Orrery Web App: Near-Earth Objects Visualization

1. Introduction

The Orrery Web App is an interactive visualization tool that displays Near-Earth Objects (NEOs) in relation to our solar system. It provides a dynamic, real-time representation of celestial bodies, including planets, Near-Earth Comets (NECs), Near-Earth Asteroids (NEAs), and Potentially Hazardous Asteroids (PHAs). This project aims to engage and educate users by allowing them to explore the orbits of these objects, understand their trajectories, and view detailed information.

Project Overview

The Orrery Web App dynamically showcases NEOs using NASA resources to accurately determine their orbits. The app features an interactive 3D model of the solar system, allowing users to view celestial objects, track their movements, and explore NEO data from NASA's NeoWs API.

2. Features

Interactive 3D Visualization: Use Three.js for rendering the solar system and NEOs.

Real-time NEO Display: Fetches updated data from NASA NeoWs API.

Categorization: Objects categorized into NECs, NEAs, and PHAs for easy identification.

Time Controls: Adjust the display to view NEO positions on specific dates or fast-forward/backward in time.

Detailed Information: View characteristics (size, orbit details) by clicking on celestial bodies.

Search Functionality: Find specific NEOs by name, designation, or date.

Customizable Display Options: Toggle orbit paths, labels, and change visual styles.

3. Implementation Details

3.1 Technology Stack

Frontend: HTML, CSS, JavaScript

3D Rendering: Three.js (v130.0)

APIs: NASA NeoWs API for real-time NEO data, NASA Near-Earth Comets API

3.Data Flow

The app loads initial solar system data from a static configuration file.
NEO data is got from NASA's NeoWs API on demand.
The frontend renders the 3D orrery using Three.js based on fetched data.
User interactions (clicks, searches) trigger updates to the visualization.

4. Usage Instructions

4.1 Navigation

Mouse/Touch Controls: Use your mouse or touch gestures to rotate, zoom, and pan the solar system view.
Select Celestial Bodies: Click on any NEO, planet, or object to view detailed information in the side panel.
Time Controls: Use the time slider or buttons to adjust the date and visualize the future or past positions of NEOs.

4.2 Filtering and Search

Filter Options: Toggle to show or hide NECs, NEAs, PHAs, or specific planetary objects using filter checkboxes.
Search: Enter an NEO name, designation, or specific date into the search bar to locate it in the 3D view.

4.3 Customization

Settings Panel: Open the settings panel to adjust visual elements like orbit paths, labels, and colours. You can also select predefined colour schemes for a more personalized experience.

5. Future Enhancements

Planned features include:

- Integration with additional data sources for enhanced NEO information.
- Implementation of predictive algorithms for future NEO positions.
- Virtual reality (VR) support for immersive exploration experiences.
- Collaborative features allowing users to share discoveries and annotations.

6. **Resources**

   NASA Small Bodies Database: https://ssd.jpl.nasa.gov/sbdb_query.cgi

   NASA Near-Earth Comets API: https://api.nasa.gov/api.php?command=orbital_elements&element_type=NEAR_EARTH_COMETS&start_date=2023-01-01&end_date=2023-12-31&format=json

   Three.js Documentation: https://threejs.org/docs/

   NASA Jet Propulsion Laboratory's Horizons Ephemeris System: https://ssd.jpl.nasa.gov/horizons.cgi

7. **Contributions**

   The tutorials below contributed to development of the app since they were used as a base for designing the app;

   https://youtu.be/wCYpLcyrEf4?si=QpwOH7AcRtPoK8G9

   https://youtu.be/q8H0gQdLem0?si=OkYscdNwUShepN-l