Abstracting photographs with 2D-3D conversion and photorealistic rendering

A workflow of 3d-rendering-based image processing

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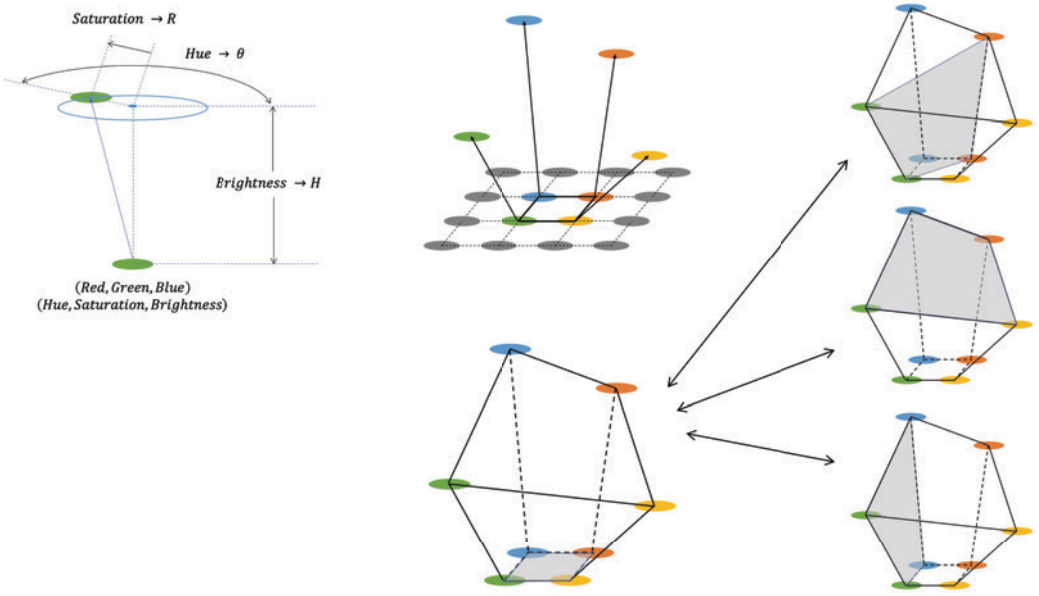
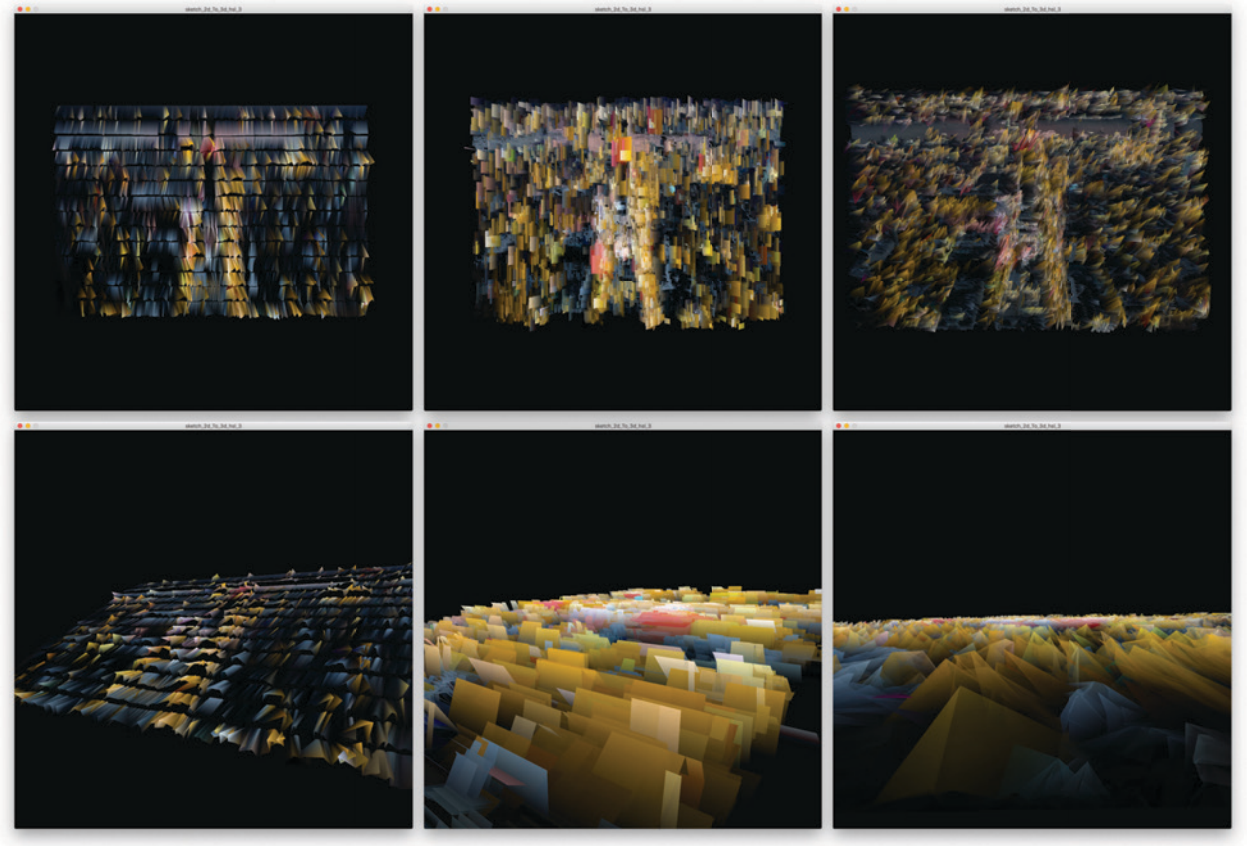
Photographs are considered to contain only 2D information. But it is actually a capture of our 4D spatial-temporal world. In this irreversible information-losing compression, how could we reconstruct the higher dimensional world from a flat image?

