EWU CSCD445 Project

Conway games of life on a cubes surface

Table of Content

Team:

- `Timbre Freeman` : Email tfreeman3@ewu.edu
- `Nicholas Gainer`: Email ngainer@ewu.edu
- `Jeremy Munson`: Email jmunson3@ewu.edu
- `Johnathan Smith` : Email jsmith245@ewu.edu

Conway games of life on a cubes surface

Each face of a cube will have a 2d grid of Conway games of life and their edges will interact with the connected face's

Functions

1. OpenGL Cube
2. CPU Conway games of life but for cube surface

3. CUDA Conway, games of life but for cube surface

Min Goal

At min, a cube with each face running Conway games of life on CUDA that has the edges interact with some start state to see it run (Ex have some Glider's)

World Start (Test data)

In `void GameOfLifeCube::cpuCreate(int size)` (file GameOfLifeCube.cpp) for the CPU Code and in `__host__ void cudaMainInitialize(int size_set)` (file cudaMain.cu) for the GPU Code

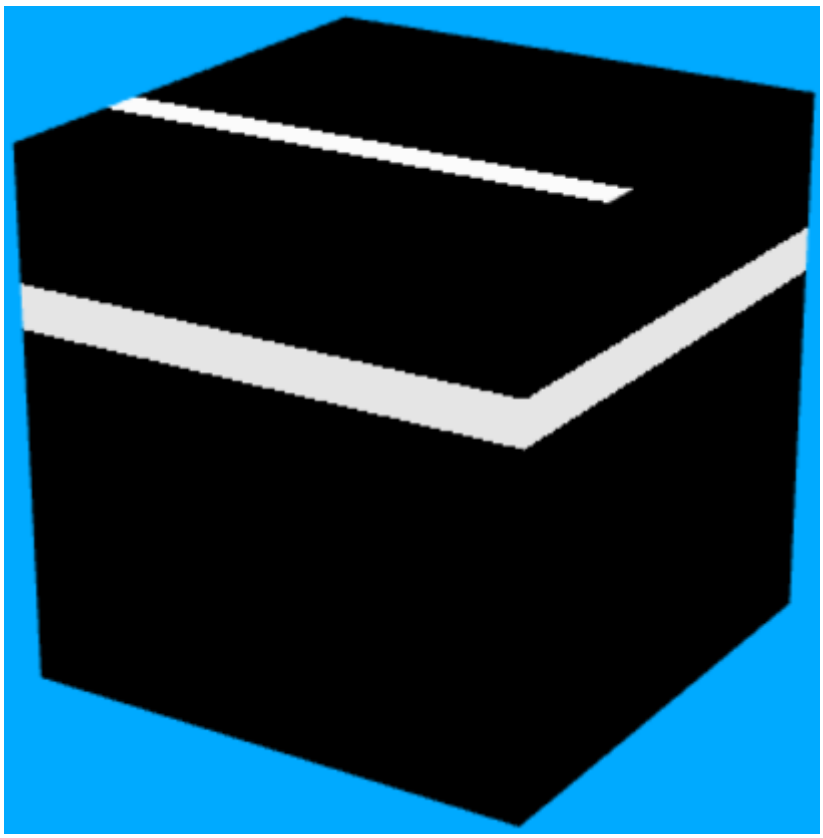
```
for (int i = 0; i < column; ++i) {
    board[(3 * column) + i] = 1;
}
```

Making a Line 3 from the top of all faces of the cube

Example

> World size of 12

Cube



Data of all faces (front, right, back, left, top, bottom)

