Sistemul Solar - Proiect Grafica

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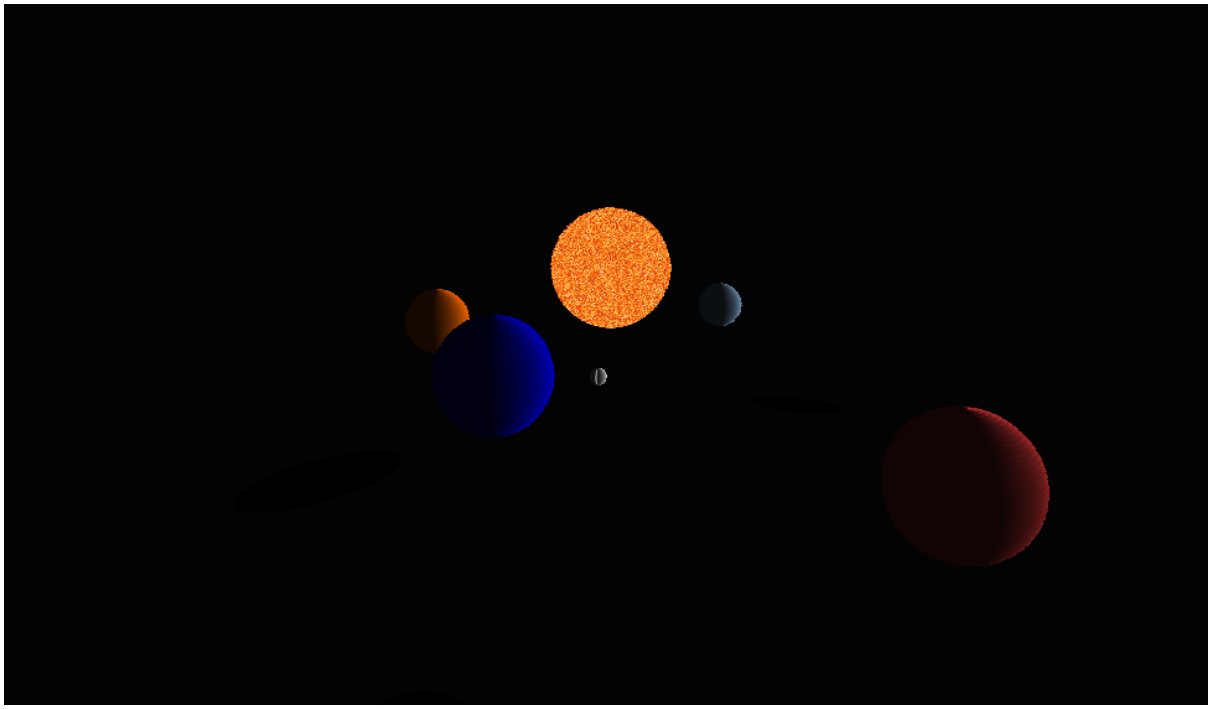
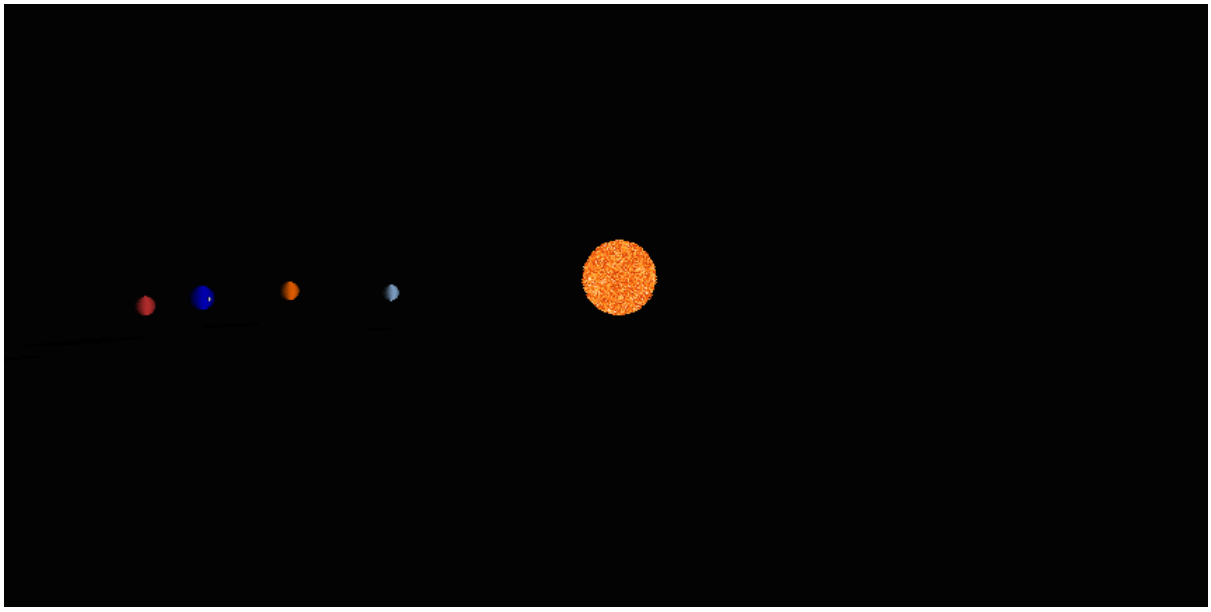
Cuprins:

