**OpenGL, GLFW, GLEW Installation Guideline**

To write graphics programs for this course, you will need three things:

**OpenGL:** OpenGL is the graphics library specification we will use to create our graphics programs. Note that OpenGL is simply a specification, which means it just defines the behavior of all the different OpenGL implementations. There is no official implementation of the library to download and use. Instead, operating system and GPU vendors generally provide users with their implementations.

**Window manager (GLFW):** OpenGL only deals with purely graphical tasks such as rendering, shading, etc. It does nothing to create and manage application windows or take input from the user. We will use the **GLFW** window management library during this course, but there are other viable alternatives such as freeglut or SDL.

**GLEW:** Open**GL** **E**xtension **W**rangler Library is a library that loads the supported OpenGL extensions for your platform. You will need it to load the supported OpenGL functions. There are other extension loaders available, and manually loading the extensions is also an option, but we chose GLEW as the simplest solution for this course. Note that you do not need GLEW on MacOS.

This document will assist you as you install OpenGL, GLFW, and GLEW for Ubuntu, Windows, and MacOS systems.

**Linux (Ubuntu)**

These instructions are for Ubuntu 20.04 64 bit. You might need to change the commands if you are using a different distro.

**OpenGL**

If you have a GPU on your machine and you have sufficiently updated drivers, your system should already have OpenGL version 4.x available to you. You can check this by using these commands:

*sudo apt install mesa-utils*

*glxinfo | grep "OpenGL version"*

If you do not have OpenGL 4.1 or later available on your device but you have a GPU, you should install the latest drivers from your GPU vendor. If your Linux distro has a driver manager, you can use it to install the GPU drivers. If not, you can use the following links to download the drivers from a web browser:

* AMD: <http://support.amd.com/en-us/download/linux>
* Nvidia: <http://www.nvidia.com/object/unix.html>
* Intel: <https://01.org/linuxgraphics>

After installing the latest drivers, please check again to make sure you have OpenGL version 4.1 or later available to you.

**GLFW**

To install GLFW you can use the command:

*sudo apt install libglfw3*

**Glew**

To install glew you can use the command:

sudo apt install libglew-dev

**Compilation**

Once you have all three libraries available on your machine, you can compile your graphics programs as follows:

*g++ example.cpp -o example -lGL -lglfw -lGLEW*

**Windows**

**OpenGL**

If you have a GPU on your machine and you have updated drivers, your system should already have OpenGL version 4.x available to you. You can check this by using this free application: <http://realtech-vr.com/home/glview>

If you do not have OpenGL 4.1 or later available on your device but you have a GPU, you should attempt to install the latest drivers from your GPU vendor. Here are some links to let you do that:

* AMD: <https://www.amd.com/en/support>
* Nvidia: <http://www.nvidia.com/Download/index.aspx>
* Intel: <http://www.nvidia.com/Download/index.aspx>

After installing the latest drivers, please check again to make sure you have OpenGL version 4.1 or later available to you.

**GLFW & GLEW using NuGet**

Nuget is a package manager included with the Visual Studio IDE. It allows a very easy setup of GLFW and GLEW. To install GLFW and GLEW with Nuget, in Visual Studio select Tools -> NuGet Package Manager -> Package Manager Console and then type “Install-Package nupengl.core”. Both libraries should then be available in your project environment.

Troubleshooting for Windows

- To disable precompiled headers for your project do; Select your project, use the "Project -> Properties" menu and go to the "Configuration Properties -> C/C++ -> Precompiled Headers" section, then change the "Precompiled Header" setting to "Not Using Precompiled Headers" option.

- When running in debug mode, If you see “cannot find or open the pdb file” error, Go to Tools -> Options -> Debugging -> Symbols and set the checkmark. Prefer running without debugging (Ctrl + F5) to avoid this.

- If you get an error regarding “\_CRT\_SECURE\_NO\_WARNINGS,” Go to Project -> Properties and then All Configurations -> C++ -> Preprocessor. Select the first field and add “\_CRT\_SECURE\_NO\_WARNINGS” without quotes to the first field. Make sure to add a semicolon ( ; ) after your addition.

Alternative GLFW installation for Windows (Advanced)

If you do not wish to use NuGet, you can download the glfw library from the following link: <https://www.glfw.org/> . You will have to then configure your project environment to include the library. This step will vary based on your IDE/compiler.

Alternative GLEW installation for Windows (Advanced)

If you do not wish to use NuGet, you can download the glew library from the following link: <https://sourceforge.net/projects/glew/files/glew/2.1.0/glew-2.1.0-win32.zip/download> . Like you did with GLFW, you need to configure your compiler/IDE so that it can access the necessary .dll, .lib and .h files.

**MacOS**

\* These instructions were made for latest versions of MacOS (Sequoia, Sonoma, Ventura, Big Sur, etc) and XCode (Version 15.2 (15C500b)). If you use old versions, you might run into issues. We suggest updating your system before attempting the installation. Note also that you do not need GLEW on Mac OS.

**GLFW**

Install GLFW using Terminal and Homebrew. You can get homebrew from <https://brew.sh/> if you do not have it installed. Then you must run the command:

*brew install glfw*

**OpenGL**

Install Xcode from App Store.

Launch Xcode, from the File menu -> New -> Project.

Select macOS then Command Line Tool.

Select C or C++ as language.

Enter name, click Next, choose folder location and click Create.

Click on **Targets** on the left pane, Select Build Phases, under Link Binary with Libraries click + button.

Use search, find and add **OpenGL** framework.

Add **libglfw** by clicking **Add** **Other.**

Default path for brew installs is /opt/homebrew/Cellar*. (For arm chips)*

Default path for brew installs is /usr/local/opt/homebrew/Cellar *(For intel chips)*

Select **libglfw.{version}.dylib (e.g. libglfw.3.3.dylib)** under:

/opt/homebrew/Cellar/glfw/{version}/lib/ (e.g./opt/ homebrew/Cellar/glfw/3.3.8/lib/)

If you can not access to the opt folder through finder, follow the instructions bellow.

Open terminal

Run one of the following command:

* ‘**defaults write com.apple.Finder AppleShowAllFiles YES**’
* ‘defaults write com.apple.finder AppleShowAllFiles -bool true’

Click the **Add Other** button again.

Press **Command+Shift+G** and open dialogue box.

Follow the aforementioned instructions.

**Some hints on Xcode project settings:**

- Make sure that shader files are in the project working folder (you can set your working folder through Product->Scheme->Edit Scheme->Options->Working Directory

- Set your header search paths through Build Settings (so that you include all the header files provided)

- /your-path/include (Homework headers, e.g.: Angel.h etc.)

- /opt/homebrew/Cellar/glfw/{version}/include (GLFW headers)

- Disable “Metal API validation” through Product->Scheme->Edit Scheme->Diagnostic

- Set “Inhibit all warnings” to “yes” through Build Settings

- Include the file InitShader.cpp into your project

- If MacOS version is Sonoma or newer, set “**Disable Library Validation**” in the Signing & Capabilities section.