Report

How to run/use

Start

Need the project executable (TODO: is dll's needed?) and res folder to run

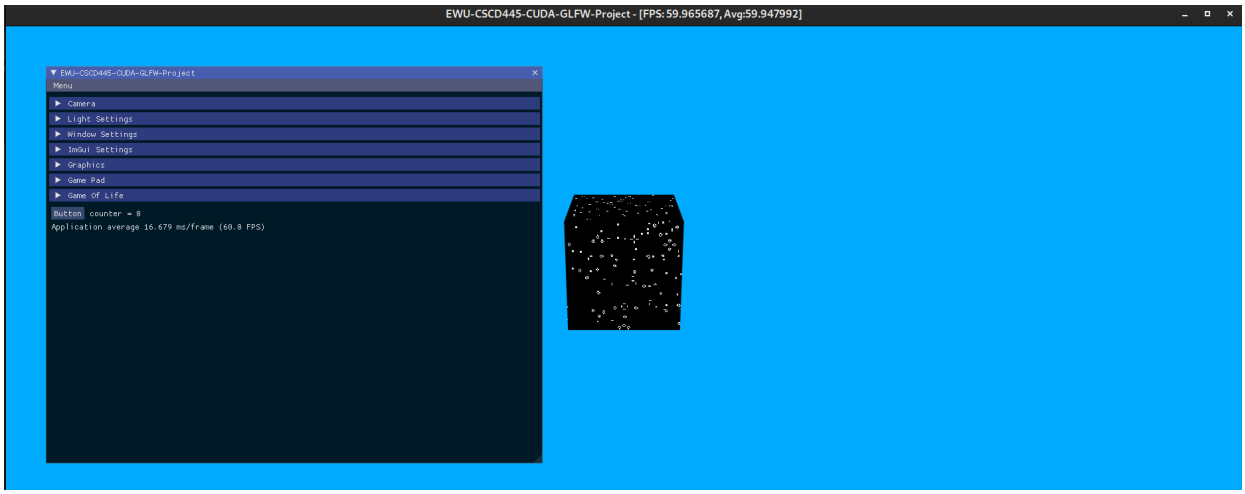
> Take no arguments

The program will log to console and log files in logs folder using spdlog

A imgui state file will also be made to remember somethings about GUI last state (Ex where within the window GUI is at)

Recommend using a game pad (Microsoft Xbox Series S|X Controller) to look that the game of life cube

