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Contents: Computer Graphics Project Documentation

Project Umls:

- **Application class:**

Public:

Application()

Virtual ~Application()

Void clearScreen()

Void run(const char * title, unsigned int width , unsigned int height, bool fullscreen)

Protected:

Virtual void startup()

Virtual void shutdown()

Virtual void update()

Virtual void draw()

- Camera class:

Public:

Camera()

~Camera()

Void update(float Deltatime)

Glm::vec4 set Perspective(float field of view, float aspect ratio, float near, float far)

Void set Look At(glm::vec3 from, glm::vec3 to, glm::vec3 up)

Void set Position(glm::vec3 position)

Glm::mat4 get World Transform()

Glm:: mat4 get View()

Glm::mat4 get Projection()

Glm::mat4 get Projection View()

Void change Projection(int is Active)

Private:

Glm::mat4 world Transform

Glm:: mat4 view Transform

Glm::mat4 projection Transform

Glm::mat4 projection View Transform

Void update Projection View Transform()

- **Fly Camera class:**

Public:

Fly Camera()
~Fly Camera()
Void update(float delta Time)
Void set Speed(float value)
Private:
Float speed
Glm::vec3 up

- **Transform class:**

Public:

Transform()
~Transform()
Glm::mat4 Translate(glm::mat model, glm::vec3 move Amount)
Glm::mat4 Rotate(float radians, glm::vec3 axis)
Glm::mat4 Scale(float size)
Private:
Glm::mat4 m_model
Glm::mat4 m_world Position
Glm::mat4 m_local Position
Glm::mat4 m_world Rotation
Glm::mat4 m_local Rotation
Glm::mat4 m_world Scale
Glm::mat4 m_local Scale

- **Mesh Renderer Class:**

Public:

Mesh Renderer()
Virtual ~Mesh Renderer()
vertex{glm::vec4 position, glm::vec4 color, glm::vec4 normal, glm::vec2
text Coord,}
void initialize(std::vector<unsigned int>& m_indices, std::vector<Vertex>&
m_vertices);
void render();
std::vector<unsigned int> m_indices;
std::vector<Vertex> m_vertices;
unsigned int vao;
unsigned int vbo;

```
unsigned int ibo;  
void create_Buffers();
```

- **Rendering Geometry App:**

Public:

```
void startup() override;  
void shutdown() override;  
void update(float dt) override;  
void draw() override;  
std::vector<glm::vec4>points;  
std::vector <glm::vec4> genHalfCircle(int np, double radius);  
std::vector<glm::vec4> genSphere(std::vector<glm::vec4>points, unsigned  
int numofM);  
std::vector<unsigned int>genSphereIndices(int np, int num of M);  
std::vector<Vertex> genPlane(int size);  
std::vector<Vertex>genCube(std::vector<Vertex> vertices);  
std::vector<glm::vec4> rotate Half Circle(std::vector<glm::vec4>points,  
unsigned int nm);  
std::vector<unsigned int> get Cube Indices();  
Shader *mShader;  
MeshRenderer* m Mesh;  
Camera *camera;  
Transform *m Transform= new Transform();  
glm::mat4 model, view, projection;
```

- **Shader Class:**

Public:

```
Shader();  
~Shader();  
enum SHADER_TYPE { VERTEX = 0, FRAGMENT = 1};  
enum Light_Type {phong = 0};  
void choose Lighting(Shader::Light_Type);  
std::string fs SourceString;  
std::string vs SourceString;  
std::string data;  
void bind();  
void unbind();
```

```

bool load(const char* filename, Shader::SHADER_TYPE);
bool attach();
void Load();
unsigned int getUniform(const char* mvp);
unsigned int m_vertexShader;
unsigned int m_fragmentShader;
const char* vs Source;
const char* fsSource;
const char* phongL;
unsigned int m_program;
struct Shader Data {Shader* shader; char* source; unsigned type; bool
Correct File;};

```

- **Intro Application class:**

Public:

```

Intro Application();
~Intro Application();
glm::mat4 view = glm::lookAt(glm::vec3(10, 10, 10), glm::vec3(0),
glm::vec3(0, 10, 0));
glm::mat4 projection = glm::perspective(glm::pi<float>() * 0.30f, 20 / 3.f,
0.15f, 1000.f);
glm::mat4 model = glm::mat4(1);
Fly Camera *mCamera = new Fly Camera();

