# Fracture Patterns for Non-Photorealistic Image Rendering

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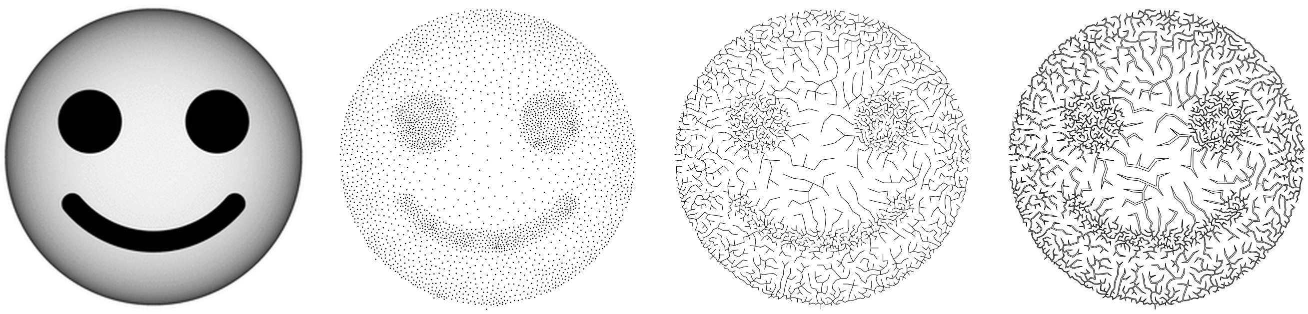


## Abstract

*We describe a method for non-photorealistic, "artistic" rendering of images that uses lines to depict fracture (or crack) patterns based on image features. The method starts by sampling the image with a set of points that is good for stippling. These points are then used as vertices of a minimum spanning tree which guides the crack propagation in image space.*

Surface crack patterns occur on a variety of materials, including glass, mud, and ceramic glaze. The generation of realistic crack patterns on the surface of 3D objects can be done with physically based methods [3, 4]. In this work, we follow a non-photorealistic approach for artistic rendering of images with crack patterns that are generated based on image features.

Several recent papers have presented methods for reproducing drawing art techniques (e.g., [5]). We considered the reproduction of cracks as an artistic line position problem. This approach is used by Wyvill et at. [6] and Mould [2]; in their individual way, these authors interpreted fracture patterns as lines or edges of some graph.

Our work is closely inspired by the work of Kaplan and Bosch [1]. They developed a technique of non-photorealistic image rendering using image point samples and a continuous line between them: the solution of the Traveling Salesman Problem on the set of point samples.