> Note: avoid using left stick

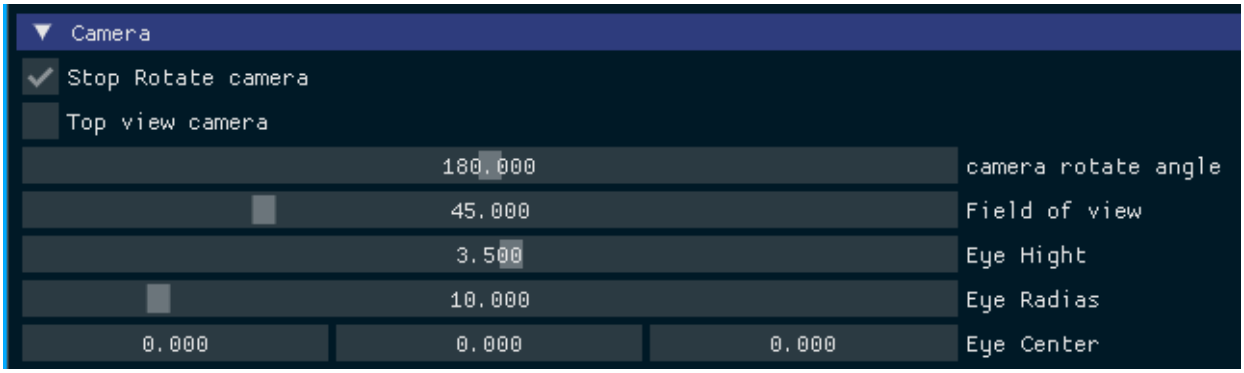


```
/home/tztz8/CLionProjects/EWU-CSCD445-project/project
[2023-03-21 01:25:12 PM -07:00 UTC](666136023) [pid:101083, tid:101083] [info] [main.cpp:121] [main]  ####################
[2023-03-21 01:25:12 PM -07:00 UTC](666178632) [pid:101083, tid:101083] [info] [main.cpp:122] [main]  #   Start of main   #
[2023-03-21 01:25:12 PM -07:00 UTC](666182991) [pid:101083, tid:101083] [info] [main.cpp:123] [main]  ####################
[2023-03-21 01:25:12 PM -07:00 UTC](666184634) [pid:101083, tid:101083] [info] [main.cpp:125] [main]  Initialise GLFW
[2023-03-21 01:25:12 PM -07:00 UTC](671224687) [pid:101083, tid:101083] [info] [main.cpp:132] [main]  Setting window hint's
[2023-03-21 01:25:12 PM -07:00 UTC](671239925) [pid:101083, tid:101083] [info] [main.cpp:144] [main]  Open a window and create its OpenGL context
[2023-03-21 01:25:12 PM -07:00 UTC](728615398) [pid:101083, tid:101083] [info] [main.cpp:154] [main]  Setup resize (size change callback)
[2023-03-21 01:25:12 PM -07:00 UTC](728763124) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:211] [loadGLFWIcon]  Setup icon "eagle.png" for the window
[2023-03-21 01:25:12 PM -07:00 UTC](733209487) [pid:101083, tid:101083] [info] [main.cpp:175] [main]  Initialize GLEW
[2023-03-21 01:25:12 PM -07:00 UTC](733902693) [pid:101083, tid:101083] [info] [main.cpp:183] [main]  Initialize GL Debug Output
[2023-03-21 01:25:12 PM -07:00 UTC](733958588) [pid:101083, tid:101083] [info] [main.cpp:197] [main]  Setting up IMGUI
[2023-03-21 01:25:12 PM -07:00 UTC](734324312) [pid:101083, tid:101083] [info] [main.cpp:200] [main]  setting up some variables for Initialize
[2023-03-21 01:25:12 PM -07:00 UTC](734332116) [pid:101083, tid:101083] [debug] [Sphere.cpp:20] [Sphere]  make using step: 32, numVertices: 1089, numTriangles: 1984, numIndices: 6144, do not forget to call create
[2023-03-21 01:25:12 PM -07:00 UTC](734335182) [pid:101083, tid:101083] [info] [main.cpp:211] [main]  Running Initialize method
[2023-03-21 01:25:12 PM -07:00 UTC](734377391) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:78] [ReadFile]  ReadFile: "shader.frag" is ready
[2023-03-21 01:25:12 PM -07:00 UTC](737491343) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:158] [initShaders]  initShaders: Fragment shader complied
[2023-03-21 01:25:12 PM -07:00 UTC](737543498) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:78] [ReadFile]  ReadFile: "shader.vert" is ready
[2023-03-21 01:25:12 PM -07:00 UTC](737577043) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:158] [initShaders]  initShaders: Vertex shader complied
[2023-03-21 01:25:12 PM -07:00 UTC](737870562) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:187] [initShaders]  initShaders: shader's linked
[2023-03-21 01:25:12 PM -07:00 UTC](809865057) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:279] [loadTexture]  Texture "Earth.jpg" is ready
[2023-03-21 01:25:12 PM -07:00 UTC](879780485) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:279] [loadTexture]  Texture "randomMade.png" is ready
[2023-03-21 01:25:12 PM -07:00 UTC](884947616) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:279] [loadTexture]  Texture "stone wall 9.png" is ready
[2023-03-21 01:25:12 PM -07:00 UTC](885089291) [pid:101083, tid:101083] [debug] [Sphere.cpp:73] [create]  NumVertices: 1089, i: 1089
[2023-03-21 01:25:12 PM -07:00 UTC](885041131) [pid:101083, tid:101083] [debug] [Sphere.cpp:106] [create]  NumIndices: 6144, index: 6144
