

Final Project Report

# *Space Explorer*

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COSC 729: Virtual Reality and its Applications • Spring 2017 • Dr. Sharad Sharma

## Overview

In this project, we built a multimodal virtual environment to simulate different aspects of moving around in space. The overall goal is the exploration of our solar system, in orbit around earth, and in hypothetical orbits around other planets.

Users of the simulation have the opportunity to interact with the simulation as an astronaut in three different ways:

- (1) as a member of the crew inside the International Space Station (ISS);
- (2) as an astronaut conducting a space walk outside of the ISS;
- (3) and as a pilot of a futurist space craft traveling across the solar system.

## Goal and Objectives

The goal is to create an environment that would give users a glimpse of what it could be like as an astronaut in space. Each mode of the simulation has a different goal, and provides a different experience.

### **ISS (Internal)**

As a member of the crew of the International Space Station, you are responsible to executing missions and experiments give you by authorities back on earth. However, keeping the space station functional is a challenge in and of itself. Alarms have started to go off, and the space craft's instruments have become unreliable. It is now imperative that issues are found and resolved before time runs out.

This is a simple game that challenges you to navigate the narrow confines of the space station, looking for anomalies, whatever the nature. Objectives include the ability to:

- navigate through the interior of the international space station,
- track down and capture anomalies

### **ISS (External)**

As an experienced astronaut, you are performing a standard maintenance on the outer hull of the space station, when space debris causes you to become untethered from the safety cable, and lose hold of various tools. It is now your responsibility to retrieve those items and return safely to the airlock.

Objectives include the ability to:

- perform a space walk around the international space station,
- retrieve important items before they are lost

### **Explorer**

As an explorer inside a futuristic starship, you travel to and explore sites of interest in our solar system. At this stage, the sites are limited to planets. This space craft comes with a unique capability: it can travel through time!

Objectives include the ability to:

- navigate a space craft through the solar system,
- interact with the space craft's control panel to get information about objects in space,
- change orbits around planets,
- modify the flow of time

## Modeling

Each mode of the simulation is implemented as a separate environment. The user has the ability to switch to either mode he or she chooses, but the models used to build each environment is different.

### **ISS (Internal)**

The primary model used in this environment is a detailed interior model of the International Space Station. The objects number in the thousands, and the textures are very elaborate and realistic. We downloaded the model from

NASA's website, and used 3DS Max to convert it to a format that Vizard could import. Also, we leveraged sounds for ship noise, and a countdown timer. Last, we used the duck that comes with Vizard as a stand in for lurking aliens aboard the station. However, these ducks don't quack; their calls are other worldly.

### **ISS (External)**

Like the internal ISS mode, the primary model here is a detailed representation of the exterior of the International Space Station. It likewise is very detailed and realistic, multiple times more complex than the interior ISS. In addition, we used a model of an astronaut in a space suit as an avatar. Both of these were also downloaded from NASA's website.

The external ISS model was placed in simulated orbit around earth. We used the *vizshape* module to create spheres, and applied textures to create representation of the earth and its moon. Both the space station and the moon actually orbit around the earth while the earth is spinning.

We also leveraged code from one of the *Vizard* examples (*Planets.py*) to generate stars that wraps the environment in 360 degrees. Lastly, we represented the sun as a fiery both emitting light as the only light source in the simulation, providing realistic shadows.

### **Explorer**

This mode includes primarily spheres created with *vizshape* with detailed photorealistic textures of all the planets. And engine was developed to put all nine planets (plus earth's moon) in orbit around the sun. Saturn was imported as an object to realistically render its rings.

There was some overlap between the models used in the Explorer and external ISS modes: the sun, planets and stars. However, the scenes created are different, and have different mechanics.

### [Vision](#)

#### **ISS (Internal)**

The view is first-person inside the space station, providing a stunning and cramped viewpoint.

#### **ISS (External)**

This mode provides a sweeping panoramic view of the space station in orbit about the earth, with the sun and moon in the background. The visual provides a third-person perspective, as the user can see the astronaut during the spacewalk.

