Universitatea Tehnica din Cluj-Napoca

Facultatea de Automatica si Calculatoare

Materie: Prelucrare Grafica

Proiect: Simulare sistem solar

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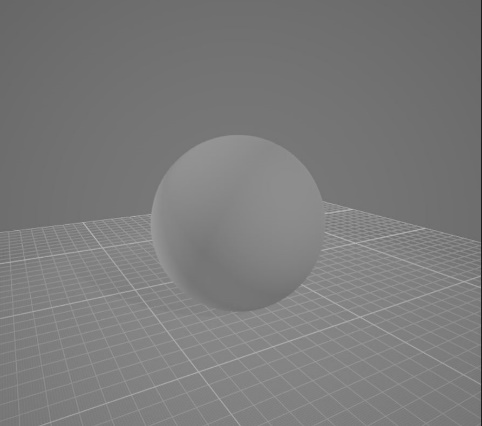
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1. **Prezentarea temei**

Ideea proiectului este de a realiza o simulare 3D a unui sistem solar care sa imite cat mai fidel atat modul in care planetele orbiteaza in jurul soarelui cat si existenta altor obiecte celeste, utilizatorul avand posibilitatea de a manipula intr-un mod interactiv scena.

1. **Scenariul**
   1. Descrierea scenei si a obiectelor

Deoarece simulam un sistem planetar, principalele elemente ale scenei sunt plantele si soarele, acestea fiind modelate folosind doua tipuri de obiecte. Primul tip este un obiect 3D sferic care reprezinta forma majoritatii planetelor, satelitilor naturali si inclusiv a soarelui[1]. Cel de al doilea tip este forma specifica planetei Saturn care pe langa forma sferica are si inele care inconjoara obiectul [2].

O imagine care conține interior, tacâmuri, veselă, bol

Descriere generată automat

Modelele din fisierele “.obj” sunt incarcate si desenate folosind facilitatile clasei “Mode3D”, care contine lista de obiecte de tip mesh precum si colectia de texturi incarcate. Obiectele alese de mine sunt insotite de fisiere “.mtl” care specifica datele de asociere ale texturii pentru obiectul dat, asadar nemaifiind necesar sa o incarcam separat. Maparea texturilor in cazul planetelor, satelitilor naturali si a soarelui se face folosind o singura imagine textura care va infasura obiectul sfera. Texturile planetelor si a soarelui au fost preluate din sursa [6], iar cele ale satelitilor naturali din sursa [7].

Daca fisierele “.mtl” sunt corect folosite atunci texturile se vor mapa automat la incarcarea modelelor, rezultand obiecte de forma:

**Soarele O imagine care conține aliment, exterior, veselă

Descriere generată automat O imagine care conține interior, portocaliu

Descriere generată automat**

**Mercur** O imagine care conține exterior, sport acvatic, val

Descriere generată automatO imagine care conține interior, podea

Descriere generată automat

**Venus O imagine care conține apus

Descriere generată automat O imagine care conține interior, gogoașă, aliment, pâine

Descriere generată automat**

**Pamant O imagine care conține exterior, grup, porțelan

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Marte O imagine care conține natură, apus

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Jupiter O imagine care conține exterior, nisipos, distanță

Descriere generată automat O imagine care conține interior, vas de ceramică

Descriere generată automat**

**Saturn O imagine care conține exterior, apă, plajă, apus

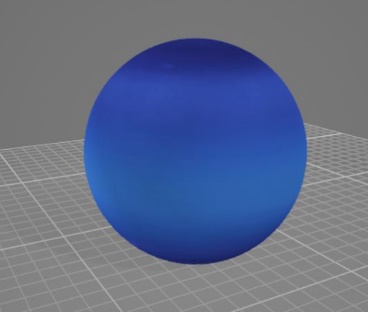
Descriere generată automat O imagine care conține podea, interior, mozaicat, faianță

Descriere generată automat**

**Uranus  O imagine care conține albastru, interior, mozaicat

Descriere generată automat**

**Neptun O imagine care conține natură, nor, cer de noapte

Descriere generată automat **

**Luna (satelit Pamant) O imagine care conține exterior, natură, val

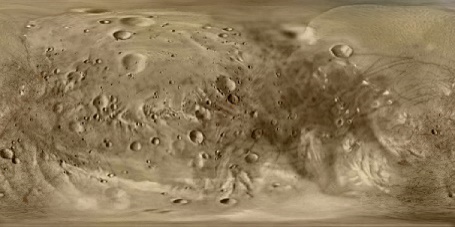
Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Phobos (satelit Marte) O imagine care conține exterior

