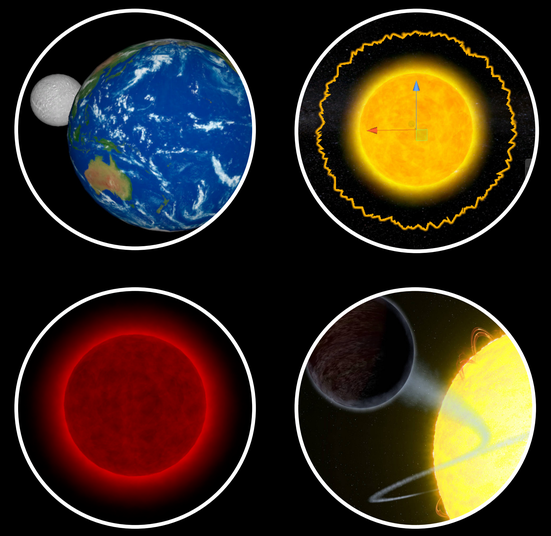
adVantage - Seeing the Universe:

An Immersive, Laboratory-like Virtual Reality Enviornment Modeling a Star-Planet-Satellite System for Undergraduate Astronomy Students

Abstract:

This poster introduces adVantage, a learning environment designed to augment introductory undergraduate astronomy education. The goal of the project is to show how an immersive virtual reality environment can be used to model the relative sizes and distances between objects in space. adVantage leverages the benefits of three-dimensional models by letting users observe astronomical phenomena from pre-set vantage points chosen to improve students' understanding of scale. The subjects of the system will be the exoplanet WASP-12b, its Sun-like star, WASP-12, and two imagined satellites. Students will interact with adVantage using a HTC Vive headset and hand



Why Use Unity and SteamVR for adVantage?

Virtual reality environments like the adVantage system allow students to dynamically explore different perspective points and frames of reference.

Above: the initial perspective of the Earth proxy and Wasp-12b in the first adVantage mission.

Key Features of Educational Virtual Reality:

Immersion: referring to the feeling (suspension of disbelief) of experiencing and responding to a virtual environment; supported by multiple represenations (or frames of reference) of the same environment [2]

Interaction: referring to natural interactions between users and the virtual environment, users and virtual reality technologies, or between multiple users [2]

Why Wasp-12b?

The astronomical bodies included in adVantage must:

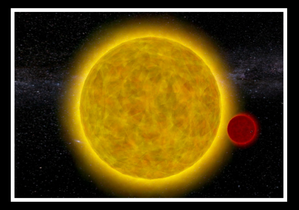
(i) Engage students by introducing some new, astronomical bodies – ideally at least one exoplanet and its star – via adVantage.

(ii) Provide both context and a sense of familiarity to students by incorporating some familiar elements from the Solar System.

The exoplanet Wssp12b and the star it orbits, Wasp-12 were selected as the subjects of the adVantage project because of Wasp-12b's relatively short orbital radius and its orbital/rotational period of approximately one Earth day. Adding proxies for the Earth and the Moon to adVantage introduces yardsticks for comparison to the exoplanet-star system.

Goals For Unity Developemnt:

My goal for the spring semester is to develop an immersive virtual reality supported version of adVantage using the game engine Unity and the virtual reality system SteamVR, to be interacted with using an HTC Vive headset and the accompanying hand controllers.



The Challenge: How to Deal With the Scale of Space?

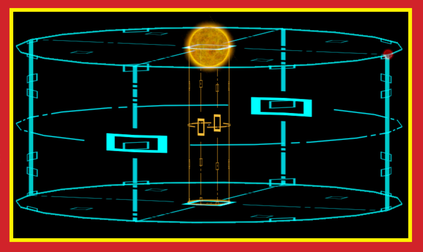
How do you negotiate the astronomical distances involved with a space simulation in a way that considers a user's time, interest, and attention span while clearly acknowledging the difference between those distances?

Wasp-12/Wasp-12b and Earth/Moon Steps:

The first mode of navigation using the Wasp-12 to Wasp-12b and Earth to Moon distances for step-sizes was a target system that would allow users to "leapfrog" through space.

Teleportation:

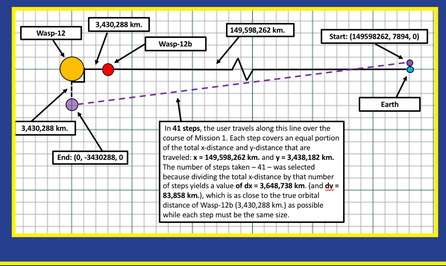
The second style of travel seriously explored for adVantage was a teleportation system that would show users the outer boundaries of cylinders with a radii equal to sizes of the steps being taken.



Warp Travel Along Preset Mission Paths:

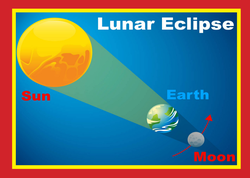
To avoid the possibility that users would become distracted or lost in the expansive, empty system and to emphasize perspective points that allow observation of relative size and distance, we decided to set a predetermined path beginning and ending with the most relevant vantage points for users to traverse.

This approach to travel incorporates freedom of exploration within a scaffolded mission by prompting users to look around at each viewpoint and make observations about the relative sizes of the planets, stars, and moons.



Mission Start Point:

The mission begins by dropping the user off directly over the Earth. From this initial vantage point, the user can see the moon and Wasp-12 on opposite sides of the Earth, positioned as they would be during a lunar eclipse. This perspective is particularly educational because Wasp-12 (a proxy for our Sun) and the Moon appear to be approximately the same size as the two have similar angular diameters. We experience eclipses on Earth because of this relationship.



Mission End Point:

The final vantage point of the mission is directly below Wasp-12, at a distance equal to the orbital radius of Wasp-12b. This positioning allows the user to look up at a 45-degree angle as they observe Wasp-12b orbiting its star. The journey between vantage points spans 42 steps, each approximately the orbital radius of Wasp-12b (1.06:1). Although a step size equal to the orbital radius would be prefereable, we determined that taking steps of a constant size was more important for conveying scale.

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References:

[1] NASA/ESA/G. Bacon. 2010. "Artist's conception of the exoplanet WASP-12b." NASA. June 7, 2010. https://www.nasa.gov/mission_pages/hubble/science/planet-eater.html. *(See bottom right in series of four circular images.)*

[2] Liu, Dejian, Kaushal Kumar Bhagat, Yuan Gao, Ting-Wen Chang, and Ronghuai Huang. 2017. "The Potentials and Trends of Virtual Reality in Education." In Virtual, Augmented, and Mixed Realities in Education, 105–30. Singapore: Springer.

[3] NASA. 2017. "Lunar Eclipse Diagram." NASA. August 7, 2017. https://www.nasa.gov/audience/forstudents/k-4/stories/lunar-eclipse-diagram. *(See image between the "Mission Start Point" and "Mission End Point" text boxes.)*