```

Protected:

```

void startup() override;
void shutdown() override;
void update(float dt) override;
void draw() override;

```

3. Code Architecture

Application class:

Prototype: Application()

Description: A constructor for the camera class

Precondition: none

Post condition: none

Protection Level: public

Prototype: ~Application()

Description: A de-constructor that deletes new instances of the application class after they are used during runtime

Precondition: none

Post condition: none

Protection Level: public

Prototype: clear Screen()

Description: A function that will clear the screen whenever called

Precondition: none

Post condition: none

Protection Level: public

Prototype: run()

Description: When called takes in an argument for title width, and height

Precondition: none

Post condition: none

Protection Level: public

Prototype: startup()

Description: A function that declares what other functions will happen at the start of the program

Precondition: none

Post condition: none

Protection Level: public

Prototype: ShutDown()

Description: A function that stops the application from running

Precondition: none

Post condition: none

Protection Level: public

Prototype: update()

Description: A function that changes over while the program is running

Precondition: none

Post condition: none

Protection Level: public

Prototype: draw()

Description: A function that draws to the window while the program is running

Precondition: none

Post condition: none

Protection Level: public

- **Camera class:**

Prototype: Camera()

Description: a Constructor for the camera class

Precondition: none

Post condition: none

Protection Level: public

Prototype: ~ Camera()

Description: A de-constructor for the camera class that deletes any new instances of camera created at runtime

Precondition: none

Post condition: none

Protection Level: public

Prototype: update()

Description: A function that updates the state of the program during runtime

Precondition: none

Post condition: none

Protection Level: public

Prototype: set Perspective()

Description: A function that allows the perspective to be set

Precondition: none

Post condition: none

Protection Level: public

Prototype: set Look At()

Description: A function that allows you to set what the camera is looking at

Precondition: none

Post condition: none

Protection Level: public

Prototype: set Position()

Description: A function that allows you to set the position of the camera

Precondition: none

Post condition: none

Protection Level: public

Prototype: get World Transform()

Description: A function that gets the value of the world transform and then returns it

Precondition: none

Post condition: none

Protection Level: public

Prototype: get View()

Description: a function that gets the value of view and then returns it

Precondition: none

Post condition: none

Protection Level: public

Prototype: get projection()

Description: A function that gets the value of projection and then returns it

Precondition: none

Post condition: none

Protection Level: public

Prototype: get Projection View()

Description: A function that gets the value of the projection view and returns it

Precondition: none

Post condition: none

Protection Level: public

Prototype: change Projection()

Description: A function that changes the projection the types it can be switched with is perspective and orthographic

Precondition: none

Post condition: none

Protection Level: public

Prototype: update projection View transform()

Description: A function that change the view transform to correspond with the projection type.

Precondition: none

Post condition: none

Protection Level: private

- **Fly Camera class:**

Prototype: Fly Camera()

Description: A constructor for the camera class

Precondition: none

Post condition: none

Protection Level: public

Prototype: ~Fly Camera()

Description: A de-constructor to delete any new instances of Fly Camera after they are used in runtime

Precondition: none

Post condition: none

Protection Level: public

Prototype: Update()

Description: A function that updates the delta time while the program is running

Precondition: none

Post condition: none

Protection Level: public

Prototype: set Speed()

Description: A function that sets the speed of the fly camera

Precondition: none

Post condition: none

Protection Level: public

- **Transform Class:**

Prototype: Transform()

Description: A constructor for the Transform class

Precondition: none

Post condition: none

Protection Level: public

Prototype: ~Transform()

Description: A de-constructor for the transform that deletes any new instances of transform after they are used in runtime

Precondition: none

Post condition: none

Protection Level: public

Prototype: Translate()

Description: A function that moves the transform by changing the position of the transform

Precondition: none

Post condition: none

Protection Level: public

Prototype: Rotate()

Description: A function that rotates the transform based on what axes value is changed

Precondition: none

Post condition: none

Protection Level: public

Prototype: Scale()

Description: A function that scale the transform by a give amount

Precondition: none

Post condition: none

Protection Level: public

- **Mesh Render class:**

Prototype: Mesh Renderer()

Description: A constructor for the mesh renderer class

Precondition: none

Post condition: none

Protection Level: public

Prototype: ~mesh Renderer()

Description: A de-constructor that deletes any new instances of the mesh renders after they are used in runtime

Precondition: none

Post condition: none

Protection Level: public

Prototype: initialize()

Description: A function that will create certain variables at the start of runtime.

