

Hyperspectral Image Segmentation: A Preliminary Study on the Oral and Dental Spectral Image Database

Luis Carlos García Peraza Herrera, Conor Horgan, Sébastien Ourselin, Michael Ebner, Tom Vercauteren



Motivation

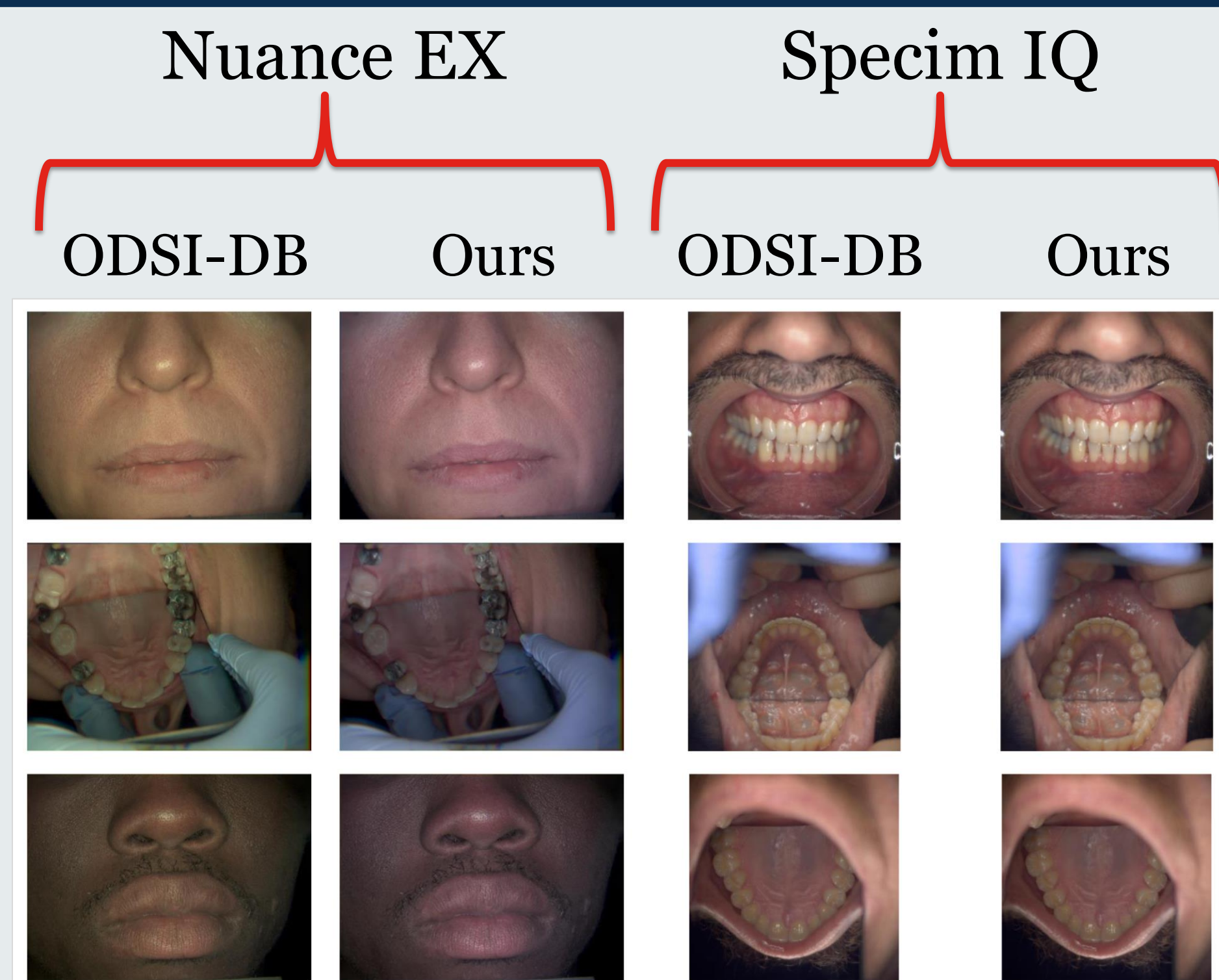
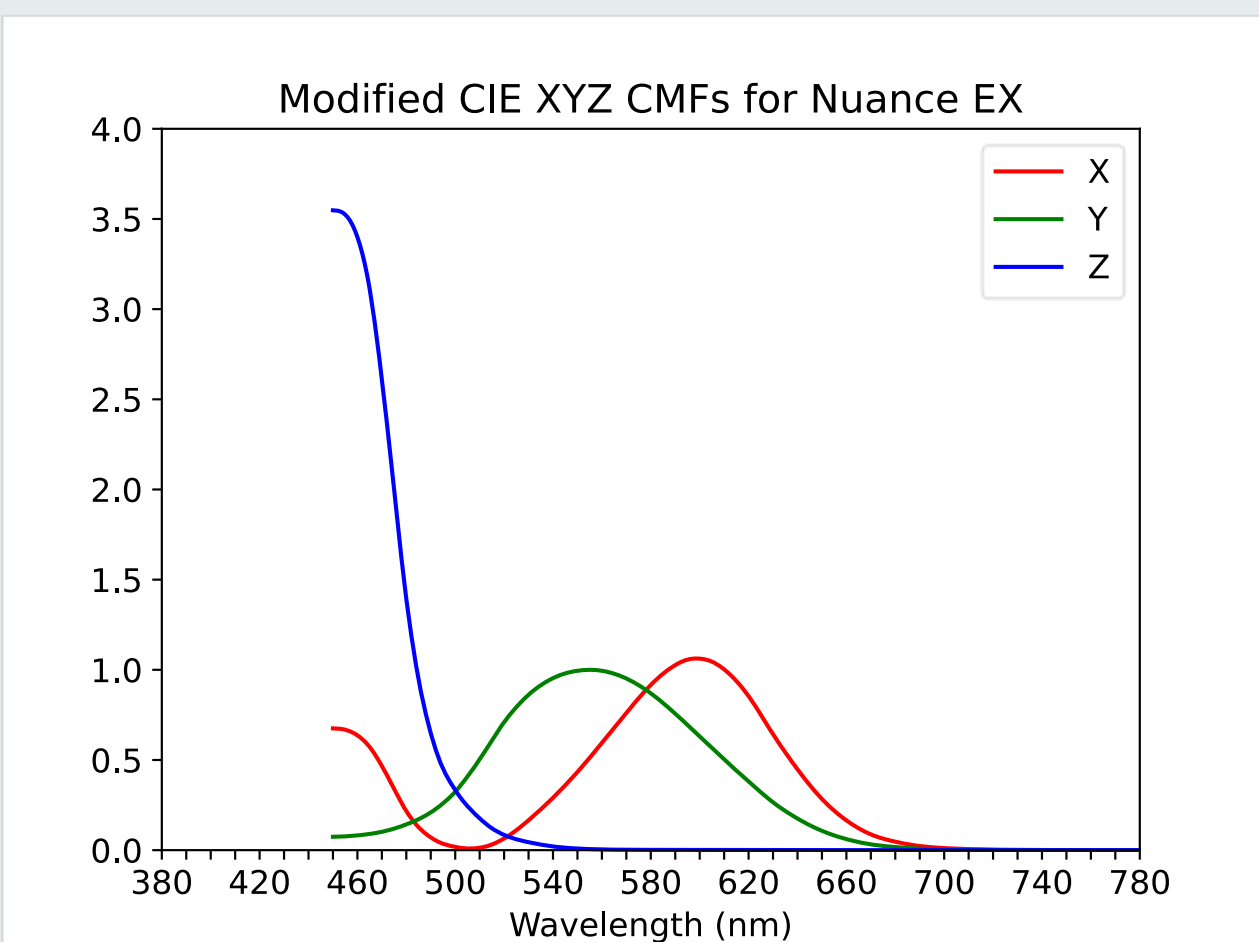
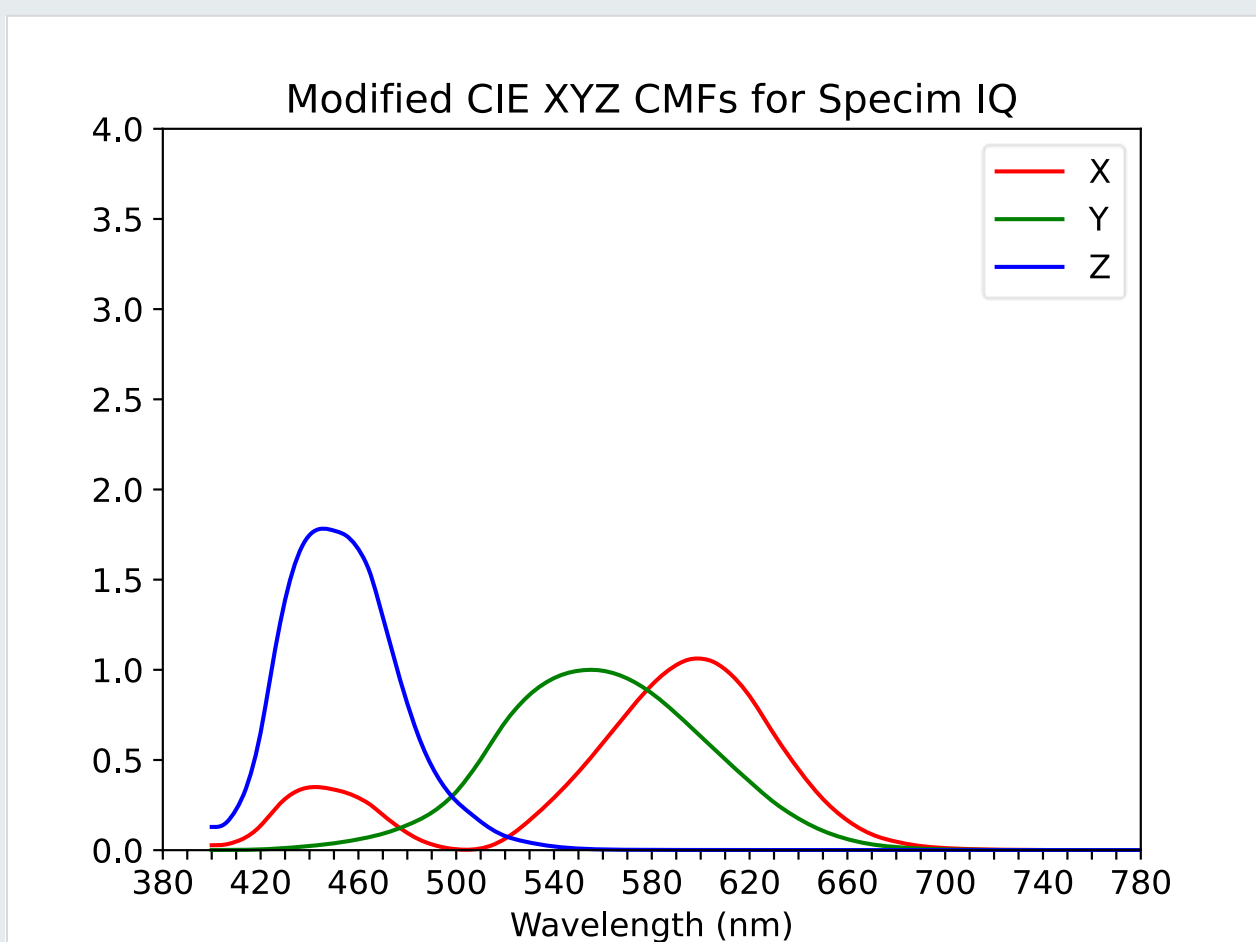
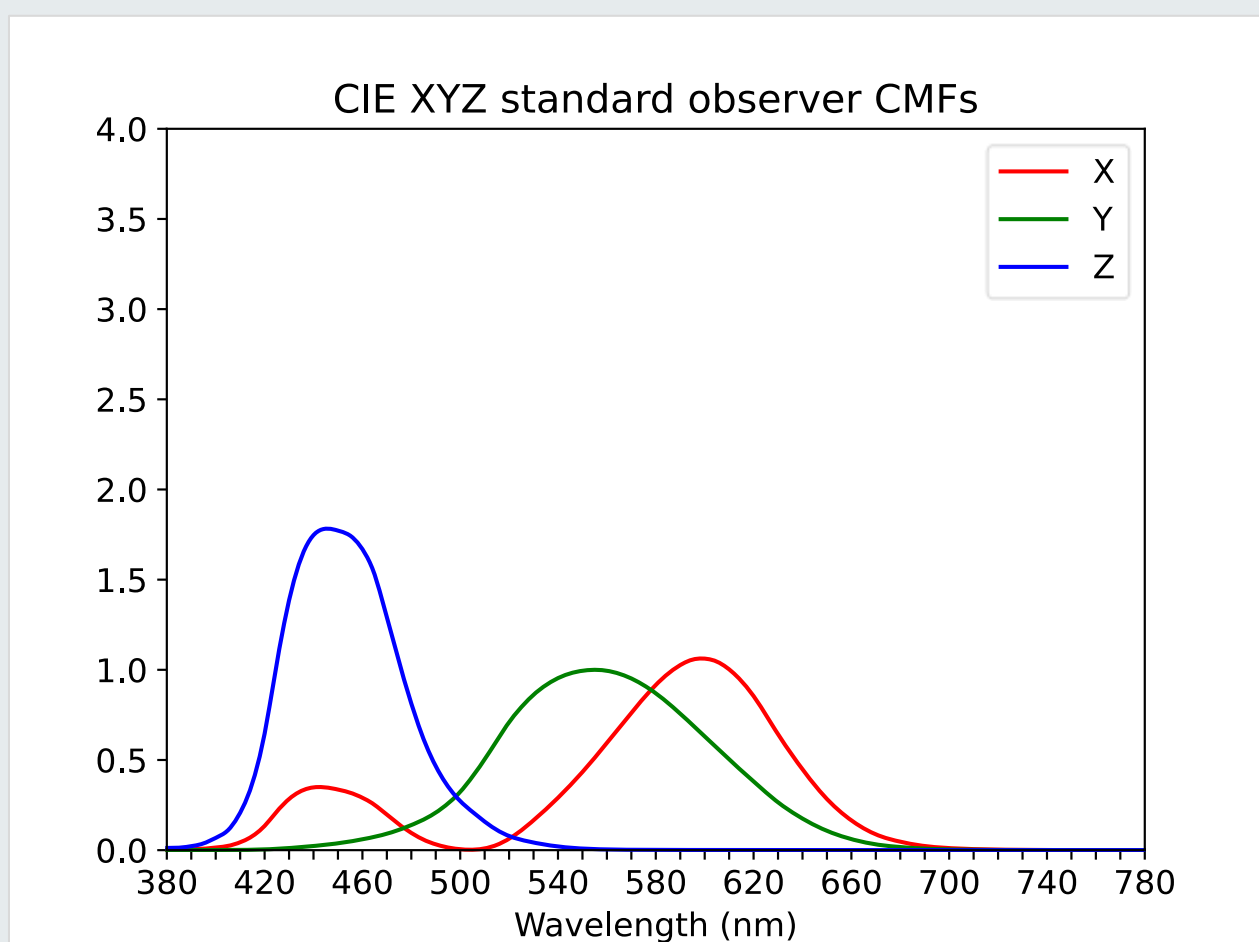
- In dentistry, RGB imaging serves a multitude of purposes: patient instruction and motivation, medico-legal reasons, treatment planning, liaison with dental laboratories, assessment of the baseline situation and progress monitoring.
- Hyperspectral imaging (HSI) cameras capture more information than RGB.