[2023-03-21 01:25:12 PM -07:00 UTC](885131480) [pid:101083, tid:101083] [info] [GameOfLifeCube.cpp:172] [create]  Making Game Of Life Cube
[2023-03-21 01:25:12 PM -07:00 UTC](885136048) [pid:101083, tid:101083] [info] [GameOfLifeCube.cpp:14] [cubeCreate]  Initialize GameOfLife Cube
[2023-03-21 01:25:12 PM -07:00 UTC](885141949) [pid:101083, tid:101083] [info] [GameOfLifeCube.cpp:146] [cpuCreate]  Initialize GameOfLife CPU code
[2023-03-21 01:25:12 PM -07:00 UTC](889610394) [pid:101083, tid:101083] [info] [cudaInfo.cu:17] [checkCuda]  Cuda Device NVIDIA GeForce RTX 2060
[2023-03-21 01:25:12 PM -07:00 UTC](889617988) [pid:101083, tid:101083] [info] [cudaInfo.cu:18] [checkCuda]     ├ Compute Units 30
[2023-03-21 01:25:12 PM -07:00 UTC](889621324) [pid:101083, tid:101083] [info] [cudaInfo.cu:19] [checkCuda]     ├ Max Work Group Size 32
[2023-03-21 01:25:12 PM -07:00 UTC](889623578) [pid:101083, tid:101083] [info] [cudaInfo.cu:20] [checkCuda]     ├ Local Mem Size 49152
[2023-03-21 01:25:12 PM -07:00 UTC](889625712) [pid:101083, tid:101083] [info] [cudaInfo.cu:21] [checkCuda]     └ Global Mem Size 6214516736
[2023-03-21 01:25:12 PM -07:00 UTC](889627586) [pid:101083, tid:101083] [info] [cudaMain.cu:38] [cudaMainInitialize]  Initialize Cuda
[2023-03-21 01:25:12 PM -07:00 UTC](943237198) [pid:101083, tid:101083] [info] [OpenGLHelperMethods.cpp:279] [loadTexture]  Texture "testImage.png" is ready
[2023-03-21 01:25:12 PM -07:00 UTC](943256474) [pid:101083, tid:101083] [info] [main.cpp:215] [main]  GL Vendor : AMD
[2023-03-21 01:25:12 PM -07:00 UTC](943259880) [pid:101083, tid:101083] [info] [main.cpp:216] [main]  GL Renderer : AMD Radeon RX 6700 XT (navi22, LLVM 15.0.7, DRM 3.49, 6.1.18-200.fc37.x86_64)
[2023-03-21 01:25:12 PM -07:00 UTC](943263006) [pid:101083, tid:101083] [info] [main.cpp:217] [main]  GL Version (shading language) : 4.60
[2023-03-21 01:25:12 PM -07:00 UTC](943265460) [pid:101083, tid:101083] [info] [main.cpp:218] [main]  GL Version : 4.6 (Core Profile) Mesa 22.3.7
[2023-03-21 01:25:12 PM -07:00 UTC](943267354) [pid:101083, tid:101083] [info] [main.cpp:221] [main]  Setup user input mode
[2023-03-21 01:25:12 PM -07:00 UTC](943278745) [pid:101083, tid:101083] [info] [main.cpp:230] [main]  Current Set Special Key: F : Description: (F11) Full Screen
[2023-03-21 01:25:12 PM -07:00 UTC](943281951) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: c : Description: GL Cull Face
[2023-03-21 01:25:12 PM -07:00 UTC](943313681) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: q : Description: Quit program
[2023-03-21 01:25:12 PM -07:00 UTC](943318409) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: r : Description: Rotate of camera
[2023-03-21 01:25:12 PM -07:00 UTC](943321746) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: t : Description: Top view
[2023-03-21 01:25:12 PM -07:00 UTC](943337205) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: u : Description: Top view
[2023-03-21 01:25:12 PM -07:00 UTC](943341593) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: x : Description: Show line view
[2023-03-21 01:25:12 PM -07:00 UTC](943344829) [pid:101083, tid:101083] [info] [main.cpp:232] [main]  Current Set Normal Key: z : Description: GL Cull Face back
[2023-03-21 01:25:12 PM -07:00 UTC](943460134) [pid:101083, tid:101083] [info] [main.cpp:239] [main]  setting up variables for the loop
[2023-03-21 01:25:12 PM -07:00 UTC](943663761) [pid:101083, tid:101083] [info] [main.cpp:251] [main]  Start window loop with exit:false and glfwWindowShouldClose(window):false
```

