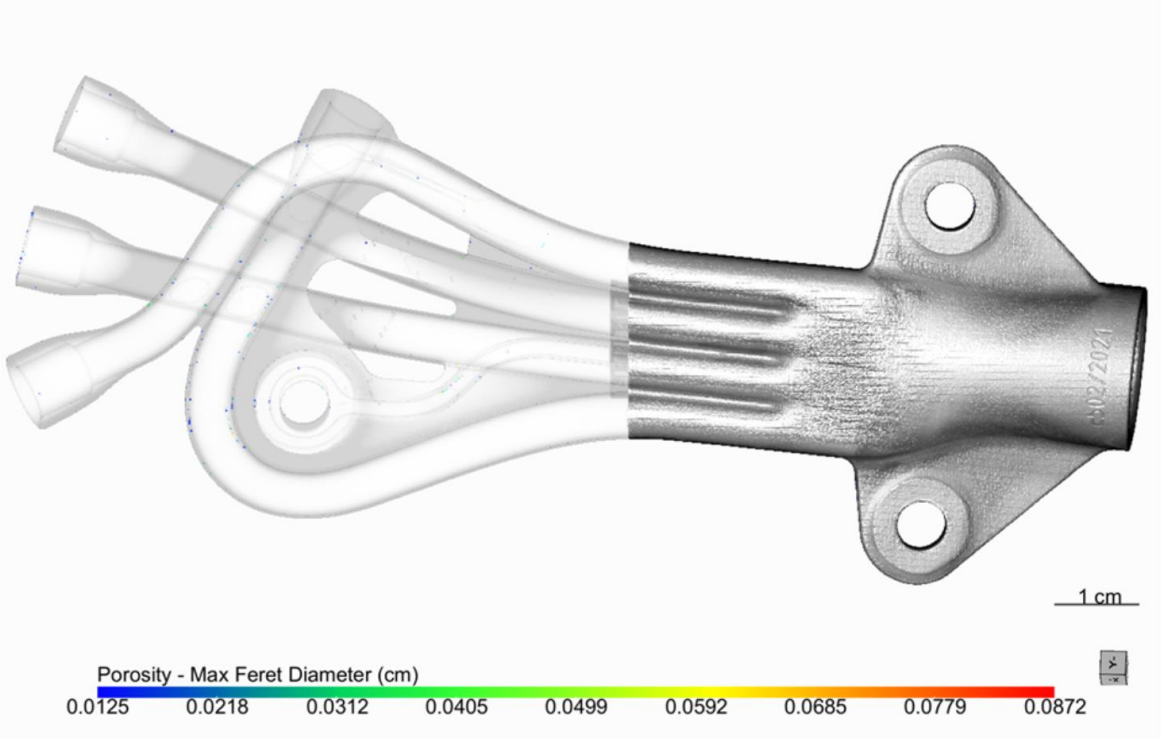
Application Note



Dragonfly's AI-powered Solution for Microporosity Analysis in Additive Manufacturing

What you will learn in this application note:

- Why to use AI porosity segmentation
- How to use AI porosity segmentation

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Introduction

In this application note, the focus is on small additive manufacturing porosity and challenges in detecting them in CT images. Often CT scans are not perfect, resulting in varying bright and dark areas in the material. This makes it hard to segment small porosities correctly or even at all with traditional image segmentation methods. Here we show with two different examples how AI segmentation can solve this problem.

Requirements

A high-resolution micro-CT scan of an additively manufactured part, the examples here are from two different industrial CT systems. Credit to Tetravision and 3D Systems for allowing us to share the complex part. A computer is needed with Dragonfly 3D World installed. High quality scans allow regular segmentation of such cases and is described elsewhere, in this case the focus is on two typical scans with varying greyscale brightness making the segmentation of the small pores challenging.

Typical outputs:

- Segmentation of microporosity
- 3D images and videos showing location of porosity
- 3D and 2D inspection and quantification of pore sizes, volumes, sphericity and more
- CSV file containing porosity information – volume, diameter, sphericity, etc.

How does it work?