Precondition: none

Post condition: none

Protection Level: public

Prototype: render()

Description: A function that binds the vertex array and draws the elements of the shape to be drawn

Precondition: none

Post condition: none

Protection Level: public

Prototype: Create Buffers()

Description: A function that generates the vertex array and buffers ,binds the buffers, and also binds the vertex array

Precondition: none
Post condition: none
Protection Level: public

- **Shader class:**

Prototype: Shader()
Description: A constructor for the shader class.
Precondition: none
Post condition: none
Protection Level: public

Prototype: ~Shader()
Description: A de-constructor that deletes any instances of shader created during runtime.
Precondition: none
Post condition: none
Protection Level: public

Prototype: Choose Lighting()
Description:
Precondition:
Post condition:
Protection Level:

Prototype: Bind()
Description: A function that binds gl use program to m_program
Precondition: none
Post condition: none
Protection Level: public

Prototype: unbind()
Description: A function that sets the program to be used to null or 0
Precondition: none
Post condition: none
Protection Level: public

Prototype: load()

Description: A function that allows the program to load the information for each shader type to be load for use elsewhere in the project

Precondition: none

Post condition: none

Protection Level: public

Prototype: attach()

Description: A function that creates the shaders, sources the shaders, complies the shaders, attaches the shaders to the program, and links the program

Precondition: none

Post condition: none

Protection Level: public

Prototype: load()

Description: A function that assigns vsSource and fsSource are equal to their counterparts as defined in the file name shader.cpp

Precondition: none

Post condition: none

Protection Level: public

Prototype: get Uniform()

Description: A function that returns the uniform location of m_program

Precondition: none

Post condition: none

Protection Level: public

Source Code

Application.cpp

```
#include "Application.h"
#include <gl_core_4_4.h>
#include <GLM\glm.hpp>
#include <GLM\ext.hpp>
```

```

#include <GLM\ fwd.hpp>
#include <GLFW\ glfw3.h>
#include <Gizmos.h>
#include "stdio.h"
#include "imgui.h"
#include "imgui_impl_glfw_gl3.h"
Application::Application() :m_window(nullptr), m_gameover(false),
m_clearColor{ 5,5,5,5 }, m_runningTime(0){}
Application::~Application()
{
}

void Application::run(const char * title, unsigned int width, unsigned int
height, bool fullscreen)
{
    glfwInit();
    float prevTime = glfwGetTime();

    m_window = glfwCreateWindow(720, 720, "ChalkZone", NULL,
NULL);
    glfwMakeContextCurrent(m_window);
    ogl_LoadFunctions();
    auto minor = ogl_GetMinorVersion();
    auto major = ogl_GetMajorVersion();
    double PreviousTime = glfwGetTime();

    printf("GL: %i.%i\n", major, minor);

    glClearColor(0.15f, 0.15f, 0.15f, 1);
    glEnable(GL_DEPTH_TEST);
    ImGui_ImplGlfwGL3_Init(m_window,true);
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
    startup();
    while (glfwWindowShouldClose(m_window) == false &&
glfwGetKey(m_window, GLFW_KEY_ESCAPE) != GLFW_PRESS)
    {
        float currentTime = glfwGetTime();

```

```

        float deltaTime = currentTime - prevTime;
        prevTime = currentTime;
        update(deltaTime);
        double CurrentTime = glfwGetTime();
        draw();
        glfwSwapBuffers(m_window);

    }

    shutdown();
}

void Application::clearScreen()
{
}

    • Camera.cpp:
#include "Camera.h"
#include <GLM\glm.hpp>
#include <GLM\fwd.hpp>
#include <GLM\ext.hpp>
#include <iostream>
Camera::Camera() : projectionTransform(glm::mat4(1))
{
    worldTransform = glm::mat4(1);
}

Camera::~Camera()
{
}

void Camera::update(float Deltatime)
{
}

glm::mat4 Camera::setPerspective(float fieldofview, float aspectRatio,
float near, float far)
{
    projectionTransform[0].x = 1 / aspectRatio * tan(fieldofview / 2);
    projectionTransform[1].y = 1 / tan(fieldofview / 2);