Descriere

Scenarea realizata este o reprezentare a sistemului nostru solar avand urmatoarele corpuri ceresti: Soarele, Mercur, Venus, Pamant, Luna si Marte. Acestea sunt pozitionate, scalate si colorate astfel incat sa reprezinte intr-un mod cat mai realist sistemul nostru solar





Desenarea obiectelor

Pentru desenarea corpurilor ceresti am folosit aceeasi sfera, aplicandu-i diferite scalari pentru modificarea dimensiunii si translatii pentru modificarea pozitiei. Coordonatele varfurilor ce compun sfera au fost calculate folosind formula:

```
      float u = U_MIN + parr * step_u;
      float v = V_MIN + merid * step_v;
      float x_vf = radius * cosf(u) * cosf(v);
      float y_vf = radius * cosf(u) * sinf(v);
      float z_vf = radius * sinf(u);
```

Un exemplu pentru desenarea planetei Pamant pornind de la sfera de baza:

```
// PAMANT
  matrTrans = glm::mat4(1.0f) * glm::translate(glm::mat4(1.0f),
glm::vec3(10.0f, -600.0f, 0.0f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(0.7f, 0.7f, 0.7f));
  glUniform3f(objectColorLoc, 0.0f, 0.0f, 0.63f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(lightPosLoc, 0.f, 1000.f, 0.f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);

  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix);
  DrawShadow(myMatrix);
```