#### **Explorer**

The sun, planets, moons are modeled as spherical objects with the appropriate textures applied to them. Lighting comes primarily from one sources, although a second one is optional. The primary source is the sun as a point source in the virtual environment. The second (optional) source is ambient lighting. With the ambient lighting turned off, the user may possibly be convinced that he or she is actually viewing the real planet in orbit. With ambient lighting turned on, every object in the simulation is provided with good lighting.

### [Sound](#)

#### **ISS (Internal)**

In this mode, we incorporated a creepy sound to represent calls from an alien intruder, beeps and clicks for noises coming from the space station, and sounds indicating success to finding items during the game.

#### **ISS (External)**

We imported gas jet sounds for when the astronaut navigates around the space station, as well as a musical score to accompany the space walk.

### [Animation](#)

#### **Explorer**

Besides the animation that *Vizard* provides as part of it viewport functionality, the motion of planets, their orbits and rotations about their axes is where the bulk of animation is. Elliptical orbits for each celestial body was calculated relative to each other, and updated at a high customizable rate.

### Interactivity

#### **ISS (Internal)**

The user floats through an empty space station, looking for anomalies. He or she can explore the entire space station. There is an option to toggle collisions to increase the difficulty level of squeezing through the narrow corridors.

#### **ISS (External)**

Custom controls were developed to help the astronaut navigate around the space station. Different key combinations control the astronaut's speed and direction relative to the space station and earth.

#### **Explorer**

The user is able to trigger several actions through a navigation control panel. There are controls for jumping to different planets within the solar system, as well as focusing the viewport to specific orbiting objects. There is a slider to control how closely the user (in their spacecraft) orbits a particular planet, as well as a slider that can increase, decrease, or reverse the flow of time. Finally, there is an option to light the scene only using the sun and starlight (for realistic rendering), or to bathe the entire environment in ambient light (to make it easier to see distant objects).

### Sensors

#### **ISS (Internal)**

In this mode, sensors were placed randomly around the space station before each trial. These were then used to indicate to the user that the items (anomalies) they were looking for were successfully found.

### Avatars

#### **ISS (External)**

The only avatar used was the astronaut model downloaded from the NASA website.

### Management Plan

The following table shows the expected breakdown in tasks for each member of the team.

<b>Tasks\Team Member</b>	Antonio Brown	John Cho	Lamar Taylor
<i>Object Timers</i>	X		
<i>Proximity Sensors</i>	X	X	
<i>Space craft modeling</i>		X	
<i>Space craft navigation</i>		X	X
<i>Solar system modeling</i>			X
<i>Star map modeling</i>			X
<i>Avatar interaction</i>	X	X	
<i>Sounds</i>	X	X	
<i>Import models</i>		X	
<i>Module Integration</i>			X
<i>Final Report</i>	X	X	X

### Problems and Recommendations

#### **Explorer**

We quickly reach the limit of *Vizard's* ability to model a large volume with the solar system. It wasn't the number of objects, but the extent of the space used. We frequently encountered strange rendering artifacts that forced us to abandon certain approaches. For example, we initially used a very detailed image to represent the star map, but beyond 2000 meters, the dome of the star map image was not visible.

Also, we had real trouble trying to integrate three different environments together as one *Vizard* project in the end. The *Vizard* Scene framework didn't work as documented, switching between different kinds of navigation trackers introduced unpredictable behavior in the simulation

## Modules

### 1) ISS Space Walk Module

**Purpose:** The user will be able to experience a simulation of Space Walk using keyboard controls. The scale of ISS model is proportional to the scale of the astronaut model.

