

OpenGL Homework 1

CS 550000 Computer Graphics

March 8, 2017

CGV Lab, NTHUCS



Outline

- Goal
- Demo
- Grading
- Submission
- Reminders



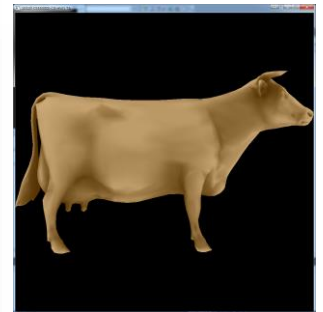
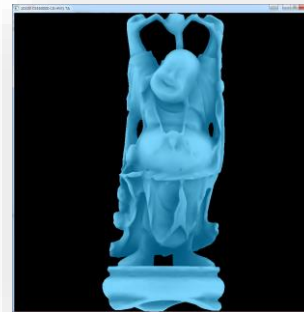
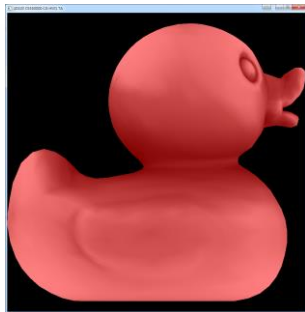
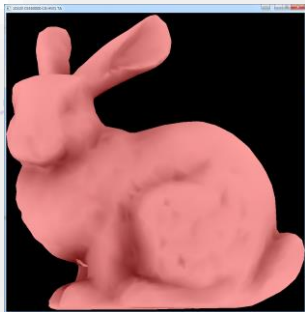
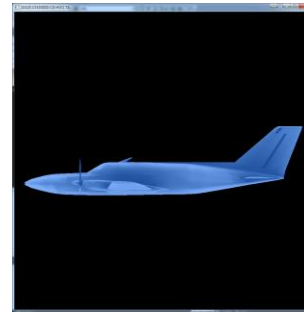
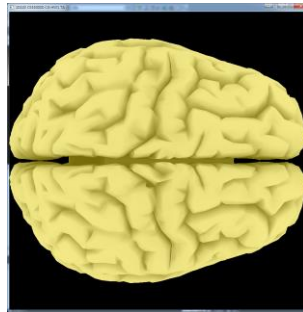
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Goal

- Render a 3D model properly on the screen.



Goal

- Render a 3D model properly on the screen.
- Step by step
 - 1) Load model(s) from external *.obj file(s).
 - 2) Normalize the model into $[-1, 1]$ and show it on the screen.
 - 3) Add color filtering function into your **shader**
 - 4) Submit your project and get full score.

• Reminders

- You **CANNOT** use the existing transform API of OpenGL 1.X.
e.g. glRotate, glTranslate, glScale
- You **DO NEED** to modify **vertex/fragment** shaders.



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DEMO



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Grading

Total score: **100**

- Loading model (**80 pt**)

- Display 3D models properly.

Vertex correctness : 10 pt

Color correctness : 10 pt

Normalize to $[-1, +1]$: **20 pt**

Wireframe/solid mode : 10 pt

- color filter function

4 kinds of filter : **30 pt**

(normal, R only, G only, B only)

Keyboard/Mouse (**10 pt**)

- Utilize the callback function.

h - to show help menu

z/x - switch different models

(**at least 3** models)

w - switch solid/wireframe mode

c - color filter function

- Report (**10 pt**)

- Express your work.

How to operate your program

How do you normalize models into $[-1, 1]$

Implementation and problems you met

Other efforts you have done

Screenshots



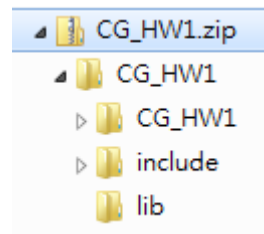
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Submission

- Submit your project to **iLMS**.
- Filename: HW1_XXXXXXXXXX.zip
- Put both “lib” and “include” in your zip file



- ***** Remove “ipch” folder and “.sdf” file. *****

名稱	大小	類型
CG_HW1.sdf	31,700 KB	SQL Server Compact ...
CG_HW1.suo	44 KB	Visual Studio Solutio...
CG_HW1.sln	1 KB	Microsoft Visual Stud...
CG_HW1.opensdf	0 KB	OPENSDF 檔案
CG_HW1		檔案資料夾
Debug		檔案資料夾
ipch		檔案資料夾

建立日期: 2015/3/17 下午 08:09
大小: 24.0 MB
資料夾: cg_hw1-f20be826



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- Submission
- **Reminders**



Reminders

- Late submission is accepted, DO NOT give up!
- Ask and share information through iLMS



1022 (2014-02-01~2014-07-31)

課程: [計算機圖學Computer Graph](#) ▼


課程資訊

訪客: 3245

文章: 166

討論: 111


容量: 剩餘 1.2 GB (2.9 GB)

老師: 李潤容 

助教: 李亞璇 , 邱俊嘉 

閱讀權限: 不開放旁聽 (僅成員可以閱讀)

課程功能

 [課程活動\(公告\)](#)

 [上課教材 \(15\)](#)

 [課堂整理](#)

 [課程說明](#)

 [課程行事曆](#)

 [討論區 \(111\)](#)

 [小組專區](#)



Appendix

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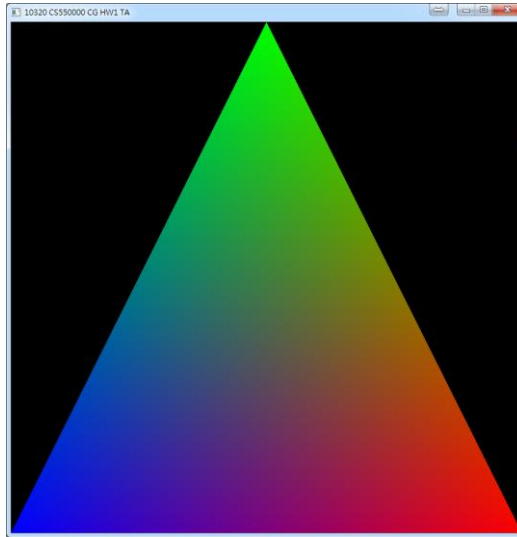
Department of Computer Science

National Tsing Hua University



How to create an OpenGL project?

