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An Improved Representation for Stroke-based Fonts

Elena J. Jakubiak, Ronald N. Perry, Sarah F. Frisken

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Abstract

Because a typical Asian typeface can consist of more than 12,000 glyphs, traditional scalable outline-based fonts require 5-10 MBs of memory. This requirement is particularly problematic in mobile devices (e.g. cell phones and PDAs) and embedded systems (e.g. car navigation systems)where memory is at a premium. Existing commercial solutions (e.g. by Bitstream and Monotype Imaging) represent glyphs using simplified uniform-width strokes. However, these light-weigh (250 KBs) stroke-based fonts lack the detail, expressiveness, and variety needed for optimal legibility and true cultural acceptance (Figure 1). Although METAFONT [Knuth 1986] is stroke-based and provides sufficient detail and expressiveness, it requires the type designer to be proficient in mathematics, rasterization and programming.

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An Improved Representation for Stroke-based Fonts

Elena J. Jakubiak* Tufts University
Ronald N. Perry† MERL
Sarah F. Frisken* Tufts University

Overview

Because a typical Asian typeface can consist of more than 12,000 glyphs, traditional scalable outline-based fonts require ~5-10 MBs of memory. This requirement is particularly problematic in mobile devices (e.g., cell phones and PDAs) and embedded systems (e.g., car navigation systems) where memory is at a premium. Existing commercial solutions (e.g., by Bitstream and Monotype Imaging) represent glyphs using simplified uniform-width strokes. However, these light-weight (~250 KBs) stroke-based fonts lack the detail, expressiveness, and variety needed for optimal legibility and true cultural acceptance (Figure 1). Although METAFONT [Knuth 1986] is stroke-based and provides sufficient detail and expressiveness, it requires the type designer to be proficient in mathematics, rasterization, and programming.

In this presentation we describe an improved representation for stroke-based fonts, entitled Stylized Stroke Fonts (SSFs). SSFs overcome the shortcomings of existing scalable font representations by providing the detail and expressiveness of outline-based fonts with a memory footprint comparable to current stroke-based fonts. Each glyph of an SSF consists of three main elements: a *stroke path* which is composed of a set of line segments and Bezier curves and runs approximately along the centerline of the glyph; a set of *stroke profiles* which define the shape of the stroke by specifying the perpendicular distance from the stroke path to the edge of the glyph where the distances are interpolated along the length of the stroke path; and a set of *stroke ends* which determine the shape of the start and end of each stroke in the glyph (Figure 2). Stroke profiles and stroke ends are repeated both within individual glyphs and across multiple glyphs in a typeface. Stroke paths are repeated across typefaces. The modular SSF construction exploits this repetition and stores only one instance of each profile set, stroke end, and stroke path, thereby achieving the expressiveness of outline-based fonts with memory requirements that are only 33% larger than current stroke-based fonts (Figure 3).

SSFs leverage recent work in font representation and rendering using Adaptively Sampled Distance Fields [Frisken et al. 2000; Frisken and Perry 2006; Perry and Frisken 2005]. Adaptively Sampled Distance Fields provide very high quality anti-aliasing, a means for aligning glyphs to the pixel grid to improve legibility, simple and efficient operators for composing glyphs from multiple overlapping strokes, and direct rendering of SSF glyphs without having to first determine explicit outlines.

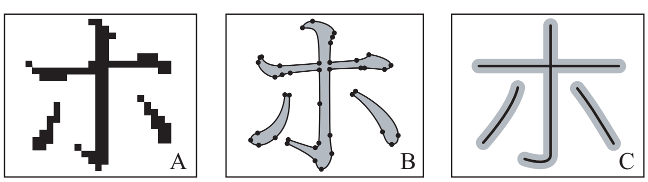

Figure 1. Common computer representations of glyphs include A) bitmaps, B) outlines, and C) strokes. Bitmaps give the best rendering at specific point sizes but are not scalable thus requiring many versions if multiple fonts and/or sizes are needed. Outlines are most expressive but can require 10 MBs for Asian fonts. Stroke-based glyphs are scalable and much smaller (~250 KBs for Asian fonts) but are neither visually appealing nor expressive.

*e-mail: {jakubiak, frisken}@cs.tufts.edu
†e-mail: perry@merl.com

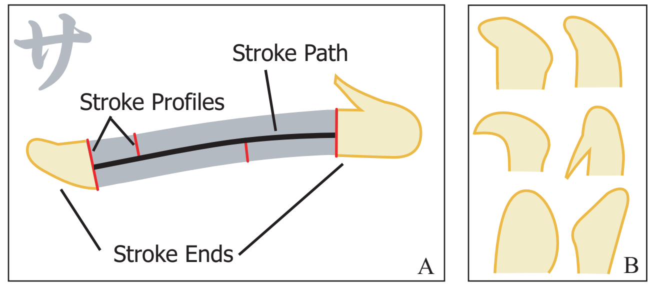

Figure 2 A) Glyphs in Stylized Stroke Fonts (SSFs) consist of *stroke paths* which run approximately along the centerline of the glyph, *stroke profiles* which specify the perpendicular distance from the stroke path to the edge of the glyph where the distances are interpolated along the stroke path, and interchangeable *stroke ends* which specify the shape of the ends of each stroke path. B) Various stroke ends.

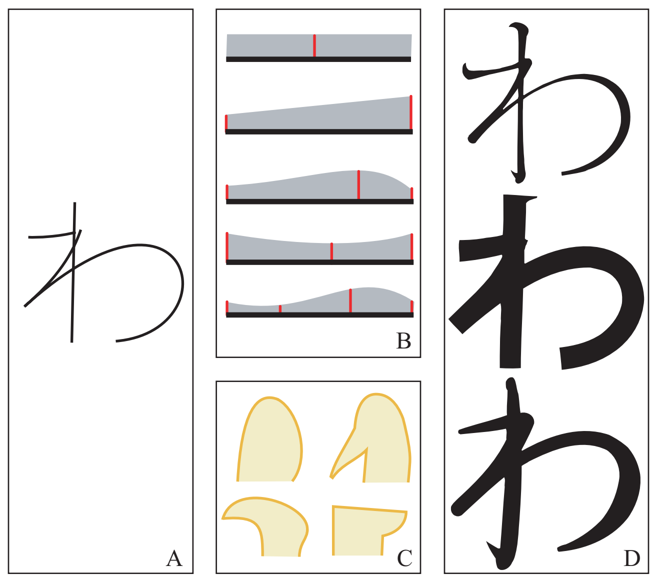

Figure 3. By combining A) a single stroke path with B) various stroke profiles, and C) various stroke ends, a rich variety of typefaces D) can be represented using very little memory. Because stroke profiles and stroke ends are repeated among glyphs both within and across typefaces, enhancing stroke-based fonts to represent multiple, expressive typefaces only requires an additional 80 KBs over the 250 KBs required for stroke-based Asian fonts.

References

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