```

```

        projectionTransform[2].z = 1 / -((far + near) / (far - near));
        projectionTransform[2].w = -1;
        projectionTransform[3].z = ((2 * far * near) / (far - near));
        return projectionTransform;
    }

    void Camera::setLookAt(glm::vec3 from, glm::vec3 to, glm::vec3 up)
    {
        viewTransform = glm::lookAt(from, to, up);
    }

    void Camera::setPosition(glm::vec3 position)
    {
        worldTransform[2].x += position[0];
        worldTransform[2].y += position[1];
        worldTransform[2].z += position[2];
        std::cout << worldTransform[2].x << " , " << worldTransform[2].y << " , "
        << worldTransform[2].z << std::endl;
    }

    glm::mat4 Camera::getWorldTransform()
    {
        return worldTransform;
    }

    glm::mat4 Camera::getView()
    {
        return viewTransform;
    }

    glm::mat4 Camera::getProjection()
    {
        return projectionTransform;
    }

    glm::mat4 Camera::getProjectionView()
    {
        return projectionViewTransform;
    }

```

```
void Camera::ChangeProjection(int isActive)
{
}
```

```
void Camera::updateProjectionViewTransform()
{
}
```

- **FlyCamera.cpp:**

```
#include "FlyCamera.h"
#include <GLFW\glfw3.h>
FlyCamera::FlyCamera()
```

```
{
    speed = 1;
}
```

```
FlyCamera::~FlyCamera()
```

```
{
}
```

```
void FlyCamera::update(float deltaTime)
{
    auto window = glfwGetCurrentContext();
    if (glfwGetKey(window, GLFW_KEY_W))
```



```

    {
        glm::vec3 prespective = glm::vec3(0, -speed * deltaTime, 0);
    }

    if (glfwGetKey(window, GLFW_KEY_A))
    {
        glm::vec3 prespective = glm::vec3(speed*deltaTime, 0, 0);
    }

    if (glfwGetKey(window, GLFW_KEY_S))
    {
        glm::vec3 prespective = glm::vec3(0, speed * deltaTime, 0);
    }

    if (glfwGetKey(window, GLFW_KEY_D))
    {
        glm::vec3 prespective= glm::vec3(-speed * deltaTime, 0, 0);
    }
}

```

```

void FlyCamera::setSpeed(float value)

```

```

{
    speed = value;
}

```

- **Transform.cpp:**

```

#include "Transform.h"

```

```

Transform::Transform()
//constructor for any instance of a transform object.
//assigns m_model to be a 4x4 matrix
{
    m_model = glm::mat4(1);
    m_worldPosition = m_model[2];
    m_localPosition = m_model[3];
    for (int col = 0; col < 3; col++)
    {
        m_worldRotation[col].x = m_model[col].x;
        m_worldRotation[col].y = m_model[col].y;
        m_worldRotation[col].z = m_model[col].z;

        m_localRotation[col].x = m_model[col].x;
        m_localRotation[col].y = m_model[col].y;
        m_localRotation[col].z = m_model[col].z;
    }
    m_worldScale = glm::vec3(m_model[0].x, m_model[1].y,
m_model[2].z);
    m_localScale = glm::vec3(m_model[0].x, m_model[1].y,
m_model[2].z);
}

```

```

Transform::~~Transform()
{
    // this will be used to deallocate memory that the instance of
transform allocates.
    //as of now no memory has been allocated.
}

```

```

glm::mat4 Transform::Scale(float size)
//scales the matrix by number value given.
//the bottom right number of the matrix.
{
    glm::mat4 m_scale = glm::mat4(1);
    m_scale[1].x = size;
}

```

```

    m_scale[2].y = size;
    m_scale[3].z = size;
    m_model *= m_scale;
    return m_model;
}

```

```

//Create two new auto assigned variables cosine and sin.
//cosine is equal to the number given.
//sine equals opposite of the number given.
//Radians is the measurement of the radius.
glm::mat4 Transform::Rotate(float radians, glm::vec3 axis)

```

```

{
    auto cosine = cos(radians);
    auto sine = sin(radians);
    //if x axis then rotate
    if (axis == glm::vec3(1, 0, 0))
    {
        //x doesn't change
        //this rotates the x axis.
        //this rotates the transform on the x axis.
        m_model[0].y = cosine;
        m_model[1].z = sine;
        m_model[2].y = -sin(radians);
        m_model[3].z = cosine;
    }
    if (axis == glm::vec3(0, 1, 0))
    {
        //if y axis then rotate
        /*this rotates the transform on the y axis.*/
        m_model[0].x = cosine;
        m_model[0].z = -sin(radians);
        m_model[2].x = sine;
        m_model[2].z = cosine;
    }
    //if z axis then rotate
}

