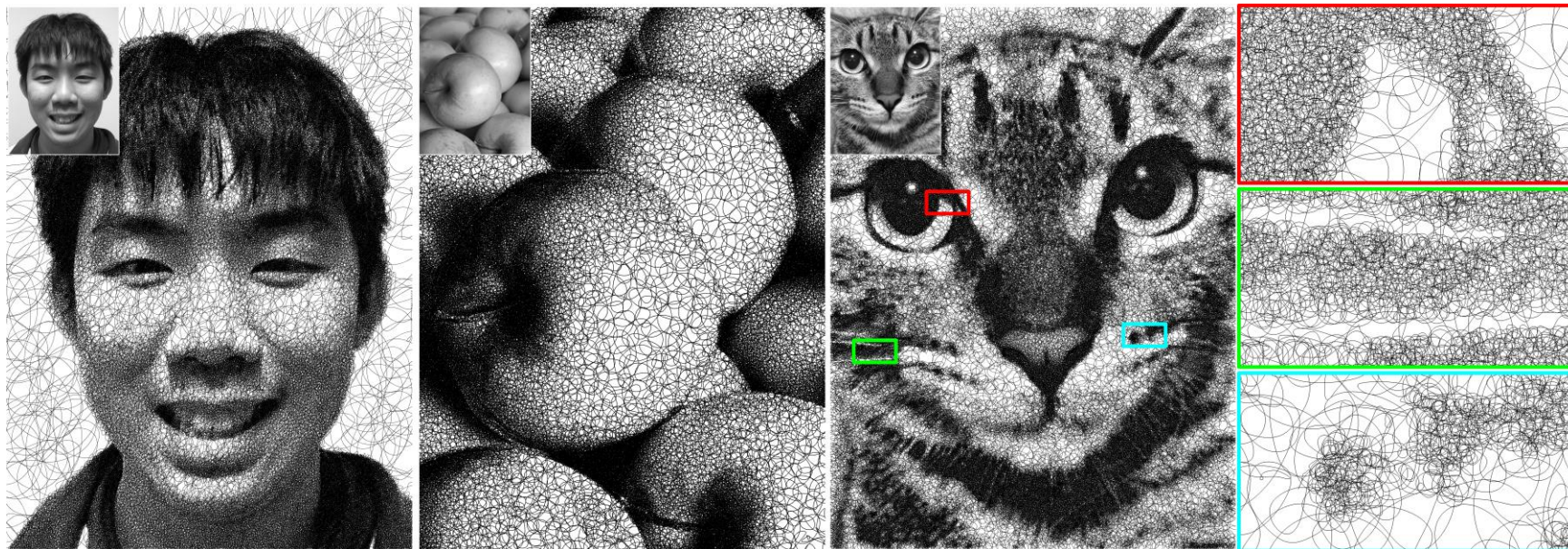




# Continuous Circular Scribble Arts

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**Figure 1:** *Circular scribble images generated using our approach.*

## **Purpose of this work.**

We present a novel system to automatically synthesize visually appealing circular scribble art from arbitrary grayscale images. Our system generates tone- and structure-preserved circular scribble images that resemble the artworks as shown in Figure 1.