#### Key Features:

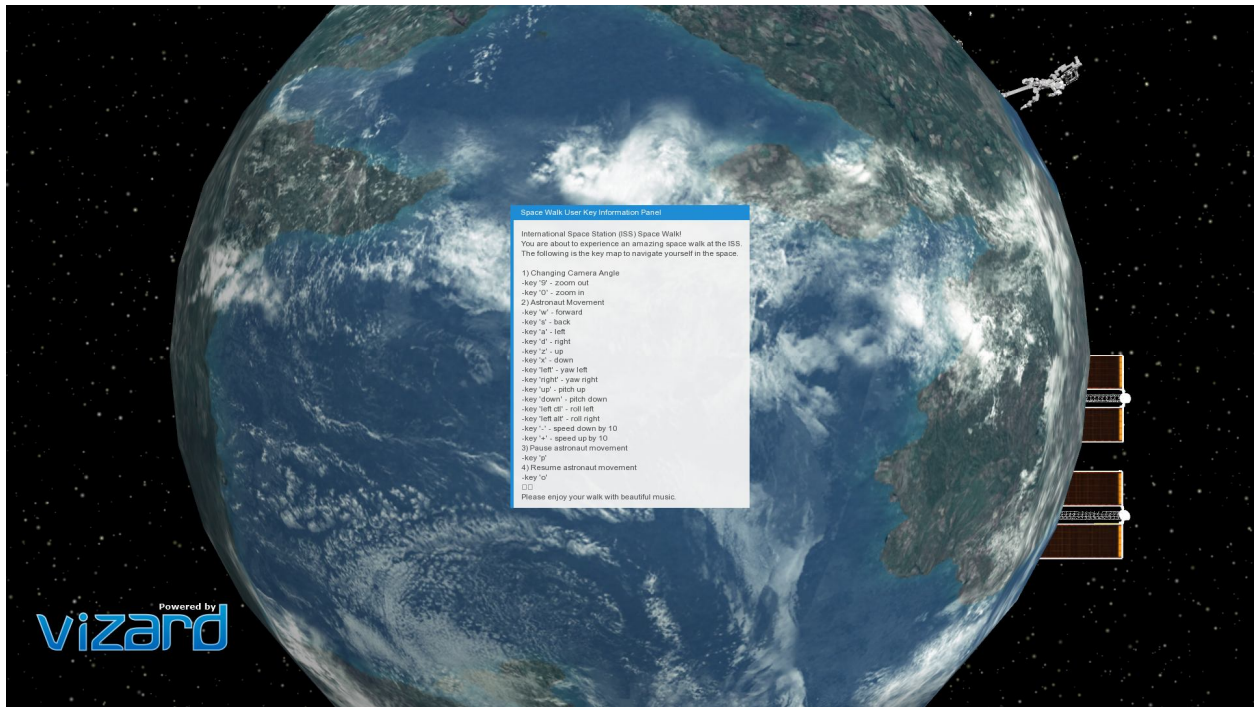
- 1) The user can control the astronaut using various keyboard keys. The key map of the module is as the following:

Key	Action	Description
'9'	Camera Zoom out	Main view is zoomed out exposing astronaut's back side
'0'	Camera Zoom in	Main view is zoomed in as 1 <sup>st</sup> person view
'w'	Move Forward	Astronaut moves forward
's'	Move Backward	Astronaut moves backward
'a'	Move Left	Astronaut moves left
'd'	Move Right	Astronaut moves right
'z'	Move Up	Astronaut moves up
'x'	Move Down	Astronaut moves down
'left arrow'	Yaw Left	Astronaut yaw left
'right arrow'	Yaw Right	Astronaut yaw right
'up arrow'	Pitch Up	Astronaut pitch up
'down arrow'	Pitch Down	Astronaut pitch down
'left ctl'	Roll Left	Astronaut roll left
'left alt'	Roll Right	Astronaut roll right
'pad -'	Speed down by 10	Astronaut's movement speed is up by 10 unit
'pad +'	Speed up by 10	Astronaut's movement speed is down by 10 unit
'p'	Pause Astronaut actions	Astronaut's actions are paused
'o'	Resume Astronaut actions	Astronaut's actions are resumed

- 2) Background music is played while the user is experiencing the simulation
- 3) When movement keys are pressed, sound of air jet simulated sound is played
- 4) A task is given to find an entry point to the internal of ISS. It is marked with yellow down arrow key.

