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“Novalyn: A Web-Based Real-Time Stargazing Platform for Astronomical Visualization”

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Abstract— There are still not enough structured and guided stargazing opportunities because of environmental factors, a lack of astronomical tools, and a lack of knowledge in the field. This paper talks about Novalyn, a web-based real-time astronomical visualization and celestial information system that uses standard browser technologies to create an interactive and easy-to-use stargazing environment. The suggested system uses HTML5, CSS3, and JavaScript to create a client-side architecture. The HTML5 Canvas API is used to make a real-time sky rendering module that plots celestial objects based on astronomical coordinate parameters, specifically Right Ascension (RA) and Declination (Dec). Structured datasets saved in JSON format are used to show well-known stars and constellation maps, which makes it possible to see constellations clearly in a simulated night sky.

The system has an educational module that is divided into categories for stars, planets, galaxies, and moons, in addition to visualization. The visualization interface and educational pages are linked in a way that lets users easily move from seeing celestial objects to reading about them. The platform also has a celestial events module that uses external weather-based API data to show event visibility information based on location and keep track of the countdown in real time.

The overall architecture focuses on modular design, real-time rendering, data-driven visualization, and browser-based access without needing special hardware or installation. The system shows how modern web technologies can be used to make a platform for learning about and observing astronomy that is interactive.

Keywords— Web-based stargazing, astronomical visualization, HTML5 Canvas, celestial event tracking, constellation mapping, astronomy education, interactive sky simulation.

I. INTRODUCTION

Astronomy has historically been a major part of scientific progress and human curiosity. But for many people, practical engagement with observational astronomy is still limited because of light pollution, not being able to get to telescopes, and not having enough guided learning resources. Many digital platforms offer astronomical information, but most of them either focus on static educational content or complicated simulation tools that need special software and a lot of technical know-how.

Modern web technologies are now widely available, and browser-based applications have become a lightweight and scalable way to visualize scientific data. HTML5, JavaScript rendering engines, and better ways to handle structured data have all made it possible to run graphical simulations in real time right in a web browser. These features make it possible to make interactive astronomical systems that are both easy to use and teach you something.

The goal of this project is to create and build Novalyn, a web-based real-time stargazing and celestial information platform that combines sky visualization, constellation mapping, educational content, and event tracking into one system. Using astronomical coordinate parameters and structured datasets, the system dynamically renders celestial objects, allowing users to see recognizable star patterns in a simulated night sky.

The platform not only lets you see things, but it also connects observational interaction with structured learning modules. This makes sure that you can go from identifying celestial objects to understanding concepts. A location-aware event module makes the program even easier to use by giving you real-time access to astronomical information that is relevant to your location.

This paper shows how to design, build, and test the proposed system. The project shows how to use client-side web technologies to make an interactive astronomy platform that is accurate, useful for learning, and easy to use.

II. LITERATURE REVIEW

A. Astronomical Visualization and Digital Sky Simulation

By offering interactive depictions of celestial objects, astronomical visualization technologies significantly contribute to the advancement of astronomy education and observational analysis. Users can investigate astronomical surroundings using digital sky simulation software without the need for actual telescopes or observational tools. The study by Zotti et al., which investigates the application of the Stellarium planetarium software in cultural astronomy research, is among the most well-known examples.

The work shows how computer-based simulation can facilitate educational investigation of celestial phenomena and replicate historical night sky [1]. These technologies demonstrate how crucial computational tools are to creating accessible astronomy learning settings.

In the same way, Mink unveiled the SKYMAP software system, which is intended to organize star catalog data and create astronomical sky maps. The study highlights how crucial precise coordinate systems and data processing methods are for depicting celestial objects in digital sky environments [2]. These systems serve as the basis for contemporary platforms for astronomy visualization.

B. Astronomical Data Processing and Visualization Frameworks

Large-scale processing and display of astronomical datasets has been the subject of several studies. Shamir demonstrated the significance of scalable computational systems in astronomical data analysis by proposing a panoramic astronomical pipeline that could effectively process massive observational datasets [3]. When processing observational data gathered from telescopes and sky surveys, these pipelines are quite helpful.

Sky dome modeling techniques have also been used to visualize celestial orientations. Star positions and astronomical alignments can be intuitively represented with Zotti's sky-dome visualization framework, which maps celestial coordinates onto spherical settings [4]. This method enhances astronomical visualization systems' precision and readability.