Aplicarea iluminarii

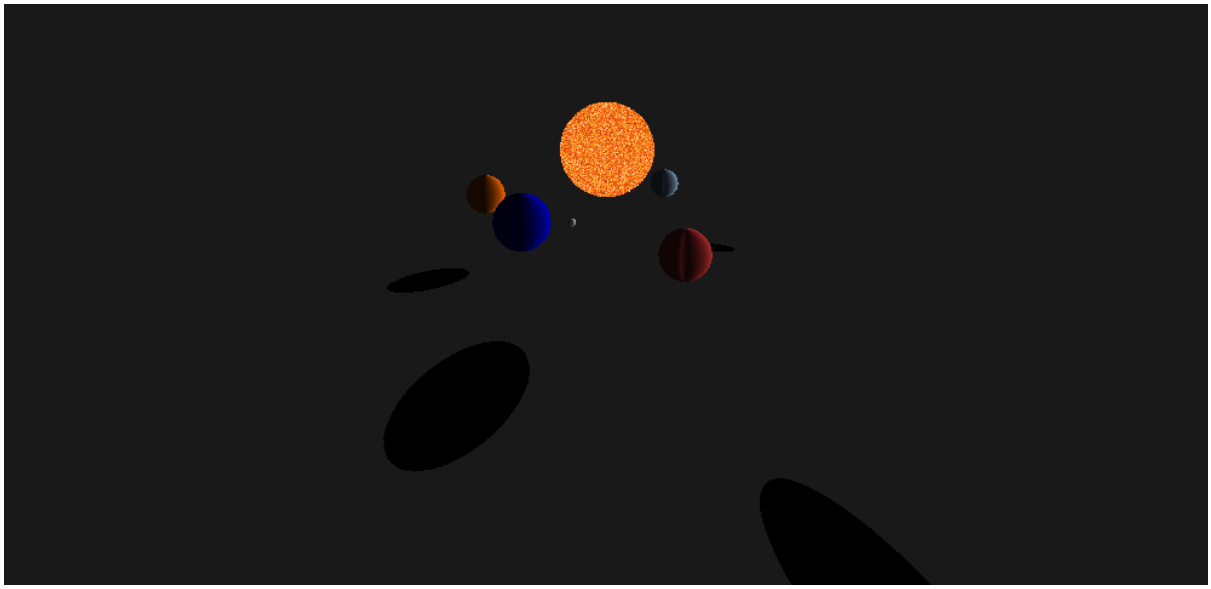
Iluminarea planetelor se realizeaza in shadere pentru variabila `codCol = 0` si este folosita lumina ambientala, difuza si speculara astfel:

```
if (codCol==0)
    {
        // Ambient
        float ambientStrength = 0.1f;
        vec3 ambient_light = ambientStrength * lightColor;
        vec3 ambient_term= ambient_light * objectColor;

        // Diffuse
        vec3 norm = normalize(Normal);
        vec3 lightDir = normalize(inLightPos - FragPos);
        float diff = max(dot(norm, lightDir), 0.0);
        vec3 diffuse_light = lightColor;
        vec3 diffuse_term = diff * diffuse_light * objectColor;

        // Specular
        float specularStrength = 0.8f;
        float shininess = 100.0f;
        vec3 viewDir = normalize(inViewPos - FragPos);
        vec3 reflectDir = normalize(reflect(-lightDir, norm));
        float spec = pow(max(dot(viewDir, reflectDir), 0.0), shininess);
        vec3 specular_light = specularStrength  * lightColor;
        vec3 specular_term = spec * specular_light * objectColor;

        // Culoarea finala
        vec3 emission=vec3(0.0, 0.0, 0.0);
        vec3 result = emission + (ambient_term + diffuse_term + specular_term);
      out_Color = vec4(result, 1.0f);
    }
```

Iluminarea soarelui s-a realizat prin `codCol = 2` folosind doar lumina ambientala intrucat acesta se suprapune aproximativ cu sursa de lumina pentru restul corpurilor. Tot pentru `codCol = 2` este aplicata si texturarea.

Realizarea umbrelor

Umbrele au fost aplicate folosind o sursa de lumina apropiata soarelui si utilizand matricea pentru umbra. Desenarea umbrelor se realizeaza in shadere folosind `codCol = 1` si functie `drawShadow()`



Texturarea obiectelor

Deoarece soarele este reprezentat ca o sursa de lumina, acesta nu este iluminat decat folosind lumina ambientala. Pentru pastrarea efectului realist am ales sa incercam sa il texturam folosind o textura de tip `GL_TEXTURE_2D`. Aplicarea texturii si calcularea coordonate de texturare se realizeaza in shadere pentru `codCol = 2`

```
void LoadTexture(void)
{
  glGenTextures(1, &texture);
  glBindTexture(GL_TEXTURE_2D, texture);

  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_S, GL_REPEAT);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_T, GL_REPEAT);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);

  int width, height;
  unsigned char* image = SOIL_load_image("sun.jpg", &width, &height, 0, SOIL_LOAD_RG
B);
  glTexImage2D(GL_TEXTURE_2D, 0, GL_RGB, width, height, 0, GL_RGB, GL_UNSIGNED_BYTE, i
mage);
  glGenerateMipmap(GL_TEXTURE_2D);

  SOIL_free_image_data(image);
  glBindTexture(GL_TEXTURE_2D, 0);
}
```

