NASA SPACE APPS CHALLENGE

Tracking The Space Station In 3D

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1 | INTRODUCTION

We choose the challenge of creating a public web application to track the international space station in 3 dimensions because:

1. We found that this challenge is very unique especially at this very moment because it is mentioned that the space station is going to be taken down in the year 2025. We took this challenge as a show of respect to the legacy and achievements of the ISS
2. This challenge was very suitable for the skills we have on board our team.
3. The graphical visualizations that could be created just by the phrase "Earth's Orbit" so we instantly knew that this is a challenge worth taking.

Furthermore, the international space station and its benefits are going to be presented on this report. Additionally, the step by step process of how we created the code that made this task an achievement.

2 | THE INTERNATIONAL SPACE STATION

The international space station (ISS) is a multi-nation construction project that is the largest

single structure humans have ever put into space. On November 20, 1998, the first ISS segment

(Zarya, Control Module) was launched aboard a Russian proton rocket from Balkonur

Cosmodrome, Kazakhstan, Zara, which translates to "sunrise", supplied fuel storage, battery

power, and docking capability for Soyuz and future space vehicles.

The first U.S. built component launched on December 4, 1998. it was the Unity connecting

module, also known as Node 1. It was sent Into space through the STS-88 mission, Joining Unity

with Zarya module was the first step in the assembly of the orbiting laboratory.

On November 2, 2000, the first crew (Astronaut Bill Shepherd and Cosmonauts Yuri Gidzenka

and Sergie, Krikalex) became the first crew to reside on the station. Expedition 1 spent four

months onboard completing tasks necessary to bring the ISS "to life" and began what is now

more than 20 years of continuous human presence in space.

Destiny, the U,S. laboratory module became part of the station, increasing the onboard living

space by 41%, It continues to be the primary research laboratory for U.S. payloads,

On February 7, 2008, the European Space Agency's Columbus Laboratory module became part

of the station. Also, in that same year, the Japanese "Kihg" laboratory module docked into the

space station,

The ISS celebrated its 10-year anniversary of continuous human occupation. Since Expedition 1

in the fall of 2000, 202 people had visited the station.

in July 2011, NASA selected The Center of The Advancement of Science in Space to manage the

ISS National Lab.

The international space stations entered its 3rd decade of human-tandem operation and science

on November 2, 2020. The first decade of the station was the construction decade; the 2nd

decade, moving from initial research to full utilization, And, we are now in the decade of

results, During the past twenty years, the space station evolved from an outpost on the edge

of space into a highly capable microgravity laboratory. Now, results are compounding, new

benefits are materializing, and the third decade is building on this previous work,

This orbiting laboratory enables researchers from around the world to take advantage of

microgravity, exposure to space, and a unique perspective on earth to conduct groundbreaking

experiments through an environment made accessible by the space station. Although the

international space station is a partnership between many nations, each with distinct goals,

every partner shares a unified goal, which is to use this amazing laboratory for the betterment

of humanity. With more than 20 years of experiments now conducted on the

_station, more breakthrquehs are materializine.tban,everbefore.....

Benefits for Humanity 2022 highlights the diversification of benefits stemming

from microgravity research--for society, science, exploration, and the economy,

This edition focuses on new areas of scientific study, future technology for the

exploration of the Moon and Mars, lives saved, and numerous companies and jobs

created.

The international Space Station advances scientific understanding of our planet,

improves human health, develops advanced technologies, and provides a space

platform that inspires and educates the leaders of tomorrow- a legacy and

influence that will be felt for decades to come.

The International Space Station is the largest modular space station currently in low

Earth orbit. It is a multinational collaborative project involving five participating

space agencies; NASA, Rososmos, JAXA, ESA, and CSA. The ownership and use of the space station is established by intergovernmental treaties and agreements.

4 | APPLICATION

Our goal is to track the ISS in 3-D, so we need to find the most advance tools to create a 3-D web browser, that will be in the same time easy to use, and accurate.

After going through multiple examples, the best tool for our project is Three.js.

Three.js:

Three.js is an application programming interface (API) and cross-browser JavaScript library that is used to produce and show animated 3D computer graphics in a web browser using WebGL. The source code is kept in a GitHub repository.

- HTML

The HTML purpose is to only create a web page which will display what it's ask for from the JavaScript (Fig. 1).

Code:

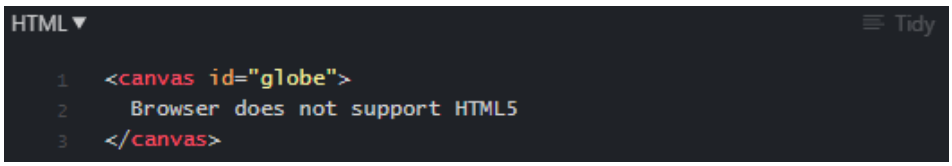

Figure 1

- CSS

The CSS code will create a plan space where everything will be displayed. Here the camera will be directed, and the size of the background will be set (Fig. 2).

