SOLAR SYSTEM

A sophisticated 3D solar system simulation with real astronomical data, interactive controls, and a property editor for educational experimentation.

Requirements

```
pip install numpy pygame PyOpenGL PyOpenGL-accelerate PyGLM pygltflib Pillow
```

How to Start

```
python run.py
```

Main Features

Interactive 3D Environment: Mouse and keyboard controls

Realistic Models: High-quality GLB planet models

Property Editor: Real-time modification of planetary properties

Scientific Accuracy: Based on real astronomical data

Smooth Animations: Professional camera transitions and orbital mechanics

Controls Summary

Keys 1-9: Select planets (1=Sun, 2=Mercury, etc.)

Mouse Drag: Rotate camera

Mouse Wheel Zoom in/out

Space: Pause/Resume

Notes

- Face forward of planets not fixed
- Saturn not rotating in right position
- No mass edit
- No realistic changes to planet after changing properties like weather changes, turning into a blackhole after a certain range, etc…
- No orbits visible due to realism
- Not accurate positions in real time since there is no NASA API

Core Python Files

main.py (998 lines)

The main application file containing the complete solar system simulation

Contains the SolarSystem class that manages the entire 3D simulation

Includes the Planet class for individual celestial bodies

Contains the Camera class for 3D navigation and planet tracking

Has the `Starfield` class for the background star field

Contains the PropertyEditorCommunicator class for communicating with the property editor

Defines PlanetConfig dataclass with planet properties (diameter, distance, mass, etc.)

Handles OpenGL rendering, physics updates, and user interactions

run.py (310 lines)

Bootstrap/launcher script that sets up the environment before running the main application

Checks and installs missing Python dependencies (numpy, pygame, PyOpenGL, etc.)

Creates required directories (models/, shaders/)

Creates default shader files if they don't exist

Creates placeholder GLB model files for missing planet models

Creates the glb_loader.py file if it doesn't exist

Runs the main application after setup

property_editor.py (259 lines)

Standalone GUI application for editing planet properties in real-time

Uses tkinter to create a property editing interface

Monitors JSON files to communicate with the main application

Allows editing of planet properties like rotation speed, orbit speed, scale, diameter, distance

Provides reset buttons for position, all properties, and entire simulation

Updates properties dynamically without restarting the main simulation

glb_loader.py (358 lines)

Handles loading and rendering of 3D GLB (GLTF binary) model files

Creates OpenGL vertex arrays and buffers for planet models

Generates sphere meshes as fallbacks when GLB files can't be parsed

Manages vertex attributes (position, color, normal) for 3D rendering

Provides the GLBLoader class used by planets to load their 3D models

shader.py (56 lines)

Manages OpenGL shader programs for 3D rendering

Loads and compiles vertex and fragment shaders from GLSL files

Provides the Shader class with methods to use shaders and set uniforms

Handles shader compilation errors and cleanup

Shader Files

shaders/vertex.glsl (37 lines)

Vertex shader that processes 3D vertex positions

Handles model, view, and projection matrix transformations
Passes vertex data to the fragment shader

shaders/fragment.glsl (58 lines)

Fragment shader that calculates pixel colors
Implements basic lighting with ambient and diffuse components
Handles both planet surfaces and star field rendering

Data Files

property_data/current_planet.json

JSON file containing the currently selected planet's properties
Used for communication between the main app and property editor

property_data/property_changes.json

JSON file containing property changes made in the property editor
Monitored by the main application to apply real-time updates

3D Model Files

models/ directory

Contains GLB (GLTF binary) files for each celestial body:
sun.glb, mercury.glb, venus.glb, earth.glb, mars.glb, jupiter.glb, saturn.glb, uranus.glb, neptune.glb