Bézier Curve-Based Stroke Extraction for Handwritten Characters

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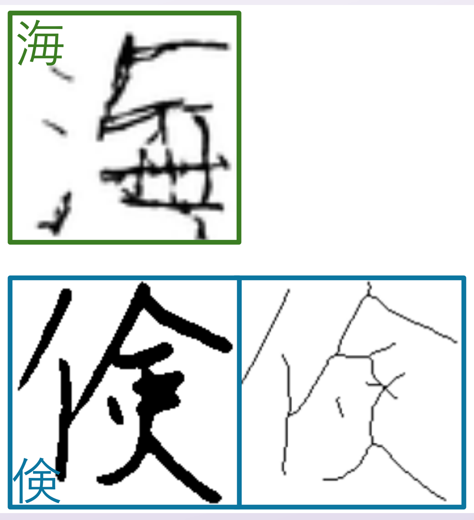
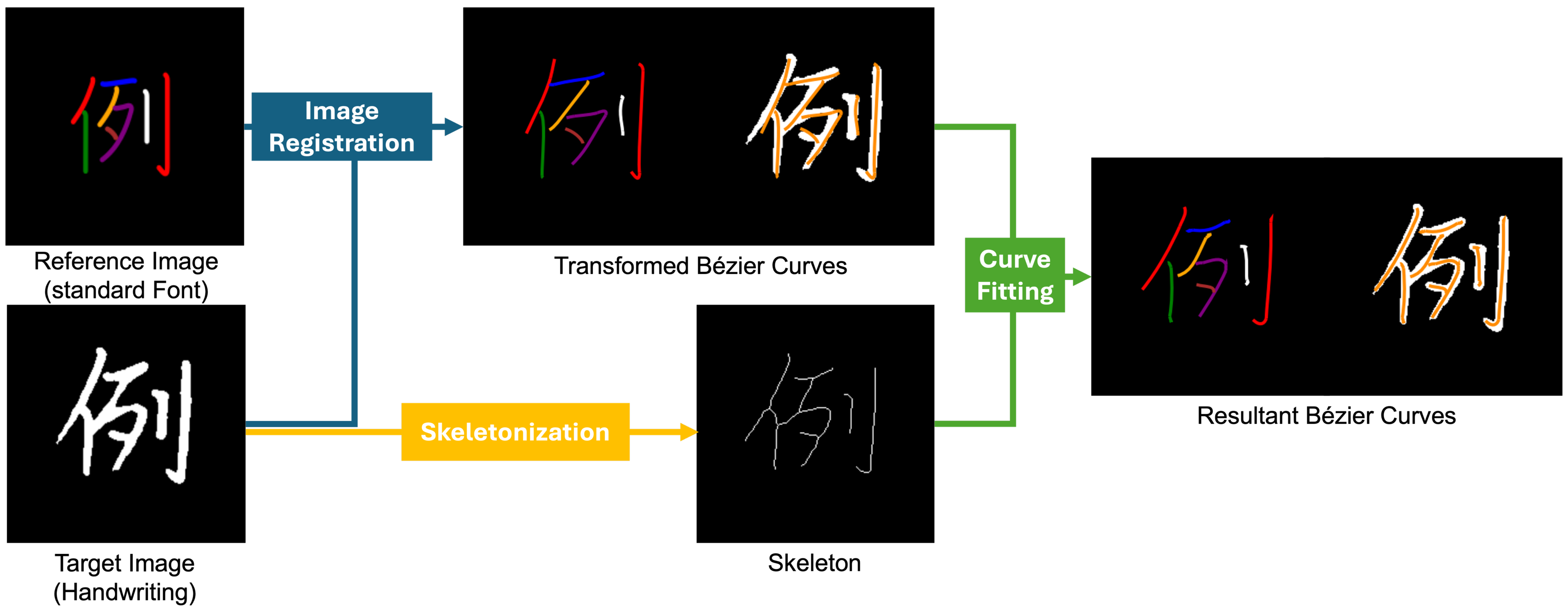
Motivation

- Pixel-based handwriting generation often fails to reproduce realistic stroke structures
  → We need stroke-level data to accurately reconstruct the structure of handwritten characters.
- Traditional methods like skeletonization often produce fragmented or distorted strokes, especially at intersections and on curves .
- Our Goal: To extract smooth, structurally accurate strokes as parametric Bézier curves directly from raster images .



