

Porosity Analysis

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1 METHOD

Method for porosity analysis exemplified on quantifying trabecular structure in the volumetric image of mice tibia. Processing steps are listed below.

1. Dividing the volume into regions to be analysed (Fig. 1, top).
2. Binarisation by thresholding (Fig. 1, middle).
3. Computing signed distance field transform.
4. Computing skeletonisation of both material and background classes by finding local extrema in the signed distance field (Fig. 1, bottom).
5. Collecting the porosity measures for a whole sample and for each region, those include:

Bone volume. The volume of the bone divided by the total volume.

Area. The area of the bone-air interface divided by the total volume.

Thickness. Values of signed distance field collected along the skeletonisation of the bone are collected in a histogram. Lognormal distribution is fitted to the histogram, and parameters of the fitted distribution (median (geometric mean), geometric standard deviation, mean, standard deviation, and mode) are used as estimates.

Separation. Values of signed distance field collected along the skeletonisation of the background, and processed in the same way as when calculating thickness.

2 RESULTS

Fig. 2 shows distribution of radii used when estimating thickness and separation. The results of the porosity analysis for sample of mice tibia are summarized in Tab. 1.

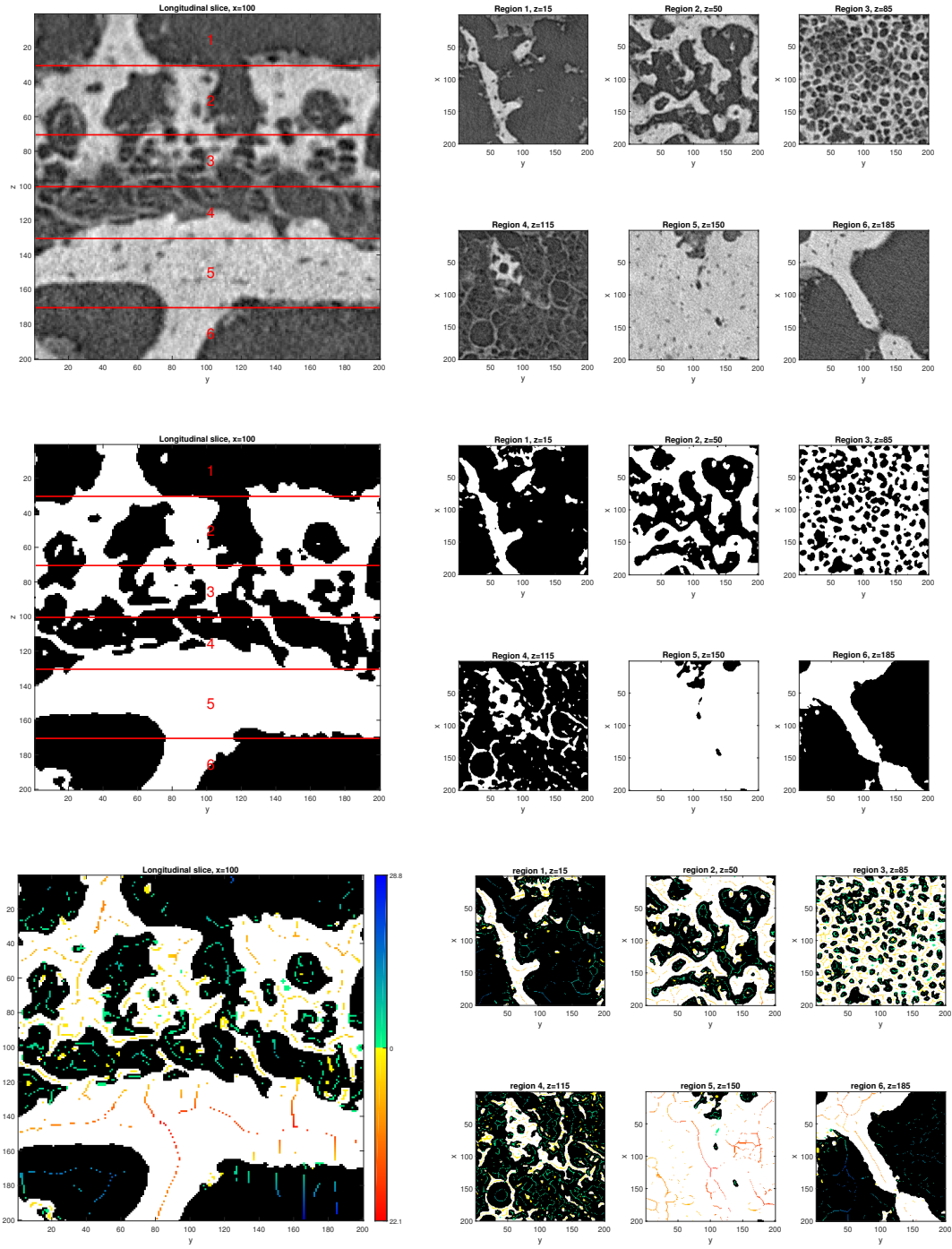


Figure 1: Slices from the volumetric image indicating division of the volume into the regions to be analyzed (top), corresponding binary images (middle), and corresponding images showing the skeletonization of the bone and the background class (bottom).

