OpenGL SC: overview and outreach

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 Contributor Member, The Khronos Group
HUONE

• Alex – Innovative Mobile Graphics Solution
  - AlexVG – OpenVG / SVG Tiny products
  - AlexGL – OpenGL ES solutions

• AlexSC – Graphics Solution for OpenGL SC
  - AlexSC engine – software OpenGL SC API
  - AlexSC forge – SC on OpenGL / OpenGL ES
  - AlexSC PMC-O3
    - PMC Graphics Card

• KHRONOS Group
  - Contributor Member
  - Sales representative in Korea
Mobile Graphics Lab, KNU

- Mobile Graphics Lab
  - School of Computer Science and Engineering
  - Kyungpook National University

- Full Software Engines and Emulators
  - OpenGL ES 1.1 and 2.0
  - OpenGL SC (Collaboration with HUONE)
  - EGL

- Consulting and Educational Services
  - Khronos standards
  - most graphics stuffs

- One of Leader of KITE Korea Chapter
Safety Critical – OpenGL SC 1.0

• targeted at safety-certified avionics and automotive displays
  - minimum driver size and complexity
  - DO-178B certification

• working group:
  - Seaweed (now, Presagis)
  - Barco
  - ALT Software
  - Diehl Aerospace
  - Esmertec (now, Myriad Group)
  - 3DLabs (now, ZiiLABS)
  - Quantum3D
Military & Avionics: the major market
OpenGL SC 1.0

- originally, OpenGL ES Security Critical Profile
  - started as a variation of OpenGL ES

- spin out as OpenGL SC 1.0

- Contributor (Acknowledgements)
  - Alt software, Seaweed systems
    Quantum3D, Esmertec, Barco,
    NVIDIA, Vincent

- Conformant Product
  - HUONE AlexSC

Removes functionality not needed in instrumentation displays: format conversions and color manipulations, blending combinations etc.

Restores functionality used by legacy and auto-generated applications: e.g. display lists
OpenGL SC features

• based on OpenGL 1.3

• extinguished features (w.r.t. OpenGL ES)
  - glBegin / glEnd paradigm
  - display support: a kind of script

• recently,
  - OpenGL SC 1.0 conformance test suites
  - discussions on the next version (F2F meeting in this Oct.)
    - OpenGL SC 1.1 ?
    - OpenGL SC 2.0 ?
Relationships

- OpenGL 1.3 → OpenGL ES 1.0
  → OpenGL SC 1.0

- OpenGL 1.5 → OpenGL ES 1.1

- OpenGL 2.0 + extra features → OpenGL ES 2.0

- OpenGL 3.x → OpenGL ES 3.0
OpenGL SC features

- **OpenGL SC core functions:** totally 101 functions
  - 32 functions are **completely new features** w.r.t. OpenGL ES
    - `glBegin / glEnd` paradigm
    - `glVertex` functions
    - display list support: a kind of script

- **core addition**
  - OES_single_precision

- **required extension**
  - EXT_paledted_texture

- **optional extension**
  - EXT_shared_texture_palette
OpenGL SC at a glance

• overview for the specification documents
Geometric Primitives

- All geometric primitives are specified by vertices
- no quadruples, no polygons
Begin/End Paradigm

• state machine approach
  - not supported by OpenGL ES
  - deprecated in new OpenGL specifications

• glBegin( GL_TRIANGLES );
  - glColor4f( 1.0F, 0.5F, 0.5F, 1.0F );
  - glVertex2f( 0.0F, 0.0F );
  - glVertex2f( 1.0F, 0.0F );
  - glVertex2f( 0.0F, 1.0F );

• glEnd( );
Light and Material Features

• no spotlight support

• no two-side lighting

• no multisampling support

• no fog support
Output Primitives

- **line stipple support**
  - not supported by OpenGL ES

- **polygon stipple support**
  - not supported by OpenGL ES
Texturing

- **texture pipeline**
  - at least 2 texture units
Getting to the Framebuffer

- Fragment
- Scissor Test
- Alpha Test
- Stencil Test
- Depth Test
- Blending
- Dithering
- Logical Operations
- Framebuffer
Pixel Rectangles / Bitmaps

- **DrawPixels**: RGBA image only
- **Bitmap**: B/W image, drawn with current raster color
  - current raster color = current color when the last `glRasterPos()` called.

### OpenGL 1.3

<table>
<thead>
<tr>
<th>Function</th>
<th>Safety-Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>PixelStorei</code></td>
<td></td>
</tr>
<tr>
<td>- pname = PACK_ALIGNMENT,UNPACK_ALIGNMENT</td>
<td>✓</td>
</tr>
<tr>
<td>- pname = all other values</td>
<td>-</td>
</tr>
<tr>
<td><code>DrawPixels</code></td>
<td></td>
</tr>
<tr>
<td>- sizei width, sizei height, enum format,</td>
<td>✓</td>
</tr>
<tr>
<td>enum type, void *data</td>
<td>-</td>
</tr>
<tr>
<td>format = RGBA type = UNSIGNED_BYTE</td>
<td></td>
</tr>
<tr>
<td>all other combinations</td>
<td></td>
</tr>
<tr>
<td><code>Bitmap</code></td>
<td></td>
</tr>
<tr>
<td>- sizei width, sizei height, float xorig, float yorig, float xmove, float ymove, const ubyte</td>
<td>✓</td>
</tr>
<tr>
<td>*bitmap</td>
<td></td>
</tr>
</tbody>
</table>
Pixels

