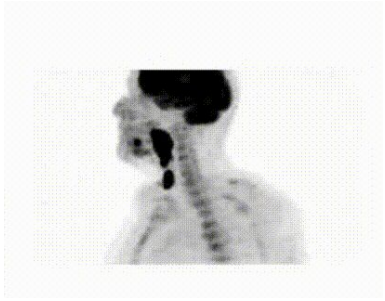


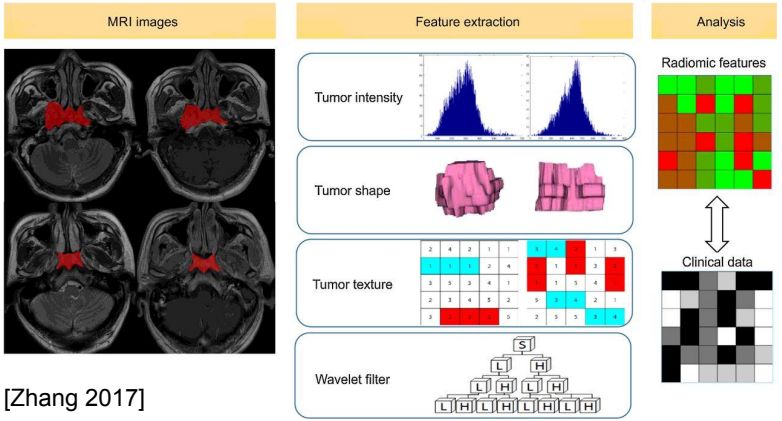
Automatic Segmentation of Head and Neck Tumors in PET-CT scans

Vincent Andrearczyk, Valentin Oreiller, Martin Vallières, Joel Castelli, Hesham Elhalawani, Sarah Boughdad, Mario Jreige, John O. Prior and Adrien Depeursinge

MIDL 2020

Introduction

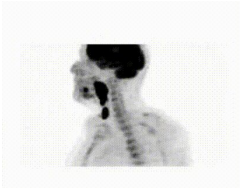
- **Radiomics**: prediction of disease characteristics using quantitative image biomarkers from medical images



[Zhang 2017]

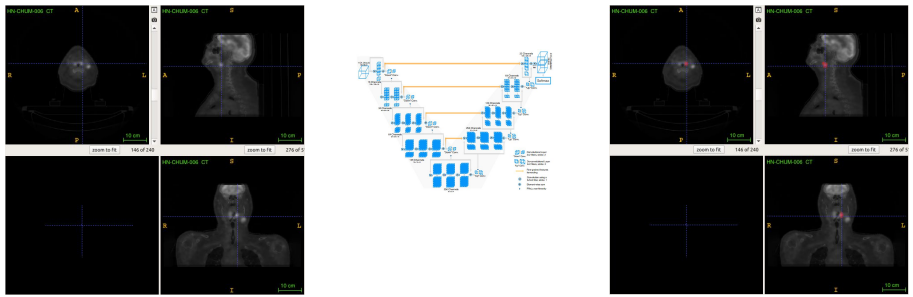
Example: Pre-treatment signature of a tumour region to predict response to treatment and survival time

Introduction



- Head and Neck (H&N) cancers: 5th leading cancer by incidence (Parkin et al. 2005)
- Radiomics studies based on PET/CT -> predict patients prognosis in a **non-invasive** fashion (Vallières et al. 2017),(Bogowicz et al. 2017),(Castelli et al. 2017)
- **Limitations**: Validated on 100-400 patients -> larger cohorts required for estimating generalization
- Manual annotations in 3D are tedious and error-prone

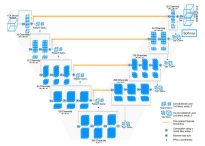
We need **automatic segmentation** of H&N tumor



Experiments design

Automatic H&N tumor segmentation in PET-CT images

- 203 PET-CT volumes with ground truth annotation (Vallières et al. 2017)
- Multi-centric (4 centers)
- Leave-one-center-out cross-validation
- U-Net (2D) vs V-Net (3D): CNNs for image segmentation
- PET vs CT vs PET/CT



Results

Table 1: Comparison of single modality and bimodal network performance of 2D and 3D V-Nets. The average DSCs, sensitivity and specificity (%) are reported with 95% CIs.

model	modalit.	DSC	precision	recall
2D/3D	CT	48.7% ±2.2/49.2% ±2.2	52.7% ±2.9/48.6% ±2.6	54.1% ±2.8/65.0% ±2.6
2D/3D	PET	58.2% ±2.3/58.6% ±2.5	59.7% ±3.0/59.1% ±2.9/	66.7% ±2.9/70.2% ±3.1
2D/3D	early fusion	58.5% ±2.2/58.9% ±2.3	58.1% ±2.9/59.0% ±2.9/	70.2% ±2.7/**70.8%** ±2.8
2D/3D	late fusion	**60.6%** ±2.1/59.7% ±2.2	**69.4%** ±2.6/62.8% ±2.8/	62.1% ±2.9/69.1% ±2.8

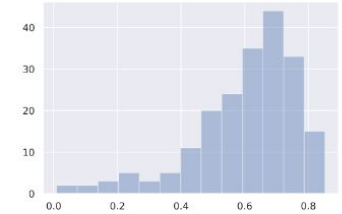
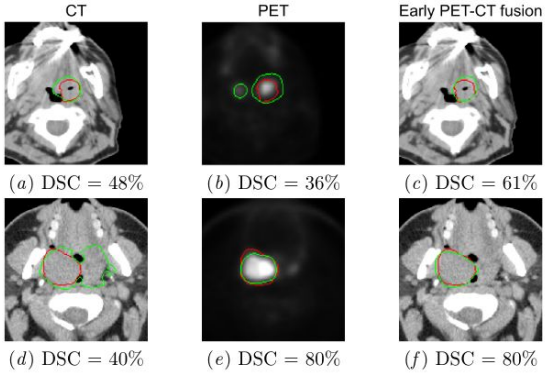


Figure 1: Count histogram of DSCs obtained by late 2D PET-CT fusion for the 4-center cross-validation.



(*a*) DSC = 48% (*b*) DSC = 36% (*c*) DSC = 61%

(*d*) DSC = 40% (*e*) DSC = 80% (*f*) DSC = 80%

Figure 3: 2D axial examples of qualitative segmentation results (green) and ground truth (red) with their corresponding DSC (evaluated on the entire 3D volumes). Top row illustrates an example in which better prediction is obtained on the CT. Bottom row illustrates an example in which better prediction is obtained on the PET. (a,d) CT segmentation, (b,e) PET segmentation, (c,f) early fusion PET/CT segmentation.

Conclusion

- Automatic segmentation necessary for large scale radiomics studies
- Promising results obtained, more details in the paper: https://openreview.net/forum?id=1Qi71nEERx
- HECKTOR challenge at MICCAI 2020: Cleaned and added data

https://www.aicrowd.com/challenges/miccai-2020-hecktor

Annotations to clean