- Download the framework by TA from iLMS.
- Start programming with OpenGL.



Hello Triangle!

- If you want to create a project from scratch...

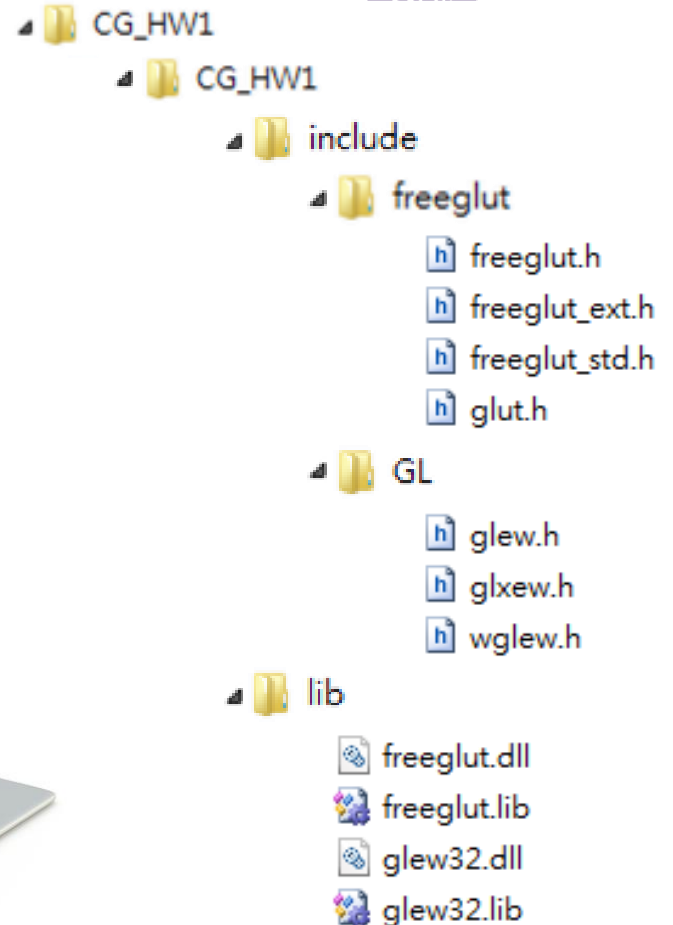


How to create an OpenGL project?

1. Make everything ready...

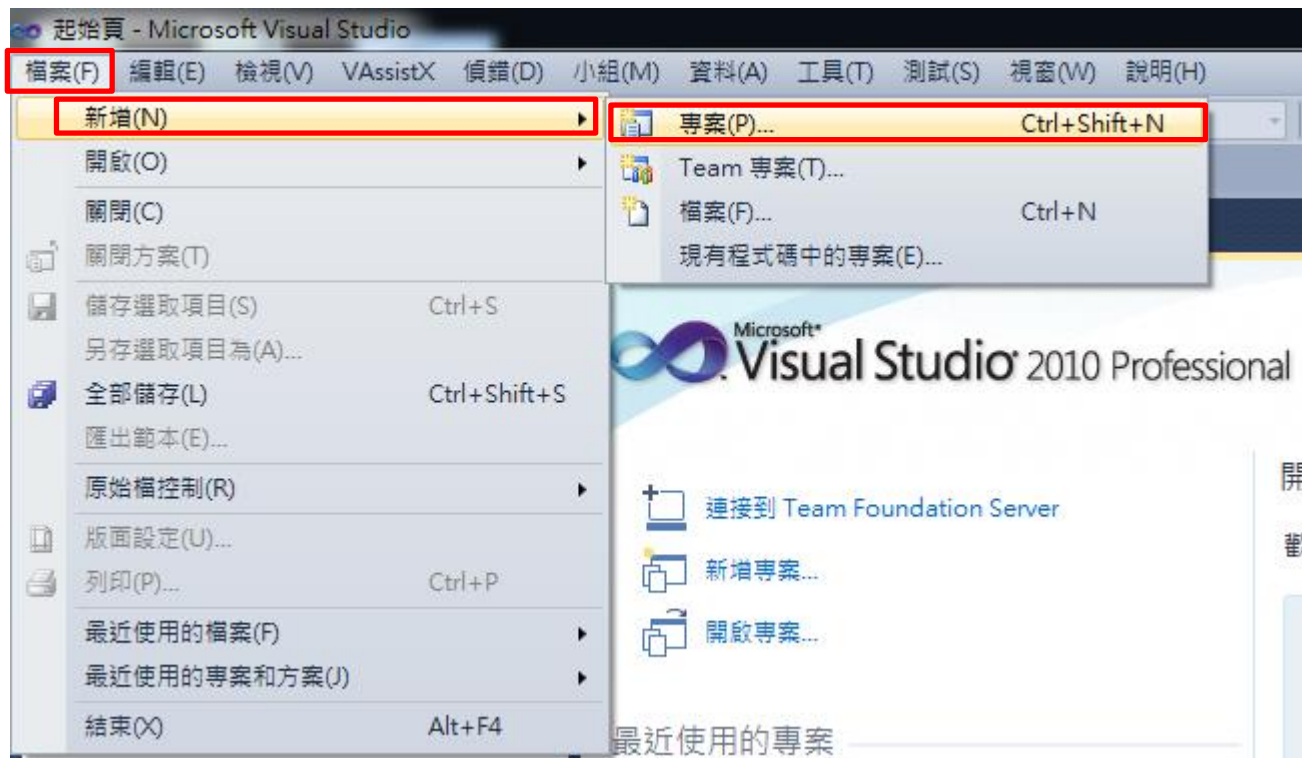
freeglut 2.8.1 ([download](#))

glew 1.12.0 ([download](#))