#### Screen Shots:

- 1.1) Intro screen describes navigation key map:



1.2) Second Information Panel describe the purpose of the given task:



1.3) Default simulation screen with Astronaut and ISS shown:



1.4) Zoom in view of ISS:



1.5) Zoom out view of ISS:





2. Entry point view – target of task:



## 2) ISS Internal Exploration

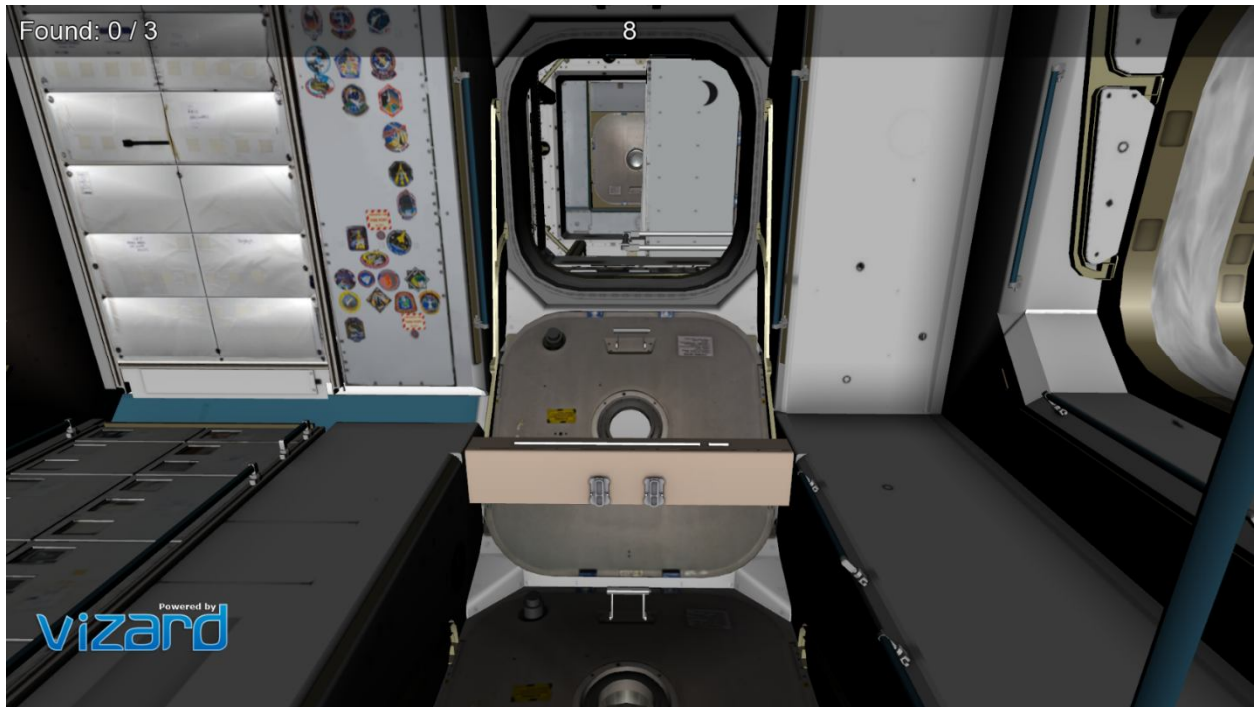
**Purpose:** Allows users to navigate within the ISS.

