

MediaQ MQ1100 Graphics Engine Test

Red Mercury™ Labs - <http://www.red-mercury.com>

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Introduction

Red Mercury™ Labs conducted tests to determine the effectiveness of adding direct hardware acceleration support to the Red Mercury Graphics Library (RMGL). The tests were conducted on a Sony CLIE PEG-N710C Palm OS handheld computer. The graphics chip on this device is the MediaQ MQ-1100 controller.

Red Mercury Graphics Library

The RMGL is a simple graphics library designed to handle graphics tasks required for video games on handheld devices.

A brief sample of RMGL features:

- Provide double buffering functionality
- Copy bitmap from system memory to video memory
- Copy bitmap with transparency from system memory to video memory
- Erase solid rectangles
- Expand 1-bit system memory font to video memory (at video memory depth)
- Synchronize double buffer page flipping

The MQ-1100 provides hardware assistance for all of these functions. It was decided at Red Mercury to create a hardware-accelerated version of RMGL for use in all Red Mercury games.

Atom Smash™ 2.0

Initially, Atom Smash 2.0 relied on RMGL software routines to draw graphics to the MQ-1100 video ram in 320x320 high resolution. This works, but when multiple balls and power-ups are active in the game, the software solution alone doesn't cut it – the frame rate drops.

Two factors contribute to the frame rate problem. The most obvious is the increased resolution – four times as much data is written to the screen in 320x320 high-resolution mode, versus the standard 160x160 resolution of Palm OS handhelds. The not so obvious factor was that Atom Smash runs at 60 frames per second (fps) on the Sony CLIE N7x0, as compared to 50 fps on other Palm OS devices.

The increase in frame rate deserves some explanation. The MQ-1100 provides a vertical sync signal to the programmer, so it is possible to synchronize double buffer page flips with the vertical sync. This has been a problem on other Palm OS handhelds, as vertical sync signals are not generally available. Page flipping without a vertical sync can cause some nasty flicker, and requires synchronizing to the system clock instead of the actual screen refresh rate. The obvious smoothness of Atom Smash game play on the Sony CLIE N7x0 is possible largely due to the ability to synchronize with the refresh of the screen.

Since the vertical refresh rate on the Sony CLIE N7x0 is approximately 60Hz, this made drawing performance even more critical. Atom Smash runs at 50Hz on all other Palm OS handhelds, allowing more time to draw each frame. The increased frame rate combined with the difficulty of drawing four times as many pixels per frame, made hardware acceleration a necessity.

What Is Accelerated

RMGL now supports direct MQ-1100 acceleration for its most commonly used functions, including:

- Rectangle Fill (Erasing)
- System Memory to Screen Memory blit
- System Memory to Screen Memory Transparency blit
- System Memory to Screen Memory 1-bit to Screen-Depth Expansion Transparency blit.

RMGL also supports direct synchronization with the vertical refresh rate of the screen, eliminating flicker and providing smooth animation.

What Is Compared

RMGL provides software (non-hardware-accelerated) routines for all graphics operations. Prior to adding MQ-1100 hardware support, these software routines were heavily optimized. When software drawing is mentioned in the test results below, it is these optimized calls that are being compared to hardware acceleration, not Palm OS API calls.

What Was Tested

The most common functions used in RMGL are transparency blit, rectangle fill, and 1-bit font expansion.

Four tests were run:

1. **“Large Blit”** - System Memory to Screen Memory Transparency Blit, 224x50 pixel, 8-bpp source, 224x50 pixel, 8bpp destination (in 320x320 pixel, 8bpp frame buffer)
2. **“Small Blit”** - System Memory to Screen Memory Transparency Blit, 16x16 pixel, 8-bpp source, 16x16 pixel, 8-bpp destination (in 320x320 pixel, 8bpp frame buffer)
3. **“Erase”** – Screen Memory Rectangle Fill, single color source, 160x160 pixel, 8bpp destination (in 320x320 pixel, 8bpp frame buffer)
4. **“Font”** – System Memory to Screen Memory 1-bit to Screen-Depth Expansion Transparency Blit, 16x16 pixel, 1-bit source repeated 12 times (drawing text “TESTING FONT”), 192x16 pixel, 8-bit destination (in 320x320 pixel, 8bpp frame buffer)

For each test, the drawing was performed 10,000 times in a closed loop, like this:

```
for (UInt32 i=0; i<NUMRUNS; i++)  
    buf->DrawBitmapNS(largeBmp, 0, yoffset);
```

where NUMRUNS is defined to be 10,000.