Using GUI

Using ImGUI give you menus to control the program from.

Camera

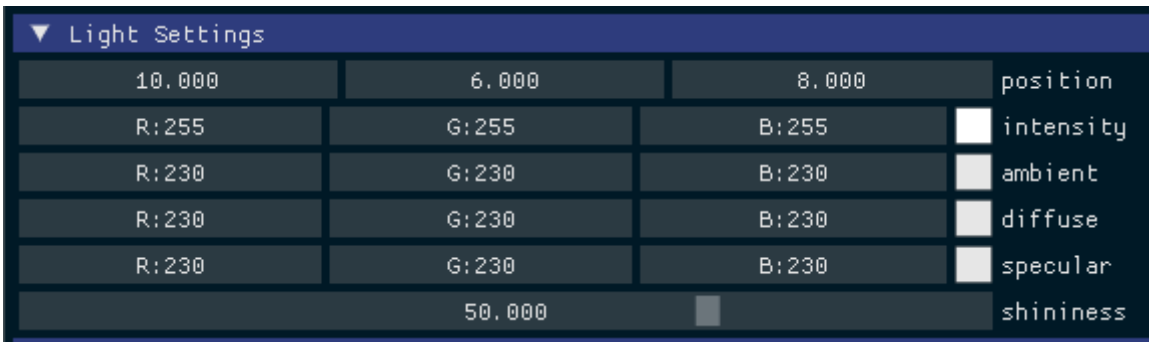


Gives control over the camera.

- Check box `Stop Rotate Camera` Auto rotate the camera (`camera rotate angle value`)
- Check box `Top view camera` when in default values move the camera to look from the top
- Slider `camera rotate angle value` rotate the camera around the `Eye Center` + `Eye Hight` at the `Eye Radias`
- Slider `Field of view` the “extent of the observable world seen at any given moment”
- Slider `Eye Hight` the hight of the eye above the `Eye Center`
- Slider `Eye Radias` the diastase the camera is from `Eye Center`
- Drag `Eye Center` where the camera looking at

> Note: a cube (not game of life cube) exist at light `Eye Center`

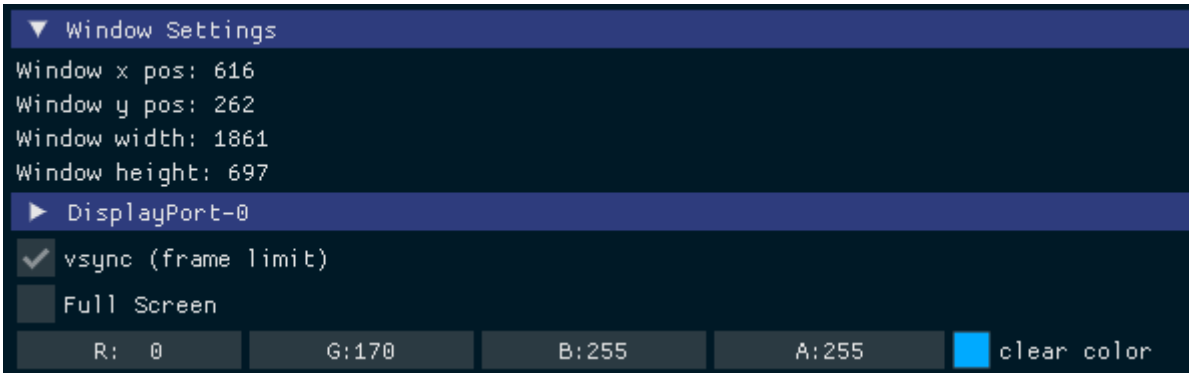
Light Settings



No need to use from the project (Leave at defaults)

