# EWU CSCD445 Project

Conway games of life on a cubes surface

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## 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

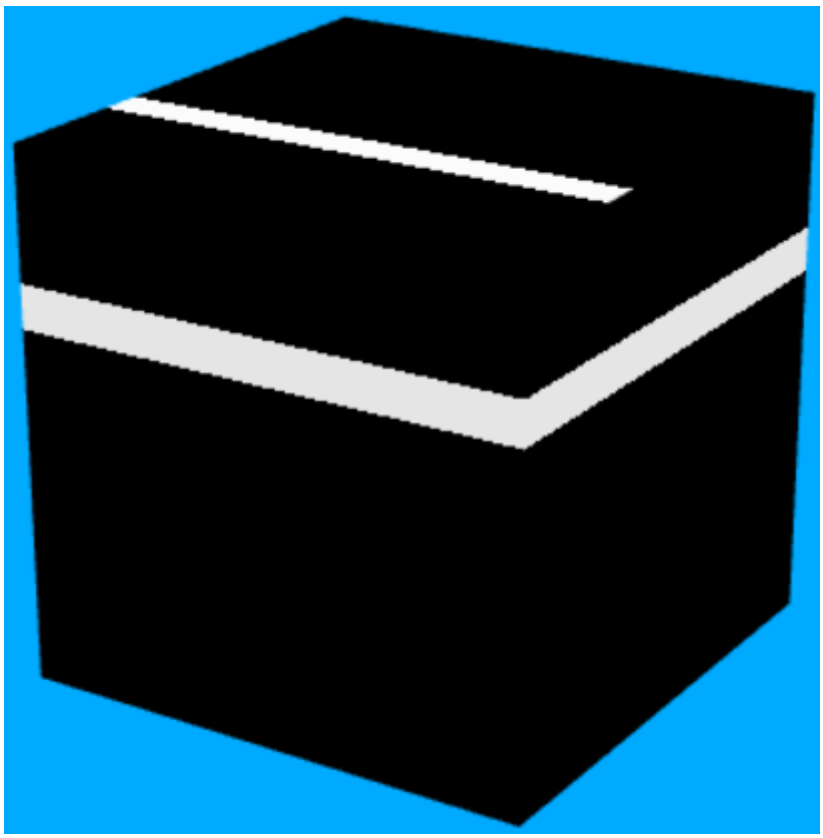
```
for (int i = 0; i < column; ++i) {
    board[(3 * column) + i] = 1;
}
```

