Segmentation and Internal Porosity Feature Extraction

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Introduction

Volumetric data acquisition from microtomographic imaging of composites provides novel opportunities for identifying internal porosities and continuities of pores within soil aggregates and other natural or artificial composite materials. After tomographic volume reconstruction, the object being evaluated must be segmented from the surrounding volume, and then the extracted object must be segmented into its component parts. In our current work we are attempting to extract pores from within a 1-mm^3 soil aggregate. A pore is defined as an air-filled region within a subvolume that encloses the soil aggregate that has been segmented from the volume. We present two techniques for segmenting a soil aggregate from a larger tomographic volume.

Methods and Materials

Two techniques have been developed to segment the soil aggregates from a larger volume. The first technique is based on an automatically detected global threshold, while the second technique is based on using a clustering technique coupled with Bayesian decision rule-based maximum likelihood estimator.

The first segmentation technique operates by computing a histogram of the values in the reconstructed volume. After the histogram has been constructed, the assumption is made that the histogram is bimodal, with the modes corresponding to air and material. The two largest peaks in the histogram are located; the minimum point between the peaks is then used as a global threshold. A binary volume is generated from the source volume using the detected threshold, extracting the soil aggregate from the volume. A convex hull is then used to define a clipping region around the aggregate. The clipping region is then used to extract the aggregate from the original volume. After extracting the aggregate from the volume, the same threshold can then be used to extract pores from internal regions of aggregates for further evaluation.

The second segmentation technique is based on a combination of clustering[1] and the Bayesian decision rule.[2] The first phase of the segmentation generates a set of clusters based on a neighborhood variance. The largest air cluster and aggregate clusters are selected by ranking the clusters by size, then choosing the first cluster that is known to be air or aggregate. The maximum likelihood estimator is then used to classify the remaining clusters as air or aggregate. The resulting set of classified clusters is used to segment the volume. As with the first technique, the aggregate is clipped from the background. The pores can then be extracted.

Results

Figure 1 shows the input to the histogram segmentation algorithm, the segmented aggregate, and the pores that have been extracted by the histogram technique. Figure 2 shows the input to the cluster-based segmentation algorithm, and the result of the cluster-based segmentation.

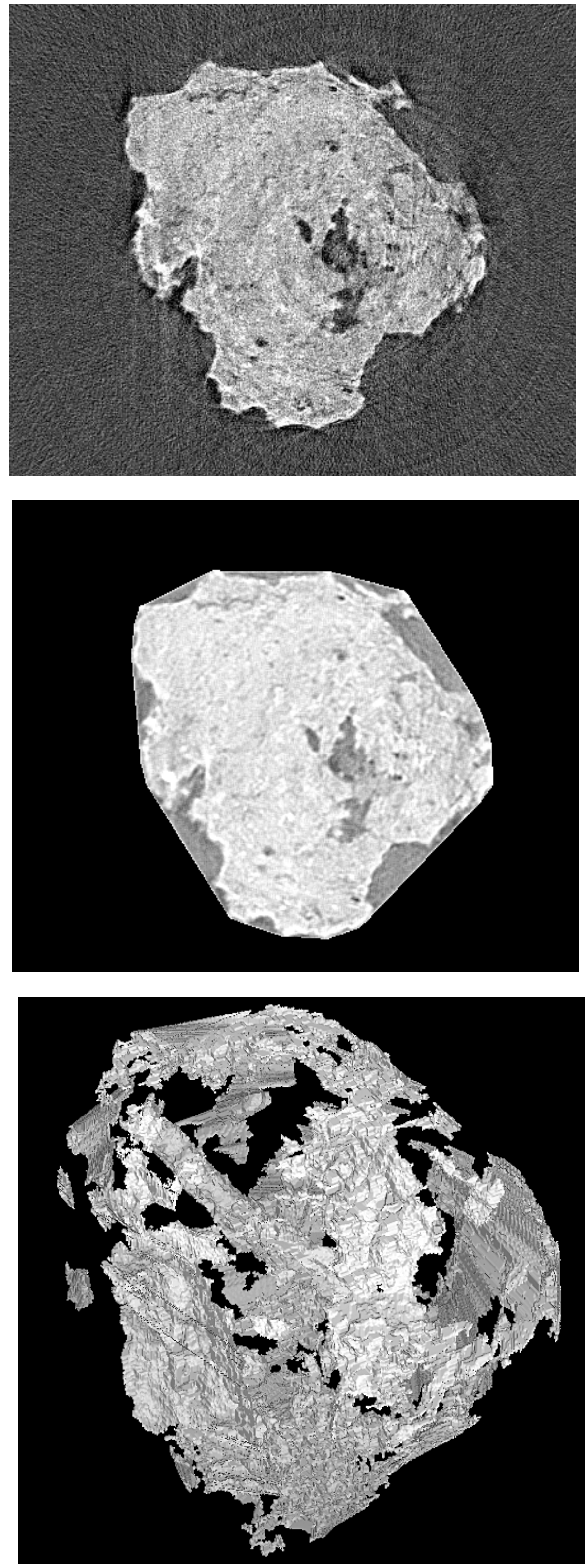

FIG. 1. The input to the histogram segmentation, the segmented volume, and the extracted pores.

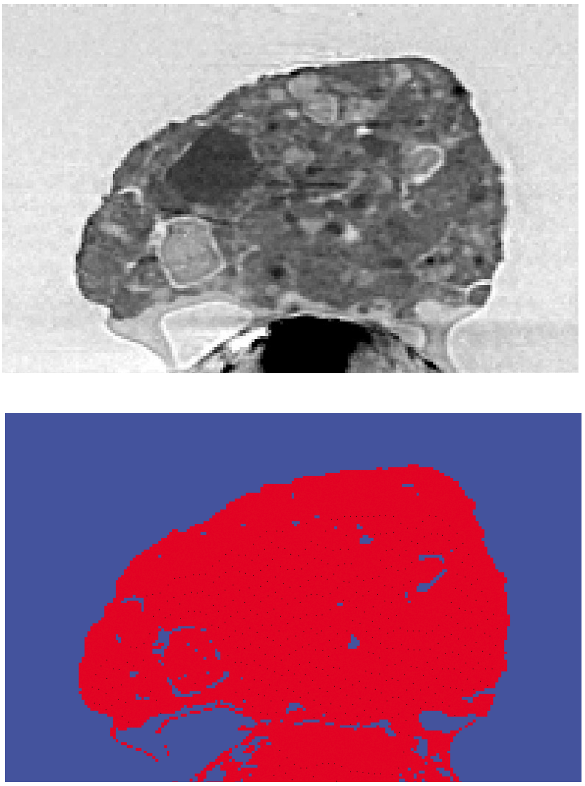

FIG. 2. Input to clustering algorithm and segmented aggregate.

Discussion

We are able to segment soil aggregates from the volume and extract the pores from the volume. Currently under development are improved techniques for defining the clipping region for the aggregates. Additionally, better techniques are being developed to extract the pores from a segmented aggregate.

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References

[1] A.K. Jain and R.C. Dubes, **Algorithms for Clustering Data** (Prentice Hall, 1988).

[2] R.O. Duda, P.E. Hart, and D.G. Stork, **Pattern Classification**, 2nd Edition (Wiley-Interscience, 2001).