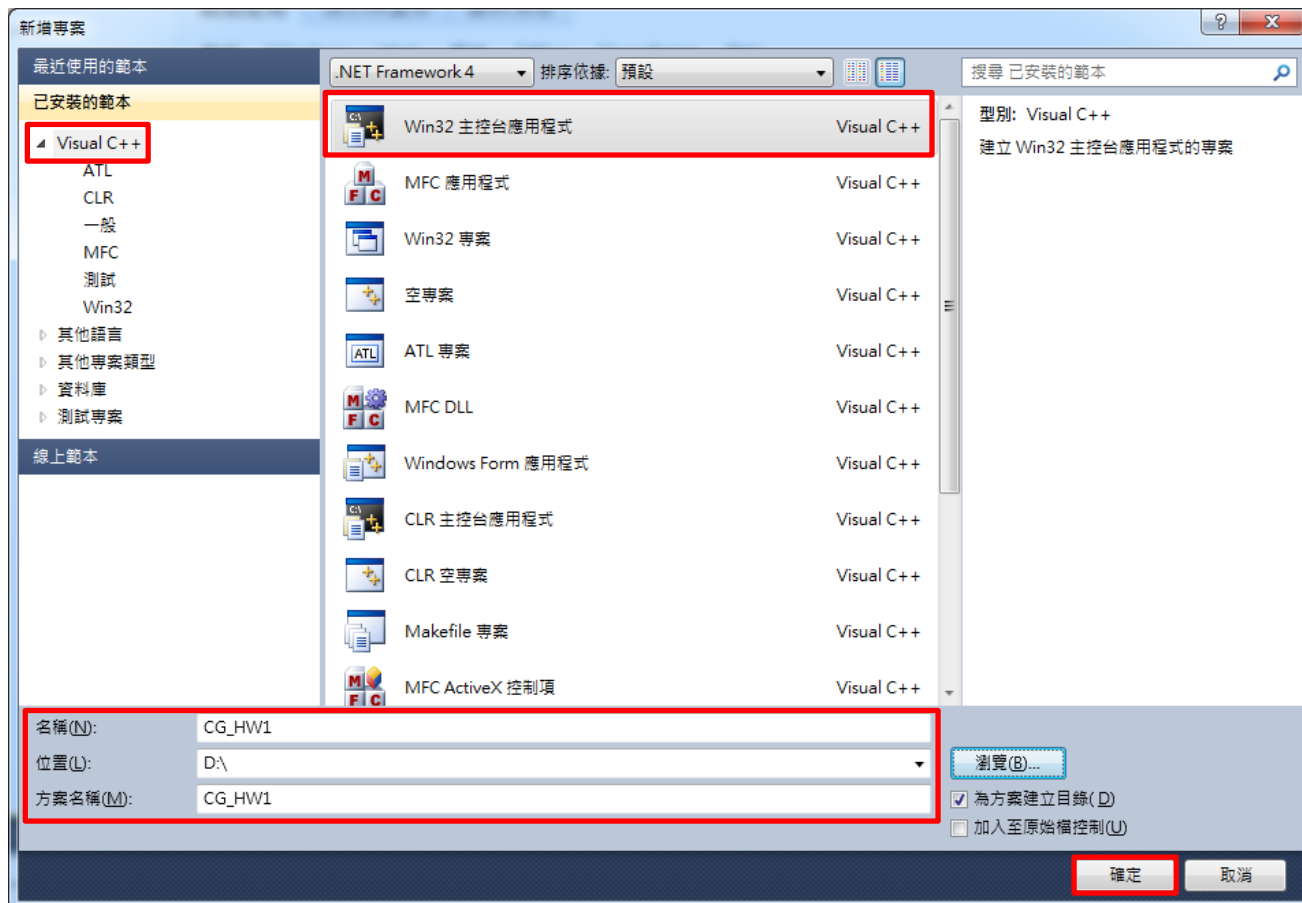
How to create an OpenGL project?

1. Create an empty project (e.g. M\$ VS C++ 2010)



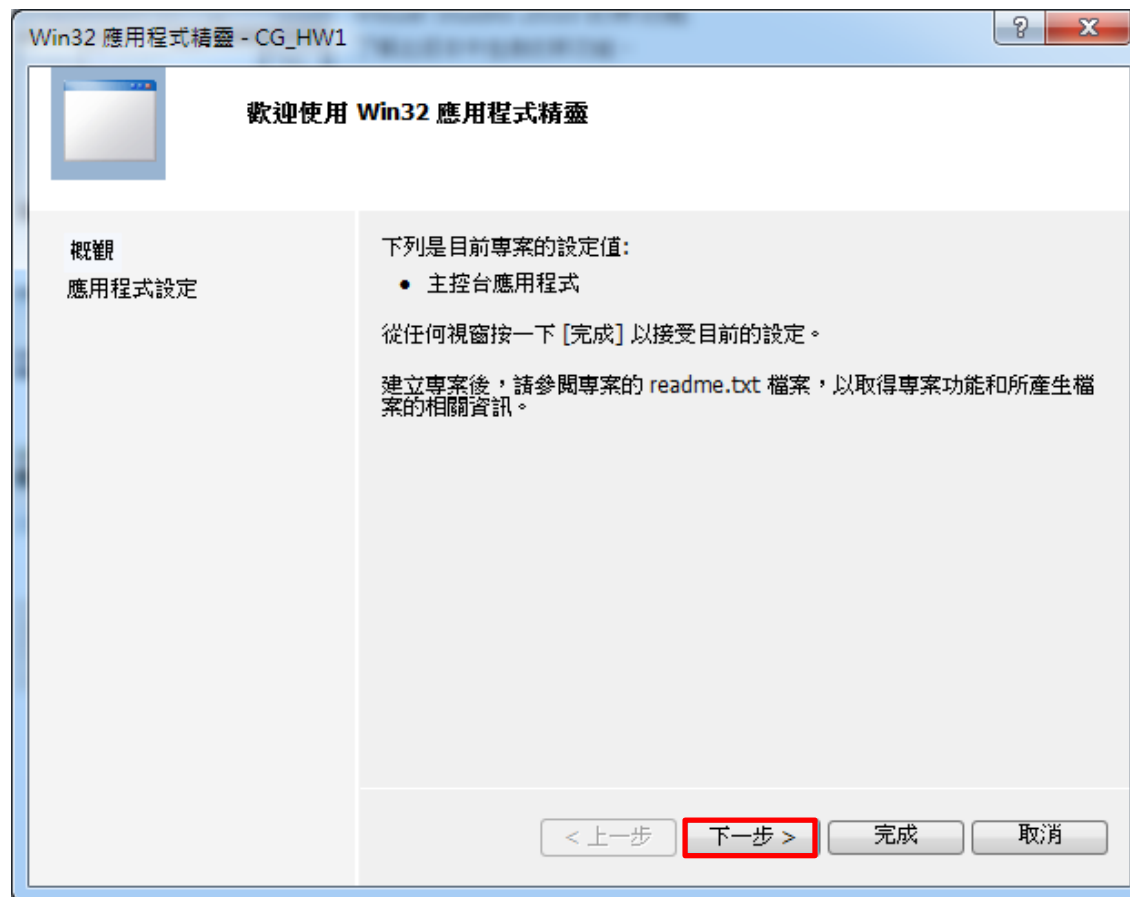
How to create an OpenGL project?