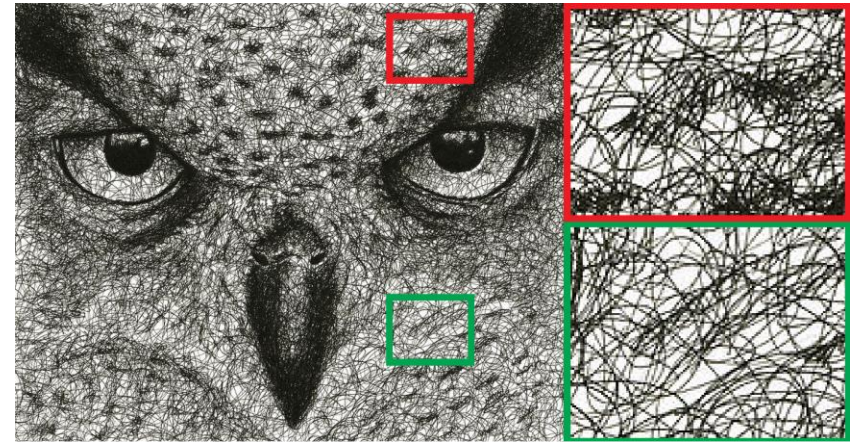






## Motivation

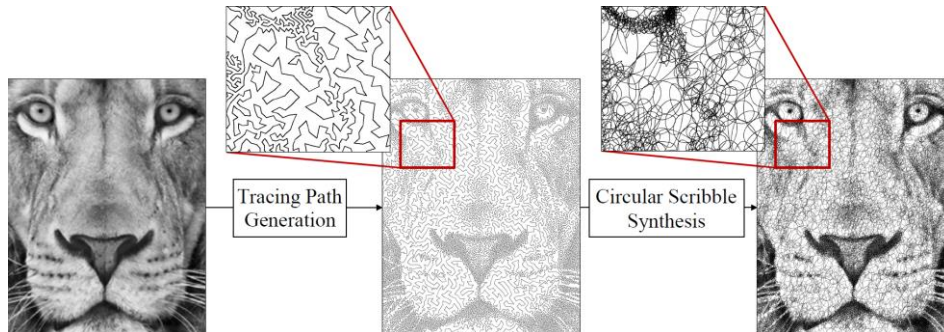
Scribble art is a kind of illustrative drawing, where the artists use seemingly random and continuous line drawing to depict images or conceptual designs as shown in Figure 2. Unlike the conventional line drawing such as sketching and hatching that use short and straight line segments, scribble artists aim at managing long and continuous curves. In this work, we study a commonly seen scribble pattern, namely circular scribble, and introduce a systematic way to synthesize the scribble art by a single continuous circular scribble.



**Figure 2:** Circular scribble art created by an artist (© Nathan Shegrud).

## System Flow

Our system is consisting of two main stages, a tracing path generation and a circular scribble synthesis, as shown in Figure 3. A continuous tracing path which minimizes feature crossing and self-intersection is first generated. Then, the circular scribbles are synthesized with parameters controlling both scribble size and speed, where the circular scribble center is tracing along the given tracing path.



**Figure 3:** Our system flow consists of a tracing path generation and a circular scribble synthesis.





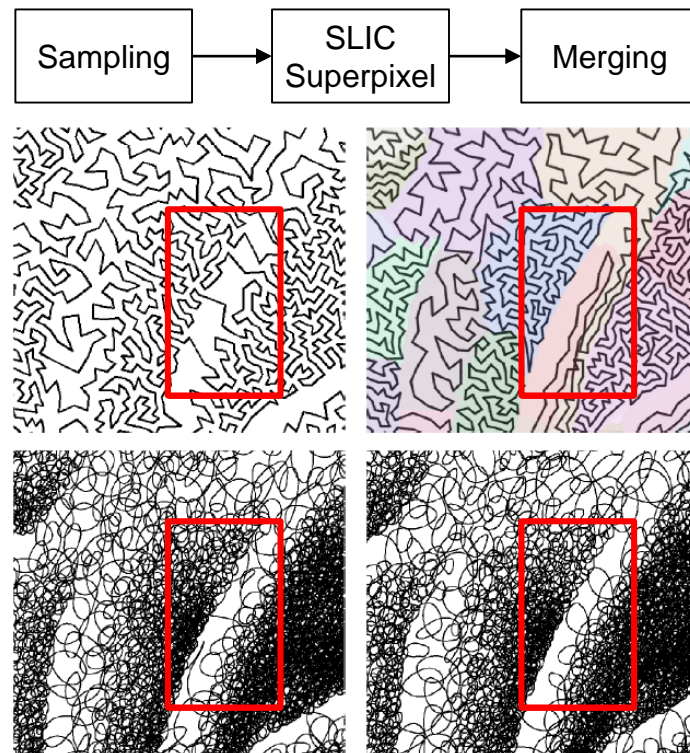
# Tracing Path Generation

In order to derive a continuous circular scribble art, a virtual tracing path for guiding the center of circular scribble is required. A proper tracing path should have two properties:

- (1) The path should cover the whole subject which is to be drawn.
- (2) It should preserve both structure and details of the subject.