Research Question

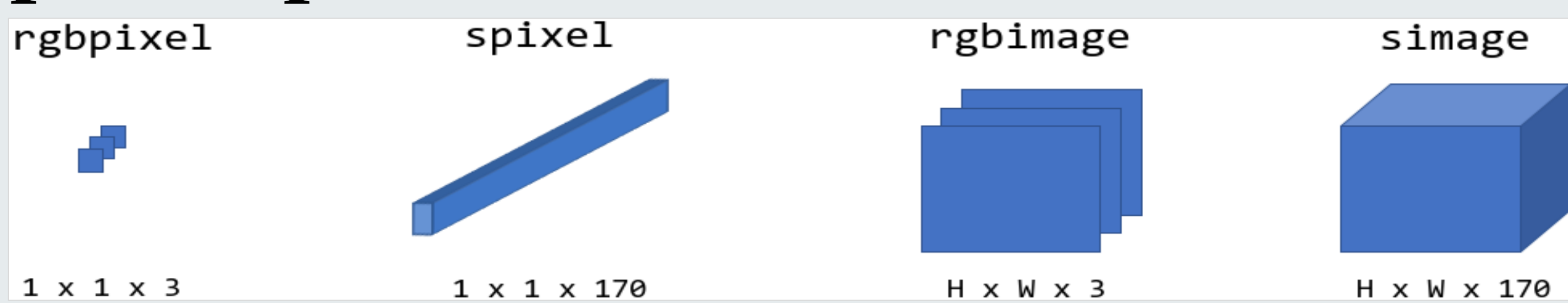
- There may be perceivable differences in the reflectance spectrum of diseased tissue compared to that of healthy anatomy.
- A preliminary step to the development of quantitative dental and oral biomarkers is to segment the different anatomical structures accurately.
- Can obtain an improved segmentations with HSI?

