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OABench™ Version 2.0

Benchmark Name: Ghostscript®

Highlights

- Benchmarks potential performance of a PostScript® printer engine
- 4 different test files stress different printer aspects
- 5 different output drivers stress different aspects of output formatting and rendering
- Based on open source AFPL Ghostscript® code base
- Implements output verification checks using a modified version of the PSNR algorithm to find bit level artifacts in comparison with reference files

Application

The Ghostscript benchmark provides an indication of the potential performance of an embedded processor running a PostScript printer engine. Performance is measured using four input files reflecting different aspects of PostScript language processing, as well as five output drivers reflecting the different types of processing found in common printer engines.

Benchmark Description

Ghostscript is an application developed to render print format files on a host application. This task must perform all of the processing normally found in a PostScript printer engine. Additionally, this task must produce final output for a wide range of available printers and FAX formatted results. This makes Ghostscript an ideal application to measure embedded processor capabilities to perform printer functions with a single consolidated score.

EEMBC Ghostscript* contains a significant number of functions and algorithms used in PostScript printer engines. These functions are implemented within a portable test harness that allows execution on a wide range of processors and DSPs without source code changes in the main application. This benchmark is supported by an automated build process to generate an embedded file system required to support this application.

Every PostScript printer engine contains a built-in interpreter that executes PostScript instructions. The engine also contains modules for reading a variety of input raster formats, fonts for rendering text characters, and an output driver to produce each page in a format for the printer engine.

The EEMBC Ghostscript application benchmark provides:

- An interpreter for the PostScript language;
- Input modules (utilities) for reading a variety of formats, including Postscript and Encapsulated PostScript;
- Output modules (drivers) for a wide variety of raster file formats, and printers, as well as a PDF output module that implements functions similar to the Adobe® Distiller® product;



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Benchmark Description (continued)

- The Ghostscript library, a set of procedures to implement the graphics and filtering capabilities that are primitive operations in the PostScript language.

Libraries are incorporated to handle graphics formats such as BMP, JPEG, PNG, JBIG2, and JPEG 2000.

Ghostscript Benchmark Printer Drivers

Ghostscript is an interpreter for the PostScript language. A PostScript interpreter takes as input a set of commands. The output is usually a page bitmap, which is then sent to an output device such as a printer or display. PostScript is embedded in many printers.

The following printer output drivers are implemented in EEMBC Ghostscript and applied to each input file:

- HP Deskjet®
- HP Laserjet®
- TIFF G4 (Fax formatting)
- 256 Color BMP Bitmap format
- PDF (Adobe Portable Document Format version 1.2)
- SpotCMYK Produces CMYK data using Device"N" support.

PostScript™ Features Supported

There are three versions of PostScript: Level 1, Level 2, and PostScript 3. Level 2 PostScript, which was released in 1992, has better support for color printing. PostScript 3, released in 1997, supports more fonts, has better graphics handling, and includes several features to speed up PostScript printing.

The following PostScript Language Level 3 features are available in EEMBC Ghostscript:

- Anti-aliased text and graphics on continuous-tone devices
- Alpha value for displays
- ICC-based color support
- Device "N" color support (6+ colors at 8 bits)
- "Argyll" color management system
- Band-at-a-time rendering for high-resolution printers

Ghostscript Benchmark Testing

The input files were selected to measure specific pre-processing with low-level graphics algorithms, PostScript Language features, and specific font and image rendering. Each input file is then output using five different printer drivers that cover aspects of color conversion, dithering, font rendering, and other aspects of printer output found on commonly available printers.

The input files are PostScript and Encapsulated PostScript files described below. Each input file is rendered by four printer drivers into separate output files. Two of these drivers can be viewed by display programs to help verify



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that the encoding was correct.

**Ghostscript
Benchmark
Testing
(continued)**

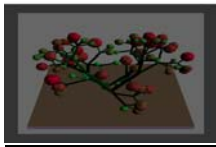
Correctness checking is also performed by a customized quality measure system using a modified form of peak signal to noise ratio analysis for graphics, direct comparison of text data, and driver output conversions to raster formats for analysis.

Ghostscript Input Data Set Descriptions

The following section contains a description of each input file used in the EEMBC Ghostscript Application Benchmark. A graphical thumbnail is also shown.

Thumbnail

Doretree



Description

Doretree is a bordered image produced by a modeling program. The file is in PostScript format for input.

The primary elements consist of a tree of geometric objects that have pixilated shading. The rendering to a printer format must preserve these objects along with the patterns of visible pixels defining the shading.

Thumbnail

Golfer



Description

A grayscale picture of a stylishly dressed woman swinging a golf club. The file format is in encapsulated PostScript format for input.

The primary elements consist of a clip-art image with highlights using closely spaced horizontal lines. Rendering, and in particular dithering, will be challenged to reproduce the line elements.