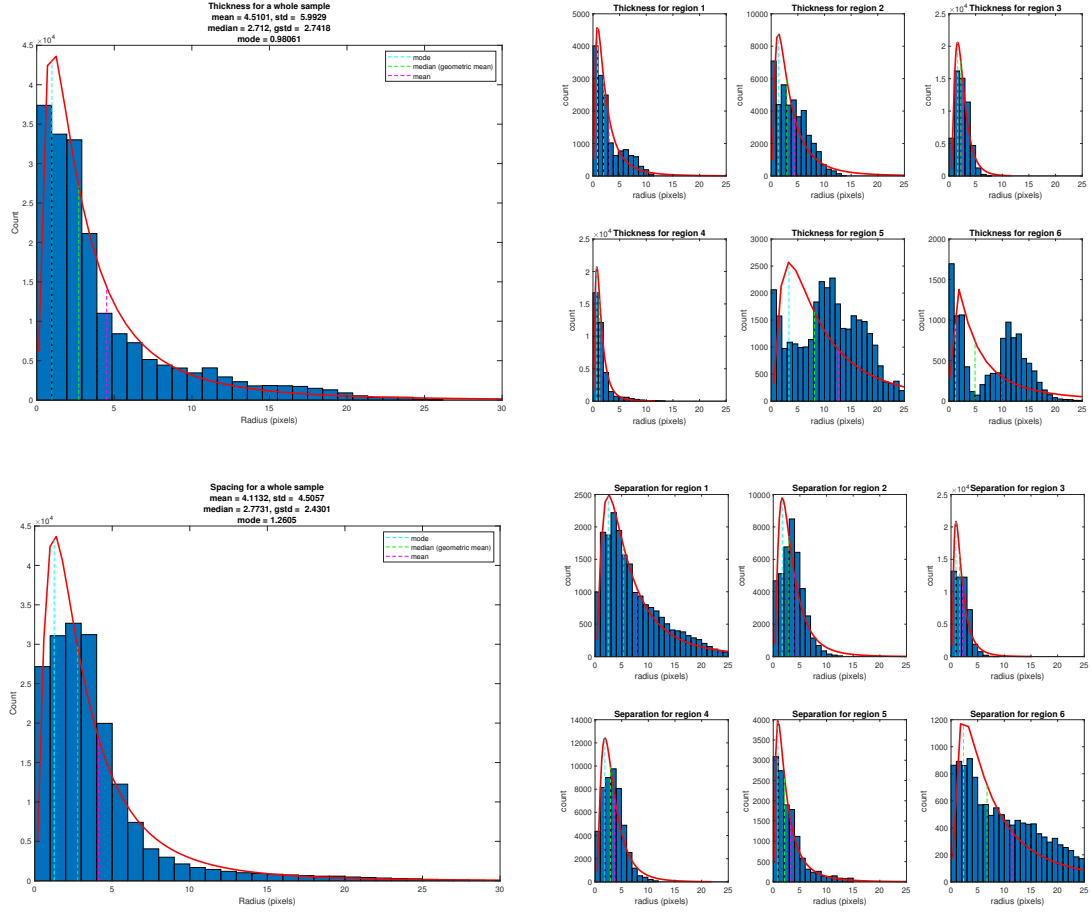


Figure 2: Thickness (top) and separation (bottom), for a whole sample (left) and separated into the six regions (right).

Measure	Sample	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
Bone volume	0.49	0.21	0.53	0.56	0.32	0.85	0.34
Area	0.13	0.09	0.15	0.26	0.19	0.05	0.05
Area per bone volume	0.27	0.42	0.29	0.46	0.60	0.06	0.15
Thickness, mode	0.98	0.86	1.33	1.63	0.73	3.33	1.20
Thickness, median	2.71	1.99	2.94	2.22	1.26	8.12	4.89
Thickness, mean	4.51	3.02	4.38	2.59	1.65	12.67	9.88
Separation, mode	1.26	2.48	1.69	0.93	1.86	0.89	2.35
Separation, median	2.77	5.36	2.94	1.62	2.91	2.10	6.76
Separation, mean	4.11	7.90	3.87	2.14	3.65	3.23	11.45

Table 1: Table with porosity measures collected for a whole sample and for each of the 6 regions.