Contributii individuale

Ideea proiectului a fost discutata si implementata de amandoi in mod egal:

- Erol Cherim: pozitionare planetelor si a soarelui, aplicari de scalari si translatii, sistem de iluminare, incercarea *nereusita* de a genera un skybox - dupa modelul https://learnopengl.com/Advanced-OpenGL/Cubemaps
- Teodora Lazaroiu: desenare planetelor si a lunii, incercarea de texturare a soarelui, aplicarea umbrelor pentru planete, delimitarea cazurilor dupa codul de culoare, refactorizare cod

Codul sursa

shaderPlanete.frag

```
in vec3 FragPos;
in vec3 Normal;
in vec3 inLightPos;
in vec3 inViewPos;
in vec2 tex_Coord;

out vec4 out_Color;

uniform vec3 objectColor;
uniform vec3 lightColor;
uniform int codCol;
uniform sampler2D myTexture;

void main(void)
  {
    if (codCol==0)
    {
        // Ambient
        float ambientStrength = 0.1f;
        vec3 ambient_light = ambientStrength * lightColor;
        vec3 ambient_term= ambient_light * objectColor;

        // Diffuse
        vec3 norm = normalize(Normal);
        vec3 lightDir = normalize(inLightPos - FragPos);
        float diff = max(dot(norm, lightDir), 0.0);
        vec3 diffuse_light = lightColor;
        vec3 diffuse_term = diff * diffuse_light * objectColor;

        // Specular
        float specularStrength = 0.8f;
        float shininess = 100.0f;
        vec3 viewDir = normalize(inViewPos - FragPos);
        vec3 reflectDir = normalize(reflect(-lightDir, norm));
        float spec = pow(max(dot(viewDir, reflectDir), 0.0), shininess);
        vec3 specular_light = specularStrength  * lightColor;
        vec3 specular_term = spec * specular_light * objectColor;

        // Culoarea finala
        vec3 emission=vec3(0.0, 0.0, 0.0);
```

```
        vec3 result = emission + (ambient_term + diffuse_term + specular_term);
      out_Color = vec4(result, 1.0f);
        }
      if (codCol==1)
      {
        vec3 black = vec3(0.0, 0.0, 0.0);
        out_Color = vec4(black, 1.0);
      }
      if (codCol==2)
      {
        // Culoare cu ambient
        float ambientStrength = 1.0f;
        vec3 ambient_light = ambientStrength * lightColor;
        vec3 ambient_term= ambient_light * objectColor;

        // Culoarea finala
        vec3 emission = vec3(0.0,0.0,0.0);
        vec3 result = emission + (ambient_term);
      out_Color = vec4(result, 1.0f);
        out_Color = mix(texture(myTexture, tex_Coord), out_Color, 0.2);
      }
    }
```

shaderPlanete.vert

```
layout(location=0) in vec3 in_Position;
layout(location=1) in vec3 in_Normal;
layout(location=2) in vec2 texCoord;

out vec4 gl_Position;
out vec3 Normal;
out vec3 FragPos;
out vec3 inLightPos;
out vec3 inViewPos;
out vec2 tex_Coord;

uniform mat4 matrUmbra;
uniform mat4 myMatrix;
uniform mat4 view;
uniform mat4 projection;
uniform vec3 lightPos;
uniform vec3 viewPos;
uniform int codCol;

void main(void)
  {
    if (codCol == 0)
    {
        gl_Position = projection*view*myMatrix*vec4(in_Position, 1.0);
        Normal=vec3(projection*view*vec4(in_Normal,0.0));
        inLightPos= vec3(projection*view*vec4(lightPos, 1.0f));
        inViewPos=vec3(projection*view*vec4(viewPos, 1.0f));
        FragPos = vec3(gl_Position);
    }
```

```
    if (codCol == 1)
    {
        gl_Position = projection*view*matrUmbra*myMatrix*vec4(in_Position, 1.0);
        FragPos = vec3(gl_Position);
    }
    if (codCol == 2)
    {
        gl_Position = projection*view*myMatrix*vec4(in_Position, 1.0);
        Normal=vec3(projection*view*vec4(in_Normal,0.0));
        tex_Coord = vec2(Normal.x, Normal.y);
    }
   }
```