The four tests were run first with MQ-1100 hardware acceleration turned on. Then, the hardware acceleration was turned off in RMGL, and the identical tests were run again to test the speed of the optimized software drawing routines.

The tests were timed using the Palm OS system tick (100 ticks per second). To determine pixels per second drawing rate, this calculation was used:

```
(DrawWidth*DrawHeight*NUMRUNS / numTicks)= PixelsPerTick;  
PixelsPerTick * 100 = PixelsPerSecond;
```

Ok, So How Fast Is It? The Results

	Optimized Software	MQ-1100 Accelerated	Speed Increase
Large Blit	498,700 pixels/second	2,630,300 pixels/second	5.2x
Small Blit	383,200 pixels/second	917,500 pixels/second	2.3x
Erase	1,062,700 pixels/second	87,671,200 pixels/second	82.4x
Font	277,100 pixels/second	1,126,900 pixels/second	4.0x

Analysis

The results of the test are consistent with what is actually seen on-screen. In real terms, for example, the Erase test took 240 seconds to run on the Sony CLIE N710C in software mode, but only took 2.9 seconds to run in MQ-1000 accelerated mode.

The largest speed increase is seen in the Erase test. Rectangle Fill on the MQ-1100 is handled completely internally, so the Graphics Engine is writing directly to its own VRAM. By comparison, the software routine must use the CPU to write data across a bus into VRAM to achieve the same Rectangle Fill.

The Large Blit is faster than the Small Blit, primarily because of drawing setup overhead. The Small Blit is only 256 pixels, so the time required to set up the drawing is more significant when compared to the time required to actually draw the bitmap. The Font drawing speedup is consistent with the Large Blit and Small Blit speedup.

Conclusion

The combination of hardware assisted drawing and the ability to double buffer, page flip, and synchronize directly with the screen refresh combines to make RMGL sing on the Sony PEG-N7x0 series of handheld computers. Atom Smash 2.0 will run on any Palm OS device – readers are encouraged to compare the game side by side running on a PEG-N7x0 and any other Palm OS device to see the improvements in game play, frame rate, and overall smoothness of animation achieved by taking full advantage of the MQ-1100.

MediaQ MQ-1100/1132

The MediaQ MQ-1100/1132 Platform Controllers redefine the end-user experience on handheld computers that utilize the Palm and other operating systems. The MQ-1100 integrates a 64-bit 2D graphics engine, direct LCD display interface, and a USB device controller. The MQ1132 additionally incorporates USB Host, I²S audio Codec interface

and a serial peripheral interface (SPI) for touch panel or MMC/SD cards. Both devices integrate 256 KB of Embedded SRAM.

Typical Graphics Acceleration Functions:

- Rectangular Source-copy BitBLTs
- Transparent Source-copy BitBLTs
- Monochrome-to-color conversion BitBLTs
- Mono source/pattern transparency and color transparency
- Pattern (rectangular) fills
- Hardware Clipping
- Panning and Scrolling
- All angle (Bresenham) line draw

The devices support glue less interface to popular CPU architectures including the Motorola Dragonball series, Intel SA-1110 and XScale series, the Hitachi SH-7750 and SH-7709 and the NEC VR-41xx™ family processors.

MediaQ, Inc., develops highly integrated semiconductors and accompanying software for key segments of the growing handheld market. MediaQ has attracted Tier 1 customers that include Sony, NTT DoCoMo, Hitachi, JVC, NEC, and Siemens.

About Red Mercury

Red Mercury, LLC was founded in November of 1999 to make games for handheld devices. All Red Mercury games are free to try. Demonstration versions of all Red Mercury games, including Atom Smash, are available for download from <http://www.red-mercury.com>.

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