Converting Hyperspectral Images to RGB

- The XYZ color model is device-independent
- Hyperspectral \rightarrow XYZ \rightarrow RGB



Type of Input



Pixel classification results

RGB pixels (*rbgpixel*)

Class	Sensitivity (%)	Specificity (%)	Accuracy (%)	Balanced Accuracy (%)
Attached gingiva	54.89	68.08	67.74	61.49
Enamel	56.52	69.98	68.64	63.25
Hair	100.00	68.48	68.94	84.24
Hard palate	44.01	68.63	66.40	56.32
Lip	47.80	68.15	66.72	57.98
Oral mucosa	42.95	68.37	66.16	55.66
Skin	38.86	69.33	62.48	54.10
Soft palate	0.00	67.37	67.12	33.68
Tongue	2.14	62.77	54.61	32.46
Average	43.02	67.91	65.42	55.46

Hyperspectral pixels (*spixel*)

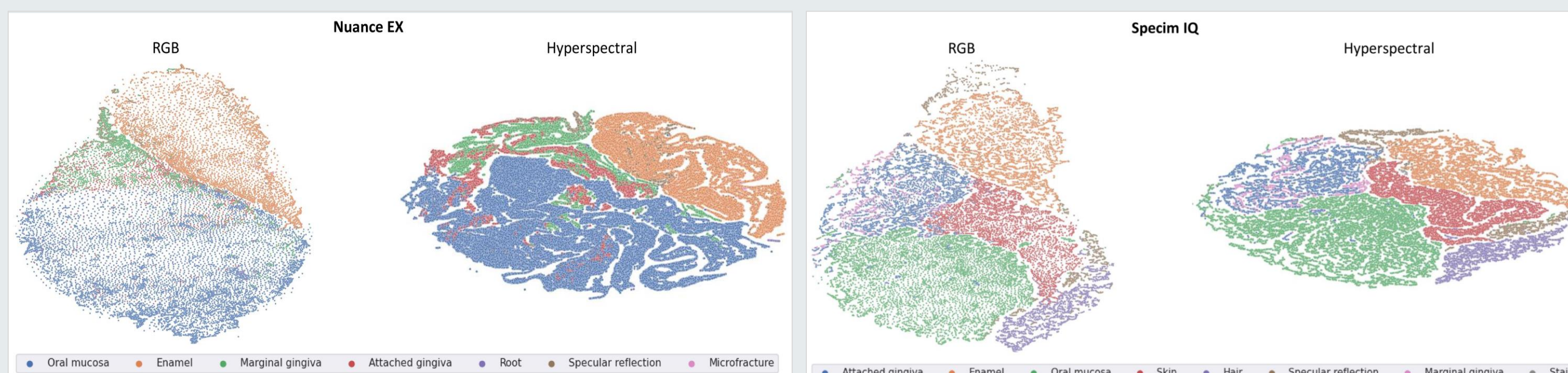
Attached gingiva	54.73	68.09	67.74	61.41
Enamel	67.49	68.00	67.95	67.74
Hair	100.00	68.48	68.94	84.24
Hard palate	44.01	68.64	66.40	56.32
Lip	60.00	66.77	66.30	63.39
Oral mucosa	42.94	68.48	66.26	55.71
Skin	39.33	69.07	62.38	54.20
Soft palate	0.00	67.37	67.12	33.68
Tongue	2.14	62.77	54.61	32.46
Average	45.63	67.52	65.30	56.57

Image-based results

- Number of image pixels well classified divided by the number of annotated pixels in the image.

Input Type	Accuracy (%)
RGB pixels (<i>rbgpixel</i>)	39.39
Hyperspectral pixels (<i>spixel</i>)	49.48
RGB image (<i>rgbimage</i>)	52.51
Hyperspectral image (<i>simage</i>)	54.98

Hyperspectral vs RGB



Pixel classification results

RGB image (*rgbimage*)

Class	Sensitivity (%)	Specificity (%)	Accuracy (%)	Balanced Accuracy (%)
Attached gingiva	26.23	99.94	98.00	63.09
Enamel	49.40	99.04	94.11	74.22
Hair	84.77	98.94	98.73	91.85
Hard palate	0.53	99.64	90.64	50.08
Lip	33.94	98.91	94.34	66.43
Oral mucosa	78.03	92.09	90.87	85.06
Skin	78.19	97.22	92.94	87.71
Soft palate	49.13	99.42	99.23	74.27
Tongue	56.48	97.20	91.73	76.84
Average	50.74	98.04	94.51	74.39

Hyperspectral image (*simage*)

Attached gingiva	40.64	99.48	97.93	70.06
Enamel	52.61	98.67	94.09	75.64
Hair	69.61	99.87	99.43	84.74
Hard palate	2.91	99.68	90.89	51.29
Lip	60.49	99.70	96.94	80.09
Oral mucosa	64.09	84.95	83.14	74.52
Skin	86.05	94.94	92.94	90.49
Soft palate	55.18	98.82	98.66	77.00
Tongue	64.58	98.99	94.36	81.79
Average	55.13	97.23	94.26	76.18

Conclusions

- Mild improvement in the segmentation results on ODSI-DB when using hyperspectral information.
- The main driver of segmentation performance for the dental anatomy present in the dataset seems to be the availability of spatial information.