```

```

//the transform will rotate on it's z axis
if (axis == glm::vec3(0, 0, 1))
{
    m_model[0].x = cosine;
    m_model[1].y = -sin(radians);
    m_model[2].x = sine;
    m_model[3].y = cosine;
}
return m_model;
}

glm::mat4 Transform::Translate(glm::mat4 model,glm::vec3
moveAmount)
{
    //^
    //^assign the value of model to equal m_model's value.
    //^model[0] is equal to m_model[0].
    //^model[1] is equal to m_model[1].
    //^model[2] is equal to m_model[2].

    //model[0], model[1], model[2] += 5;
    //^
    //^model[0] which is the transforms x position add 5 to the x
position.
    //^model[1] which is the transforms y position add 5 to the y
position.
    //^model[2] which is the transforms z position add 5 to the z
position.
    return model;
    //^
    //^return model's new values.
}

```

- **MeshRenderer.cpp**

```

#include "MeshRenderer.h"
#include "gl_core_4_4.h"
#include "Shader.h"

```

```
MeshRenderer::MeshRenderer() {}
```

```
MeshRenderer::~MeshRenderer()
```

```
{  
    glDeleteVertexArrays(1, &vao);  
    glDeleteBuffers(1, &vbo);  
    glDeleteBuffers(1, &ibo);  
}
```

```
void MeshRenderer::initialize(std::vector<unsigned int>& indices,  
std::vector<Vertex>& vertices)
```

```
{  
    m_indices = indices;  
    m_vertices = vertices;  
    create_Buffers();  
}
```

```
void MeshRenderer::render()
```

```
{  
    glBindVertexArray(vao);  
    glPolygonMode(GL_FRONT_AND_BACK, GL_FILL);  
    glPrimitiveRestartIndex(0xFFFF);  
  
    glEnable(GL_PRIMITIVE_RESTART);  
    glDrawElements(GL_TRIANGLE_STRIP, m_indices.size(),  
GL_UNSIGNED_INT, 0);  
    glDisable(GL_PRIMITIVE_RESTART);  
  
    glBindVertexArray(0);  
}
```

```
void MeshRenderer::create_Buffers()
```

```
{  
    glGenVertexArrays(1, &vao);  
    glGenBuffers(1, &vbo);  
    glGenBuffers(1, &ibo);  
  
    glBindVertexArray(vao);
```

```

        glBindBuffer(GL_ARRAY_BUFFER, vbo);
        glBufferData(GL_ARRAY_BUFFER, m_vertices.size() * sizeof(Vertex),
m_vertices.data(), GL_STATIC_DRAW);

        glBindBuffer(GL_ELEMENT_ARRAY_BUFFER, ibo);
        glBufferData(GL_ELEMENT_ARRAY_BUFFER, m_indices.size() *
sizeof(unsigned int), m_indices.data(), GL_STATIC_DRAW);

        glEnableVertexAttribArray(0);
        glVertexAttribPointer(0, 4, GL_FLOAT, GL_FALSE, sizeof(Vertex),
(void*)0);

        glEnableVertexAttribArray(1);
        glVertexAttribPointer(1, 4, GL_FLOAT, GL_FALSE, sizeof(Vertex),
(void*)sizeof(glm::vec4));

        glBindVertexArray(0);
        glBindBuffer(GL_ARRAY_BUFFER, 0);
        glBindBuffer(GL_ELEMENT_ARRAY_BUFFER, 0);
    }

```

- **RenderingGeometry.cpp**

```

#define GLM_FORCE_SWIZZLE
#include "RenderingGeometryApp.h"

void RenderingGeometryApp::startup()
{
    int nm = 30;
    int np = 30;

    mMesh = new MeshRenderer();

    points=    genHalfCircle(np, 5);

    points = genSphere(points, nm);