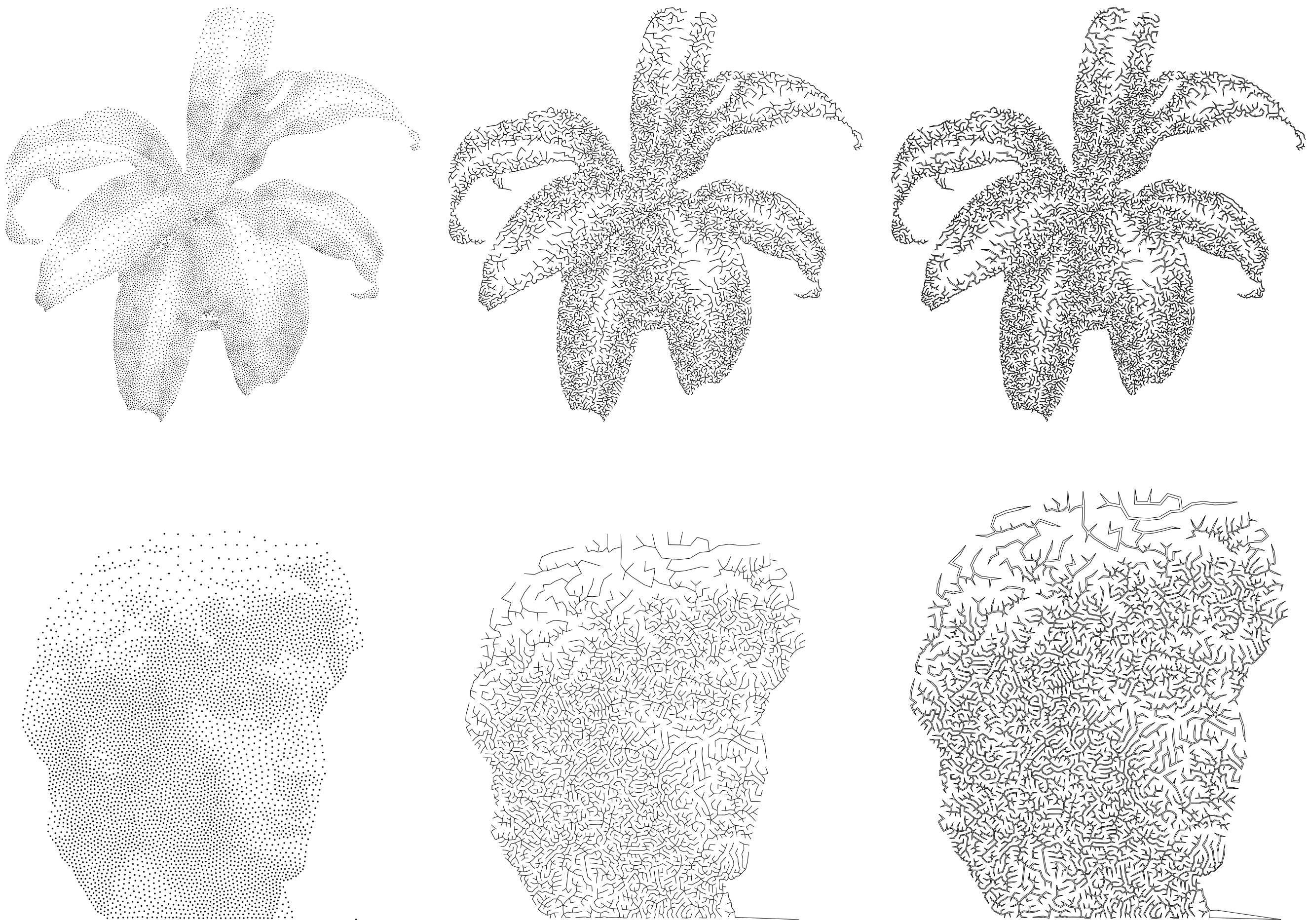
Here, we extended this method for drawing multiple lines based on some set of image point samples. We aimed to draw lines so that their distribution are similar to the design of a fracture. With this objective, our method connects, in a simple way, the sample points as vertices of a minimum spanning tree. This results in short edges for dark regions and long edges for lighter areas. Thus, the tree edges can represent the original gray levels by their concentration, length, or thickness shown in a given region.

This method has produced interesting results for images with relatively few gray levels. Not surprisingly, our tests have shown that having good initial sample set is very important for good visual results [5]. However, our main contribution is an unusual and artistic filter for digital image reproduction.

As shown in the banner picture above, the method has three steps: (1) generate a point sample of an image; (2) connect the sample points with minimum spanning tree; (3) create a crack pattern from the tree.

There are many methods for generating image points samples. We used a sampling method by Centroidal Vononoi Diagram such as the one by Secord [5] for the *stippling* problem. This method computes good samples in a short number of iterations.

The points are connected by an Euclidean minimum spanning tree, which can be rendered directly or by rendering tree edges as corridors of variable width. Smaller edges imply narrow corridors. This naturally controls the simulation of area gray levels, because the perceptible effect of near lines is the same effect of thick lines. In addition to variable width, we can also add small disturbances to the corridors.



Since this method is almost entirely based on the construction of a minimum spanning tree, its implementation is simple and has many options of algorithms with different computational complexities, unlike the expensive TSP algorithm used by Kaplan and Bosch [1]. However, the geometrical construction needed for creating corridors is needs a depth search in the original tree; this may interfere in the method's interactivity for large sample sets.

The figure above shows some examples of the artistic effects achieved with the method. More results and details on the method can be found at

`http://w3.impa.br/~corbo/diss/`

Our tests showed that good results can be obtained without any image information besides an initial good sample set of image's density. On the other hand, the less points we have, the more emphasized the fracture will be.

As a future work, we intend to create simulations to process the growth (of fractures or plants, for example) in two or three-dimensional objects, from arbitrary intensity maps. We also intend to extend this technique for realistic rendering of 3D objects.

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## References

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