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

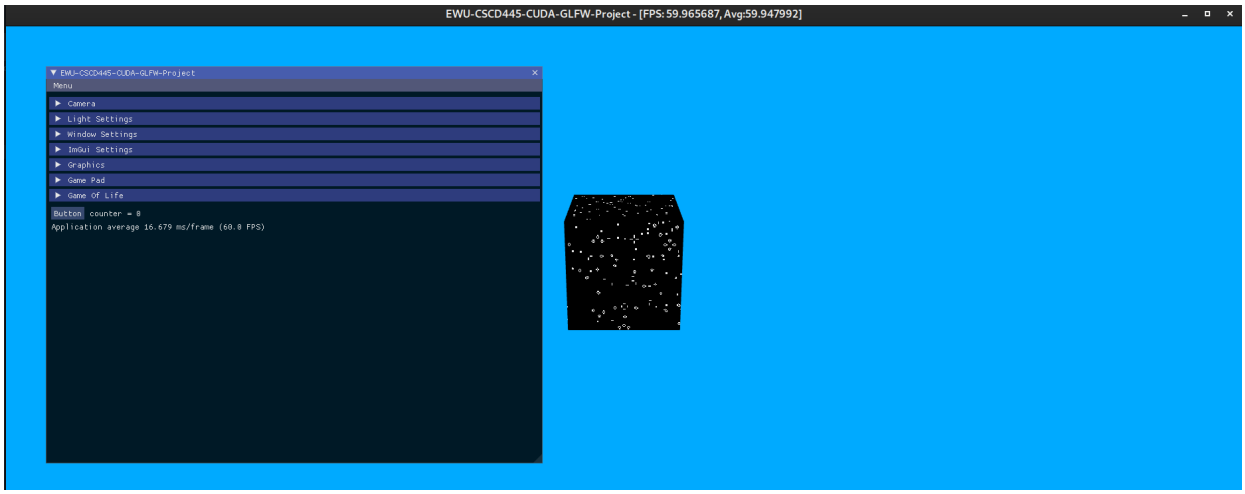
> Take no arguments

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

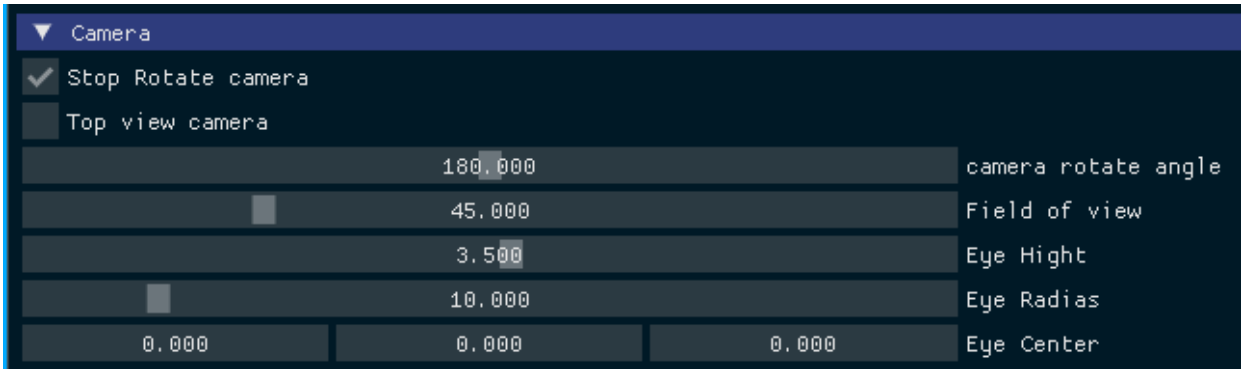


```
/home/tztz8/CLionProjects/EWU-CSCD445-project/project
[2023-03-21 01:25:12 PM -07:00 UTC](666136023) [pid:101083, tid:101083] [info] [main.cpp:121] [main]  ####################
[2023-03-21 01:25:12 PM -07:00 UTC](666178632) [pid:101083, tid:101083] [info] [main.cpp:122] [main]  #   Start of main   #
[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

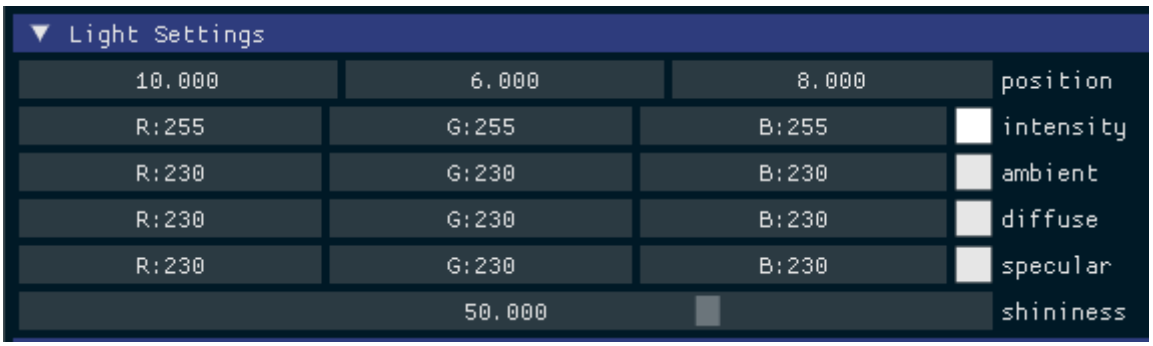