This project defines a pipeline that converts any photograph into a 3D model and generates a new photorealistic image of the 3D model. First, the photograph is placed in a virtual 3D space created by the software. Next the photograph is divided into a grid of rectangles: each rectangle consists of four vertices. Every vertex has a 3D position. It also has a color value according to the rectangle's coordinates in the original image. Based on the color value, the four vertices are then mapped to four new positions to create 4 new vertices. For example, the y-coordinate of the new position can be determined by its brightness value. In this project, the color is converted from RGB value to HSB value. And the vertex is transformed based on the hue, saturation, and brightness value, as demonstrated in the diagram below.

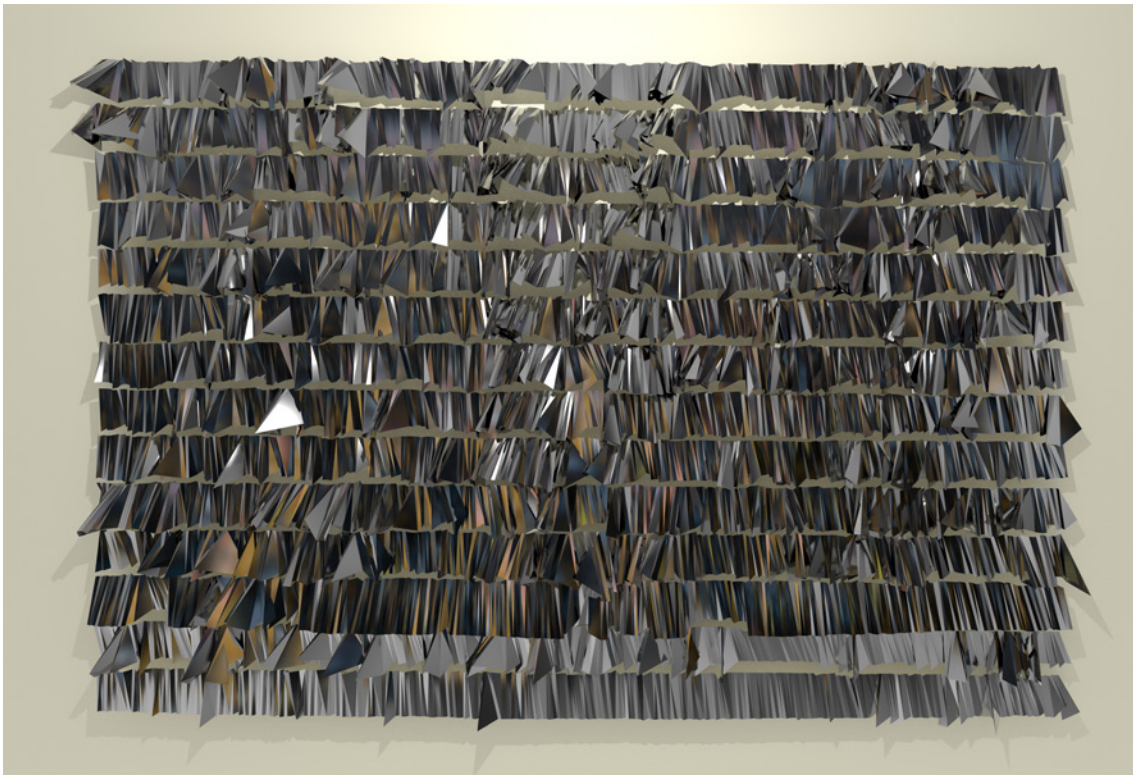


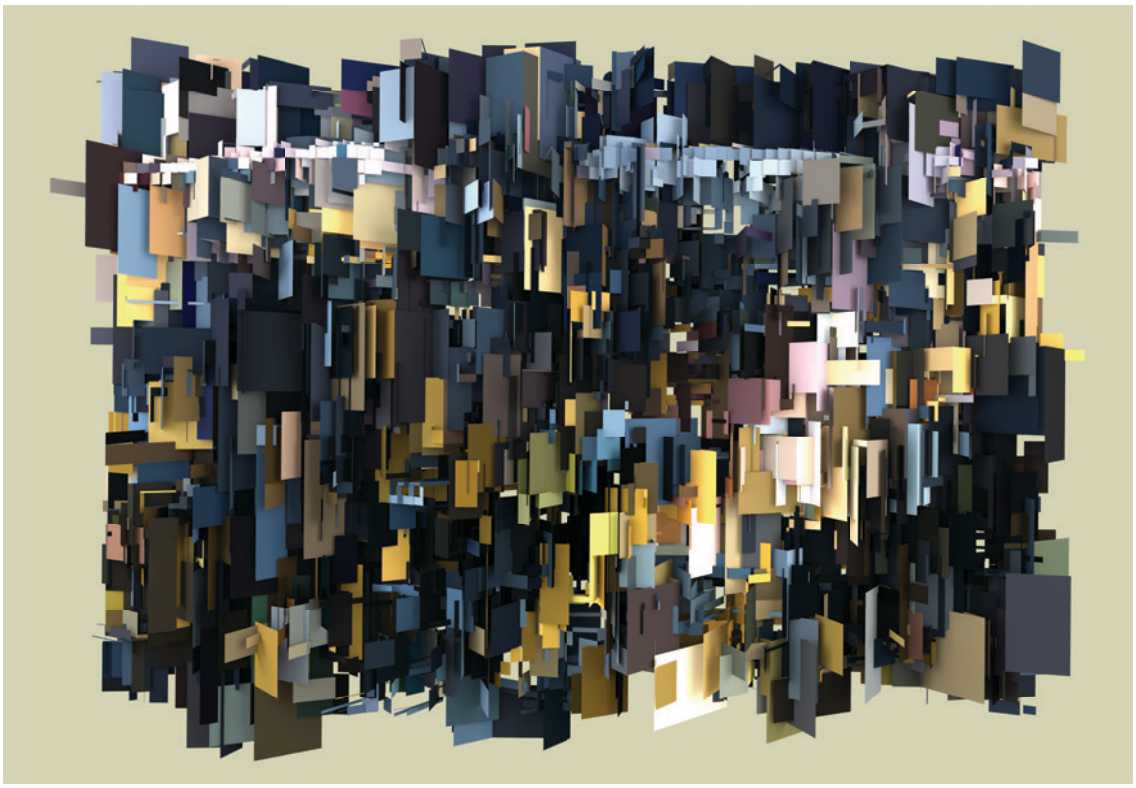
The algorithm would select any four vertices to create a new polygon from the eight, which consists of the 4 original vertices and the 4 new vertices. Then the 2D flat image is