> Note: a cube (not game of life cube) exist at light `position`

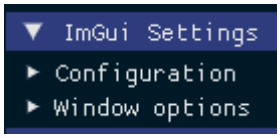
Window Settings



Gives control and info over the window

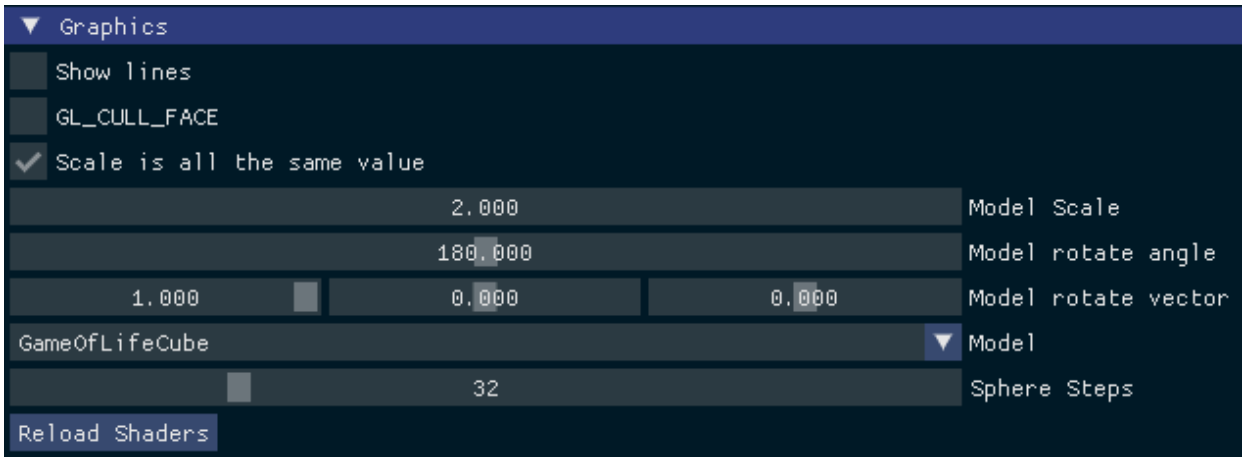
- Show info about the window and displays
- Check box `vsync (frame limit)` let you trune on and off the frame limit to the frame rate of your display.
- Check box `Full Screen` set the screen full screen
- Color Edit `clear color` set the background color

ImGui Settings



No need to use from the project (Leave at defaults)

Graphics



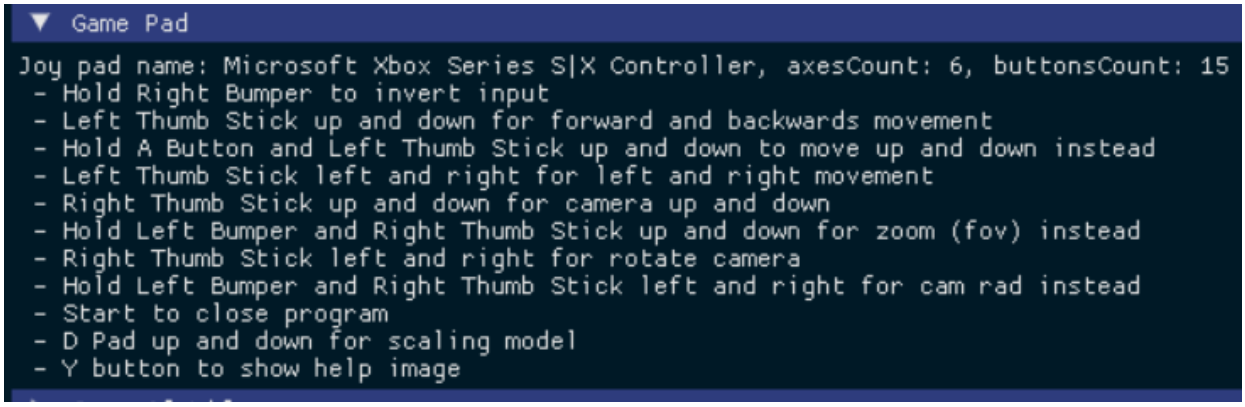
Gives control over the graphics settings

- Check box `Show lines` No need to use from the project (Leave at defaults)
- Check box `CL_CULL_FACE` No need to use from the project (Leave at defaults)
  - Check box `CL_CULL_FACE back` No need to use from the project (Leave at defaults)
- Check box `Scale is all the same value` Has the `Model Scale` be the same value for all axis
- Drag `Model Scale` scale of the model
  - Drag 3 `Model Scale` scale of the model x, y, z

    > Note: when change the scale using game pad will have all (x, y, z) be the same value
- Slider `Model rotate angle` the angle the model is rotated about (`Model rotate vector`)
- Slider 3 `Model rotate vector` the vector used when rotating the model
- Combo `Model` No need to use from the project (Leave at defaults of `GameOfLifeCube`)
- Slider `Sphere Steps` No need to use from the project (Leave at defaults) (used for the sphere model)
- Button `Reload Shaders` No need to use from the project (Leave at defaults)