Kaplan and Bosch introduced TSP Art which generates a long continuous circuit to trace over the entire subject while still preserves the visual tone and saliency when looking from a distance. To obtain a proper tracing path, we have done some improvements based on their approach.

We use SLIC superpixels to segment the image and generate local TSP tracing path for each superpixel. Then, the local TSP circuits are merged into the final tracing path. The superpixels help to reduce the possibility of generating paths which cross over the image edge features. Moreover, the execution time is significantly reduced by a parallelization in local path generation and also in the final path merging process. Figure 4 shows the final scribble arts with and without SLIC superpixel segmentation.



**Figure 4:** Top row: tracing path without and with SLIC superpixel segmentation; Bottom row: circular scribble art without and with SLIC superpixel segmentation.







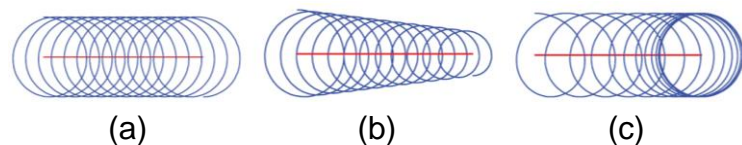
# Circular Scribble Synthesis

The circular scribble is very similar to a trochoid which is a curve defined by the locus of a fixed point on a circle as it rolls along a fixed line. By observing how the circular scribble is drawn by an artist, we extend the concept of a rolling circle to a rolling 3D disk as follows:

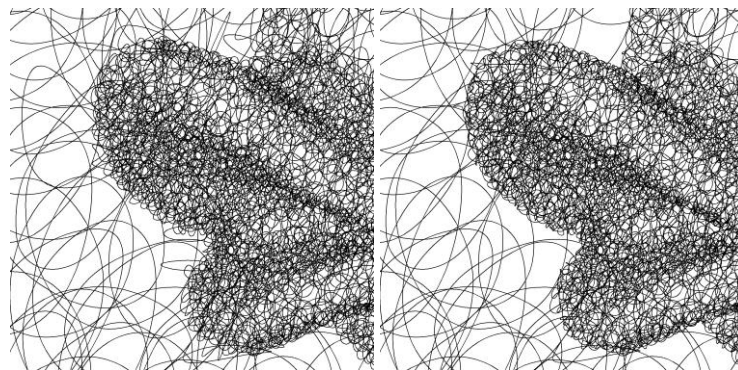
$$C: (p, r, n, \omega, v_c) \rightarrow S$$

where  $C$  is the circular scribble generator.  $p$  is the center position of the disk moving along a tracing path.  $r$  represents the disk radius, which controls the size of circular scribble.  $n$  defines the normal vector of the 3D disk.  $\omega$  and  $v_c$  are angular velocity and the instantaneous velocity of the moving disk, respectively. By varying these parameters, the circular scribble  $S$  is generated as a projection of the fixed point on the rolling disk to the 2D Euclidean space with its center follow through the given tracing path. Figure 5 illustrates the variations of circular scribble generated by our model.

In order to better preserve the salient features, dynamic adjustment to the scribble size with respect to the salient edge map during scribble synthesis is also proposed. Figure 6 demonstrates the result with additional feature preserving adjustment.



**Figure 5:** Circular scribbles are drawn from left to right: (a) Original scribble model. (b) Scribble with radius varying from 100% to 50%. (c) Scribble with decreasing center velocity.