When inspecting a CT scan of additively manufactured parts, often there are CT artifacts resulting in varying bright and dark areas, bright edges, streaks and so on. These effects occur quite often even with excellent CT systems, and can make it hard to segment porosity that can exist in all these areas and should not be missed. In Figure 1 are shown cross-sectional images contrasted strongly to emphasize the problematic areas for accurate segmentation – these are typical problem cases that don’t work well with normal segmentation tools based on thresholding.

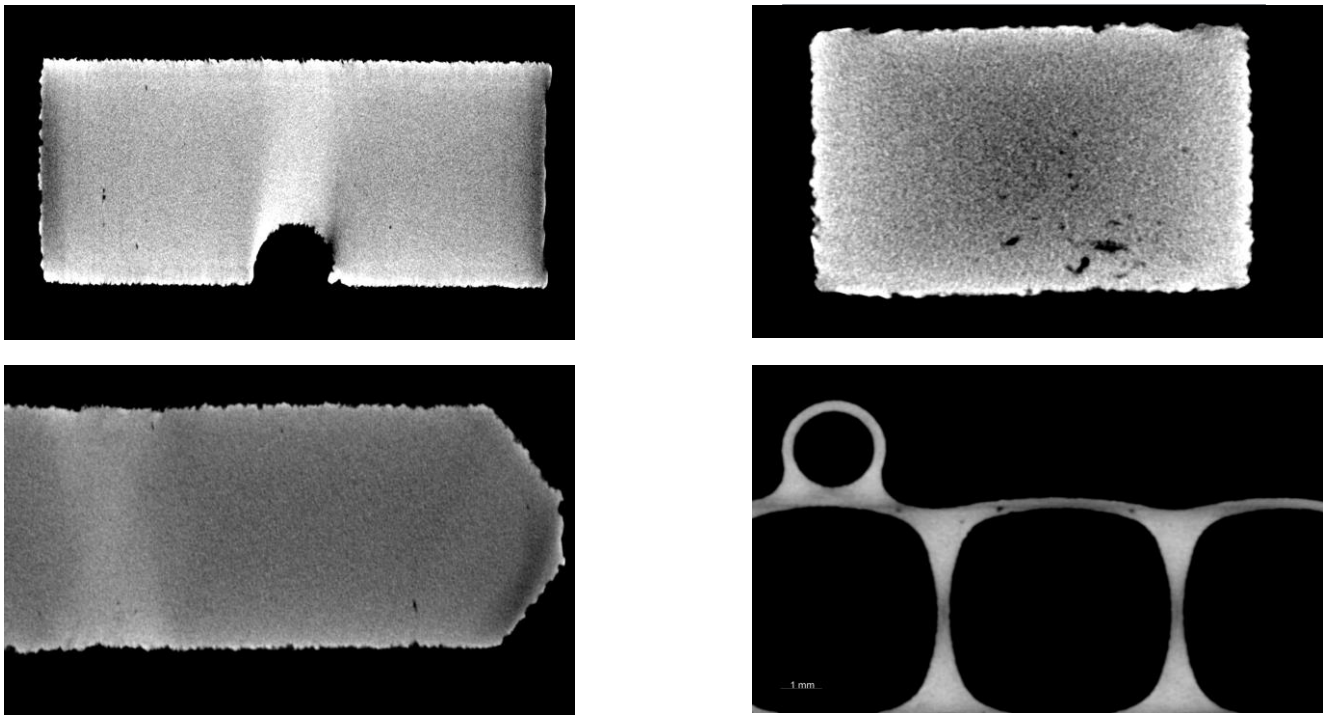


Figure 1: Examples of cross-sectional CT images showing challenging cases for porosity segmentation based on thresholding – the local material brightness varies too much

The problems shown above can lead to missing of porosity in the subsequent analysis. It is also possible that, with traditional segmentation tools, pores in bright areas are under-segmented and pores in dark areas are over-segmented. It becomes possible that lots of noise is falsely identified as porosity, especially in dark areas. These problems are shown below.

