Freescale Semiconductor
Application Note

Document Number: AN3723
Rev. 1.0, 04/2008

Using OpenGL Applications on the i.MX31 ADS Board

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This application note shows the procedures for running OpenGL applications on an i.MX31 ADS board running Linux. It also provides an overview on the MBX hardware, the steps for using the Linux MBX driver, and installing the Software Development Kit from Imagination Technologies.

Contents

1 Introduction

The usage of 3D graphics is growing substantially in the consumer space. Always popular in gaming applications, 3D graphics are also deployed on a broad range of devices, such as PDAs, portable media players, mobile phones, navigation systems, car radios, and devices with 3D-style user interfaces.

OpenGL is a very popular programming standard for developing 3D graphics applications. The i.MX31 ADS board supports the OpenGL ES 1.1 standard. On the i.MX31 multimedia processor, OpenGL applications can be accelerated using the built-in MBX hardware and also the vector floating point unit (VFP) present in the ARM1136JF-S core.

1.1 Overview of the MBX Module

The MBX R-S 3D Graphics Core is an Advanced Microcontroller Bus Architecture (AMBA) compliant System-on-a-Chip (SoC) component. Figure 1 shows a top-level block diagram of the MBX R-S 3D Graphics Core.

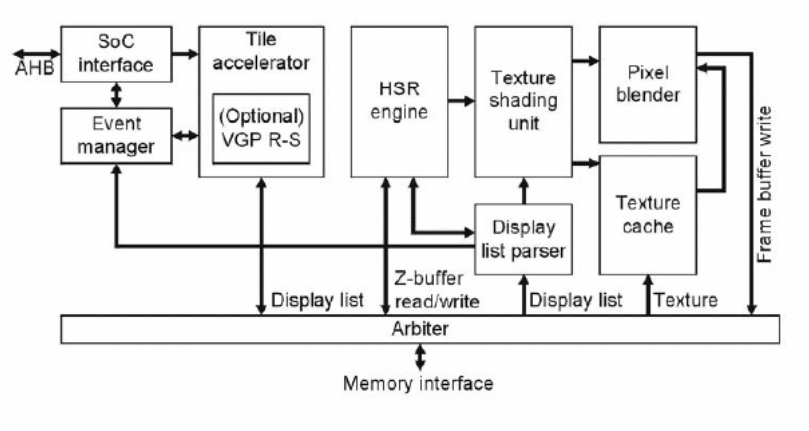

Figure 1 MBX R-S Graphics Core

The MBX R-S 3D Graphics Core consists of the following modules:

- *Tile Accelerator* (TA)
- Event manager
- Display list parser
- Hidden Surface Removal (HSR) engine
- Texture shading unit
- Texture cache
- Pixel blender

The MBX R-S 3D Graphics Core operates on 3D scene data (sent as batches of triangles) that are transformed and lit either by the central processing unit (CPU) or by the optional VGP R-S. The triangles are written directly to the TA on a first-in-first-out (FIFO) basis, to prevent the CPU from stalling. The TA performs advanced culling on triangle data, by writing the tiled non-culled triangles to the external memory.

The HSR engine reads the tiled data and implements per-pixel HSR with full Z-accuracy. The resulting visible pixels are textured and shaded in Internal True Color (ITC) before rendering the final image for display.

1.2 Features of the MBX R-S 3D Graphics Core

The MBX R-S 3D Graphics Core provides the following features:

- Deferred texturing
- Screen tiling
- Flat and Gouraud shading
- Perspective correct texturing
- Specular highlights
- Floating-point Z-buffer
- 32-bit ARGB internal rendering and layer buffering
- Full tile blend buffer
- Z-load and store mode
- Per-vertex fog
- 16-bit RGB textures, 1555, 565, 4444, 8332, 88
- 32-bit RGB textures, 8888
- YUV 422 textures
- PVR-TC compressed textures
- One-bit textures for text acceleration
- Point, bilinear, trilinear and anisotropic filtering
- Full range of OpenGL and Direct3D (D3D) blend modes
- Dot3 bump mapping
- Alpha test
- Zero-cost full-scene anti-aliasing
- 2Dvia3D

NOTE

The MBX module is present on the i.MX31 processor, but not on the i.MX31L.