1. Create an empty project



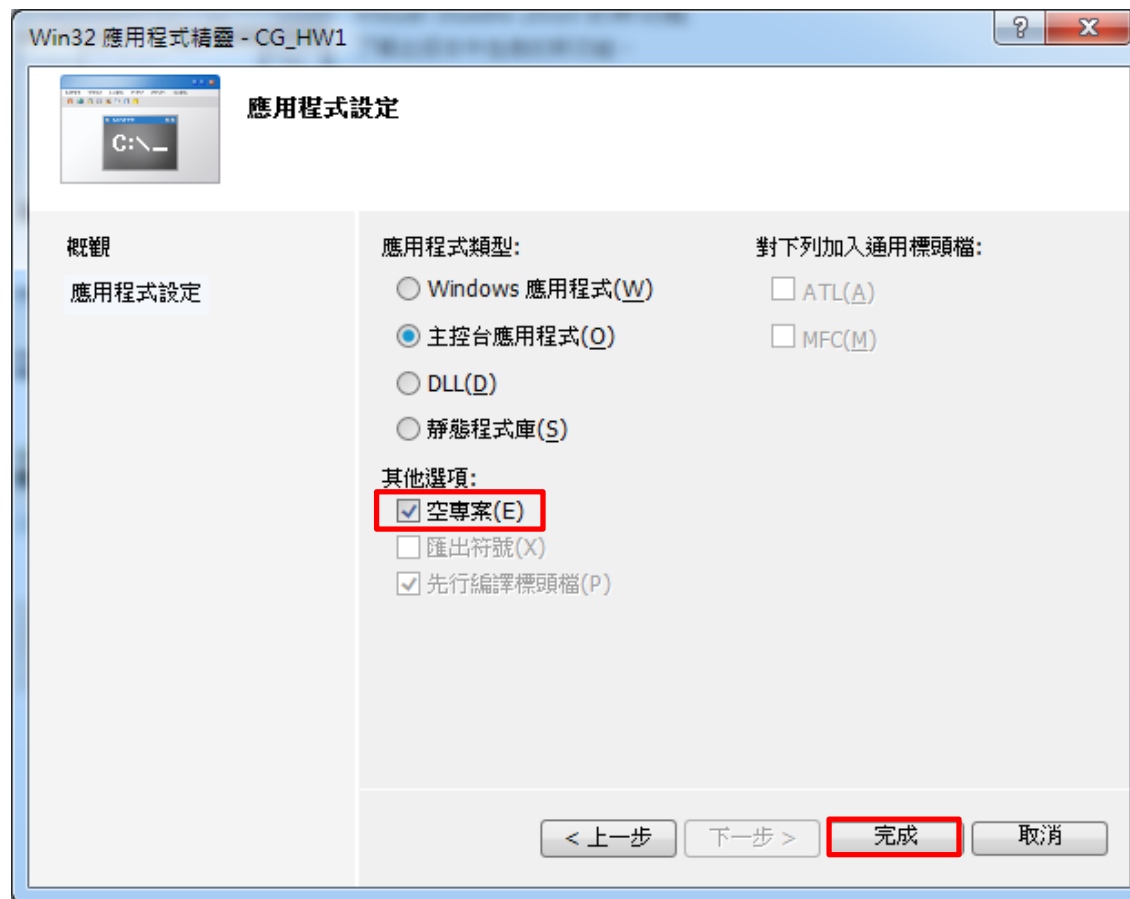
How to create an OpenGL project?