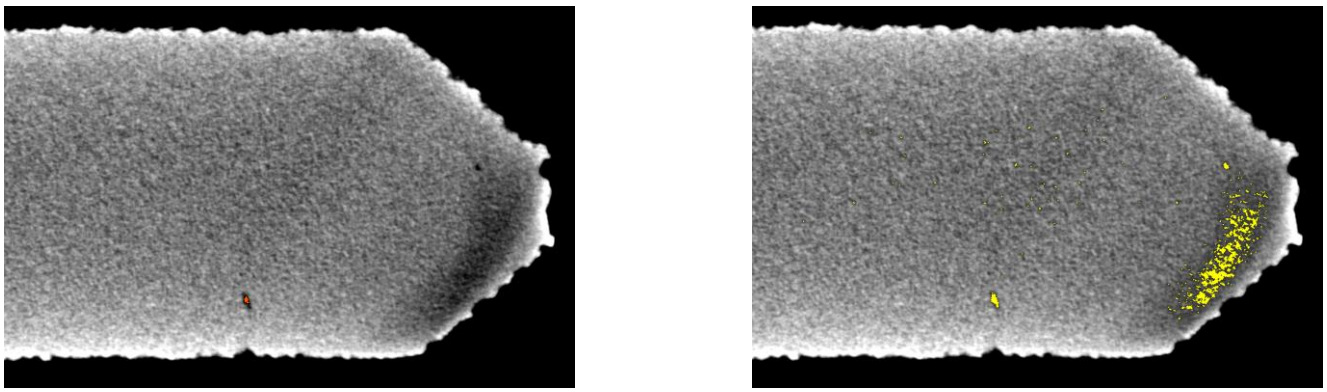


Figure 2: Examples of incorrect segmentations demonstrated on one of the cases from figure 1. On the left is a threshold value chosen low – in this case the one pore is undersegmented and the other is missed. On the right both pores are captured in the segmentation with a higher threshold value, but now lots of noise is also captured incorrectly.

The challenges above can be overcome by manually fixing errors or by ignoring small pores that are missed. This is not ideal, is very labor-intensive and prone to human error. A better solution is to use AI to segment the pores. In this case a pretrained AI model in Dragonfly for additive manufacturing porosity was used as starting point for further training on these datasets. The final result solves the problem well as shown below for the cases in Figure 1 and 2.