2 Selecting the MBX Linux Driver

At the time of the writing of this document, the most recent i.MX31 ADS Linux BSP is release 5 (ltib-imx31-20071008), which is available at:

http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02VS0l320822D0033202A7

It is assumed that you can boot Linux on the i.MX31 ADS via NFS from a Linux host. For detailed instructions, see the *User_Manual_MX31ADS_LTIB_BSP.pdf* document available in the i.MX31 BSP iso. (`<CDROM_mount_point>/help/software`)

The MBX drivers are based on proprietary code and can be released only as kernel modules. The MBX module driver source code is not available as part of the standard Linux BSP release. Contact your Freescale representative if you need access to the source code for the driver.

To select the MBX driver, use these steps:

1. On the Linux host PC, go to the LTIB configuration screen: ***./ltib -c***

   The LTIB configuration screen is displayed.

2. Scroll down to *Package list* (Figure 2).

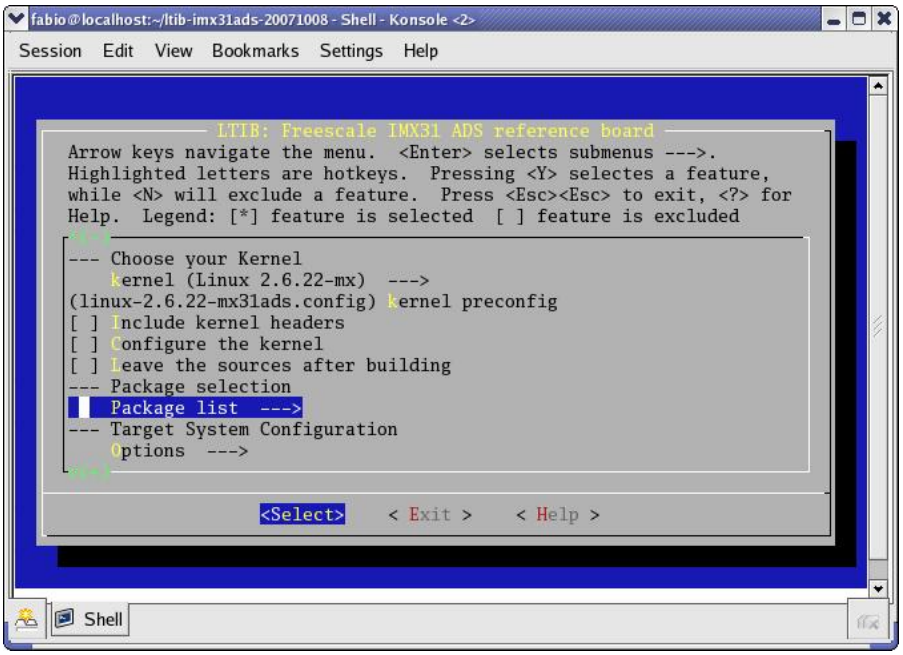

Figure 2 Package List Option

3. In the displayed list, select the MBX driver *[*] GX200-BU-98000* (Figure 3).

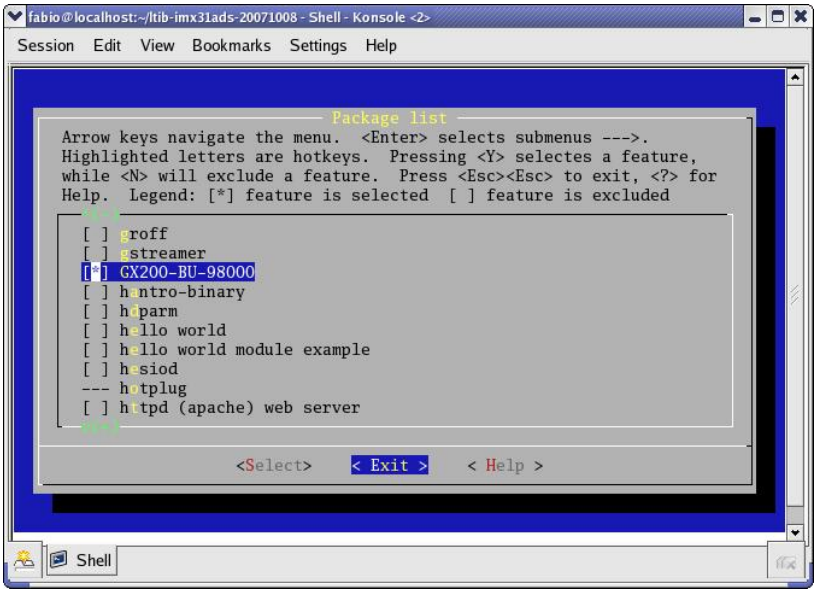

Figure 3 MBX Driver Selection

4. Exit the configuration screen and save the configuration.

3 Installing the SDK from Imagination Technologies

Imagination Technologies provides an OpenGL ES 1.1 SDK (Software Development Kit) for the i.MX31 ADS board, which contains documentation, training materials, OpenGL Demos in source and binary formats, and several graphics utilities.