```

```

camera = new Camera();

std::vector<unsigned int> indices = genSphereIndices(np, nm);

std::vector<MeshRenderer::Vertex> vertexs;
for (glm::vec4 point : points)
{
    MeshRenderer::Vertex vertex = { point, glm::vec4(150, 25, 50, 0)
};
    vertexs.push_back(vertex);
}
mMesh->initialize(indices, vertexs);

mShader = new Shader();

mShader->load("vertex.vert", Shader::SHADER_TYPE::VERTEX);
mShader->load("fragment.frag",
Shader::SHADER_TYPE::FRAGMENT);

mShader->attach();

}

```

//it happens inside of the rendering geometryapp startup function every time after attach is Hit

```

void RenderingGeometryApp::shutdown()
{
}

```

```

void RenderingGeometryApp::update(float dt)
{
    model = glm::mat4(1);
    glm::vec3 eye = glm::vec3(10, -10, -10);
    view = glm::lookAt(eye, glm::vec3(0, 0, 0), glm::vec3(0, 1, 0));

    projection=camera->setPerspective(glm::pi<float>(), 800 / (float)600,
    .1f, 1000.f);
}

```

```

        view = camera->getView();

    }

void RenderingGeometryApp::draw()
{
    glUseProgram(mShader->m_program);
    mShader->bind();
    glm::mat4 mvp = projection * view * model;
    mMesh->render();
    glUniformMatrix4fv(mShader->getUniform("ProjectionViewWorld"),
1, GL_FALSE, &mvp[0][0]);
    mShader->unbind();
    glUseProgram(0);

}

std::vector<glm::vec4> RenderingGeometryApp::genHalfCircle(int np,
double radius)
{
    //1st two arguments int np(Number of Points); double radius;
    //2nd declare number of points;
    //3rd declare local variable that will represent an vertex's position.
    std::vector<glm::vec4>CircleVerts;

    for (float i=0;i<np;i++)
    {
        //calculate (angle or theta) in for loop.
        //angle is equals the answer of (3.14/number of points)
        float angle = glm::pi<float>() / ((float) np - 1);
        float theta = i * angle;

        //push back each vertice in the vertex _points->
        //that shows each generated portion of the half circle
        CircleVerts.push_back(glm::vec4(glm::cos(theta)*radius,
glm::sin(theta)*radius, 0, 1));
    }
}

```



```

    }
    return CircleVerts;

}

std::vector<glm::vec4>
RenderingGeometryApp::genSphere(std::vector<glm::vec4>points,
unsigned int numofM)
{

    std::vector<glm::vec4> SpherePoints;
    for (int i = 0; i < numofM + 1; i++)
    {
        float sphereSlice = (glm::pi<float>() * 2) / (float)numofM;
        float theta = i * sphereSlice;
        for (int j = 0; j < points.size(); j++)
        {
            float X = points[j].x;
            float Y = points[j].y * cos(theta) + points[j].z * -sin(theta);
            float Z = points[j].z * cos(theta) + points[j].y * sin(theta);
            glm::vec4 point = glm::vec4(X, Y, Z, 1);
            SpherePoints.push_back(point);
        }
    }
    return SpherePoints;

}

```

```

std::vector<unsigned int> RenderingGeometryApp::genSphereIndices(int
np, int numofM)
{
    std::vector<unsigned int> Sphereindices;
    unsigned int start;
    unsigned int bottom_left;
    unsigned int bottom_right;
    for (int r = 0; r < numofM; r++)

```

```

{
    start = r * np;
    for (int p = 0; p < np; p++)
    {
        bottom_left = start + p;
        bottom_right = bottom_left + np;
        Sphereindices.push_back(bottom_left);
        Sphereindices.push_back(bottom_right);
    }
    Sphereindices.push_back(0xFFFF);
}
return Sphereindices;
}

std::vector<Vertex> RenderingGeometryApp::genPlane(int size)
{
    Vertex A = Vertex(glm::vec4(-size, size, 0, 1), glm::vec4(1, 0, 0, 1));
    Vertex B = Vertex(glm::vec4(size, size, 0, 1), glm::vec4(1, 0, 0, 1));
    Vertex C = Vertex(glm::vec4(size, -size, 0, 1), glm::vec4(1, 0, 0, 1));
    Vertex D = Vertex(glm::vec4(-size, -size, 0, 1), glm::vec4(1, 0, 0, 1));
    std::vector<Vertex> PlaneVertices = { A,B,C,D };
    return PlaneVertices;
}

std::vector<Vertex>
RenderingGeometryApp::genCube(std::vector<Vertex> vertices)
{
    std::vector<Vertex> CubePoints;

    CubePoints.push_back(Vertex(glm::vec4(0, 1, 1, 1),glm::vec4(1)));
    CubePoints.push_back(Vertex(glm::vec4(1, 1, 1, 1), glm::vec4(1)));
    CubePoints.push_back(Vertex(glm::vec4(1, 0, 1, 1), glm::vec4(1)));
    CubePoints.push_back(Vertex(glm::vec4(0, 0, 1, 1), glm::vec4(1)));
    CubePoints.push_back(Vertex(glm::vec4(0, 0, 0, 1), glm::vec4(1)));
    CubePoints.push_back(Vertex(glm::vec4(1, 0, 0, 1), glm::vec4(1)));
    CubePoints.push_back(Vertex(glm::vec4(1, 1, 0, 1), glm::vec4(1)));