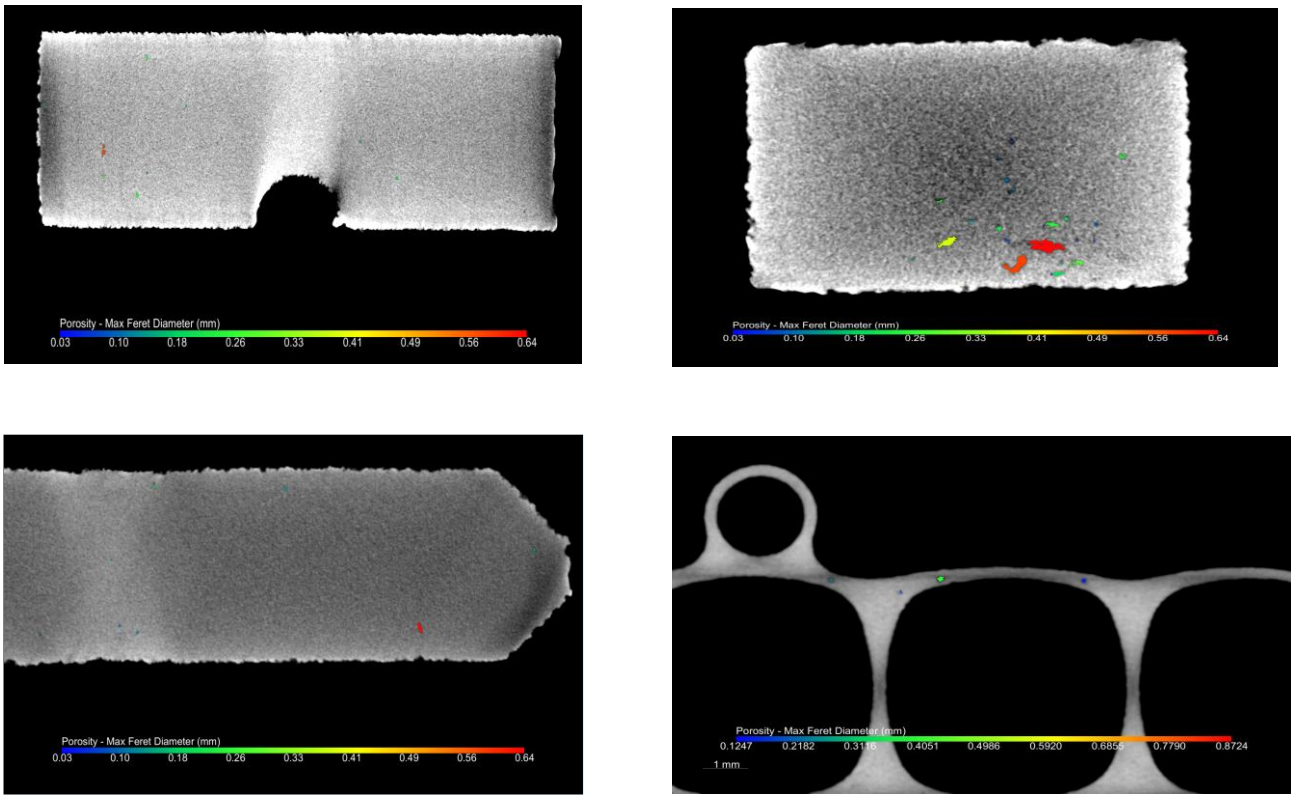


Figure 3: Examples of good AI segmentation of small pores in challenging data, color coding is based on pore size in each case

One additional benefit of this approach is that it can easily identify surface-connected pores which can highlight important issues in AM produced parts, such as the example shown below.