Method

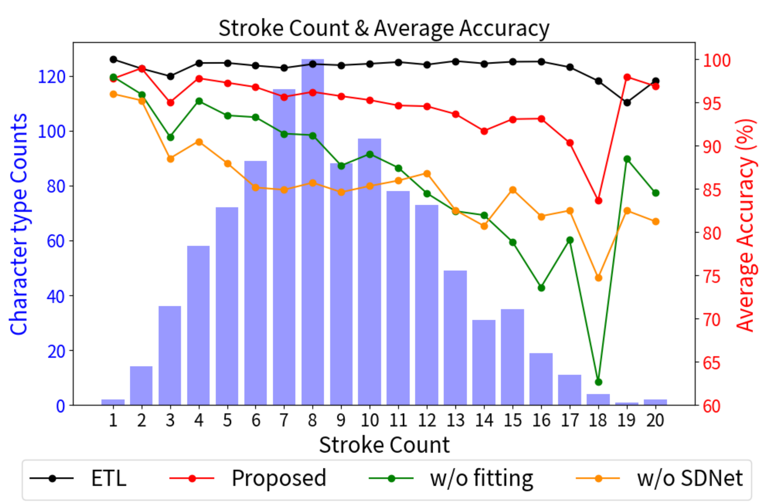


Stage 1: Initial Alignment (Image Registration)
- A deep learning model (SDNet) performs deformable image registration .
- It aligns a vector-based reference font with the target handwritten character image .
- This provides a rough initial placement of the Bézier curves .

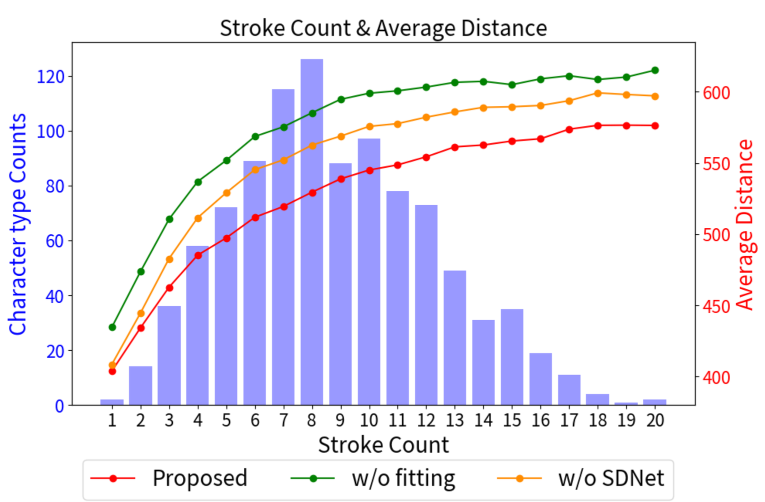
Stage 2: Refinement (Curve Fitting)
- The target image is thinned to its skeleton.
- Skeleton points are matched to the closest points on the initial Bézier curves .
- The control points of each Bézier curve are re-optimized to minimize the distance to the matched skeleton.