```

```

CubePoints.push_back(Vertex(glm::vec4(0, 1, 0, 1), glm::vec4(1)));
CubePoints.push_back(Vertex(glm::vec4(0, 1, 1, 1), glm::vec4(1)));
CubePoints.push_back(Vertex(glm::vec4(1, 1, 1, 1), glm::vec4(1)));
CubePoints.push_back(Vertex(glm::vec4(1, 1, 0, 1), glm::vec4(1)));
CubePoints.push_back(Vertex(glm::vec4(1, 0, 0, 1), glm::vec4(1)));
CubePoints.push_back(Vertex(glm::vec4(0, 1, 0, 1), glm::vec4(1)));
CubePoints.push_back(Vertex(glm::vec4(0, 0, 0, 1), glm::vec4(1)));
return CubePoints;
}

```

```

std::vector<glm::vec4>
RenderingGeometryApp::rotateHalfCircle(std::vector<glm::vec4> points,
unsigned int nm)
{
    std::vector<glm::vec4> allPoints;
    for (int i = 0; i <= nm; i++)
    {
        float slice = 2.0f * glm::pi<float>() / (float)nm;
        float theta = i * slice;
        for (int j = 0; j < points.size(); j++)
        {
            float newX = points[j].x;
            float newY = points[j].y * cos(theta) + points[j].z *
-sin(theta);
            float newZ = points[j].z * cos(theta) + points[j].y *
sin(theta);
            allPoints.push_back(glm::vec4(newX, newY, newZ, 1));
            //allPoints[i] = glm::round(allPoints[i]);
        }
    }
    return allPoints;
}

```

```

std::vector<unsigned int> RenderingGeometryApp::getCubeIndices()
{
    std::vector<unsigned int> indices =
    { 0, 1, 2, 2, 3, 0, //front

```

```

        3, 2, 4, 4, 5, 2, //Bot
        4, 5, 6, 6, 7, 4, //Back
        6, 7, 8, 8, 9, 6, //Top
        2, 1, 10, 10, 11, 2, //Right
        0, 3, 12, 12, 13, 0, //Left
    };
    return indices;
}

```

- **Shader.cpp**

```

#define GLM_FORCE_SWIZZLE
#define _CRT_SECURE_NO_WARNINGS 1
#include "Shader.h"
#include <GLCORE/gl_core_4_4.h>
#include <fstream>
Shader::Shader()
{
    m_program = glCreateProgram();
}

Shader::~Shader()
{
}

void Shader::bind()
{
    glUseProgram(m_program);
}

void Shader::unbind()
{
    glUseProgram(0);
}

```

```

bool Shader::load(const char *Filename, Shader::SHADER_TYPE
shadertype)
{
    errno_t err;
    FILE *file;
    err = fopen_s(&file, Filename, "r");
    char mstring[500];
    while(std::fgets(mstring, sizeof mstring, file))
    {
        if (shadertype == Shader::SHADER_TYPE::VERTEX)
        {
            vsSourceString.append(mstring);
        }
        else if (shadertype == Shader::SHADER_TYPE::FRAGMENT)
        {
            fsSourceString.append(mstring);
        }
    }
    vsSource = vsSourceString.c_str();
    fsSource = fsSourceString.c_str();
    return true;
}

bool Shader::attach()
{
    m_vertexShader = glCreateShader(GL_VERTEX_SHADER);
    m_fragmentShader = glCreateShader(GL_FRAGMENT_SHADER);
    glShaderSource(m_vertexShader, 1, (const char**)&vsSource, 0);
    glCompileShader(m_vertexShader);
    glShaderSource(m_fragmentShader, 1, (const char**)&fsSource, 0);
    glCompileShader(m_fragmentShader);
    glAttachShader(m_program, m_vertexShader);
    glAttachShader(m_program, m_fragmentShader);
    glLinkProgram(m_program);

    int success = GL_FALSE;