**Key Features:**

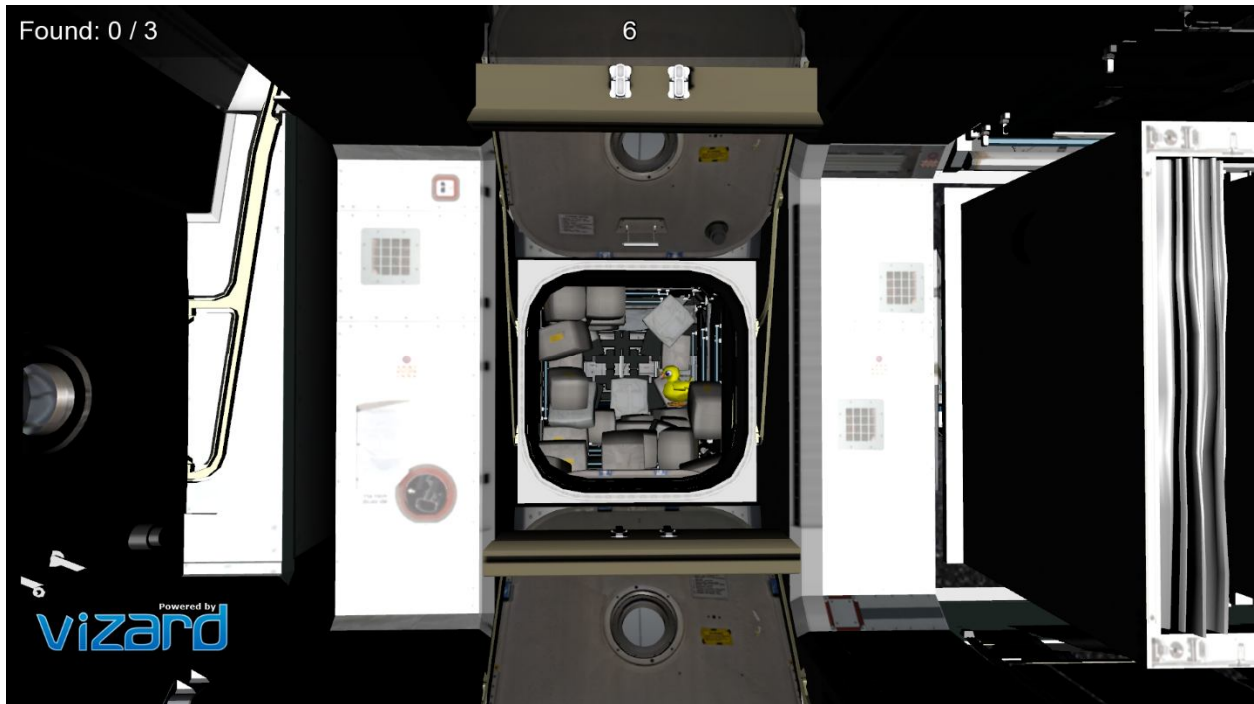
- User task to locate ducks within ISS environment given predefined time limits
- Keyboard and mouse keys and gestures were utilized to navigate

