OpenType Color Fonts in PDF

Implementing emoji and other colored symbols in PDF

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Topics

- Four OpenType color font flavors
- Emoji and Unicode
- Color fonts in PDF
Why Color Fonts?

- All stand-alone font formats so far are monochromatic
- Glyphs can be colorized when used, but not inside the font
- "Color is the new Black"
  - wide-spread use of emoji on mobile devices
  - color fonts are mainly driven by Web and mobile applications
  - artistic use of color in fonts
- Simplified exchange of emoji due to Unicode standardization
  (emoji are a big step back in the long history of writing...)
Commercial Font Samples

AQUA
OpenType Font

BATIK INDIA
Color OTF Font

BULB LAMP
Font System

CHILDISH REVERIE
A Playful, New Font with Extras!

POPSKY
Simply type multicolor text!

COLOR ALPHABET

COLOR BLOCK

FIERCE

WOODEN TILES

PRIDE
A Colour Opentype Font
Color Font Standards

- Four vendors invented competing color font formats
- All four formats ended up in ISO 14496-22:2019
  - Information technology — Coding of audio-visual objects — Part 22: Open Font Format
- Existence of a standard doesn’t mean that everybody supports it
General Properties

- Color fonts need much more space than monochromatic fonts
- 3 of 4 color font formats don’t support hinting for improved rendering at small sizes
- Color fonts don’t work on all systems and applications
- Color fonts may contain a combination of mono and color glyphs
- Mono versions of color glyphs are usually present for compatibility with old environments
Transparency in Glyphs

- Transparency may be used in glyphs
  - for typographic effects
  - to simplify combination of glyph layers
    (e.g. transparent glasses for all skin tones)
Adobe/Mozilla OpenType SVG

- Glyph descriptions use the power of SVG
  - vector graphics
  - transparency
  - smooth shadings (gradients)
  - patterns and masks
- SVG may also include PNG and JPEG raster images
Some SVG features are restricted for security and performance reasons

- SVG Integration (www.w3.org/TR/svg-integration)
- disables scripting, external references, interactivity
- support not required in applications: CSS, animation, filter, mask, pattern

Minor SVG features added
- e.g. for selecting color from a palette
Adobe/Mozilla OpenType SVG

- Reference fonts:
  - Adobe EmojiOneColor: 1836 glyphs, 4MB
  - Adobe TrajanColor-Concept: 1366 glyphs, 8MB
- OpenType SVG support in operating systems
Layered Glyphs:
- each color glyph is built from multiple mono layers
- each layer is assigned color and transparency

Hinting is possible (unlike all other formats)

Relevant font tables:
- »COLR«: list of mono glyphs used to construct color glyphs
- »CPAL«: one or more RGBA color palettes, e.g. for light or dark background

One of the CPAL palettes can be selected when using the font
- different palettes for dark and light background
- palette selection not yet supported in applications
Microsoft OpenType COLR

- COLR table version 0
  - glyph parts are stacked and can use solid fills and transparency

- COLR table version 1
  - will be introduced in OpenType 1.9
  - gradient fills, affine transformations, masks, blending modes
  - color information may be variable, e.g. number of color stops in a gradient
  - requires much more complex implementation than version 0
Microsoft OpenType COLR

- Reference font Microsoft Segoe UI Emoji: 3665 glyphs, 2MB
- OpenType COLR support in operating systems
Apple OpenType SBIX

- SBIX = Standard Bitmap Graphics table
- Glyphs in common image formats PNG, JPEG, TIFF
- Scaling to large glyph sizes is problematic
- Mono glyphs for applications without color support are optional
Reference font Apple Color Emoji: 2600 glyphs, 156MB
OpenType SBIX support in operating systems
- Windows 10 Anniversary Update (2016), macOS 10.7 (2011)
- but Apple Color Emoji doesn’t work in Windows 10
Google OpenType CBDT

- CBDT = Color Bitmap Data Table
- Raster image data: PNG with alpha or uncompressed 32-bit RGBA
- Scaling to large glyph sizes is problematic
- No »glyph« table for mono glyph descriptions required
  - no fallback for applications which cannot handle color glyphs
- Reference font NotoColorEmoji: 3600 glyphs, 9MB
- OpenType CBDT support in operating systems
  - Windows 10 Anniversary Update (2016), Android
  - but NotoColorEmoji doesn’t work in Windows 10 for lack of »glyph« table
Emoji in Unicode

- Emoji are standardized in Unicode
  - First emoji in Unicode 6.0 (2010)
  - Unicode 14.0 (2021-09) adds 112 emoji
  - Unicode 14.0 contains 3633 emoji
- Unicode Technical Standard #51 specifies details of emoji processing
  - modifiers, sort order
  - emoji presentation vs. text presentation (when to use color or mono)
  - zero-width joiner (ZWJ) sequences
Emoji Sequences