The Montage software framework, introduced by Jacob et al., is another significant contribution to astronomy visualization. By merging several observational photos, it is possible to create science-grade astronomical image mosaics [5]. Further research by Berriman and Good showed how well Montage works for handling complicated image files and creating high-resolution astronomical visuals [6].

C. Representation and Analysis of Large Astronomical Datasets

Large astronomical datasets must be represented using effective computing frameworks that can handle spherical data structures. The HEALPix framework, developed by Górski et al., offers a hierarchical pixelization technique for discretizing data on spherical surfaces [7]. In astrophysics, this technique is now commonly used for the analysis of large-scale astronomical surveys and cosmic microwave background data.

Software for processing observational data from telescopes and space missions has also been developed. A thorough framework for processing, calibrating, and visualizing radio astronomical data is offered by the Common Astronomy Software Applications (CASA) system [8]. These systems show how contemporary astronomical research is supported by computational software environments.

D. Web-Based Astronomical Visualization Systems

Recent developments in web technology have made it possible to create browser-based platforms that can interactively visualize astronomical data. Van der Walt et al. launched SkyPortal, a web-based platform for managing and visualizing observational astronomy datasets in real time [9]. The system illustrates the usefulness of browser-based visualization environments by enabling users to access astronomical data via online interfaces.

Interactive visualization methods for scientific datasets have been investigated in other studies. Borkin et al. looked into ways to make complex data visualizations easier for users to interact with, emphasizing the significance of user-friendly interfaces for efficient data interpretation [10]. These guidelines are especially pertinent to educational astronomy websites where user involvement and accessibility are crucial.

III. PROBLEM DESCRIPTION

People of all ages are curious and interested in astronomy, but many novices find it challenging to engage in actual stargazing because there aren't many easily accessible and user-friendly tools. Many planetarium software systems and astronomy apps currently in use are intended for professional use and may require prior technical knowledge in order to function properly. Beginners and casual learners find it difficult to comfortably explore the night sky due to its intricacy.

The lack of integrated educational advice is another drawback of the astronomy systems available today. Although some systems offer sky visualization, they frequently don't provide organized descriptions of the celestial objects on display. Because of this, users might see stars or constellations but find it difficult to comprehend their significance without using outside educational resources.

Furthermore, it can be challenging for users to effectively track celestial occurrences like lunar phases, planetary alignments, and meteor showers because information about them is often dispersed across multiple sources.

A streamlined platform that integrates celestial event notices, beginner-level educational information, and real-time sky imagery into one easily accessible system is required. By offering an integrated and user-friendly stargazing environment, Novalyn, the suggested web-based program, seeks to overcome these issues.

IV. SYSTEM ANALYSIS

A. Existing System Analysis

Numerous current stargazing applications currently offer very detailed sky simulations and sophisticated astronomy instruments. However, these applications may be difficult for novices to comprehend and are frequently made for seasoned astronomy lovers.

Certain systems demand extensive prior knowledge of astronomical terminologies and navigation, with a primary focus on professional sky mapping. Furthermore, a lot of apps are mobile-based and might not necessarily give novice users straightforward instructional explanations.

This intricacy may make it challenging for novices who want to learn about the night sky to comfortably investigate astronomy with the instruments now available.

B. Proposed System

The goal of the suggested system is to develop an instructional and beginner-friendly stargazing platform that enables users to effortlessly explore the night sky without the need for astronomical expertise.

Using astronomical coordinate conversions like Right Ascension, Declination, Local Sidereal Time, Altitude, and Azimuth, the system will create a real-time sky display. Based on the user's location and the current time, these computations enable the system to accurately identify the positions of stars and other celestial objects.

To help viewers comprehend what they are seeing, the technology will also offer educational material on prominent celestial objects in addition to visualization. A celestial event reminder system that alerts users to significant impending astronomical events will also be included in the program.

V. SYSTEM ARCHITECTURE



Figure 1: System Architecture of the Proposed Web-Based Stargazing Application

The user interacts with the program using a web interface created with HTML, CSS, and JavaScript in the browser-based architecture of the proposed system. Three main modules are accessible through the user interface: the celestial event reminder system, the educational module for learning about celestial objects, and the stargazing visualization module. Local Sidereal Time, Hour Angle, Altitude, and Azimuth calculations are among the coordinate transformations carried out by an astronomical computing engine that processes user interactions. The system makes use of organized astronomical databases that include data from star catalogs, including magnitude, declination, and right ascension. The rendering engine uses HTML5 Canvas to interpret these data and create a dynamic night sky visualization in the browser.