**Screen Shots:**

2.1) An example of Internal of ISS

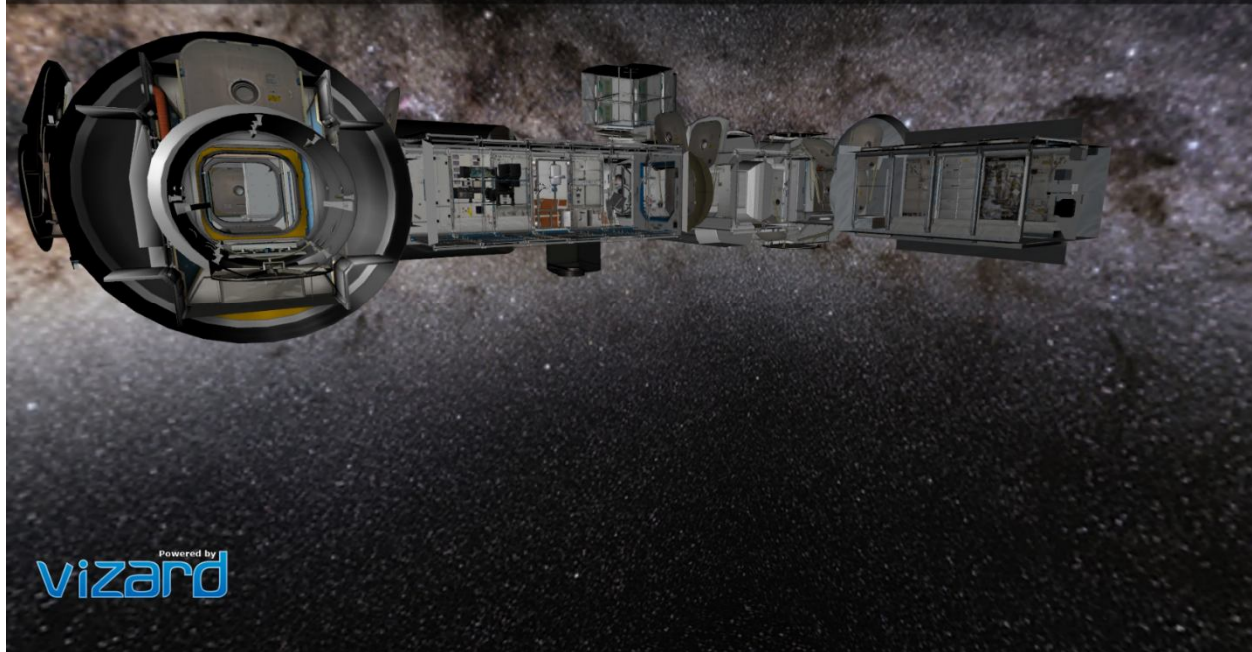


2.2) Screen image showing target object



2.3) External View of ISS for ISS Interior Model

Found: 0 / 3



### 3) Solar System Exploration

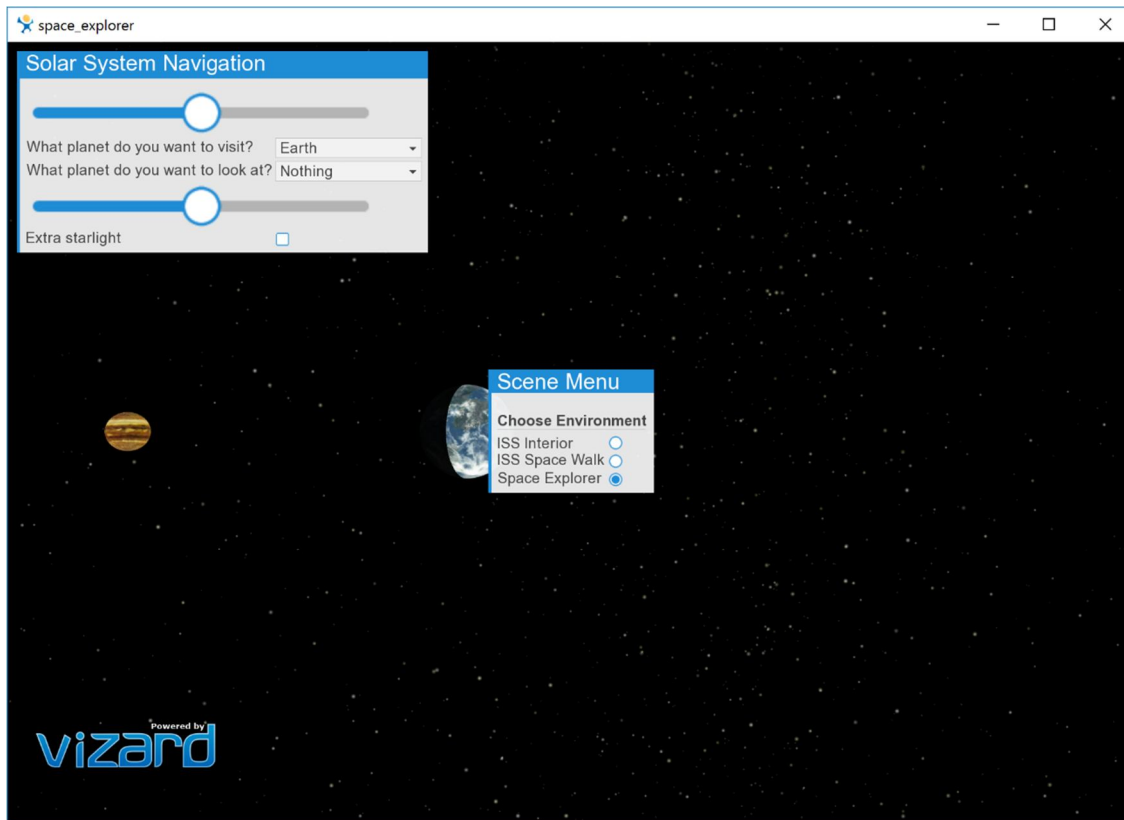
**Purpose:** Explore different planet system within our solar system