main.cpp

```
#include <windows.h>
#include <stdlib.h>
#include <stdio.h>
#include <math.h>
#include <iostream>
#include <GL/glew.h>
#include <GL/freeglut.h>
#include <GLFW/glfw3.h>
#include "loadShaders.h"
#include "glm/glm.hpp"
#include "glm/gtc/matrix_transform.hpp"
#include "glm/gtx/transform.hpp"
#include "glm/gtc/type_ptr.hpp"
#include "SOIL.h"

using namespace std;

GLuint
VaoId1, VaoId2,
VboId1, VboId2,
EboId1, EboId2,
ColorBufferId,
ProgramIdv,
ProgramIdf,
viewLocation,
projLocation,
codColLocation,
myMatrixLocation,
matrUmbraLocation,
depthLocation,
codCol;
GLint objectColorLoc, lightColorLoc, lightPosLoc, viewPosLoc;
GLuint texture;

float const PI = 3.141592f;
float const U_MIN = -PI / 2, U_MAX = PI / 2, V_MIN = 0, V_MAX = 2 * PI;
int const NR_PARR = 131, NR_MERID = 132;
float step_u = (U_MAX - U_MIN) / NR_PARR, step_v = (V_MAX - V_MIN) / NR_MERID;
```

```
float radius = 50;
int index, index_aux;

// variabile pentru matricea de vizualizare
float Obsx = 100.0, Obsy = -1500.0, Obsz = 200;
float Refx = 0.0f, Refy = 1000.0f, Refz = 0.0f;
float Vx = 0.0, Vy = 0.0, Vz = 1.0;

// variabile pentru matricea de proiectie
float width = 800, height = 600, znear = 0.1, fov = 45;

// matrice utilizate
glm::mat4 view, projection;
glm::mat4 myMatrix, matrTrans, matrScale;

// sursa de lumina
float xL = 0.0f, yL = 100.0f, zL = 250.0f;

// matricea umbrei
float matrUmbra[4][4];

void processNormalKeys(unsigned char key, int x, int y)
{
  switch (key) {
  case 'l':
    Vx -= 0.1;
    break;
  case 'r':
    Vx += 0.1;
    break;
  case '+':
    Obsy += 10;
    break;
  case '-':
    Obsy -= 10;
    break;
  }
  if (key == 27)
    exit(0);
}
void processSpecialKeys(int key, int xx, int yy)
{
  switch (key) {
  case GLUT_KEY_LEFT:
    Obsx -= 20;
    break;
  case GLUT_KEY_RIGHT:
    Obsx += 20;
    break;
  case GLUT_KEY_UP:
    Obsz += 20;
    break;
  case GLUT_KEY_DOWN:
    Obsz -= 20;
    break;
  }
}
void CreateVBO1(void)
```

```
{
  glm::vec4 Vertices1[(NR_PARR + 1) * NR_MERID];
  GLushort Indices1[2 * (NR_PARR + 1) * NR_MERID + 4 * (NR_PARR + 1) * NR_MERID];
  for (int merid = 0; merid < NR_MERID; merid++)
  {
    for (int parr = 0; parr < NR_PARR + 1; parr++)
    {
      float u = U_MIN + parr * step_u;
      float v = V_MIN + merid * step_v;
      float x_vf = radius * cosf(u) * cosf(v);
      float y_vf = radius * cosf(u) * sinf(v);
      float z_vf = radius * sinf(u);

      index = merid * (NR_PARR + 1) + parr;
      Vertices1[index] = glm::vec4(x_vf, y_vf, z_vf, 1.0);
      Indices1[index] = index;

      index_aux = parr * (NR_MERID)+merid;
      Indices1[(NR_PARR + 1) * NR_MERID + index_aux] = index;

      if ((parr + 1) % (NR_PARR + 1) != 0)
      {
        int AUX = 2 * (NR_PARR + 1) * NR_MERID;
        int index1 = index;