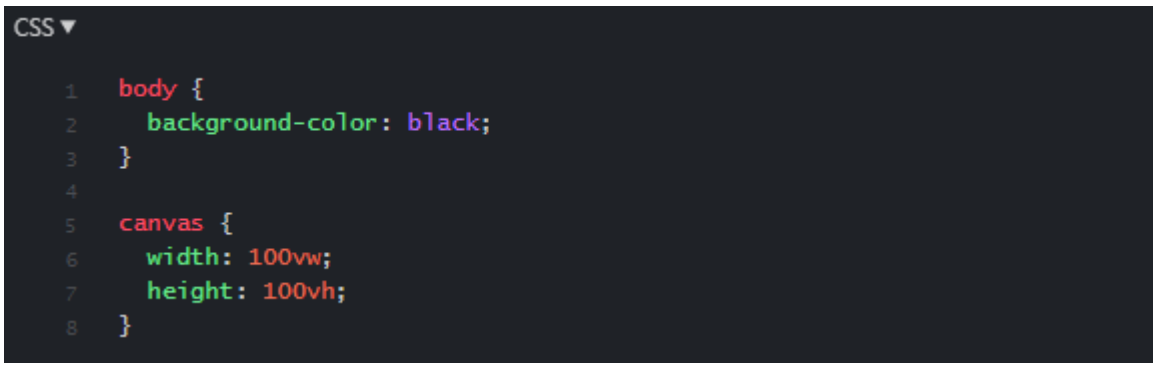

Figure 2

- JavaScript

JavaScript is where the main commands and function will have place. For example, importing the model of the earth, importing the model of the ISS…

First, importing data from World Wind (data set from NASA website) model of the earth, the atmosphere, the land, renders, and the coordinates each on a different layer (fig.3).

```
var wwd = new WorldWind.WorldWindow("globe");
wwd.addLayer(new WorldWind.BMNGLandsatLayer());
wwd.addLayer(new WorldWind.AtmosphereLayer());
wwd.addLayer(new WorldWind.StarFieldLayer());
wwd.addLayer(new WorldWind.CoordinatesDisplayLayer(wwd));

var renderableLayer = new WorldWind.RenderableLayer();
wwd.addLayer(renderableLayer);
```

Figure 3

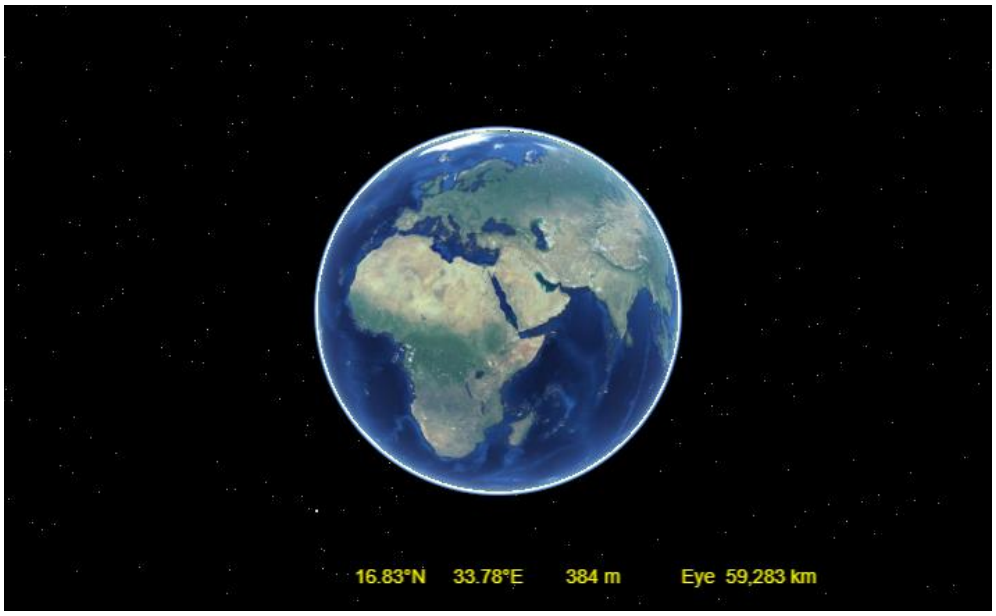

Figure 4

Second, now the glob is there we need to import a 3-D model. Therefore, we uploaded the model on a GitHub repository and call it. (Fig. 5)

Now we included a function that calls the model give it a scale and place it on the plan, but three.js only takes (x, y, z) coordinates, so we need to transform the coordinates from latitude, longitude, and radius to (x, y, z).