Thumbnail

EEMBCJournalPage1



Description

A 2 column print page with color graphics and logos. The image reflects an office document that has been rotated. The file is in PostScript format for input.

EEMBC Journal Page 1 is a bitmap of a rotated document. The color conversion of earth tone colors to CMYK printer colors is challenging in this file.

The artifacts to watch for are incorrect scaling to the lower right of an A4 size page. The resulting image does not fill the page, and an area of transparent (white/alpha) background surrounds the image.

Thumbnail

Rotate-fontlist2



Description

A simple text string that is rotated. This is specific to emphasize the low level bit rotation graphics algorithm.

There are no difficult renderings in this picture; the primary focus is a speed test of the rotation algorithm kernel within Ghostscript.

Analysis of Computing Resources

Ghostscript is a fully functional printer application with PostScript language interpretation, low-level graphics conversions, and printer drivers.

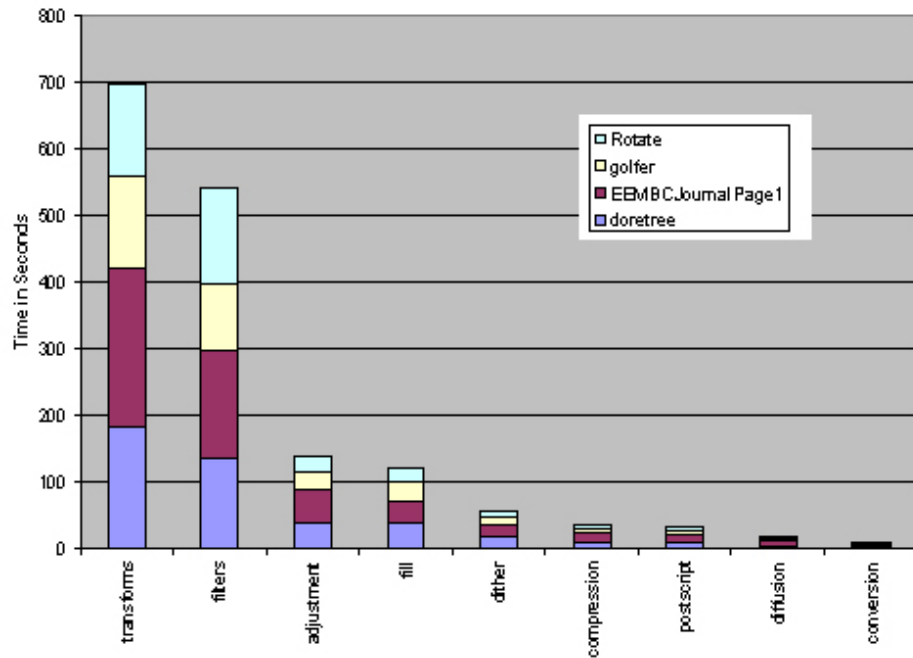
Internally, the file system required for font selection and processing is also implemented with over 400 resources used during the processing on an embedded platform.

	Rotate	Golfer	EEMBC Journal Page	doretree
Dithering/halftone	√	√	√	√
Error Diffusion	√	√	√	√
Color Adjustment	√	√	√	√
Color Conversion	√	√	√	√
Image transforms (rotate, scale, clip, mirror, etc.)	√	√	√	√
Compression	√	√	√	√
Fill	√	√	√	√
PostScript™ Interpreter	√	√	√	√

Profiling Analysis

The Ghostscript benchmark with the above-mentioned datasets was profiled, and the resulting data categorized to show that the following functions are being performed by the benchmark.

- Dithering / half toning (Color and Monochrome)
- Error diffusion
- Color adjustment
- Color conversion
- Image transforms (rotate, scale, clip, mirror, etc.)
- Compression
- Fill
- PostScript Interpreter



**Ghostscript Profile
Graphic Function by Dataset**



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Optimizations Allowed	Out of the Box/Standard C Full Fury/Optimized
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- The C code must not be changed for Out-of-the-Box unless it must be modified to get it to compile. All changes must be documented and must not have a performance impact.
- For Out-of-the-Box, additional hardware can be used if it does not require code changes.
- All optimized libraries must be part of the standard compiler package, and/or available to all customers
- The EEMBC Test Harness Regular or Test Harness Lite may be used. Test harness changes may be made for portability reasons if they do not impact performance
- For Optimized, the basic algorithm may be changed and/or the code can be rewritten in assembler. We report a modified form of the PSNR score to help you judge quality of computational processing.
- For Optimized, optimized libraries can be used if they are publicly available.
- For Optimized, hardware-assist can be used if it is on the same processor as that being benchmarked.
- For Optimized, in-lining is allowed.
- Additional data files may be used by ECL during certification to ensure the correctness of the optimized benchmark. You should not assume data patterns during optimization.

*This version of Ghostscript is based on AFPL 8.15.

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