1. Create an empty project



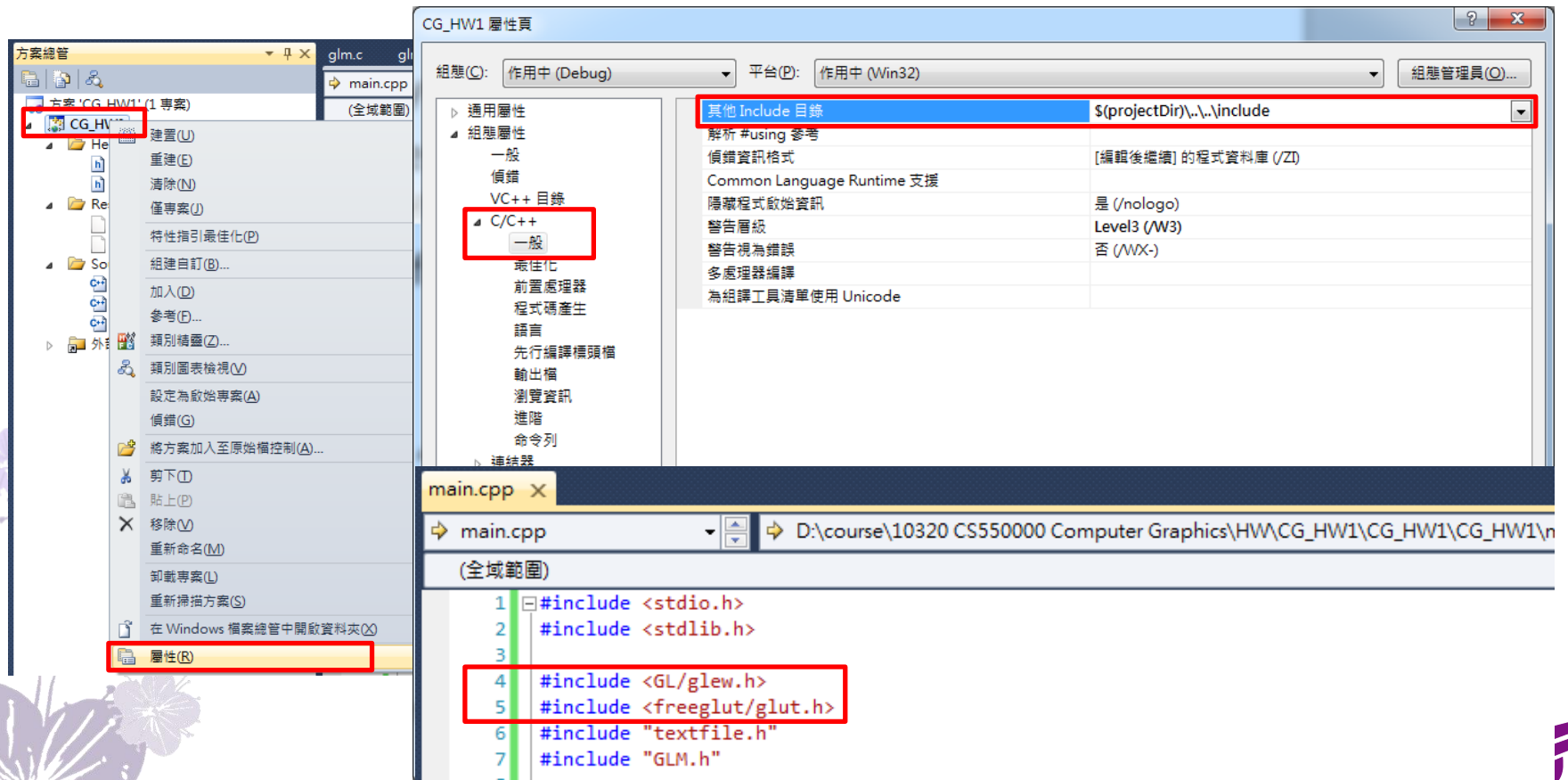
How to create an OpenGL project?

1. Create an empty project



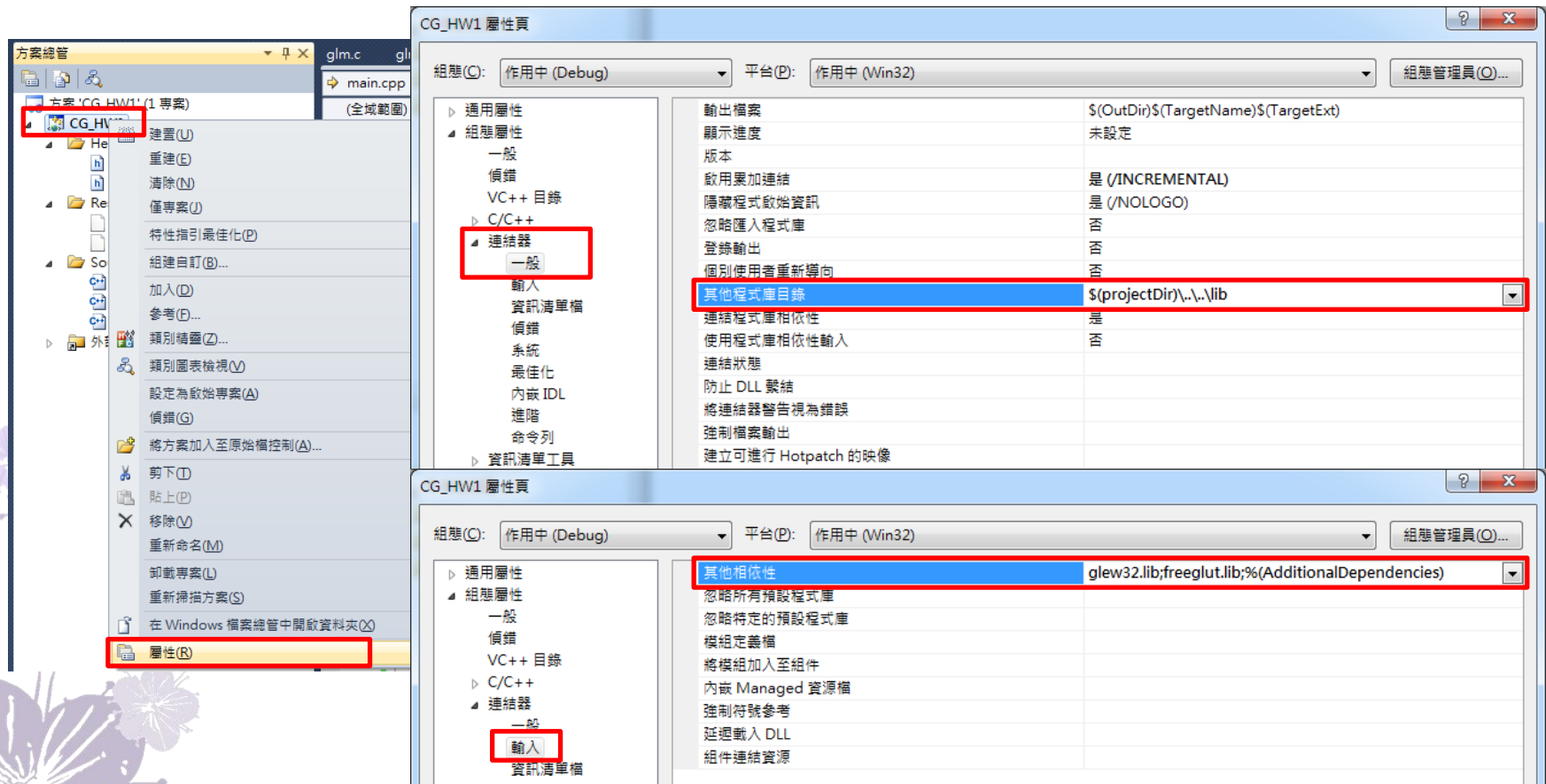
How to create an OpenGL project?