Gives control over the camera.

- 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`

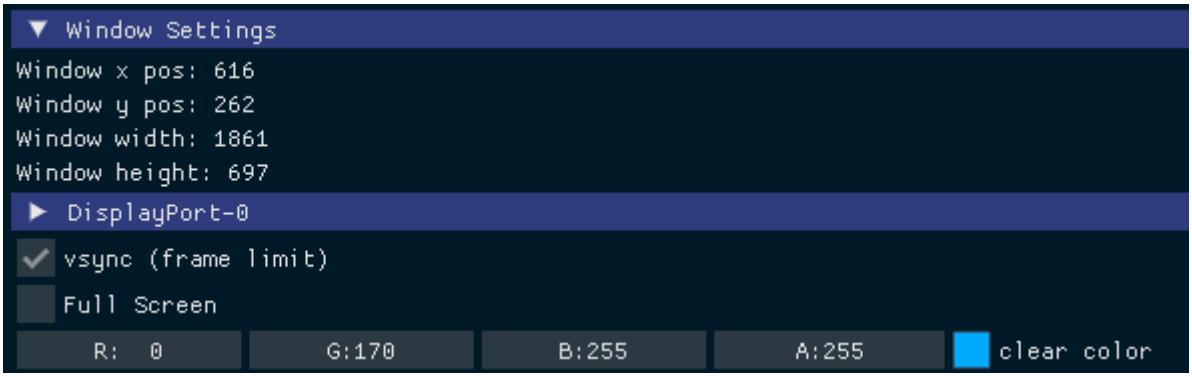
**Light Settings**




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

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

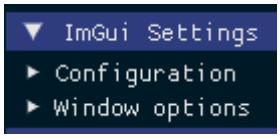
**Window Settings**




Gives control and info over the window

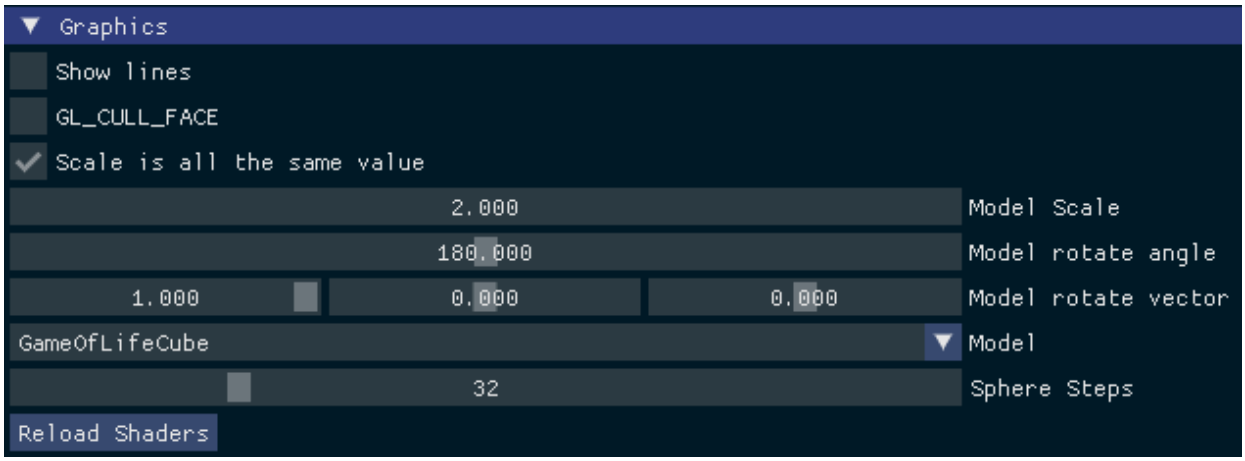
- Show info about the window and displays
- Check box `vsync (frame limit)` let you trune on and off the frame limit to the frame rate of your display.
- Check box `Full Screen` set the screen full screen