transformed to 3-dimensional by replacing the original rectangle with the newly created polygon. Below are a sample photograph and some models generated with the transformation.



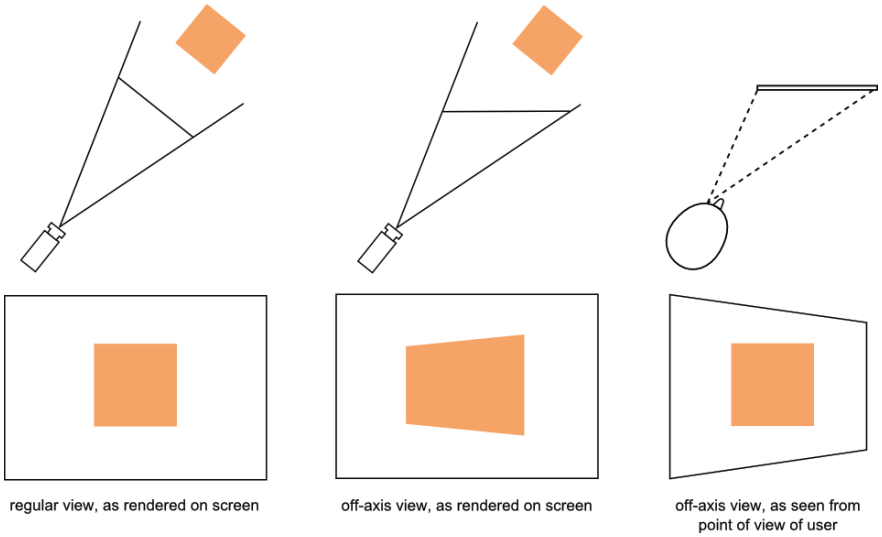
With a 3D model created, the model can be exported into a 3D animation software, such as Blender, Cinema 4D to create photorealistic images. The users are free to design a virtual scene

for the best presentation of the model. Some typical rendering result are included below. To be noted, these generated image can be extremely high resolution, such as 7680*4320.





To present the 3D model in another interactive way, I made a camera video frames as the source image, and create the model in realtime. Particularly, I uses a iPad and turn its front camera as the image source. As people interact with the iPad, the model is modified in real time.



To enhance the 3D visibility, an off-axis projection is used to adjust the rendering perspective according to the audience's eye position, which is acquired by the depth sensor embedded in the front camera of iPad.