3. Include headers...



How to create an OpenGL project?

4. Link libraries...



How to create an OpenGL project?

5. Start programming!



```
main.cpp x
processNormalKeys void processNormalKeys(unsigned char key, int x, int y)
(全域範圍)

235
236 int main(int argc, char **argv) {
237     // glut init
238     glutInit(&argc, argv);
239     glutInitDisplayMode(GLUT_DEPTH | GLUT_DOUBLE | GLUT_RGBA);
240
241     // create window
242     glutInitWindowPosition(460, 40);
243     glutInitWindowSize(800, 800);
244     glutCreateWindow("10320 CS550000 CG HW1 TA");
245
246     glewInit();
247     if(glewIsSupported("GL_VERSION_2_0")){
248         printf("Ready for OpenGL 2.0\n");
249     }else{
250         printf("OpenGL 2.0 not supported\n");
251         system("pause");
252         exit(1);
253     }
254
255     // load obj models through glm
256     loadOBJModel();
257
258     // register glut callback functions
259     glutDisplayFunc (renderScene);
260     glutIdleFunc (idle);
261     glutKeyboardFunc(processNormalKeys);
262     glutMouseFunc (processMouse);
263     glutMotionFunc (processMouseMotion);
264
265     glEnable(GL_DEPTH_TEST);
266
267     // set up shaders here
268     setShaders();
269
270     // main loop
271     glutMainLoop();
272
273     // free
274     glmDelete(OBJ);
275
276     return 0;
277 }
278
279
```



API & Library

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Department of Computer Science


National Tsing Hua University



GLM

- OpenGL Mathematics

- <http://glm.g-truc.net/0.9.6/index.html>



OpenGL Mathematics


GLSL + Optional features = OpenGL Mathematics (GLM)
A C++ mathematics library for graphics programming

Download GLM 0.9.6.3
0.9.6.3
15/02/2015

Manual
API
Code samples
Snapshot

Updates
Downloads
Repository
Report a bug

GLSL Specification
GLSL man pages
GLSL data types
Forum
Stack Overflow
OpenGL SDK page



OpenGL Mathematics (GLM) is a header only C++ mathematics library for graphics software based on the [OpenGL Shading Language \(GLSL\)](#) specifications.

GLM provides classes and functions designed and implemented with the same naming conventions and functionalities than GLSL so that when a programmer knows GLSL, he knows GLM as well which makes it really easy to use.

This project isn't limited to GLSL features. An extension system, based on the GLSL extension conventions, provides extended capabilities: matrix transformations, quaternions, data packing, random numbers, noise, etc...

This library works perfectly with OpenGL but it also ensures interoperability with other third party libraries and SDK. It is a good candidate for software rendering (raytracing / rasterisation), image processing, physic simulations and any development context that requires a simple and convenient mathematics library.

GLM is written in C++98 but can take advantage of C++11 when supported by the compiler. It is a platform independent library with no dependence and it officially supports the following compilers:

- [Apple Clang](#) 4.0 and higher
- [GCC](#) 4.2 and higher
- [Intel C++ Composer](#) XE 2013 and higher
- [LLVM](#) 3.0 and higher
- [Visual C++](#) 2010 and higher
- [CUDA](#) 4.0 and higher (experimental)
- Any conform C++98 or C++11 compiler

For more information about GLM, please have a look at [the manual](#) and [the API reference documentation](#).

The source code and the documentation, including this manual, are licensed under [the Happy Bunny License \(Modified MIT\)](#) and [the MIT License](#).

Thanks for contributing to the project by [submitting issues](#) for bug reports and feature requests. Any feedback is welcome at glm@g-truc.net.