        int index2 = index + (NR_PARR + 1);
        int index3 = index2 + 1;
        int index4 = index + 1;
        if (merid == NR_MERID - 1)
        {
          index2 = index2 % (NR_PARR + 1);
          index3 = index3 % (NR_PARR + 1);
        }
        Indices1[AUX + 4 * index] = index1;
        Indices1[AUX + 4 * index + 1] = index2;
        Indices1[AUX + 4 * index + 2] = index3;
        Indices1[AUX + 4 * index + 3] = index4;
      }
    }
  }

  glGenVertexArrays(1, &VaoId1);
  glGenBuffers(1, &VboId1);
  glGenBuffers(1, &EboId1);
  glBindVertexArray(VaoId1);
  glBindBuffer(GL_ARRAY_BUFFER, VboId1);
  glBufferData(GL_ARRAY_BUFFER, sizeof(Vertices1), Vertices1, GL_STATIC_DRAW);
  glBindBuffer(GL_ELEMENT_ARRAY_BUFFER, EboId1);
  glBufferData(GL_ELEMENT_ARRAY_BUFFER, sizeof(Indices1), Indices1, GL_STATIC_DRAW);

  glEnableVertexAttribArray(0);
  glVertexAttribPointer(0, 3, GL_FLOAT, GL_FALSE, 6 * sizeof(GLfloat), (GLvoid*)0);
  glEnableVertexAttribArray(1);
  glVertexAttribPointer(1, 3, GL_FLOAT, GL_FALSE, 6 * sizeof(GLfloat), (GLvoid*)(3 * s
izeof(GLfloat)));
  glEnableVertexAttribArray(2);
  glVertexAttribPointer(2, 2, GL_FLOAT, GL_FALSE, 9 * sizeof(GLfloat), (GLvoid*)(3 * s
izeof(GLfloat)));
}
```

```
void DestroyVBO(void)
{
  glDisableVertexAttribArray(1);
  glDisableVertexAttribArray(0);
  glBindBuffer(GL_ARRAY_BUFFER, 0);
  glDeleteBuffers(1, &VboId1);
  glDeleteBuffers(1, &EboId1);
  glBindVertexArray(0);
  glDeleteVertexArrays(1, &VaoId1);
}
void LoadTexture(void)
{
  glGenTextures(1, &texture);
  glBindTexture(GL_TEXTURE_2D, texture);

  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_S, GL_REPEAT);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_T, GL_REPEAT);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
  glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);

  int width, height;
  unsigned char* image = SOIL_load_image("sun.jpg", &width, &height, 0, SOIL_LOAD_RG
B);
  glTexImage2D(GL_TEXTURE_2D, 0, GL_RGB, width, height, 0, GL_RGB, GL_UNSIGNED_BYTE, i
mage);
  glGenerateMipmap(GL_TEXTURE_2D);

  SOIL_free_image_data(image);
  glBindTexture(GL_TEXTURE_2D, 0);
}
void CreateShadersFragment(void)
{
  ProgramIdf = LoadShaders("shaderPlanete.vert", "shaderPlanete.frag");
  glUseProgram(ProgramIdf);
}
void DestroyShaders(void)
{
  glDeleteProgram(ProgramIdf);
}
```

```
void Initialize(void)
{
  glClearColor(0.01, 0.01f, 0.01f, 0.f);
  CreateVBO1();
  CreateShadersFragment();
  objectColorLoc = glGetUniformLocation(ProgramIdf, "objectColor");
  lightColorLoc = glGetUniformLocation(ProgramIdf, "lightColor");
  lightPosLoc = glGetUniformLocation(ProgramIdf, "lightPos");
  viewPosLoc = glGetUniformLocation(ProgramIdf, "viewPos");
  viewLocation = glGetUniformLocation(ProgramIdf, "view");