```

```

        // check that it compiled and linked correctly
        glGetProgramiv(m_program, GL_LINK_STATUS, &success);
        if (success == GL_FALSE) {
            int infoLogLength = 0;
            glGetProgramiv(m_program, GL_INFO_LOG_LENGTH,
&infoLogLength);
            char* infoLog = new char[infoLogLength + 1];
            glGetProgramInfoLog(m_program, infoLogLength, 0, infoLog);
            printf("Error: Failed to link shader program!\n");
            printf("%s\n", infoLog);
            delete[] infoLog;
        }

        return true;
    }

void Shader::Load()
{
    vsSource = "#version 410\n \
        layout(location = 0) in vec4 Position; \
        layout(location = 1) in vec4 Color; \
        out vec4 vColor; \
        uniform mat4 ProjectionViewWorld; \
        void main() { vColor = Color; \
        gl_Position = ProjectionViewWorld * Position; }";

    fsSource = "#version 410\n \
        in vec4 vColor; \
        out vec4 FragColor; \
        void main() { FragColor = vColor; }";
}

unsigned int Shader::getUniform(const char *mvp)
{
    return glGetUniformLocation(m_program, mvp);
}

```

- **IntroApplication.cpp**

```
#include "IntroApplication.h"
#include "gl_core_4_4.h"
#include "GLFW/glfw3.h"
#include "Camera.h"
#include "FlyCamera.h"
#include "Gizmos.h"
#include <GLM/glm.hpp>
#include <GLM/ext.hpp>
```

```
IntroApplication::IntroApplication()
{
}
```

```
IntroApplication::~IntroApplication()
{
}
```

```
void IntroApplication::startup()
{
    Gizmos::create();
    mCamera = new FlyCamera();
    mCamera->setLookAt(glm::vec3(10, 10, 10), glm::vec3(0), glm::vec3(0,
1, 0));
    mCamera->setPerspective(glm::pi<float>()*0.25f, 16 / 9.0f, 0.1f,
1000.0f);
    mCamera->setSpeed(10);
}
```

```

void IntroApplication::update(float dt)
{
    mCamera->update(dt);
}

void IntroApplication::shutdown()
{
    Gizmos::destroy();
    glfwDestroyWindow(m_window);
    glfwTerminate();
}

void IntroApplication::draw()
{
    Gizmos::clear();
    Gizmos::addTransform(glm::mat4(1));
    glm::vec4 white(1);
    glm::vec4 black(0, 0, 0, 1);
    for (int i = 0; i < 21; ++i) {
        Gizmos::addLine(glm::vec3(-10 + i, 0, 10),
                        glm::vec3(-10 + i, 0, -10),
                        i == 10 ? white : black);
        Gizmos::addLine(glm::vec3(10, 0, -10 + i),
                        glm::vec3(-10, 0, -10 + i),
                        i == 10 ? white : black);
    }
    Gizmos::addSphere(glm::vec3(0, 0, 0), 5, 15, 10, glm::vec4(1, 1, 1, 1),
&model);
    Gizmos::draw(mCamera->getProjection() * mCamera->getView() *
mCamera->getWorldTransform());
}

```

- **GUIApplication.cpp**

```
#include "GUIApplication.h"
```



```
#include "imgui.h"
```

```
GUIApplication::GUIApplication()  
{  
}
```

```
GUIApplication::~GUIApplication()  
{  
}
```

```
void GUIApplication::startup()  
{  
  
}
```

```
void GUIApplication::shutdown()  
{  
}
```

```
void GUIApplication::update(float dt)  
{//use the model matrix to move the square around  
  
}
```

```
void GUIApplication::draw()  
{  
    if(ImGui::Button("Move Left")){}  
    if (ImGui::Button("Move Right")) {}  
    if (ImGui::Button("Move Up")) {}  
    if (ImGui::Button("Move Down")) {}  
    if (ImGui::Button("Move Left")) {}  
  
}
```