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Deimos (satelit Marte)  O imagine care conține interior, muzică

Descriere generată automat**

**Europa (satelit Jupiter) O imagine care conține exterior, echitație, val, mal

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Io (satelit Jupiter) O imagine care conține aliment, veselă, închidere, desert

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Ganymede (satelit Jupiter) O imagine care conține exterior, apă, val, ocean

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Callisto (satelit Jupiter) O imagine care conține apă, exterior, mamifer acvatic, mamifer

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Titan (satelit Saturn) O imagine care conține natură, nor, apus

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Titania (satelit Uranus) O imagine care conține exterior

Descriere generată automat O imagine care conține interior

Descriere generată automat**

**Triton (satelit Neptun) O imagine care conține apă, surf, val, exterior

Descriere generată automat O imagine care conține interior

Descriere generată automat**

Pentru a completa scena am mai adaugat cateva obiecte spatiale inspirate din Star Trek care intruchipeaza nave spatiale [3] [4] si satelit artificial [5], texturarea acestora facandu-se de asemenea implicit prin specificarea imaginilor in fisierul “.mtl”.

O imagine care conține podea, interior

Descriere generată automat O imagine care conține podea, interior

Descriere generată automat

O imagine care conține podea

Descriere generată automat ![O imagine care conține podea, interior

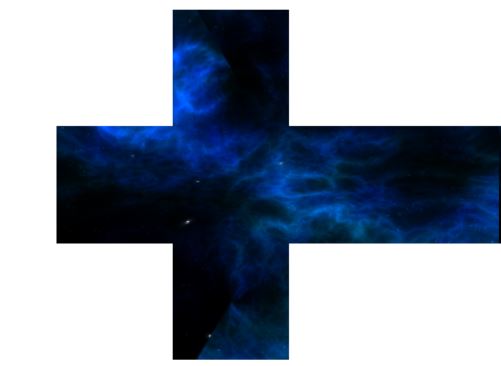
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automat](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEl1bGlhAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAMyNgAAkpIAAgAAAAMyNgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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O imagine care conține podea

Descriere generată automat O imagine care conține podea

Descriere generată automat

De asemenea, pentru “fundal” am folosit un skybox (sursa [10]), un cub cu texturi aplicate pe fiecare fata in interiorul caruia includem scena:

 ![O imagine care conține închis, cer de noapte

Descriere generată automat](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEl1bGlhAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAMzMAAAkpIAAgAAAAMzMAAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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* 1. Functionalitati

Una din functionalitatile esentiale ale proiectului consta in vizualizarea scenei utilizand atat tastatura cat si mouse-ul. Utilizatorul are posibilitatea de a se plimba prin scena si de a roti camera folosind tastele. De asemenea, utilizand butonul de scroll al mouse-ului se poate observa efectul de zoom in/ zoom out. La rularea executabilului si apasarea tastei corespunzatoare scena va fi afisata folosind o animatie de prezentare.

Pentru a crea o scena mult mai vivanta si fotorealista planetele efectueaza doua tipuri de animatii. Prima animatie consta in rotatia planetelor in jurul axei proprii (axa Y). Viteza rotatiei prograde este distincta pentru fiecare tip de planeta, parametrul “angle” fiind modificat conform tabelului din resursa [8]. Cea de a doua animatie se refera la rotatia planetelor in jurul soarelui, numita miscare de revolutie. Desi in lumea reala planetele se misca dupa o orbita de forma eliptica, putin inclinata si decentrata in functie de planeta, pentru simplitate si estetica vizualizarii am considerat orbitele sub forma circulara. Pentru a crea iluzia miscarii circulare am translatat obiectele la coordonatele x si y aflate daca se cunosc raza (distanta de la soare la planeta) si unghiul corespunzator fiecarei planete, conform formulelor:

x = radius \* sin(PI \* 2 \* angle / 360);

y = radius \* cos(PI \* 2 \* angle / 360);

Viteza de rotatie in jurul soarelui se poate mari incremenand variabila “speed”.