To solve this problem, we coded a function that takes (Latitude, Longitude, Radius) and outputs (x, y, z) (Fig. 6).

```
var modelAddress = "https://williamsalame.github.io/ISS.dae";
colladaLoader.load(modelAddress, function(model) {


  model.scale = 500;
  renderableLayer.addRenderable(model);
  wwd.goTo(new WorldWind.Position(lat, lon, 1000000));
```

Figure 5

```
function Position(lat, lon, radius) {
    var phi = (90 - lat) * (Math.PI / 180);
    var theta = (lon + 180) * (Math.PI / 180);

    x = (radius * Math.sin(phi) * Math.cos(theta));
    z = (radius * Math.sin(phi) * Math.sin(theta));
    y = (radius * Math.cos(phi));

    return [x, y, z];

}
```

Figure 6

TLE's:

Finally, there are more than 6000 satellites around the earth. Therefor NASA created TLE's stands for two-line elements, which is a data format that stores a list of an object's orbital components for a specific epoch in time. The state (position and velocity) at any time in the past or future can be roughly predicted using a proper prediction formula (Fig. 7).

ISS TLE:

```
const tle = `ISS (ZARYA)
1 25544U 98067A   17206.18396726  .00001961  00000-0  36771-4 0  9993
2 25544  51.6400 208.9163 0006317  69.9862  25.2906 15.54225995 67660`;

const { getLatLngObj } = require("tle.js/dist/tlejs.cjs");
const optionalTimestampMS = 1502342329860;
const latLonObj = getLatLngObj(tle, optionalTimestampMS);
```

Figure 7

Final output (Fig. 8,9,10).

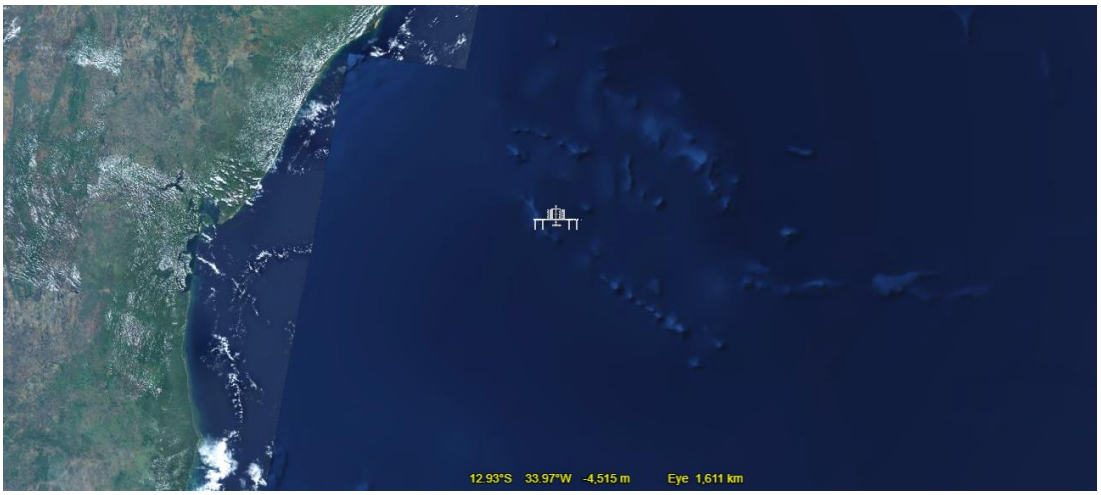

Figure 8

Figure 9

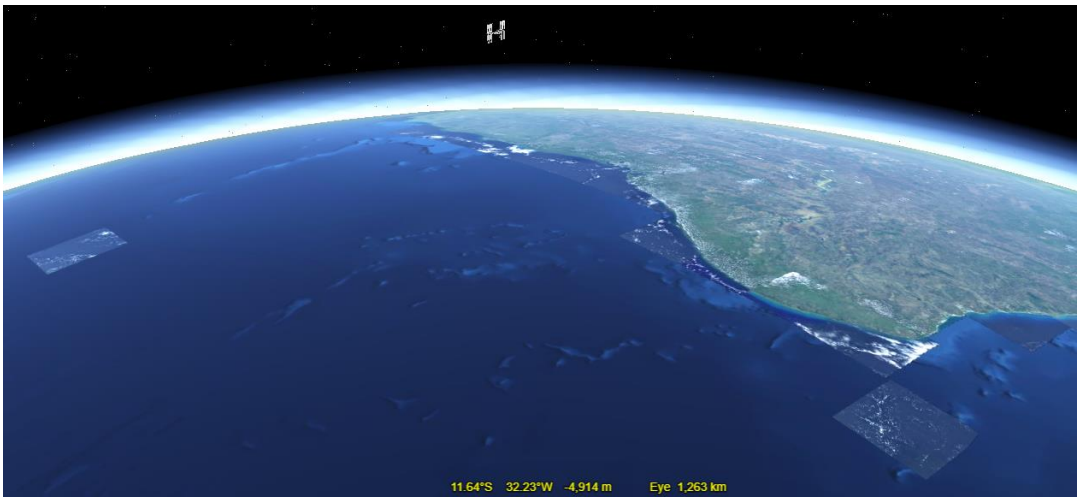

Figure 10

3 | CONCLUSION

The program created satisfies the task wanted and for that we consider this project a complete success. The hustle of going through different coding language and sleepless nights working to ensure the progression of this project was the hardest part.

In conclusion, this opportunity was fascinating and extremely enthusiastic. We are glad we joined this event and fulfilled the tasks wanted.