Assignment 1 - Data Collection

1. OpenGL and CG

OpenGL is the shorthand of "Open Graphics Library", which defines the professional, cross-programming language and cross-platform graphics programming interface. It's a super powerful underlying graphic library and easy to use. As it is cross-programming and cross-platform, we can call the function of this library in different OS and different programming language in the same way without changing the code.

From the first lecture, we know that the three main function of computer graphic science are modeling, rendering, and animation.

- **Modeling**: in OpenGL, we use the pixel data or the coordinates of vertexes (in 2D or 3D) to describe the graphics.
- **Rendering**: is a procedure of displaying the object in the screen so that it look in the way we expect (to be photorealistic, be interactive or be artistic, etc.), OpenGL finish this by inputting the vertexes or the pixels into a rendering pipeline (Figure 1.), and the final output will be stored in the frame buffer waiting to be use (such as becoming the input of other application).
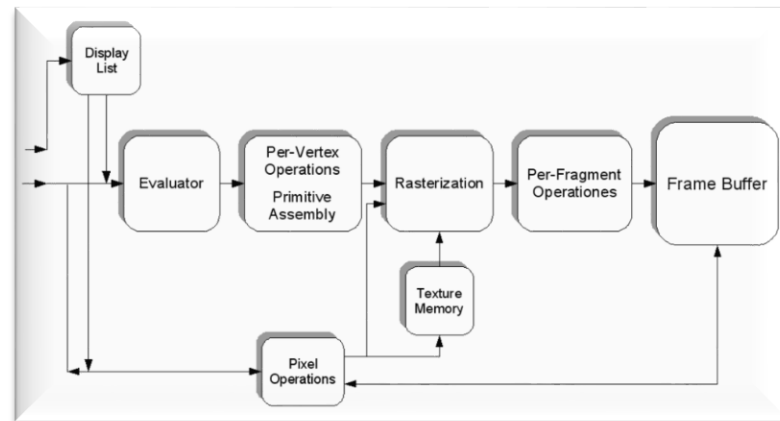

Figure 1. An illustration of the graphics pipeline process

- **Animation**: by displaying different pictures one after another in a certain frequency (no smaller than 24 picture/second). OpenGL need to perform transition for the object and "draw" them in a new "canvas", then replace the original picture in the screen. The transition is the operation in matrix usually. Double buffering is used to improve the smoothness of the animation (just like create another canvas).

These methods are not only applied in OpenGL. The following graphics programming interface, Microsoft's Direct X and Apple's Metal also use the same basic methods for graphics processing.

2. Comparison

2.1. Between OpenGL Members

Name	Features & Differences
OpenGL (GL)	Consists of over 250 different functions to draw complex three-dimensional scenes.

	It can use the GPU directly, so the speed of graphic processing (typically rendering) can be accelerated. Function Prefix: gl
OpenGL Utility Library (GLU)	Provides some higher-level drawing functions. It focus on: 1. **Mapping coordinates** between the screen and the world 2. **Texture** mipmap 3. **Quadric surfaces drawing** (by *polygonal primitives*, more 3D liked) Function Prefix: glu
OpenGL Utility Toolkit (GLUT)	Much better at system-level I/O and interacting with OS. It help us to do the following thing more quickly: 1. **Window definition and controlling** (user interface) 2. **Keyboard and mouse input** event handling 3. **Draw Common geometry figure** (in *solid* or *wireframe* mode) Stop supporting since May 2005. (freeglut is a version that keep updating based on GLUT) Function Prefix: glut

Simple DirectMedia Layer (SDL)	Provide simple interface for graphic, sound, input device of different platform.
	Two concept:
	1. Six subsystems
	video, audio, CD-ROM, joystick, and timer
	2. SDL standard library
	   ✚ SDL_image (support for multiple image formats).
	   ✚ SDL_mixer (complex audio functions, mainly for sound mixing).
	   ✚ SDL_net (networking support).
	   ✚ SDL_ttf (TrueType font rendering support).
	   ✚ SDL_rtf (simple Rich Text Format rendering).

OpenGL for Embedded Systems (GLES)	A subset of the rendering part of OpenGL. Designed for embedded systems, such as smartphones, computer tablets and video game consoles.
OpenGL User Interface Library (GLUI)	Based on GLUT, provides simple UI (**extremely simple UI**) such as buttons, checkboxes, radio buttons, and so on. It is not as powerful as some other GUI toolkit (such as Qt, FLTK) which has much more component properties, but it's very easy to use.
the Fast, Light Toolkit (FLTK)	For GUI programming. FLTK has its own widget, drawing and event systems, when comparing to Qt, GTK+, it's obviously much more **lightweight**, so the size of the program of the same function will be smaller.
OpenGL Easy Extension library (GLEE)	This extension help programmer to **link the specific needed extension of OpenGL automatically** at **initialization time**.
OpenGL Extension Wrangler Library (GLEW)	Has the same function as GLEE. Difference between GLEE: • Will query and load the needed extension at **run time** instead of initialization time.
Portable Game Library (PLIB)	For developing computer game.

	Is an integrated extension as it Includes sound effects, music, complete 3D engine, font rendering, simple windowing library, game scripting language, GUI, networking, 3D math library and a collection of utility functions.
OpenSG	For creating real-time graphic program (virtual reality application).
OpenSenceGraphic	Has the same function sa OpenSG. Difference: • OpenSG has some more advanced **multithreading** and **clustering** support features that OpenSceneGraph lacks. • OpenSceneGraph seems to make up for it with a much larger and more vibrant **community**, and **more extensive** derivative and **add-on tools**.
OpenGL Perform	A **commercial** library of utility code built on top of OpenGL for the purpose of enabling **hard real-time** visual simulation applications.
WebGL	It connect GLES and JavaScript to form a 3D drawing standard, Can be used to render graphic in browser (Canvas of HTML5), now we are free of flash plugin.

Table 1. Features & differences of the OpenGL family

2.2. Between OpenGL, WebGL, Direct X and Metal

	Pros	Cons
OpenGL	• Cross-platform and cross-programming language • Already lets people build good, interactive games on mobile devices, gaming consoles and PC of cause • Maybe more job opportunities	• Has security holes that are being filled slowly, some of them are through Google's ANGLE project (risk of open source) • Worse Drivers than DirectX or Metal
DirectX	• Have perfect performance on Windows • Great driver support • Safer	• It's proprietary, which means it costs more to learn, through Microsoft's classes • Windows/Xbox only
Metal	• No need to consider different kind of hardware (Everything are designed and produced by Apple itself) except for GPU, so it's can be most simplified (less code) • Safer	• It's proprietary • For Apple's device only
WebGL	• Can be used in website	• It's for web application only, programmer have to be familiar with JavaScript and CSS, etc.

Table 2. Pros & Cons of Tree graphic programming API

3. Reference Websites

- http://en.wikipedia.org/wiki/OpenGL
- http://everything.explained.at/OpenGL/
- http://stackoverflow.com/questions/16022853/difference-between-opensg-and-openscenegraph
- https://www.youtube.com/watch?v=z8EECO_TKkQ

- http://www.cplusplus.com/forum/general/122457/
- http://tieba.baidu.com/p/3084671967