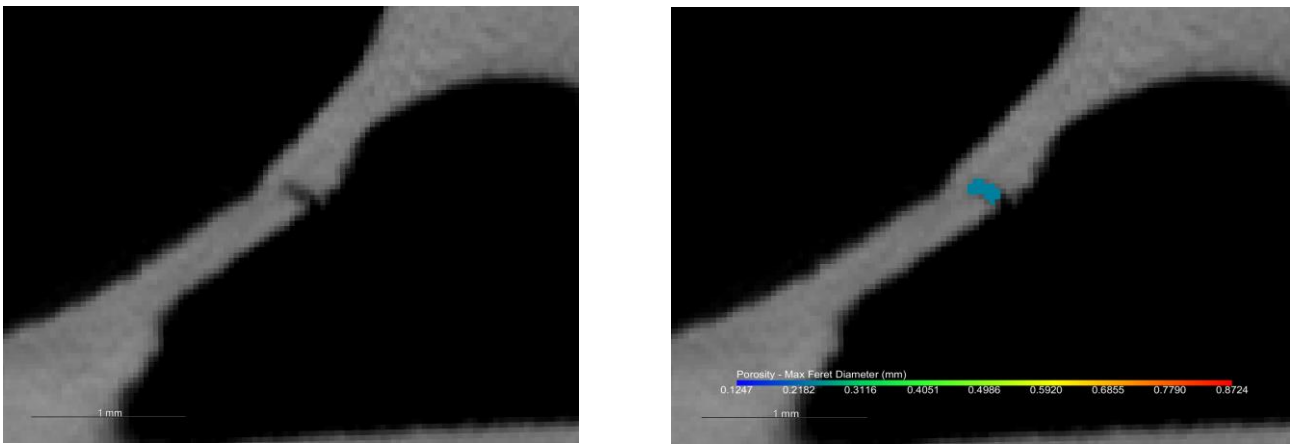


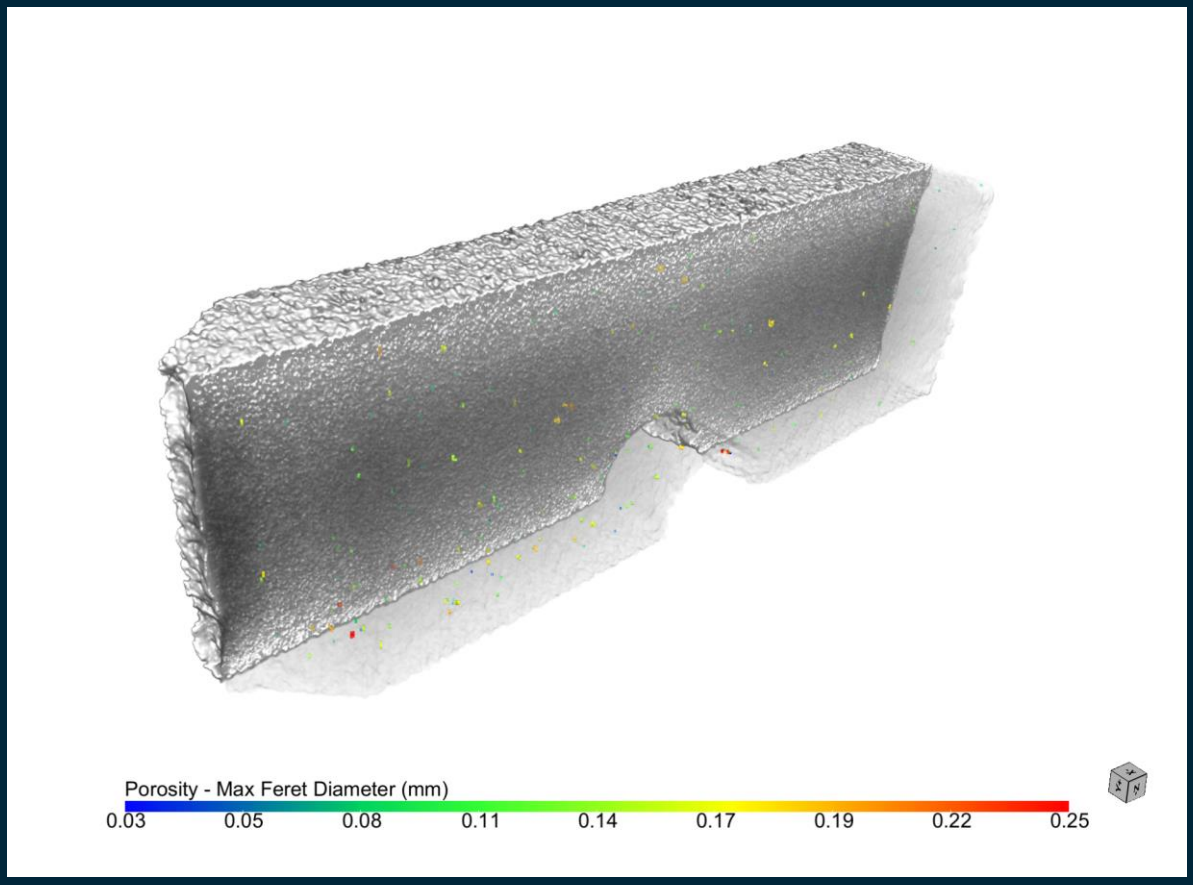
Figure 4: AI segmentation includes surface-connected pores, that can be very useful for cases as shown here (a critical thin area with a large open pore). The image is shown in its original pixels (not interpolated) to highlight the challenge of small pore detection.

Summary:

- AI segmentation ideally needs refinement for each new type of dataset or scanned object
- Re-use of the same model on multiple scans of the same sample type saves a lot of time
- Small pores can be identified even in scans with brightness variations
- Surface connected pores can be identified by AI
- Surface connected pores can be removed by simple thresholding subtraction operation if needed

The benefits

The benefits for you as an additive manufacturing engineer or researcher, is that no pores are missed and this gives not only a better quality evaluation but also an improved understanding of the structural details of your samples. By using AI tools, it is possible to ensure the smallest pores are all captured in your analysis, irrespective of the noise or artifacts in the scan. Since no scan is perfect, this is useful in almost all practical applications to get a better quantification and analysis of your porosity.



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For a video workflow demonstration of the above case:
https://www.youtube.com/watch?v=VgS2ubioIgk

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