Game Pad

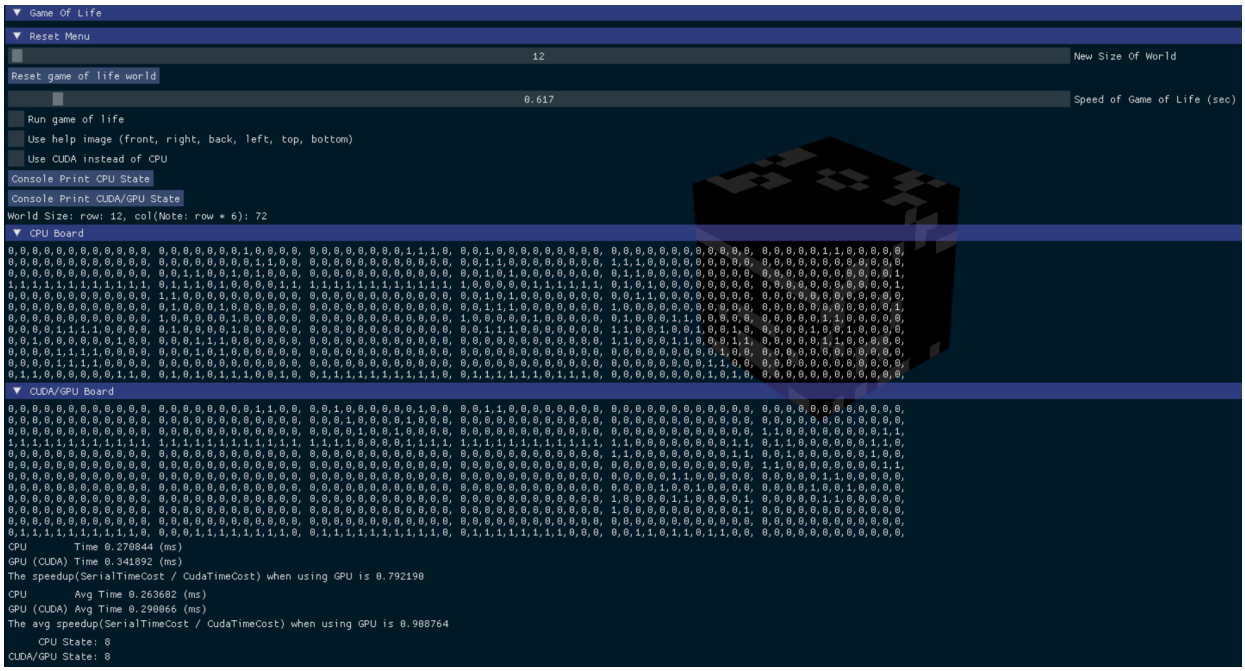


Give info about use the game pad and how to use it

> Note: avoid using left thumb stick

> Note: only test with Xbox Series Controller over usb c cable on Linux

Game Of Life



Gives control and info over the Game Of Life

- Reset Menu
  - New world size
  - Reset button
- Slider `Speed of Game of Life (sec)` how much time need to pass before next state of current game of life (run update)
- Check box `Run game of life` if the game of life is ruining or not (Use to stop the game of life and look at it without changing)
- Check box `Use help image (f, l, r, b, t, b)` to use the help image to know what face we are looking at
- Check box `Use CUDA instead of CPU` to use CUDA or CPU code
  - Text `Warring, Using Help Image` when using the help image
  - Text `Cuda not available` when no Nvidia CUDA device found
- Button `Console Print CPU State` to print all 6 sides of Game Of Life from CPU to console and log files
- Text
  - World size
  - CPU Board