Utilizatorul poate decide daca miscarea de revolutie sa fie activata sau nu utilizand tastele. De asemenea, acesta poate activa prin intermediul tastaturii afisarea satelitilor naturali ai planetelor precum si a catorva obiecte spatiale: un satelit artificial care se roteste langa soare precum si o nava extraterestra care orbiteaza in preajma Pamantului. La apasarea butonului stanga al mouse-ului se va genera o nava spatiala la o pozitie aleatoare pe ecran.

Alta functionalitate este data de posibilitatea de a opta daca se doreste utilizarea unei surse de lumina punctiforme (Soarele) sau a unei surse directionale (un obiect astral ipotetic care orbiteaza in sistemul solar si lumineaza scena), precum si daca sa se genereze umbre in cazul utilizarii sursei directionale.

Nu in ultimul rand, s-a implementat vizualizararea scenei in modurile solid, wireframe, punctiform si smooth, schimbarea acestora facandu-se utilizand tastele.

1. **Detalii de implementare**
   1. Functii si algoritmi
      1. Solutii posibile
2. Functiile pentru desenarea si miscarea obiectelor

* Sunt denumite in mod generic renderNumeObiect() si au ca rol specificarea transformarilor model pentru fiecare obiect infividual, necesare pozitionarii obiectului in scena transferand varfurile obiectului din spatiul local in spatiul global
* Principalele operatii efectuate sunt de translatie, scalare si rotatie, asigurand realizarea animarii obiectelor
* Pentru aceasta se poate folosi matricea model din initUniforms() trimisa catre shader la locatia modelLoc, setand valorile necesare obiectelor pentru fiecare tip de transformare si reactualizand matricea pentru fiecare nou obiect desenat
* O alta metoda al carui scop este identic este de a folosi o matrice model unica pentru fiecare obiect desenat, dar care sa fie trimisa la o locatie comuna pentru distingerea mult mai clara a proprietatilor specifice fiecarei planete
* Abordari diferite pot exista si in cazul simularii rotatiei planetelor in jurul soarelui, aceasta putandu-se face folosind rotatii, translatii succesive pe conturul unei elipse sau translatii pe conturul unui cerc
* Nu in ultimul rand, este importanta si alegerea valorilor numerice in cadrul scalarii si translatiilor, scena putand fi trasata fie prioritizand estetica, fie prioritizand simularea realitatii
* Dupa ce toti acesti parametri au fost setati obiectul este desenat apeland functia “draw” din clasa Model3D
* Toate aceste functii de render vor fi apelate in cadrul functiei drawObjects() iar aceasta in renderScene() pentru a desena scena

1. Iluminarea scenei

* Sursele de lumina fotorealise depind de dimensiune, forma, culoare si intensitate, acestea putand sa genereze lumini: directionale, pozitionale sau de tip reflector
* Pentru a le simula avem nevoie de utilizarea unor modele de iluminare(locala sau globala) pentru a descrie matematic modul in care lumina interactioneaza cu suprafata obiectelor
* Exista mai multe optiuni de modele de iluminare, printre care:
* Modelul Gourand: model de iluminare cu pipeline fix clasic care calculeaza iluminarea per-varf prin specificarea componentelor ambientale, speculare si difuze
* Modelul Phong: asemanator modelului Gourand insa calculul se face per-pixel in fragment shader folosind normalele interpolate in loc sa se foloseasca normalele varfului
* Modelul Blinn-Phong: versiune modificata a modelului Phong care imbunatateste reflexiile speculare prin utilizarea unui semi-vector in locul vectorului de reflexie pentru a calcula componenta speculara

1. Umbrirea scenei

* Pentru cresterea fotorealismului pot fi activate umbrele care au scopul de a lua in calcul ocluziile, permitand o perceptie mai profunda a adancimii
* Exista numerosi algorimi de calcul a umbrelor printre care Ray Tracing si Radiosity pentru modele de surse de lumina globala si Scan line, Shadow volumes sau Shadow Z-Buffer utilizate atunci cand exista modele de surse de lumina locala
  + 1. Motivarea abordarii alese