  projLocation = glGetUniformLocation(ProgramIdf, "projection");
  myMatrixLocation = glGetUniformLocation(ProgramIdf, "myMatrix");
  matrUmbraLocation = glGetUniformLocation(ProgramIdf, "matrUmbra");
  codColLocation = glGetUniformLocation(ProgramIdf, "codCol");
  glUniform1i(glGetUniformLocation(ProgramIdf, "myTexture"), 0);
```

```
  LoadTexture();
  glActiveTexture(GL_TEXTURE0);
  glBindTexture(GL_TEXTURE_2D, texture);
  glUniform1i(glGetUniformLocation(ProgramIdf, "myTexture"), 0);
}
void DrawPlanet(glm::mat4 myMatrix, int codCol = 0)
{
  glBindVertexArray(VaoId1);
  glUniform1i(codColLocation, codCol);
  glUniformMatrix4fv(myMatrixLocation, 1, GL_FALSE, &myMatrix[0][0]);
  for (int patr = 0; patr < (NR_PARR + 1) * NR_MERID; patr++)
  {
    if ((patr + 1) % (NR_PARR + 1) != 0)
      glDrawElements(GL_TRIANGLES, 4, GL_UNSIGNED_SHORT, (GLvoid*)((2 * (NR_PARR + 1)
 * (NR_MERID)+4 * patr) * sizeof(GLushort)));
  }
}
void DrawShadow(glm::mat4 myMatrix)
{
  glBindVertexArray(VaoId1);
  codCol = 1;
  glUniform1i(codColLocation, codCol);
  glUniformMatrix4fv(myMatrixLocation, 1, GL_FALSE, &myMatrix[0][0]);
  for (int patr = 0; patr < (NR_PARR + 1) * NR_MERID; patr++)
  {
    if ((patr + 1) % (NR_PARR + 1) != 0)
      glDrawElements(GL_TRIANGLES, 4, GL_UNSIGNED_SHORT, (GLvoid*)((2 * (NR_PARR + 1)
 * (NR_MERID)+4 * patr) * sizeof(GLushort)));
  }
}
void RenderFunction(void)
{
  glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
  glEnable(GL_DEPTH_TEST);

  // vizualizare + proiectie
  glm::vec3 Obs = glm::vec3(Obsx, Obsy, Obsz);
  glm::vec3 PctRef = glm::vec3(Refx, Refy, Refz);
  glm::vec3 Vert = glm::vec3(Vx, Vy, Vz);
  view = glm::lookAt(Obs, PctRef, Vert);
  glUniformMatrix4fv(viewLocation, 1, GL_FALSE, &view[0][0]);
  projection = glm::infinitePerspective(fov, GLfloat(width) / GLfloat(height), znear);
  glUniformMatrix4fv(projLocation, 1, GL_FALSE, &projection[0][0]);

  // matricea pentru umbra
  float D = 100.0f;
  matrUmbra[0][0] = zL + D; matrUmbra[0][1] = 0; matrUmbra[0][2] = 0; matrUmbra[0][3]
 = 0;
  matrUmbra[1][0] = 0; matrUmbra[1][1] = zL + D; matrUmbra[1][2] = 0; matrUmbra[1][3]
 = 0;
  matrUmbra[2][0] = -xL; matrUmbra[2][1] = -yL; matrUmbra[2][2] = D; matrUmbra[2][3] =
-1;
  matrUmbra[3][0] = -D * xL; matrUmbra[3][1] = -D * yL; matrUmbra[3][2] = -D * zL; mat
rUmbra[3][3] = zL;
  glUniformMatrix4fv(matrUmbraLocation, 1, GL_FALSE, &matrUmbra[0][0]);

  glUseProgram(ProgramIdf);
```

```
  // SOARELE
  matrTrans = glm::translate(glm::mat4(1.0f), glm::vec3(0.0f, 1000.0f, 0.0f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(3.f, 3.f, 3.f));
  glUniform3f(objectColorLoc, 1.0f, 0.4f, 0.2f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);

  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix, 2);

  // MERCUR