- ZWJ grouping
- Skin tone
- Emoji flag
- ZWJ gender
- Skin tone and gender
- ZWJ hair components
- ZWJ role: man farmer
Emoji Sequences

- Additional features for emoji with zero-width joiner U+200D (ZWJ):
  - the ZWJ is invisible and combines characters
  - sequence and combinations vary some aspect of a character
  - gender, hair components, role (occupation), flags, keycaps
- Amazing list at unicode.org/emoji/charts/emoji-zwj-sequences.html
- Fonts support emoji sequences via OpenType feature tables
  - usually the »ccmp« feature (glyph composition/decomposition)
  - applications should should enable »ccmp« feature by default
How to create a female dark-skinned scientist:

- start with U+1F469 WOMAN
- add U+1F3FF EMOJI MODIFIER FITZPATRICK TYPE-6
- add U+200D ZERO WIDTH JOINER
- add U+1F52C MICROSCOPE

- right – she doesn’t use a microscope, but that’s the font designer’s liberty
- create farmers, teachers, painters, cooks, astronauts and many other roles
- see unicode.org/emoji/charts/emoji-zwj-sequences.html
Color Fonts in PDF

- PDF 2.0 doesn’t support any of the four color font formats
- Alternative approach: rasterize color glyphs – many disadvantages
- Type 3 fonts:
  - very flexible
  - arbitrary contents: raster, vector, shadings, glyphs from other fonts
  - transparency
  - can use intrinsic glyph color or inherit color from outside
  - all glyph descriptions can share common resources like, e.g. color spaces, shadings
  - ToUnicode CMap defines Unicode mapping of Type 3 glyphs for text extraction
  - glyphs created by emoji sequences must be encoded by a sequence
Disadvantages of Type 3 Fonts

- Type 3 fonts exist only in PDF documents; cannot be exchanged
- Not supported in operating systems
  - PDF viewer cannot use »local fonts«
- No hinting
- 8-bit encoding, i.e. max. 255 glyphs per font instance
  - font objects may contain an arbitrary number of glyphs
  - glyphs cannot be addressed by Unicode value
  - Large fonts can be segmented in subfonts with max. 255 glyphs
- Glyph names required; inefficient for large fonts
Type 3 Font Subsetting

- Subsetting is not defined for Type 3 fonts
  - are all glyphs embedded or only a subset?
  - compare with the original OpenType color font
  - use random subset prefix in the font name?
- Skipping unused color glyphs is important to keep file size down
  - typically only a few emoji of a large set are used
  - Microsoft Segoe UI Emoji with 1 glyph: 5.5 KB
  - ...with 10 glyphs: 10 KB
  - ...with full set of 3665 glyphs: 2.6 MB
Converting COLR Fonts to PDF

- Type 3 fonts derived from COLR fonts:
  - Type 3 font references glyph parts (layers) from the OpenType font
  - OpenType font must be embedded in addition to the Type 3 font
  - hinting is preserved
  - OpenType font contains more glyphs than Type 3 font because of glyph parts
  - Segoe UI Emoji: ca. 12000 full and partial glyphs for ca. 3700 final glyphs
Color Fonts in PDF Standards

- PDF/A-1 and PDF/X-3:
  - transparent glyphs not allowed
  - a single glyph can spoil standard conformance
- PDF/A-1a/2a/2u/3a/3u/4 and PDF/UA-1:
  - proper Unicode mappings must be provided
  - application must handle supplementary Unicode characters > U+FFFF
- Color management:
  - SVG, COLR and CBDT: sRGB required
  - SBIX: sRGB optional
Accessibility and Emoji

- How to present emoji with Assistive Technology (AT)?
- All Unicode characters have descriptive names
  - e.g. U+1F494 BROKEN HEART 💔, U+1F602 FACE WITH TEARS OF JOY 😭
  - names are also useful when searching emoji on the virtual keyboard
- Assistive Technology can use these names
- The »Read Out Loud« feature in Acrobat DC uses Unicode names
  - proper ToUnicode CMap required in PDF
Summary

- PDF doesn’t support OpenType color fonts natively
- Nevertheless they can be used due to the versatility of Type 3 fonts

Thanks for your Attention!
Resources

- OpenType specification: docs.microsoft.com/en-us/typography/opentype/spec/
- Unicode Resources for emoji: unicode.org/emoji/techindex.html
- Realtime emoji use on Twitter: emojitracker.com/
- »Read Out Loud« emoji test page (distributed with the presentation slides)
- PDFlib 10 (available soon) supports color fonts: www.pdflib.com