GLM GLI
0.9.6 0.9.5 0.9.4 0.9.3 0.9.2 0.9.1 0.9.0

Copyright © 2005 - 2014 G-Truc Creation



```

65
66 /* GLMmodel: Structure that defines a model.
67 */
68 typedef struct _GLMmodel {
69     GLfloat scale;           /* the scale to make the model's max width as 2 unit */
70
71     char*    pathname;       /* path to this model */
72     char*    mtlname;        /* name of the material library */
73
74     GLuint   numvertices;    /* number of vertices in model */
75     GLfloat* vertices;       /* array of vertices */
76     GLfloat* colors;
77
78     GLuint   numnormals;     /* number of normals in model */
79     GLfloat* normals;        /* array of normals */
80
81     GLuint   numtexcoords;   /* number of texcoords in model */
82     GLfloat* texcoords;      /* array of texture coordinates */
83
84     GLuint   numfacetnorms;  /* number of facetnorms in model */
85     GLfloat* facetnorms;     /* array of facetnorms */
86
87     GLuint   numtriangles;   /* number of triangles in model */
88     GLMtriangle* triangles;   /* array of triangles */
89
90     GLuint   nummaterials;   /* number of materials in model */
91     GLMmaterial* materials;   /* array of materials */
92
93     GLuint   numgroups;      /* number of groups in model */
94     GLMgroup* groups;         /* linked list of groups */
95
96     GLfloat position[3];      /* position of the model */
97 } GLMmodel;
98

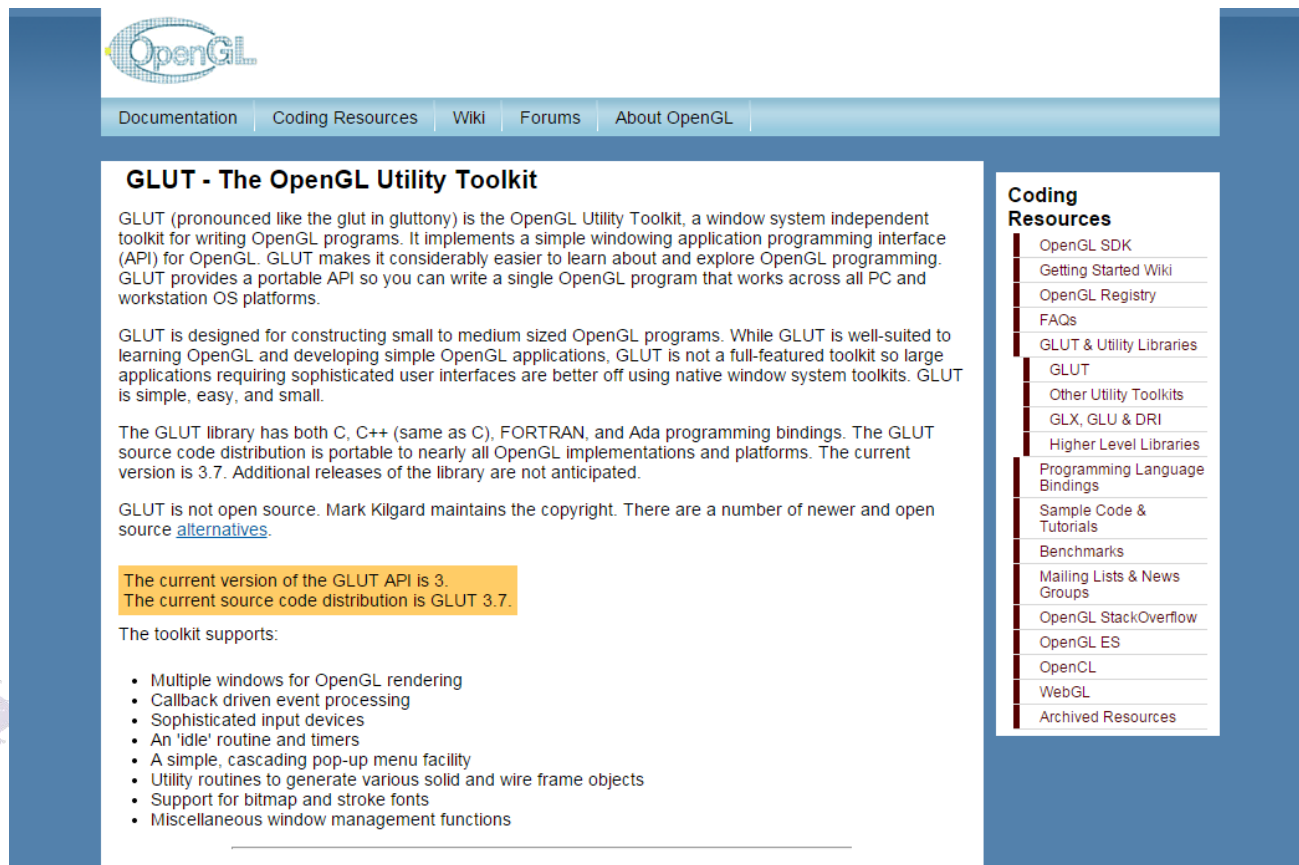
```



GLUT

- The OpenGL Utility Toolkit

- <https://www.opengl.org/resources/libraries/glut/>



The screenshot shows the OpenGL.org website. At the top is the OpenGL logo and a navigation bar with links: Documentation, Coding Resources, Wiki, Forums, and About OpenGL. The main content area is titled "GLUT - The OpenGL Utility Toolkit". It contains a paragraph describing GLUT as a window system independent toolkit for writing OpenGL programs. Below this is another paragraph explaining that GLUT is designed for small to medium sized OpenGL programs. A third paragraph states that the GLUT library has bindings for C, C++, FORTRAN, and Ada. A fourth paragraph mentions that GLUT is not open source and that Mark Kilgard maintains the copyright. A yellow box highlights that the current version of the GLUT API is 3 and the current source code distribution is GLUT 3.7. Below this, it says "The toolkit supports:" followed by a bulleted list of features: Multiple windows for OpenGL rendering, Callback driven event processing, Sophisticated input devices, An 'idle' routine and timers, A simple, cascading pop-up menu facility, Utility routines to generate various solid and wire frame objects, Support for bitmap and stroke fonts, and Miscellaneous window management functions. On the right side of the page, there is a "Coding Resources" sidebar with a list of links: OpenGL SDK, Getting Started Wiki, OpenGL Registry, FAQs, GLUT & Utility Libraries (with GLUT selected), Other Utility Toolkits, GLX, GLU & DRI, Higher Level Libraries, Programming Language Bindings, Sample Code & Tutorials, Benchmarks, Mailing Lists & News Groups, OpenGL StackOverflow, OpenGL ES, OpenCL, WebGL, and Archived Resources.

GLUT - The OpenGL Utility Toolkit

GLUT (pronounced like the glut in gluttony) is the OpenGL Utility Toolkit, a window system independent toolkit for writing OpenGL programs. It implements a simple windowing application programming interface (API) for OpenGL. GLUT makes it considerably easier to learn about and explore OpenGL programming. GLUT provides a portable API so you can write a single OpenGL program that works across all PC and workstation OS platforms.