    > Note: text output set up to world size 12

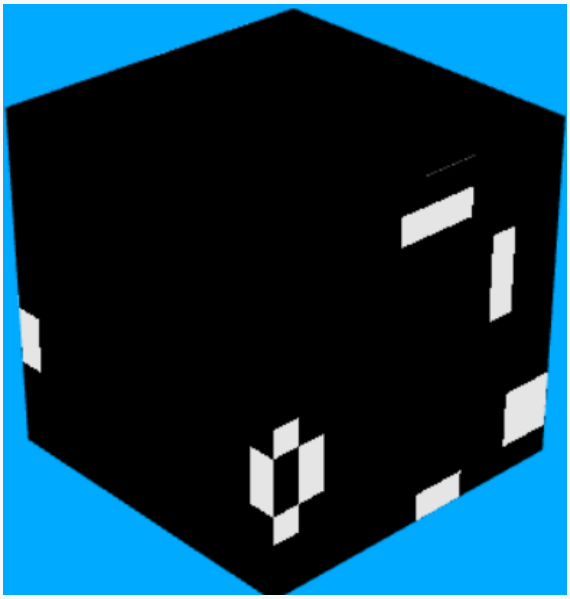
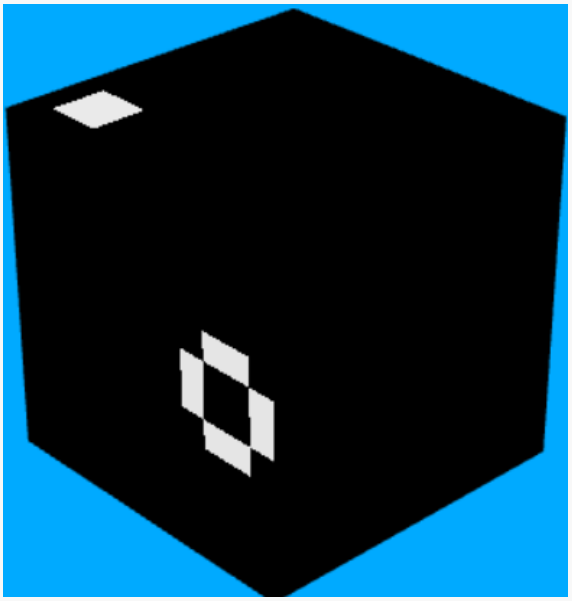
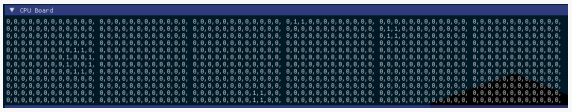
  - GPU Board

> Note: text output set up to world size 12

- Time info
  - Time need to run last update
  - The speed up of the last update in cpu and gpu
  - Continuous average of time need to run update
  - The speed up of the Continuous average time in cpu and gpu
  - What state each are at (number of time update is called)

Sample runNote: text output set up to world size 12

World size of `12`

Cuda/GPU	**CPU**
Cube	Cube
	
Data of all faces (front, right, back, left, top, bottom)	Data of all faces (front, right, back, left, top, bottom)
	

Speed Up

World size of `163`

```
CPU        Time 32.443047 (ms)
GPU (CUDA) Time 1.406908 (ms)
The speedup(SerialTimeCost / CudaTimeCost) when using GPU is 23.059820
CPU        Avg Time 15.266601 (ms)
GPU (CUDA) Avg Time 1.401716 (ms)
The avg speedup(SerialTimeCost / CudaTimeCost) when using GPU is 10.891367
     CPU State: 162
CUDA/GPU State: 162
```

Video

https://drive.google.com/file/d/16g-Gnnah8pfelmU87dxCpXrcnlp3tsaQ/view?usp=sharing

Making the program

We only test on Linux

For the program

Need OpenGL lib and dev

Need GLEW lib and dev

Need GLU lib and dev

Need GLM dev

Need `git` clone sub modules

> Note: If altered cloned use `git submodule update --init --recursive`

For Makefile

Need `CMake`

Need `pandoc` and `wkhtmltopdf`

Need `nvcc`

Wants `clang`

May Need `gcc`

Fedora install commands

```
sudo dnf group install "C Development Tools and Libraries" "Development Tools"
sudo dnf install cmake
sudo dnf install libXi libXi-devel
sudo dnf install glew glew-devel libGLEW
sudo dnf install clang clang-devel clang-libs clang-tools-extra
sudo dnf install glew glew-devel glfw glfw-devel glm-devel
sudo dnf install pandoc wkhtmltopdf
```

Notes

- OpenGL Code base off