  matrTrans = glm::translate(glm::mat4(1.0f), glm::vec3(180.f, -100.f, 0.f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(0.5f, 0.5f, 0.5f));
  glUniform3f(objectColorLoc, 0.45f, 0.57f, 0.7f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(lightPosLoc, 0.f, 1000.f, 0.f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);

  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix);
  DrawShadow(myMatrix);

  // VENUS
  matrTrans = glm::mat4(1.0f) * glm::translate(glm::mat4(1.0f), glm::vec3(-100.0f, -30
0.0f, 0.0f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(0.6f, 0.6f, 0.6f));
  glUniform3f(objectColorLoc, 0.8f, 0.33f, 0.0f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(lightPosLoc, 0.f, 1000.f, 0.f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);

  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix);
  DrawShadow(myMatrix);

  // PAMANT
  matrTrans = glm::mat4(1.0f) * glm::translate(glm::mat4(1.0f), glm::vec3(10.0f, -600.
0f, 0.0f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(0.7f, 0.7f, 0.7f));
  glUniform3f(objectColorLoc, 0.0f, 0.0f, 0.63f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(lightPosLoc, 0.f, 1000.f, 0.f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);

  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix);
  DrawShadow(myMatrix);

  // LUNA
  matrTrans = glm::mat4(1.0f) * glm::translate(glm::mat4(1.0f), glm::vec3(70.0f, -600.
0f, 0.0f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(0.1f, 0.1f, 0.1f));
  glUniform3f(objectColorLoc, 0.7f, 0.7f, 0.7f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(lightPosLoc, 0.f, 1000.f, 0.f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);
```

```
  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix);

  // MARTE
  matrTrans = glm::mat4(1.0f) * glm::translate(glm::mat4(1.0f), glm::vec3(200.0f, -80
0.0f, 0.0f));
  matrScale = glm::scale(glm::mat4(1.0f), glm::vec3(0.5f, 0.5f, 0.5f));
  glUniform3f(objectColorLoc, 0.64f, 0.16f, 0.16f);
  glUniform3f(lightColorLoc, 1.0f, 1.0f, 1.0f);
  glUniform3f(lightPosLoc, 0.f, 1000.f, 0.f);
  glUniform3f(viewPosLoc, Obsx, Obsy, Obsz);

  myMatrix = matrTrans * matrScale;
  DrawPlanet(myMatrix);
  DrawShadow(myMatrix);

  glutSwapBuffers();
  glFlush();
}
void Cleanup(void)
{
  DestroyShaders();
  DestroyVBO();
}
int main(int argc, char* argv[])
{
  glutInit(&argc, argv);
  glutInitDisplayMode(GLUT_RGB | GLUT_DEPTH | GLUT_DOUBLE);
  glutInitWindowPosition(100, 10);
  glutInitWindowSize(1000, 750);
  glutCreateWindow("Sistemul Solar");
  glewInit();
  Initialize();
  glutIdleFunc(RenderFunction);
  glutDisplayFunc(RenderFunction);
  glutKeyboardFunc(processNormalKeys);
  glutSpecialFunc(processSpecialKeys);
  glutAttachMenu(GLUT_RIGHT_BUTTON);
  glutCloseFunc(Cleanup);
  glutMainLoop();

}
```