VI. MODULES

A. Real-Time Stargazing Module



Figure 2: Stargazing feature



The central part of the Novalyn system is the Real-Time Stargazing Module. It uses JavaScript-based rendering techniques and the HTML5 Canvas element to create a dynamic night sky. To plot stars in the visualization interface, structured JSON files containing star names, brightness values, and celestial coordinates are utilized. To create a location-aware sky representation, the system modifies coordinates according to the user's location. Using pre-established mapping datasets, constellation patterns are created by joining related stars.

Users can click on a star in the visualization to be taken to the relevant educational content part through an interactive star-selection method. This feature connects the application's learning module to the visual viewing interface.

B. Celestial Events Module

Information on significant astronomical events that will take place in 2026 may be found in the Celestial Events Module. *CelestialEvents2026.js* stores event data, and the Visual Crossing Weather API is used to receive weather data based on the user's location.

Using structured event cards to display event details like the event name, date, description, and visibility is one of the key features. A countdown timer uses JavaScript date functions to determine how much time is left till each event. Additionally, users have the option to set reminders, which are saved in the browser's local Storage and remain active throughout sessions.

By integrating real-time environmental data with astronomical event tracking, this module enhances usability.

C. Education Module

Stars, Planets, Galaxies, and Moons are the four primary categories into which the Education Module offers structured astronomical knowledge. Every category is built as a distinct HTML site with information about different celestial objects.

The module dynamically renders content cards for various objects using *education.js*. The system uses JavaScript to automatically scroll to the appropriate part and redirect to the appropriate education page when a user chooses a star from the stargazing module.

By fusing accessible educational information with sky imagery, this module improves the program and lets users explore the simulated sky while learning about celestial objects.

VII. RESULTS

A. Real-Time Sky Rendering Performance

The rendering performance of the sky visualization system was assessed using the real-time stargazing module. The simulated night sky was successfully created by the HTML5 Canvas-based rendering environment, and there was no discernible lag during interaction. Plotting celestial objects dynamically depending on star dataset values was made possible using JavaScript-based coordinate transformations. Throughout continuous animation and user input, the rendering process was steady.

B. Star Density and Sky Visualization

By dynamically arranging some 300 stars, including background stars and stars that represented the projected Milky Way band, the system produced a visually dense night sky. These stars were created by combining pre-existing astronomical datasets with organized JavaScript logic. A realistic visual depiction appropriate for educational investigation was produced by the arrangement of stars throughout the sky.

C. Event Tracking and Reminder Functionality

The celestial events module used structured event cards with the event name, date, description, and visibility details to show astronomical events. JavaScript date functions were used to calculate countdown timers that show the amount of time left till each occurrence. In order to ensure that reminders remained active between user sessions, the reminder function permitted users to store specific events in browser local storage.

D. Navigation Between Visualization and Educational Modules

The educational module and the stargazing interface were successfully connected by the system. The application used query parameters and JavaScript-based scroll capability to reroute users to the relevant educational material site when they chose a star inside the visualization interface. The smooth transition between the learning and observation modules was made possible by this integration.

E. Space Technology News Carousel

The technology shows a scrolling news carousel on the main webpage to keep readers interested in recent advancements in the space business. Important updates on space missions and research advancements are quickly accessible thanks to this tool.



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HTML and CSS animation are used in the implementation of the news section. Space-related headlines are constantly displayed in a carousel that scrolls horizontally. For more in-depth information, each headline serves as a clickable link that takes the user to the authoritative source website. The carousel's glowing borders and dark cosmic theme complement the web application's overall visual style.

VIII. CONCLUSION

The web-based stargazing and astronomical information platform Novalyn, created with contemporary web technologies, was presented in this study. The system combines structured teaching materials, celestial event tracking, and real-time sky imagery into a unified browser-based experience. The program shows how lightweight web frameworks may effectively create interactive astronomical visualization by employing technologies like HTML5 Canvas, JavaScript, and structured JSON datasets.

Through an integrated instructional module, the system effectively creates a simulated night sky environment, shows constellation formations, and lets users investigate celestial objects. While the space technology news part links users with recent advancements in space exploration, the celestial events module offers information on significant astronomical events along with countdown timers and reminder features.

Overall, the study shows how web-based technology may successfully facilitate interactive stargazing experiences and accessible astronomy learning.

The suggested method makes astronomy more approachable for users without requiring specialized software or equipment by offering a beginner-friendly platform that integrates visualization, learning, and event awareness.

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