1. Functii pentru desenarea si miscara obiectelor

* Am considerat o matrice individuala pentru fiecare obiect desenat deoarece consider ca aceasta abordare faciliteaza alegerea valoriilor numerice utilizate in scalarea si translatarea obiectelor
* Astfel, fiecare planeta este translatata si scalata relativ la Soare fiind mult mai usor sa respectam dimensiunile si proportiile din cadrul scenei. Satelitii naturali ai planetelor au fost considerati relativ la planetele in jurul carora orbiteaza
* In cazul rotatiei in jurul soarelui am ales ca orbita planetelor sa aiba un contur de cerc deoarece este mai usor de modelat din punct de vedere matematic
* Pentru alegerea valorilor numerice in cazul distantei intre planete, dimensiunea obiectelor si viteza de miscare am facut un compromis intre simularea realitatii si estetica. Astfel, viteza cu care se misca planetele imita realitatea folosind valorile din resursa [8] insa distanta intre planete si dimensiunea acestora a fost aleasa arbitrar pentru a fi frumoasa scena deoarece daca as fi respectat proportiile ar fi fost discrepante mult prea mari intre obiecte. Totusi, daca se doreste o simulare mai reala a distantei dintre obiecte se poate schimba in cod constanta “scale” utilizata in fiecare translatie

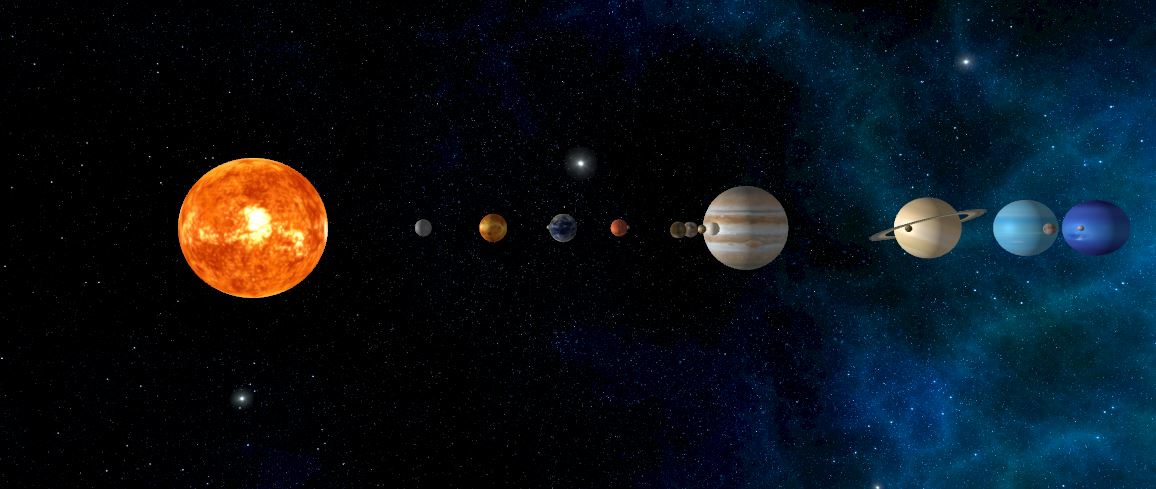
1. Iluminarea scenei

* Potrivita scenei mele este utilizarea unei surse de lumina punctiforme pozitionata in centrul soarelui pentru a lumina uniform si radial in toate directiile, razele estompandu-se in functie de distanta
* Pentru configurarea acestei surse am folosit modelul Blinn-Phong deoarece acesta imbunatateste performanta, evitand calculul costisitor al vectorului de reflexie
* Efectul de atenuare este asigurat de calculul coeficientului de atenuare ca o functie patratica deoendenta de distanta
* In scop didactic am adaugat o a doua sursa de lumina directionala a carei pozitie poate fi modificata pentru a lumina diferit obiectele din diverse unghiuri, modelul utilizat fiind Phong
* Cele doua surse de lumina sunt exclusive pentru a evidentia diferenta dintre cele doua surse de lumina
* Am utilizat de asemenea harti de iluminare care furnizeaza un mijloc de esantionare a culorii de baza pentru fiecare fragment dintr-o textura, acestea fiind incorporate in proprietatile modelelor specificate in fisierul “.mtl”

1. Umbrirea scenei

* Am ales metoda Shadow Mapping deoarece este usor de implemetat si ofera rezultate relevante
* Ideea principala este de a utiliza texturi de adancime pentru a decide daca un punct se afla in umbra prin utilizarea unei tehnici multi-trecere: se rasterizeaza prima data scena din punct de vedere al luminii, apoi din punct de vedere al observatorului
  1. Modelul grafic