- **ReadPixels**: RGBA, unsigned byte only
- **CopyPixels**: specified region → current raster position

<table>
<thead>
<tr>
<th>OpenGL 1.3</th>
<th>Safety-Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ReadBuffer</strong> (enum mode)</td>
<td>-</td>
</tr>
<tr>
<td><strong>ReadPixels</strong> (int x, int y, sizei width, sizei height, enum format, enum type, void *pixels)</td>
<td>✓‡</td>
</tr>
</tbody>
</table>
| **CopyPixels** (int x, int y, sizei width, sizei height, enum type)  
  type = COLOR  
  type = DEPTH, STENCIL | ✓ - |
## Display Lists

- no release of allocated lists

<table>
<thead>
<tr>
<th>OpenGL 1.3</th>
<th>Safety-Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NewList</strong>(uint list, enum mode)</td>
<td></td>
</tr>
<tr>
<td>mode = COMPILE</td>
<td>✓</td>
</tr>
<tr>
<td>mode = COMPILE_AND_EXECUTE</td>
<td>-</td>
</tr>
<tr>
<td><strong>EndList</strong>(void)</td>
<td>✓</td>
</tr>
<tr>
<td><strong>CallList</strong>(uint list)</td>
<td>-</td>
</tr>
<tr>
<td><strong>CallLists</strong>(sizei n, enum type, const void *lists)</td>
<td></td>
</tr>
<tr>
<td>type = UNSIGNED_BYTE, UNSIGNED_INT</td>
<td>✓</td>
</tr>
<tr>
<td>type = BYTE, SHORT, UNSIGNED_SHORT, INT</td>
<td>-</td>
</tr>
<tr>
<td><strong>ListBase</strong>(uint base)</td>
<td>✓</td>
</tr>
<tr>
<td><strong>GenLists</strong>(sizei range)</td>
<td>✓</td>
</tr>
<tr>
<td><strong>IsList</strong>(uint list)</td>
<td>-</td>
</tr>
<tr>
<td><strong>DeleteLists</strong>(uint list, sizei range)</td>
<td>-</td>
</tr>
</tbody>
</table>
Core Addition

• OES_single_precision extension
  - DepthRangef(clampf n, clampf f)
  - Frustumf(float l, float r, float b, float t, float n, float f)
  - Orthof(float l, float r, float b, float t, float n, float f)
  - ClearDepthf(clampf depth)

• same to OpenGL ES 1.0 and 1.1
Required Extension

- **EXT_paletted_texture**
  - need COLOR_INDEX8_EXT extension support for texturing functions
  - need some extensions into the TexImage2D function

- ColorTableEXT
- ColorSubTableEXT
- GetColorTableEXT
- GetColorTableParameterivEXT
Required: EXT_paletted_texture

- paletted texture
Optional Extension

- **EXT_shared_texture_palette**
  - several textures can share a single texture palette
  
  - need some extensions to Enable, Disable, IsEnabled, GetBooleanv, GetFloatv, GetIntegerv functions

- extra extensions to:
  - ColorTableEXT
  - ColorSubTableEXT
  - GetColorTableEXT
  - GetColorTableParameterivEXT
Technical Issues

• new implementations are needed for:
  - required extension: EXT_paletted_texture
  - optional extension: EXT_shared_texture_palette

• since year 2004, there is no graphics card supporting the above extensions
  - old NVIDIA chips such as GeForce 5 series can support it.
  - no ATI chips support it.

• Conclusively, new implementations are required
Implementation

OpenGL SC Application Program

OpenGL SC API calls

OpenGL SC device driver

OpenGL hardware instructions

OpenGL hardware

Framebuffer

OpenGL SC Application Program

OpenGL SC API calls

OpenGL SC device driver

OpenGL API calls

OpenGL device driver

OpenGL hardware

Framebuffer
# Emulation Results

<table>
<thead>
<tr>
<th></th>
<th>OpenGL</th>
<th>SC on GL</th>
<th>ratio</th>
<th>delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>gears with GLX</td>
<td>4742.7</td>
<td>4676.9</td>
<td>98.61%</td>
<td>1.39%</td>
</tr>
<tr>
<td>gears with EGL</td>
<td>4776.2</td>
<td>4692.6</td>
<td>98.25%</td>
<td>1.75%</td>
</tr>
<tr>
<td>gears with glut</td>
<td>1325.5</td>
<td>1301.8</td>
<td>98.21%</td>
<td>1.79%</td>
</tr>
<tr>
<td>clock with glut</td>
<td>1178.6</td>
<td>1159.0</td>
<td>98.34%</td>
<td>1.66%</td>
</tr>
<tr>
<td>spin with glut</td>
<td>1261.3</td>
<td>1239.0</td>
<td>98.23%</td>
<td>1.77%</td>
</tr>
<tr>
<td>angeles with glut</td>
<td>339.4</td>
<td>332.6</td>
<td>97.99%</td>
<td>2.01%</td>
</tr>
<tr>
<td>average</td>
<td></td>
<td></td>
<td>98.27%</td>
<td>1.73%</td>
</tr>
</tbody>
</table>
Standard Outreach

- **WG is in state of hibernation**

- **3 Adapters**
  - HUONE, ISS, Curtiss Wright

- **1 Conformant Result is submitted**
  - HUONE

- **New Activities**
  - New SC Profile based on OpenGL ES 2.0 proposed to TAP meeting.

- **OpenGL SC chapter in**