Results

- Quantitative Results



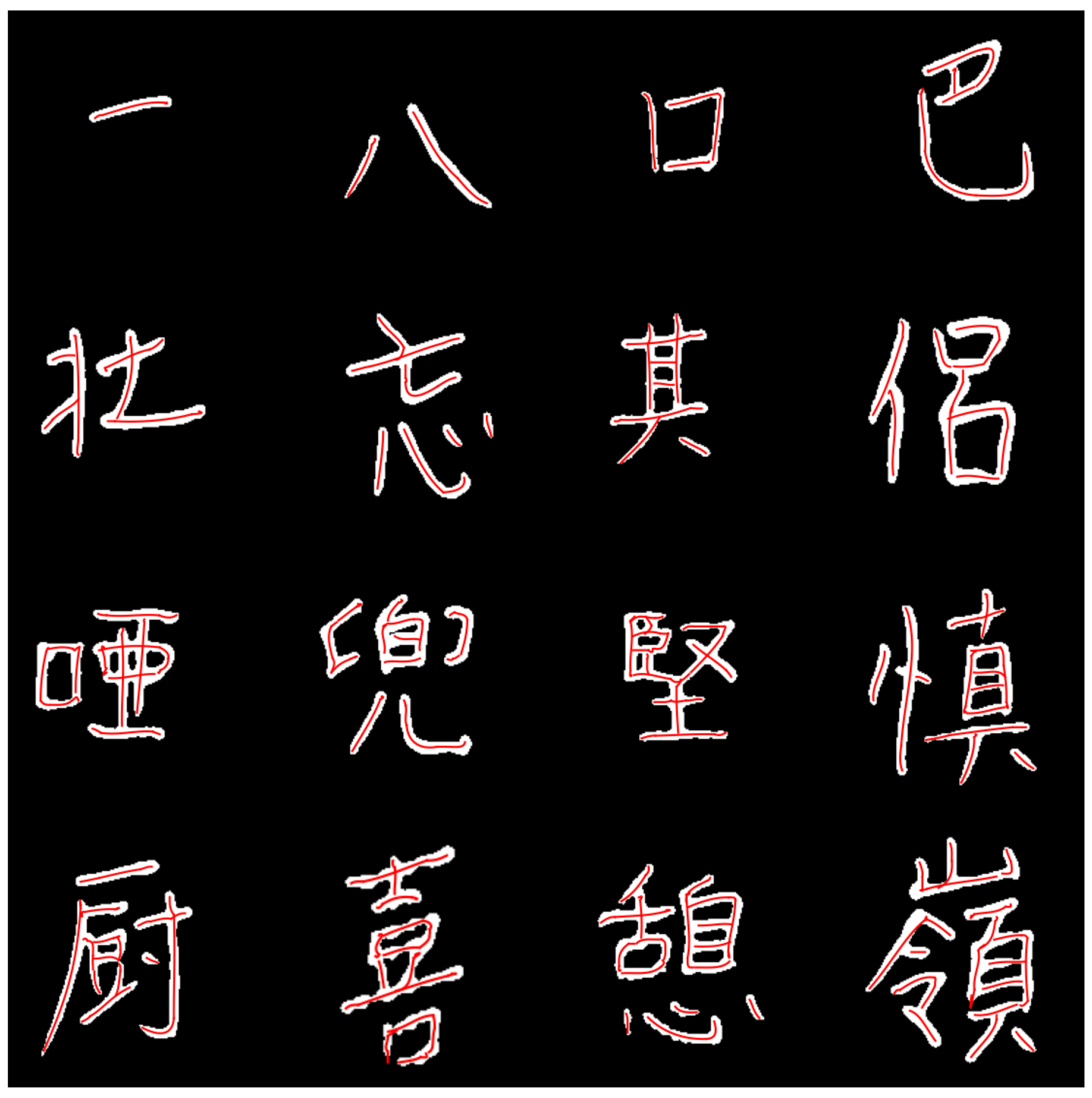
OCR Accuracy



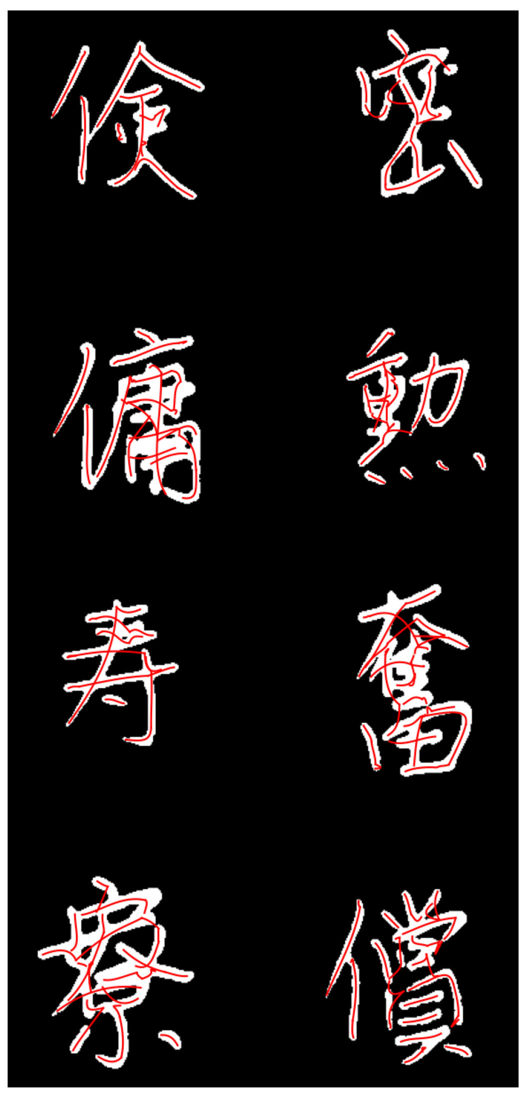
Geometric Similarity

- Both the initial alignment by SDNet and the subsequent curve fitting are crucial for high-quality stroke extraction.
- The quality of the reconstructed character images tends to decrease as the number of strokes increases.

- Qualitative Results

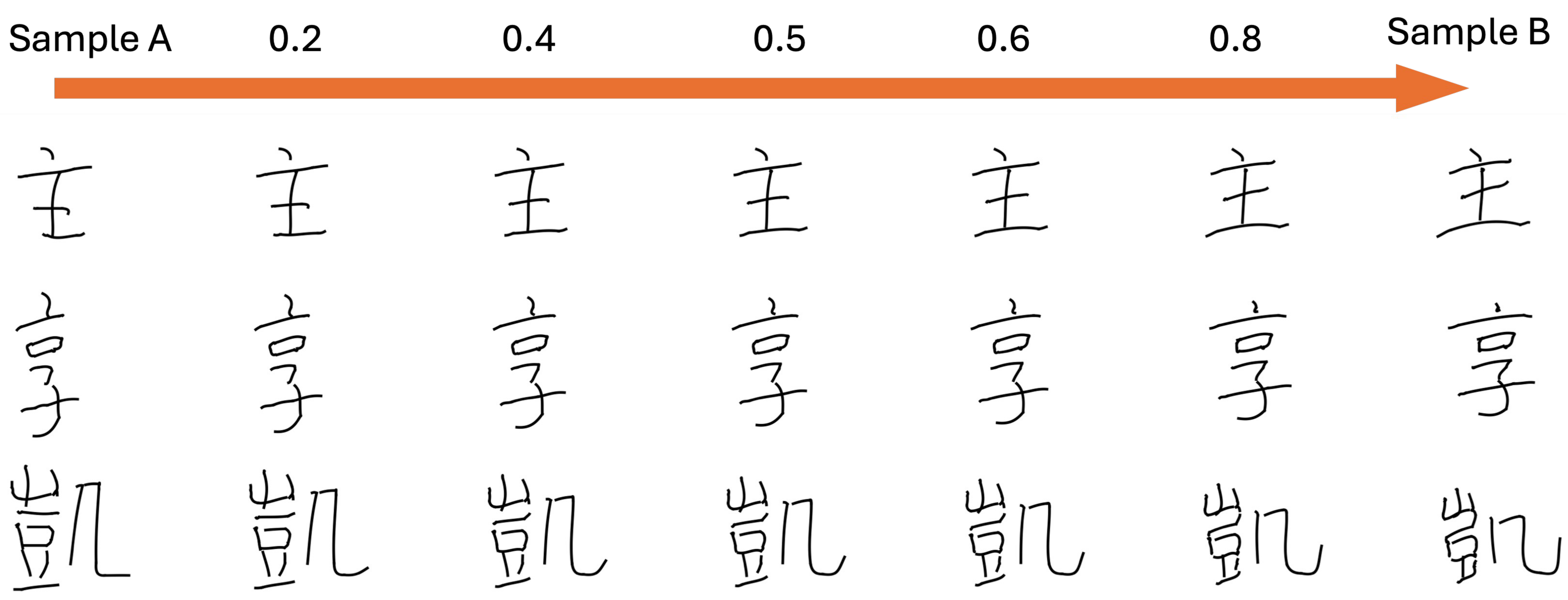


succeeded



failed

Application: Character Synthesis by Interpolation



Conclusion & Future Work

Conclusion:
- Our method successfully extracts structurally accurate strokes from handwritten character images.
- The two-stage approach (alignment + fitting) is critical, outperforming baseline methods in both OCR and geometric evaluations .

Future Work:
- Incorporate character feature points as constraints to improve alignment for complex characters .
- Develop a high-quality generative model for handwritten characters based on the extracted stroke data .