Modul in care obiectele prezentate in sectiunea 2.1 se integreaza in scena e observabil in urmatoarele capturi de ecran:



![O imagine care conține stea, obiect în aer liber, cer de noapte

Descriere generată automat](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEl1bGlhAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM4NAAAkpIAAgAAAAM4NAAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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nJJOSTQAlLj5c8dfWkooAKXJIGTwBgUlL6A9KAAYBGf0NGTtA4wCT05/OldzI+4gA4H3VA6cdqRQWYKO5wM0AJijFKcjIz0pMc4oAXqMAAf1pKOlORgrZZFfjo2f6UANozxRR9KAClOCeMgY/Wg8cd6Q0wCnpkuBHu3NwMH14xTfvNQOD9O4oEK6hXIVtw7HHWkx8p9c0lFADlxu5GRgjrjntSEbSQQQenWgkdh9aGcsxZiWJOSSc5oGGM5IGAKU4O0DOcc5PGf6dqTJ2Y7E/wCf50Fjt2nGAc9OfzoAcNquQwOBkcEGmk+nSkxg80vQ8jtQIXPAHb604PsYhduc43jPTBH5c+lM69Owoz6cVV7gKQTxjn09aXac7U+bJ4IHU0cBOM7snJzwRTvKbfsyM7d556jbu/lQAxQNx39MHoe/b9afj92GUYRuPmwckDn+f60wN2I4704AY3Dse9XBCYfw4/OlLDHC4OTlsnoccfz/ADpF4H9aTPJ78Vq9hEkz+ZgqSEGQiM+7aOv8yfzNNRRuOWUbRkbsnd7cUjEBkJGR1PvzQTlQOmKQEhjZJHSRCrrnKv8AKQfof5U0JwCQQDnBpWIEagKAck7u/bj0x/iaar7SO4BztPQ+taqwg6ccEdTSbCBk9M4pxG3G7v6D6ikLkjB6Yxzz3z+FJpMBUJXkdFqVZiQcLkZ4xTYiE2yNllRwdpPX2/GmxNhwO2c+/wCdNaEtJllgnVSTzxkdqXqOWDHt7UmSjApg7eRuGR+R4qOMMmPm56gjtVXszO10WIhnfggkKSTgHPfv7+najzBtGWySeQBjH+eaa42bWPVsnjjjOP6GhZDGDsYqenHcH1q0yGhz7ZFyO3TJ/So24bhQOPWpgpChs5BXIz6Zx/SmkA9elTISdiNsD7rZA4HGCaZk47VIXLMCOPwpjMOg6Z796zkWh3y5zkt1AyMfTvS+WQzI4CMgOQ4IOR2+tM6qSfwpSQFGBzjBye+aSsMcI5WjfAJVfmY+nIGf1p/kgRA+YCc4KjPHv6Y/XrTBlhyx9T/KrDajKdPFl8oh8zzMBVzuxjO7GcY7ZxVpJEu/QiEWeHIX3/DpTwu3bj5QRnr1qPztzvlF+foBxt+n8qkJBHI4A9aq6Id+pev7+41BYpLq5MphQRxqTjy1HICjoFyTgDpzxUUSCVVWJWd8nIA6jtioF+YhT1B9KlTaZEjAOWIy2au93qYtWVkPdQMY5+qinRqnc7OOwyc44/WhWXBBGcjrnpT2G7p1+9k9fetF3M79BrnezOduGJ6AD9O1OV8MOAw9xgf5FRsoPK5BA5pyjOATkdqtMWli7EzeWRngn8KkA+U4PfOfWoBldoB9xz0/ziplwFGfqa3TOWQu5kYq4KkcEHgimmXcxOeM0gAE377cyjG/BwSOOhOcVI8Dwxwyu/EgJGDk4yw/9lNF2wshGlLLtzu789vp+VNXh+eCRkc47e9Mxk9SeO9PdmkUb2LbRgZOcD0qG29wskNYqQSQWZh1J6HNHlAj5e3v3pYkQhtxIOBtAGc8/XirKICnOSexz0oSuKUuUrbBkjGfQ1f0q3tWuV/tBJ2tV5laADeq9OM8dSOtRyKgTbsAZSTuycn29KiMrDC9h2qlaL1IbcloOlQRtwOB0z6UxpACVXgAnGRSSSsdu7o3PH5UxjtwTzkVMn2Go6akxfzN8kkpMjMOG53Zzkk/l+dNI53MvBGflPSoAx+YjqOQakiLMC2eAOR+n9ai4+WxJ5e4HBpHjXzCqP8AIDwXGCfwGasrGvlKQTkj075/+tTJsIxRo0LKSCcnmm4malqf/9k=)

