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Tissue Classification of Oncologic Esophageal Resectates based on Hyperspectral Data

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Introduction

Esophageal carcinoma is the eighth most common cancer worldwide. Esophageal resection with gastric pull-up is one of the therapeutic options. After this procedure, the specimen is examined by the pathologist to confirm complete removal of the cancer. A intraoperative analysis of the resectate would be less time-consuming and therefore improve patient safety.

Methods

Hyperspectral imaging (HSI) is a relatively new modality, which has shown promising results for the detection of tumors. Automatic approaches could support the surgeon in the visualization of tumor margins. Therefore, we evaluated four supervised classification algorithms: Random Forest (RF), Support Vector Machines (SVM), Multilayer perceptron (MLP) and k-nearest neighbor (k-NN) to differentiate malignant from healthy tissue based on HSI recordings of esophagus and stomach resectates in 11 patients.

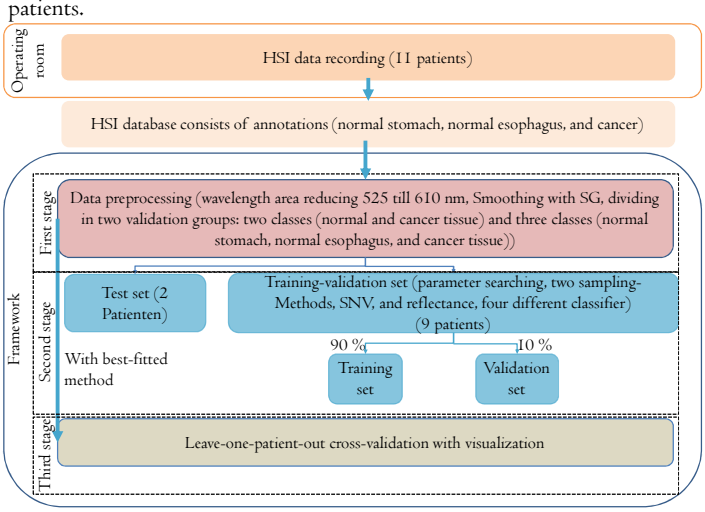

Fig. 1: Tissue classification pipeline with our implemented used three-stage framework.

Tab. 1: Patient information of each patient used in the leave one out cross validation (ADC: adeno cell, SCC: squamous cell).

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
therapy	radiochemo	chemo	chemo	radatio	radiochemo
TNM-classification	pT3	pT3	pT1	pT3	pT 3/pT1
histologic tumor type	SCC	ADC	ADC	SCC	SCC and ADC
tumor size	8,9 x 8,2 x 0,6 cm	2,5 x 2,1 x 0,2 cm	3 x 1,5 cm	no information	8,9 x 8,2 x 0,6 cm/no information

Results

The best performances were obtained with a cancer tissue detection of 63 % sensitivity and 69% specificity with the SVM. In a leave-one patient-out cross-validation, the classification showed larger performance differences according to the patient data used. In less than 1 second, a data classification and visualization were shown.

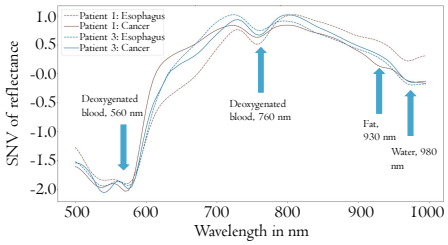

Fig. 2: The mean reflectance of the annotated carcinoma and esophagus for patient 1 (radiochemotherapy, pT3) and patient 3 (chemotherapy, pT1).

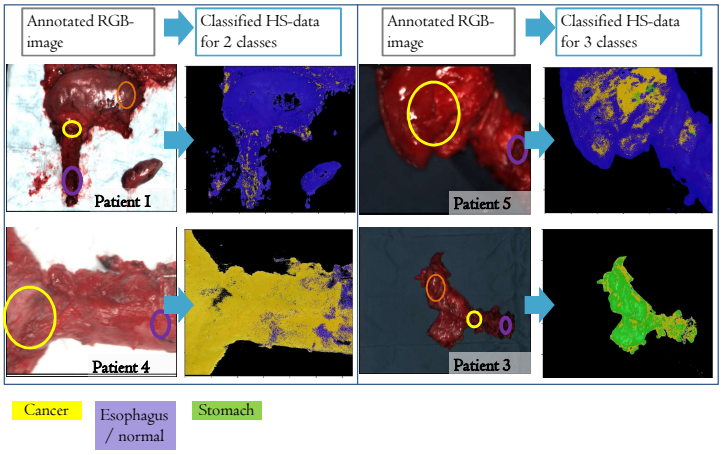

Fig. 3: The figure shows on the left side the 2-classes approach with the annotated RGB image and the classified HSI image and on the right side the 3- classes approach with the annotated RGB image and the classified HSI image.

Conclusion

In this work, we successfully tested several classification algorithms for the automatic detection of esophageal carcinoma in resected tissue. A larger data set and a combination of several methods would probably increase the performance. Moreover, the implementation of software tools for intraoperative tumor boundary visualization will further support the surgeon during operations.

References

[1] Maktabi M, Köhler H, Margarita I, Jansen-Winkeln B, Takoh J, Niebisch S, Rabe S M, Gockel I, Chalopin C. Tissue classification of esophagus resected tissue based on hyperspectral data. International Journal of Computer Assisted Radiology and Surgery. 2019.

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DIASPECTIVE VISION

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