To install the SDK, use these steps:

1. Go to the following location to download the i.MX31 OpenGL ES 1.1 SDK:

   http://www.imgtec.com/powervr/insider/sdkdownloads/

2. Under OpenGL ES 1.1, click **Freescale i.MX31.**

   The registration screen is displayed. To download the SDK, you must register to the website.

3. Download the tar file to your Linux PC.

4. Copy the tar file to `/home/user/imx31sdk`.

5. Extract it: `tar -xzvf SDK_OGLES-1.1_LINUX_MX31_2.01.21.0983.tar.gz`

4 Running Pre-Built OpenGL Binaries

The Imagination SDK provides interesting demos in binary format. These demos explore various aspects and techniques of 3D graphics, such as those shown in Figure 4.

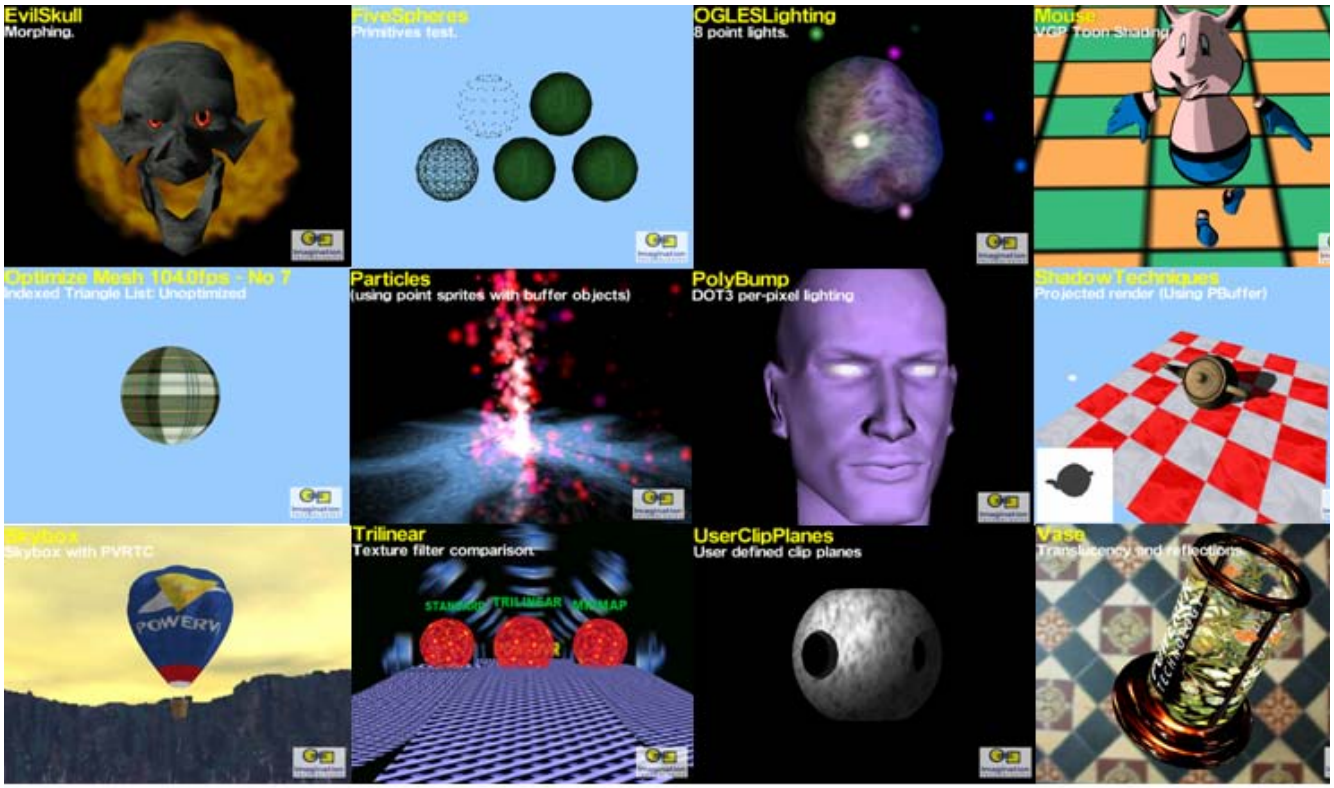

Figure 4 Screenshot of the PowerV SR Demos

4.1 Linux Host Setup

The pre-built OpenGL binaries are located in the following folder of the SDK:

`…/imx31sdk/SDKPackage/Binaries/NullWS_Common/Demos`

Copy the binary you want to run to the i.MX31 target root file system. For example, for running the Vase demo, use this command:

```
# cp /home/user/imx31sdk/SDKPackage/Binaries/NullWS_Common/Demos/Vase/OGLESVase
/home/user/ltib-imx31ads-20071008/rootfs/home
```

4.2 i.MX31 ADS Setup

To set up the i.MX31 ADS, use these steps:

1. Boot Linux on the i.MX31ADS and then load the MBX driver using the rc.pvr script:

```
mx31# depmod -a
mx31# /etc/rc.d/init.d/rc.pvr start
```

2. Run the OGLESVase binary:

```
mx31# cd /home
mx31# ./OGLESVase -qaf=1000 &
```

   where: `-qaf=1000` means “quit after 1000 frames”

   You should see a 3D vase spinning on the LCD screen (Figure 5).

Figure 5 Vase Demo

5 Building OpenGL Applications

To build the demo applications, create the following setup on the Linux host using these steps:

1. Specify the OpenGL libraries location:

   The …/SDKPackage/Builds/OGLES/LinuxMX31/Lib/directory should contain the OpenGL libraries for the i.MX31 ADS. Rather than copying these libraries from the i.MX31 root file system to this directory, use the following symbolic link approach:

   ```
   # cd /home/user/imx31sdk/SDKPackage/Demos/PolyBump/OGLES/Build/LinuxGeneric

   # rm -rf /home/user/imx31sdk/SDKPackage/Builds/OGLES/LinuxMX31/Lib/

   # ln -s /home/user/ltib-imx31ads-20071008/rootfs/usr/lib\
   /home/user/imx31sdk/SDKPackage/Builds/OGLES/LinuxMX31/Lib
   ```

   The OpenGL related libraries are:

   — libclcdc.so
   — libGLES_CM.so
   — libpvrmmap.so
   — libsrv_um.a
   — libswcamera.so

   These libraries will be located at …/ltib-imx31ads-20071008/rootfs/usr/lib if the GX200-BU98000 package was selected as shown in Figure 2.

2. Select the correct toolchain by opening the following file and changing the TOOLCHAIN variable according to the toolchain present on the BSP being used:

   ```
   ../SDKPackage/Builds.OGLES/LinuxMX31/make_platform.mak
   ```

   For example: on ltib-imx31ads-20071008 BSP, change it to:

   ```
   TOOLCHAIN = /opt/freescale/usr/local/gcc-4.1.2-glibc-2.5-nptl-3/arm-none-
   linux-gnueabi
   ```

3. Select the platform:

   ```
   # export PLATFORM=LinuxMX31
   ```

4. Build the application:

   ```
   # make
   ```

5. Deploy, by copying the resultant binary from the following location to the i.MX31 file root file system:

   ```
   /home/user/imx31sdk/SDKPackage/Demos/PolyBump/OGLES/Build/LinuxMX31/Common
   /Release/OGLESPolyBump
   ```

6. Run the binary on the i.MX31 ADS, as follows:

```
mx31# ./OGLESPolyBump -qaf=1000 &
```

The PolyBump Demo is displayed (Figure 6).

Figure 6 PolyBump Demo

6 References

1. *MCIMX31 and MCIMX31L Applications Processors Reference Manual* - MCIMX31RM – Chapter 46

2. *Linux BSP for the Freescale i.MX27ADS, i.MX31ADS, i.MX32ADS Devices Driver Reference Manual* – mx_linux.pdf - Chapter 10

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