**Key Features:**

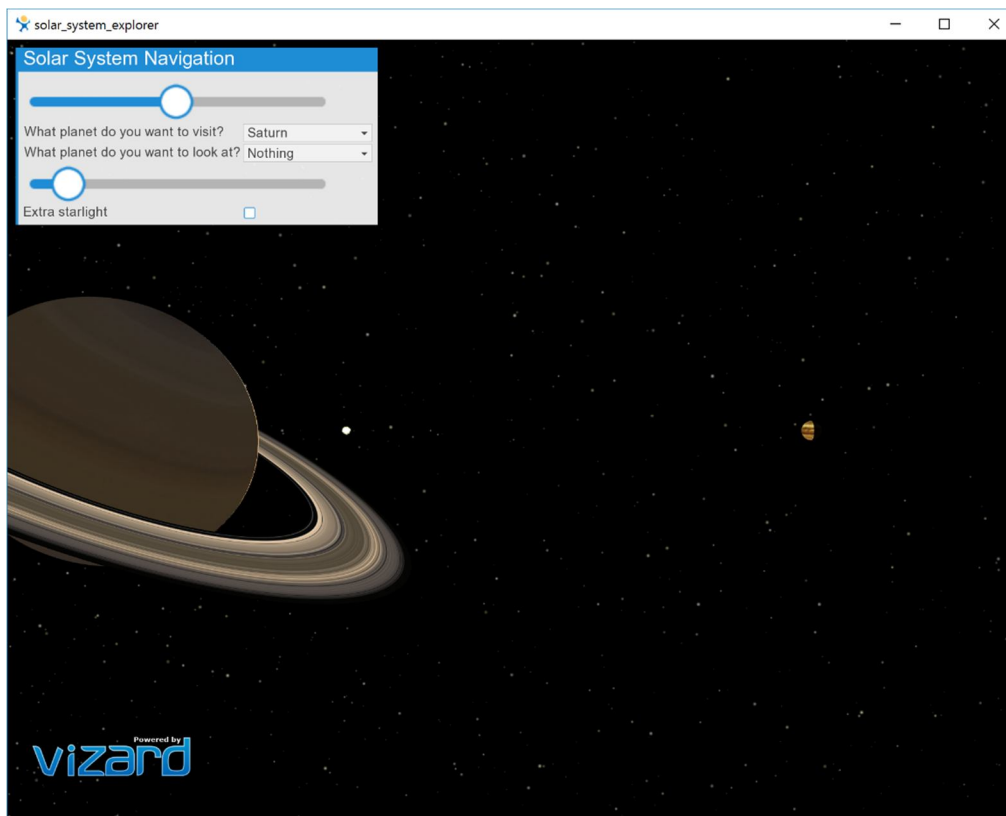
- Users can navigate to different planet using the menu system
- Users can view different planet regardless of their location
- Simulate solar particles
- Simulate movement of planets

**Screen Shots:**

3.1) Menu system was shown



3.2) shown one of the planet with zoom/out and speed control menu



### 3.3) External view of detailed model of ISS