* 1. Structuri de date

Structuri de date utilizate in realizarea proiectului sunt:

* std::vector<const GLchar\*> faces; pentru retinerea fetelor cubemap-ului
* struct WindowDimensions dim; pentru retinerea dimensiunilor ferestrei
* gps::Camera myCamera(

glm::vec3(45.0f, 5.0f, 250.0f), //camera position

glm::vec3(0.0f, 0.0f, -10.0f), //camera target

glm::vec3(0.0f, 1.0f, 0.0f)); //camera Up

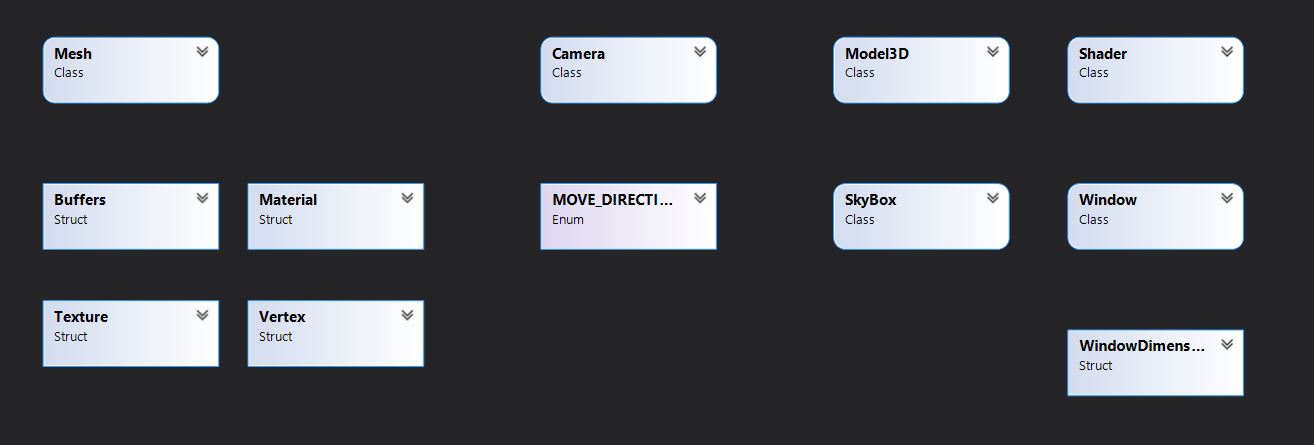
contine cei trei vectori corespondenti

* 1. Ierarhia de clase

In cadrul acestui proiect am utilizat multiple clase predefinite care au facilitat crearea scenei, printre acestea enumerandu-se:

* Mesh: folosita pentru desenarea si specificarea obiectelor
* Model3D: cu rol in incarcarea si desenarea obiectelor 3d complexe, continand o lista de obiecte de tip “mesh”
* Shader: citeste, incarca, compileaza si leaga shaderele
* Window: scopul principal este de creare a ferestrei de vizualizare
* Skybox: utilizata in maparea obiectului de tip cubemap

Acestora li se adauga clasa Camera in care am specificat constructorul camerei, pozitia acesteia precum si modul in care aceasta efectueaza miscarea sau rotatia. (mod de functionare preluat din [9])



1. **Manual de utilizare**

Metodele prin care utilizatorul interactioneaza cu scena sunt utilizarea mouse-ului si a tastaturii. Tastele sunt folosite atat pentru procesarea miscarii scenei cat si in cadrul interactiunii, functionalitatea acestora fiind urmatoarea:

* Tasta “W”: miscarea camerei inainte
* Tasta “S”: miscarea camerei inapoi
* Tasta “A”: miscarea camerei la stanga
* Tasta “D”: miscarea camerei la dreapta
* Tasta “Up”: incrementare pitch, rotirea camerei in jurul axei X
* Tasta “Down”: decrementare pitch, rotirea camerei in jurul axei X
* Tasta “Right”: incrementare yaw, rotirea camerei in jurul axei Y
* Tasta “Left”: decrementare yaw, rotirea camerei in jurul axei Y
* Tasta “J”: decrementare a unghiului sursei de lumina directionala
* Tasta “L”: incrementare a unghiului sursei de lumina directionala
* Tasta “Z”: incrementare a vitezei de rotatie a planetelor in jurul Soarelui
* Tasta “X”: decrementare a vitezei de rotatie a planetelor in jurul Soarelui
* Tasta “Y”: alternare intre sursa de lumina punctiforma sau directionala
* Tasta “U”: activarea/dezactivarea umbrelor cand folosim lumina directionala
* Tasta “I”: alternare intre vizualizarea scenei in modul wireframe sau solid (daca nu e activat punctiform)
* Tasta “P”: alternare intre vizualizarea scenei in modul punctiform sau solid
* Tasta “O”: activarea/dezactivarea vizualizarea scenei in modul smooth
* Tasta “C”: activarea animatiei de prezentare (trebuie pornita pentru a putea vizualiza scena)
* Tasta “M”: activarea miscarii de revolutie a planetelor
* Tasta “B”: activarea afisarii satelitilor naturali
* Tasta “N”: activarea afisarii celorlalte obiecte spatiale (nava spatiala si satelitul)

Mouse-ul face posibila interactiunea cu scena astfel:

* Butonul de scroll: la miscarea acestuia se mareste/scade spatiul de vizualizare creand efectul de zoom in/ zoom out
* Butonul “Left”: la apasarea acestuia se preiau coordonatele x si y si se afiseaza o nava spatiala la pozitie aleatoare fata de acestea
* Pozitia cursorului: am implementat un callback pentru rotirea camerei in scena utilizand pozitia cursorului insa aceasta functionalitate este comentata deoarece se aceasta functionalitate realizeaza mai usor utilizand tastele deoarece avem mai mult control

O alta functionalitate implementata este redimensionarea ferestrei pentru o vizualizare in detaliu a scenei, aceasta facandu-se tragand de marginile ferestrei de vizualizare sau accesand icon-ul de “Full Screen”.

1. **Concluzii si dezvoltari ulterioare**

Conclusiv, pot spune ca acest proiect cumuleaza o parte din avantajele utilizarii graficii pe calculator deoarece reuseste sa simuleze o scena fotorealista cu rol atat estetic cat si didactic. Respectarea a trasaturilor geografice esentiale, texturarea apropiata de aspectul real al corpurilor, utilizarea luminii punctiforme pentru a simula Soarele si miscarea camerei in cadrul scenei confera autenticitate si veridicitate sistemului.

Ca dezvoltari ulterioare putem adauga mai multe obiecte in scena sau sa cream animatii si functionalitati mai vivante care sa imite ploi de asteroizi sau comete, punerea in evidenta a constelatiilor. O alta imbunatatire ar fi folosirea unor modele diferite pentru planete deoarece nu toate au o forma perfect sferica, precum si respectarea proportiilor reale pentru a reprezenta verosimil realitatea. O reprezentare maximala a dezvoltarilor ce pot fi adaugate este space explorerul din resursa [11] care a reprezentat o sursa de inspiratie in alegerea temei.

1. **Referinte**

Materialele bibliografice care au ajutat la realizarea proiectului sunt preluate din urmatoare surse:

[1] - <https://free3d.com/3d-model/sun-v2--446713.html>

[2] - <https://free3d.com/3d-model/saturn-v1--741827.html>

[3]- <https://free3d.com/3d-model/uss-enterprise-ncc-1701-3608.html>

[4] - <https://free3d.com/3d-model/negh-var-class-klingon-spaceship-56412.html>

[5] - <https://free3d.com/3d-model/satellite-v1--384167.html>

[6] - <https://www.solarsystemscope.com/textures/>

[7] - <http://www.planetaryvisions.com/TM_intro.php?pid=4206>

[8] - <https://nssdc.gsfc.nasa.gov/planetary/factsheet/>

[9] - <https://learnopengl.com/>

[10] - <https://opengameart.org/content/space-skyboxes-0>

[11] - <https://www.solarsystemscope.com/>