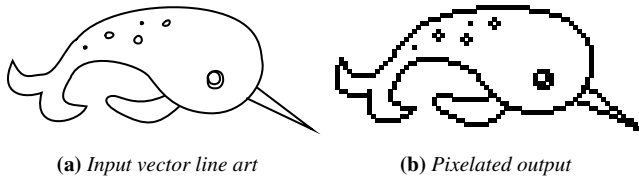


# Pixelating Vector Line Art

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**Figure 1:** Our algorithm converts vector line art into pixel drawings. It also allows users to draw and edit the vector components while providing real-time feedback on the pixelated result.

## 1 Introduction

Pixel art is a style of digital art in which images are edited on the pixel level. This art form emerged in the 1980s in many computer and video games as a way to make the best use of devices with limited graphics capabilities. As digital displays improve in resolution and colour range, digital art is no longer bound by these restrictions. However, pixel art remains popular, particularly in the gaming community, due to its retro charm.

We might naturally wish to create pixel art by rasterizing vector illustrations. However, software that creates satisfactory results still does not exist, and experts place pixels by hand. Adobe Illustrator and Adobe Photoshop are able to rasterize vector objects, but the results often contain jagged boundaries or missing pixels.

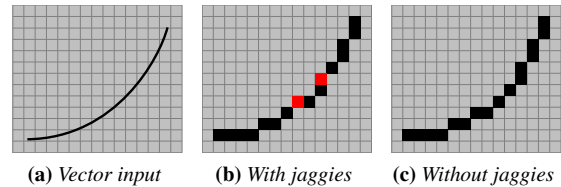
In this work, we introduce a pixelation algorithm that rasterizes a given vector drawing consisting of lines and curves into a line drawing with single-pixel-wide paths [Inglis and Kaplan 2012] (see Figure 1). Unlike many rasterization techniques that focus on efficiency and high resolution results, our approach focuses on creating more aesthetically pleasing images by allowing the pixelated image to deviate slightly from input. To evaluate our results, we conducted a user study to collect human-generated pixel art and then asked the participants to compare computer- and human-generated images. The analysis shows that our algorithm outperforms commercial software and participants with less pixel art experience.

## 2 Approach

To pixelate a curve, it is first divided into smooth monotonic curve segments. For each curve segment, we use a greedy algorithm to compute a piecewise polygonal approximation in which each line segment has slope  $n$  or  $1/n$  for a positive integer  $n$ . Then each line segment is replaced by either a column or a row of pixels to obtain the pixelated curve corresponding to the curve segment.

The basic algorithm we just described may produce jagged curves (see Figure 2b). To remove jaggies, we shift the curve segments so that they are better aligned with the pixel grid, and then the final pixelated curve is checked for slope monotonicity. For example, in Figure 2, since the vector curve is monotonically increasing in slope, the pixels in the corresponding pixelated curve are rearranged to reflect this property.

To evaluate our pixelation algorithm, we conducted a two-part user



**Figure 2:** Our algorithm uses slope-sorting to remove jaggies (shown in red) in curve segments with monotonic slope.

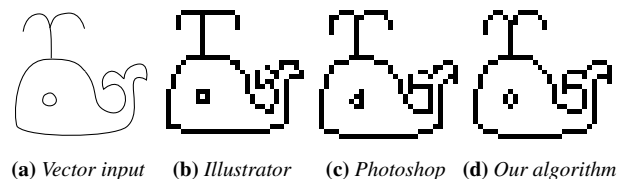
study. In Part 1, participants were given eight vector images, each superimposed on a pixel grid, and asked to draw the corresponding pixel art. In Part 2, we merged the participants' drawings with results generated by our algorithm as well as Adobe Illustrator and Adobe Photoshop (see Figures 3 and 4). Participants were then presented with pairs of pixel drawings and asked to choose which they preferred based on visual appeal and fidelity.

We had a total of more than 300 participants, ranging from amateurs to professional pixel artists. According to the results, our algorithm significantly outperformed both Adobe Illustrator and Photoshop. However, the highest rated drawings came from pixel artists, because they understand how to simplify certain features while maintaining readability at low resolutions.

For future work, we are interested in developing techniques for other aspects of pixel art such as selecting relevant features to include based on the resolution, choosing a suitable colour palette, applying artistic dithering and anti-aliasing, and creating isometric pixel art from 3D models.

## References

INGLIS, T. C., AND KAPLAN, C. S. 2012. Pixelating vector line art. In *Proceedings of the international symposium on Non-photorealistic animation and rendering, to appear*, NPAR '12.



**Figure 3:** Computer-generated pixel art drawings.



**Figure 4:** Pixel art drawings by user study participants.