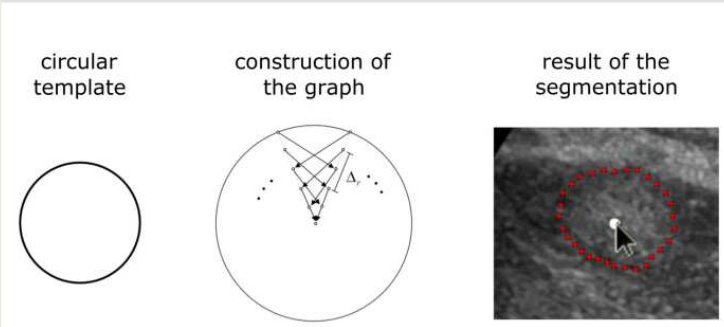

Figure 2: Interactive segmentation workflow. Left image: a circular template is used for the underlying graph. Second image from the left: based on the underlying circular template, the graph is constructed using rays sent out radially from the center of the circle. The right image displays the user predefined seed point and the recognized border of the lesion marked by smaller red dots.

Results

Using images of different echo pattern we were able to adjust the settings of the algorithm to fit the majority of the cases (**Figure 3**). The algorithm works quickly and outlines precisely the metastasis border. Even difficult cases like nearly isoechoic echo pattern are recognized well by the software. This enables a good differentiation between normal liver tissue and metastasis (**Figure 4**).

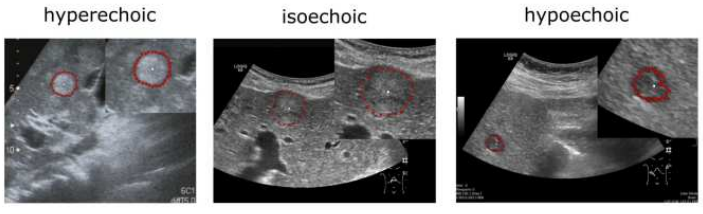

Figure 3: For adjustment of the algorithm metastasis with different echo pattern were used. The algorithm was able to recognize homogenous hyperechoic, isoechoic and hypoechoic liver lesions.

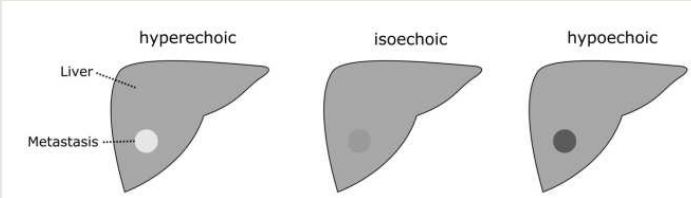

Figure 1: The three images represent the main echo pattern of neoplastic tissue in the liver.

Methods

We selected images of liver metastases mainly derived from pancreatic cancer pattients resembling the following main echo pattern: hyperechoic, isoechoic and hyporechoic (**Figure 1**). After removing all identifying image parts, including name of the patient and date of the examination, the images were processed using our segmentation algorithm, which was integrated into the medical prototyping platform MeVisLab (Fraunhofer MeVis, Bremen, Germany) [1,2]. The algorithm uses a circular template resembling the clonal expansion of neoplastic tissue. This type of growth pattern is seen in most of the liver metastasis. The algorithm belongs to the class of graph-based algorithms. Rays are projected centrifugal from a predefined seed point (**Figure 2**). Along these rays the algorithm assess the gray values to differentiate between liver and metastatic tissue. Red dots represent the borderline of the two detected tissues.

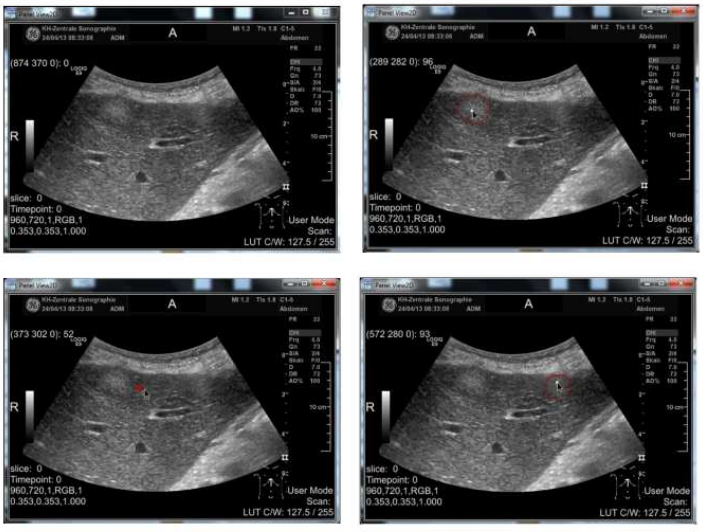

Figure 4: Demonstration of the algorithm. After loading the US image displaying two liver metastasis (upper left) the user defines a seed point (upper right). Dragging the cursor to the right (lower left) visualizes the real time feed back of the segmented area. Reaching the second metastasis results in the immediate segmentation of the same.

Conclusion

This work presents the successful application of a graph based algorithm to segment liver metastasis in ultrasound.

References

[1] Egger J, Gall M, Wallner J, Boechat P, Hann A, Li X, et al. (2017) HTC Vive MeVisLab integration via OpenVR for medical applications. PLoS ONE 12(3): e0173972.

[2] J. Egger, P. Voglreiter, M. Dokter, M. Hofmann, X. Chen, W. G. Zoller, D. Schmalstieg, A. Hann "US-Cut: interactive algorithm for rapid detection and segmentation of liver tumors in ultrasound acquisitions" In: Proceedings of SPIE Medical Imaging Conference, Paper 9790-47, San Diego, USA, Feb. 2016.

No conflicts of interest. Contact: Alexander.Hann@uniklinik-ulm.de