GLUT is designed for constructing small to medium sized OpenGL programs. While GLUT is well-suited to learning OpenGL and developing simple OpenGL applications, GLUT is not a full-featured toolkit so large applications requiring sophisticated user interfaces are better off using native window system toolkits. GLUT is simple, easy, and small.

The GLUT library has both C, C++ (same as C), FORTRAN, and Ada programming bindings. The GLUT source code distribution is portable to nearly all OpenGL implementations and platforms. The current version is 3.7. Additional releases of the library are not anticipated.

GLUT is not open source. Mark Kilgard maintains the copyright. There are a number of newer and open source [alternatives](#).

The current version of the GLUT API is 3.
The current source code distribution is GLUT 3.7.

The toolkit supports:

- Multiple windows for OpenGL rendering
- Callback driven event processing
- Sophisticated input devices
- An 'idle' routine and timers
- A simple, cascading pop-up menu facility
- Utility routines to generate various solid and wire frame objects
- Support for bitmap and stroke fonts
- Miscellaneous window management functions

Coding Resources

- OpenGL SDK
- Getting Started Wiki
- OpenGL Registry
- FAQs
- GLUT & Utility Libraries
 - GLUT
- Other Utility Toolkits
- GLX, GLU & DRI
- Higher Level Libraries
- Programming Language Bindings
- Sample Code & Tutorials
- Benchmarks
- Mailing Lists & News Groups
- OpenGL StackOverflow
- OpenGL ES
- OpenCL
- WebGL
- Archived Resources

```

235
236 int main(int argc, char **argv) {
237     // glut init
238     glutInit(&argc, argv);
239     glutInitDisplayMode(GLUT_DEPTH | GLUT_DOUBLE | GLUT_RGBA);
240
241     // create window
242     glutInitWindowPosition(460, 40);
243     glutInitWindowSize(800, 800);
244     glutCreateWindow("10320 CS550000 CG HW1 TA");
245
246     glewInit();
247     if(glewIsSupported("GL_VERSION_2_0")){
248         printf("Ready for OpenGL 2.0\n");
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253     }
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258     // register glut callback functions
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261     glutKeyboardFunc(processNormalKeys);
262     glutMouseFunc(processMouse);
263     glutMotionFunc(processMouseMotion);
264
265     glEnable(GL_DEPTH_TEST);
266
267     // set up shaders here
268     setShaders();
269
270     // main loop
271     glutMainLoop();
272
273     // free
274     glmDelete(OBJ);
275
276     return 0;
277 }
278

```

```

// glut init
glutInit(&argc, argv);
glutInitDisplayMode(GLUT_DEPTH | GLUT_DOUBLE | GLUT_RGBA);

// create window
glutInitWindowPosition(460, 40);
glutInitWindowSize(800, 800);
glutCreateWindow("10320 CS550000 CG HW1 TA");

```

```

// register glut callback functions
glutDisplayFunc(renderScene);
glutIdleFunc(idle);
glutKeyboardFunc(processNormalKeys);
glutMouseFunc(processMouse);
glutMotionFunc(processMouseMotion);

```

```

// main loop
glutMainLoop();

```



GLEW

- The OpenGL Extension Wrangler Library
 - <http://glew.sourceforge.net/>

Latest Release: **1.12.0**



Download
Usage
Building
Installation
Source Generation
Credits & Copyright
Change Log
GitHub
Project Page
Bug Tracker

Last Update: 26-01-15



The OpenGL Extension Wrangler Library

The OpenGL Extension Wrangler Library (GLEW) is a cross-platform open-source C/C++ extension loading library. GLEW provides efficient run-time mechanisms for determining which OpenGL extensions are supported on the target platform. OpenGL core and extension functionality is exposed in a single header file. GLEW has been tested on a variety of operating systems, including Windows, Linux, Mac OS X, FreeBSD, Irix, and Solaris.

Downloads

GLEW is distributed as source and precompiled binaries.
The latest release is **1.12.0**[26-01-15]:

Source [ZIP](#) | [TGZ](#)

Binaries [Windows 32-bit and 64-bit](#)

An up-to-date copy is also available using `git`:

- `github`
`git clone https://github.com/nigels-com/glew.git glew`
- `Sourceforge`
`git clone git://git.code.sf.net/p/glew/code glew`

Unsupported snapshots are also available:

- `glew-20150124.tgz`
- `glew-20140918.tgz`

Supported Extensions

```

108 void renderScene(void)
109 {
110     // clear canvas
111     glClearColor(0.0f, 0.0f, 0.0f, 1.0f);
112     glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
113
114     glEnableVertexAttribArray(iLocPosition);
115     glEnableVertexAttribArray(iLocColor);
116
117     static GLfloat triangle_color[] = {
118         1.0f, 0.0f, 0.0f,
119         0.0f, 1.0f, 0.0f,
120         0.0f, 0.0f, 1.0f
121     };
122
123     static GLfloat triangle_vertex[] = {
124         1.0f, -1.0f, 0.0f,
125         0.0f, 1.0f, 0.0f,
126         -1.0f, -1.0f, 0.0f
127     };
128
129     glVertexAttribPointer(iLocPosition, 3, GL_FLOAT, GL_FALSE, 0, triangle_vertex);
130     glVertexAttribPointer(iLocColor, 3, GL_FLOAT, GL_FALSE, 0, triangle_color);
131
132     // draw the array we just bound
133     glDrawArrays(GL_TRIANGLES, 0, 3);
134
135     glutSwapBuffers();
136 }

```

clear frame buffer & z buffer

$x_1, y_1, z_1, x_2, y_2, z_2, x_3, y_3, z_3, \dots$

$r_1, g_1, b_1, r_2, g_2, b_2, r_3, g_3, b_3, \dots$

stride start index

num of vertices draw the entire array