- Color Edit `clear color` set the background color

**ImGui Settings**




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

**Graphics**



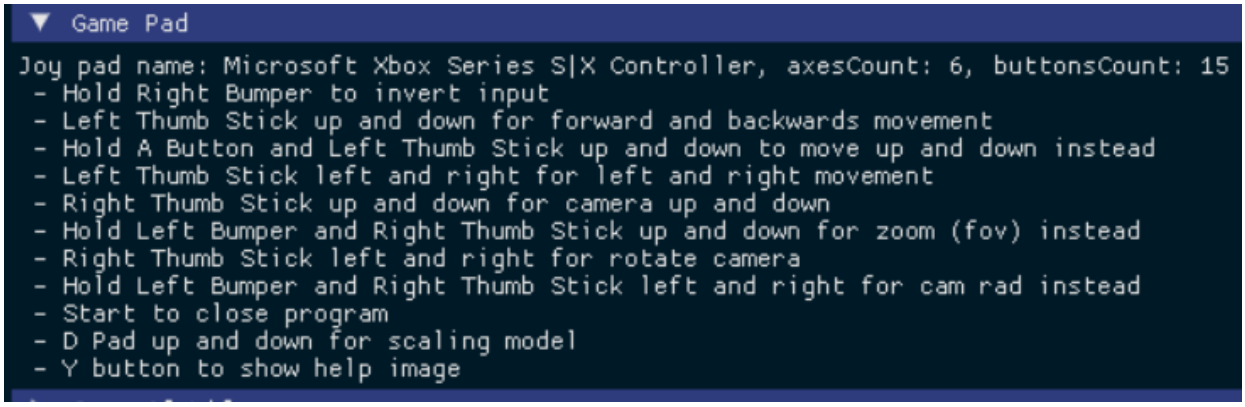

Gives control over the graphics settings

- 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**

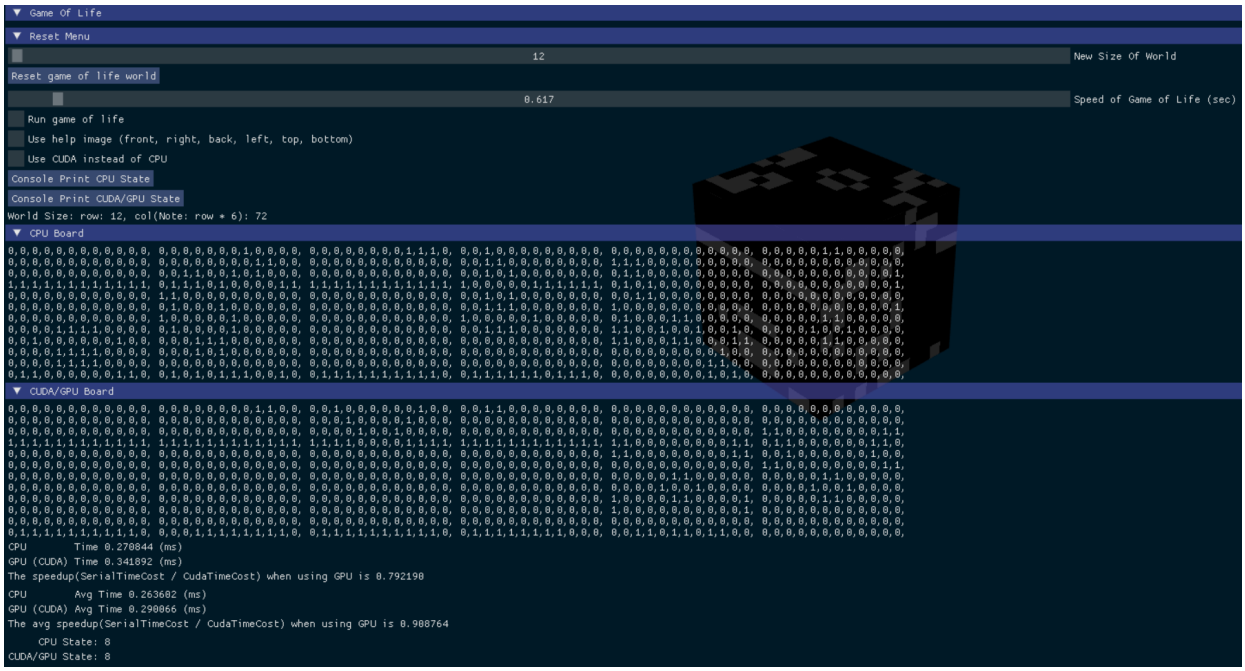



Give info about use the game pad and how to use it

> 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

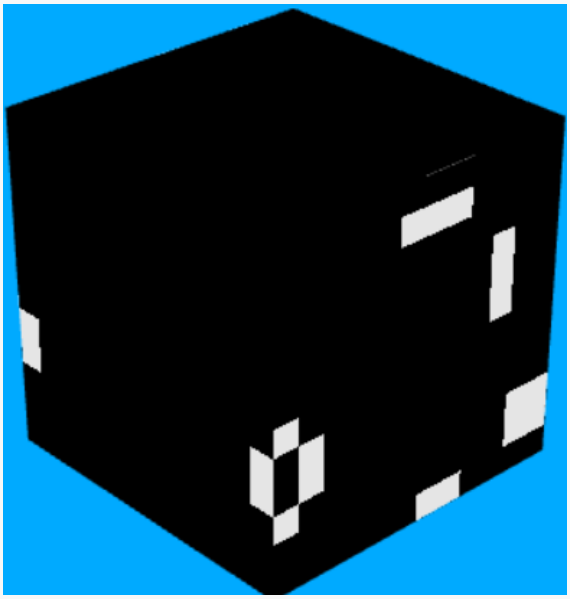
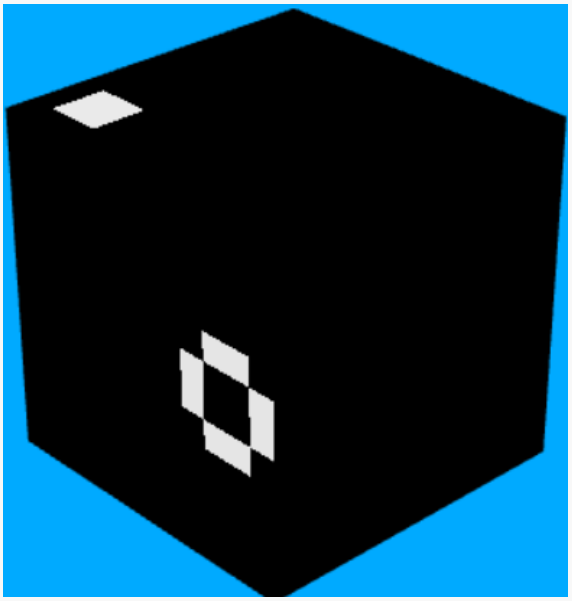
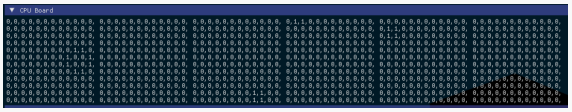
  - GPU Board

> 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