**Figure 6:** Left: circular scribble art before feature preservation. Right: after feature preservation, the features are well preserved.

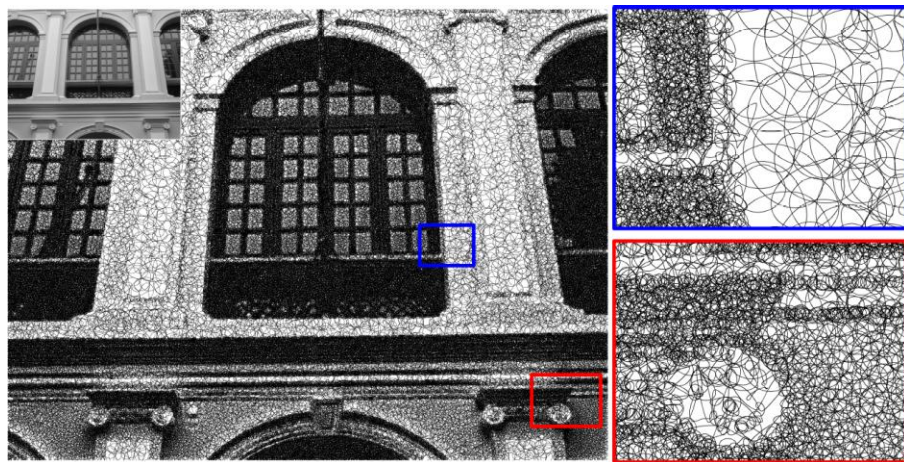




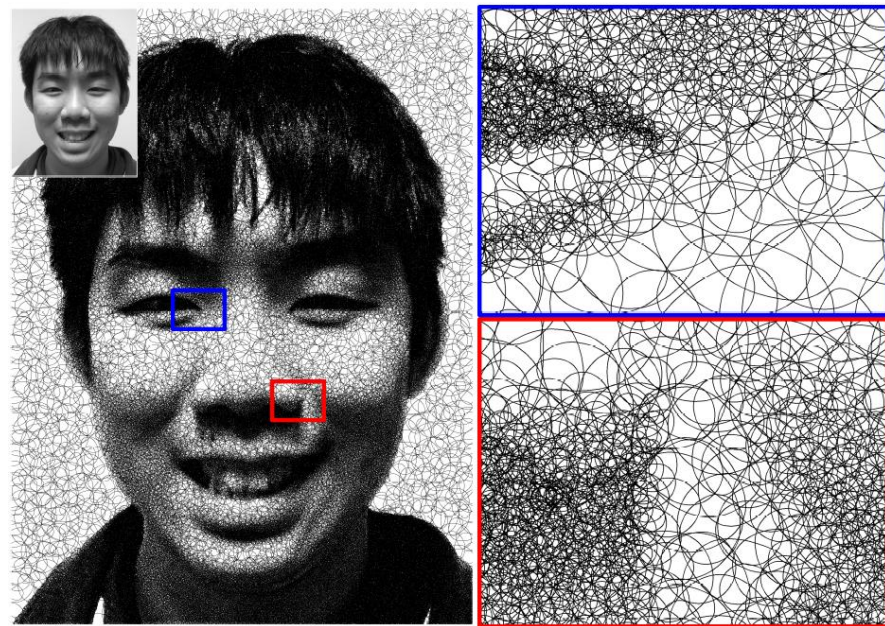


# Conclusion and Results

We have proposed a novel approach in simulating the process of circular scribble art creation. Through an efficient tracing path construction and a flexible circular scribble generator, together with the aid of tone and feature preserving control, an artwork consisting of a single continuous circular scribble can then be generated digitally. Figure 7 and Figure 8 show some results with close up views at blue and red windows.



**Figure 7:** *Circular scribble art from a photo of building.*



**Figure 8:** *Portrait circular scribble art generated by our system.*

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