**ENGR151 — Accelerated Introduction to Computer and Programming**

*Lab 8*

Manuel — UM-JI (Fall 2021)

**Goals of the lab**

- Understand what is OpenGL
- Install OpenGL
- Run a simple OnpenGL program

# 1 Background

Last night the three sisters could not sleep: beyond the stress of their C exam, their roommate kept playing video games. Although she had headphones on, the flashes of light were very disturbing, without speaking of her loud complains each times she was killed...

During breakfast while they were discussing their terrible night Kana raised a very interesting question: "How to draw on a computer?" Chiaki looked up thinking, when she noticed Jane not too far buying a mantou. She waved at her and Jane joined them for breakfast. Of course Jane knew much about computer drawing and she introduced them to one of the most common drawing library `Glut`.

Jane explained them that `glut` was in fact designed to ease the work of programmers while dealing with OpenGL, the Open Graphics Library. Those libraries work directly with the graphic card to draw simple or complex shapes and figures on the screen. They are used in many games, design and image manipulation software, as well as phones and even in MATLAB!

# 2 Tasks

Following Jane's introduction, the three sisters now have only one thing in mind: installing and playing with OpenGL. Still they find it wise to wait until their C exam before diving into the magic new world of computer drawing.

## 2.1 OpenGL installation

As usual when it comes to install and configure her development environment Haruka is the first: this is very easy for her since she is running Linux, so she simply uses her package manager to download and install OpenGL and Glut development packages. All done within a few seconds.

Chiaki who runs MacOS comes second with not too much struggle. They now both look at Kana who is still fighting with her Windows. For some reason it seems she is really attached to that terrible Operating System. Maybe she enjoys making her life more complicated and wasting time?

### 2.1.1 Linux

Use the package manager to search for Glut and OpenGL development packages, i.e. the packages containing the header files. Then simply install them. If a compiler is already installed on the computer everything should be ready.

### 2.1.2 MacOS

What took most time to Chiaki was to figure out how to obtain OpenGL and Glut. In the end it appears that those libraries were already available on on her computer, so not much was needed from her. Then she experienced some strange behaviours with her test program, but nothing major, maximizing the window and resizing it would fixed her problem. She envies Haruka with her Linux...

### 2.1.3 Windows

Everything takes more time and is more complicated on Windows. The funniest to Haruka and Chiaki is that some people have a Mac and install a Windows on it; if at least they were installing Linux that would be an improvement, but Windows on a Mac is one of the worst idea ever. While they keep discussing and mocking Kana with her Windows system, Kana seriously jumps from webpage to webpage, clicks everywhere, trying to figure out how to install OpenGL and FreeGlut. After a while however she realises that she has installed a package manger earlier in the semester!

```sh
sh $ pacman -S mingw-w64-x86_64-freeglut
```

Unfortunately she is not done yet, extra steps are now needed to ensure all the necessary files are found by the compiler.

- Copy the directory `/msys2/mingw64/include/GL` into `/msys2/usr/include`
- Copy the file `/msys2/mingw64/bin/libfreeglut.dll` into `/msys2/usr/bin`
- Copy the files `/msys2/mingw64/lib/libfreeglut.dll.a` and `/msys2/mingw64/lib/libfreeglut_static.a` into `/msys2/usr/lib`

Being distracted by her two sisters who make fun of her, Kana got mixed up when copying the files. Because of that she had to restart the whole installation, making the others laugh even more. For Kana it is hard to use Windows: she has to fight more than others and on the top of that, her sisters keep making fun of her. It will soon be time for her to switch to a proper operating system...

## 2.2 Test program

In the notes that Jane shared with them, the three sisters have found some sample code that draws a teapot. She warned them that the compilation process would depend on their operating system, but she gave them all the necessary information to succeed.

teapot.cpp

```cpp
/* macos */
#include <GLUT/glut.h>
/* windows */
#include <GL/freeglut.h>
#include <windows.h>
/* linux */
#include <GL/freeglut.h>
```

```c
void display() {
/* clear window */
    glClear(GL_COLOR_BUFFER_BIT);
/* draw scene */
    glutWireTeapot(.5);
/* flush drawing routines to the window */
    glFlush();
}
int main(int argc, char *argv[]) {
/* initialize GLUT, using any commandline parameters passed to the program */
    glutInit(&argc, argv);
/* setup the size, position, and display mode for new windows */
    glutInitWindowSize(500, 500);
    glutInitWindowPosition(0, 0);
    glutInitDisplayMode(GLUT_RGB);
/* create and set up a window */
    glutCreateWindow("hello, teapot!");
    glutDisplayFunc(display);
/* tell GLUT to wait for events */
    glutMainLoop();
}
```

**Linux.**

```sh
sh $ g++ -Wall -Wextra -Wpedantic -Werror -std=c++17 -o MyProg main.cpp -lglut -lGL -lGLU
```

**MacOS.**

```sh
sh $ g++ -Wall -Wextra -Wpedantic -Werror -std=c++17 -o MyProg main.cpp -framework OpenGL \
    -framework GLUT
```

**Windows.**

```sh
sh $ g++ -Wall -Wextra -Wpedantic -Werror -std=c++17 -o MyProg main.cpp -lglu32 -lfreeglut \
    -lopengl32
```

Help the three sisters to

- Proper write the header part of the file such that it can compile on any platform; (5 min – 2-3 students)
- Write a `Makefile` or a `CMakeLists.txt` to compile an OpenGL program; (7 min – 2-3 students)
- Understand how Jane's code works; (8 min – 2-3 students)

Poor Kana is facing some more troubles with her Windows: see copied exactly the content of the file but it is not working. It seems something is wrong with the headers she included. What about changing their order? Kana is exhausted and on the nerves. For students running

- Windows, we hope the lab was not too long and too complicated;
- MacOS, we hope Apple did not decide to randomly change their setup without letting anybody know, making it almost impossible to fix the issue;
- Linux, we hope the lab was not too short and too simple;