Digital Twin Technology for Aviation

PROJECT MEMBERS / **CONTACT INFORMATION**
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ABSTRACT

As technology progresses, so have the tools for data visualization. This project presents a digital twin model of the San Francisco airport displaying a 10-minute window of historical flight data, visualizing the trajectory data of airplanes and vehicles in three dimensions. Multiple different cameras where implemented to fully utilize the 3D visualization. This is a 100:1 feet scale model created in Autodesk Maya, using the airport center as the origin and recalculating all coordinates accordingly featuring the airport, some surrounding buildings, and the bay. For this project, six different models of airplanes were modeled at a 50:1 feet scale with texturing to mimic real-world aircraft models along with certain airlines. The animation is driven through archived data captured from NASA's Sherlock Open-Data Portal, cleaned of noisy data points, processed into useable data formats, and implemented into a Maya ASCII file of animation paths with the corresponding previously-stated airplane models attached all using Java based conversion program.

INTRODUCTION

Digital Twin is digital representation of a real world object using real world data, an airport in this case. For this project, we based the digital model on the real world San Francisco Airport (SFO) and the real world data for flight tracks was captured from Sherlock public data.

METHODS - MODELING

The terrain and tracks were modeled by hand in Autodesk Maya with photo references and data points [1] while buildings were imported from a Blender add-on [2]. The completed model is a simplified, scaled 100:1 feet representation of SFO, the bay, and some surrounding houses.

Planes were modeled individually also in Autodesk Maya, using dimensions and pictures found online [3] and scaled down to 50:1 feet. Each plane was then mapped onto a texture PNG file made in Adobe Illustrator. All planes have a unique standard file with just the windows. Many planes of extra files for popular airlines for added realism as seen in Figure 2.

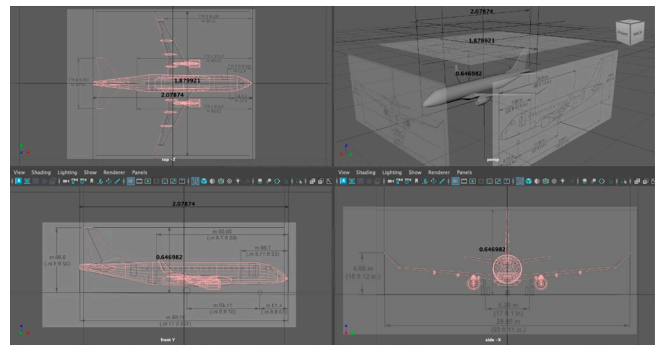
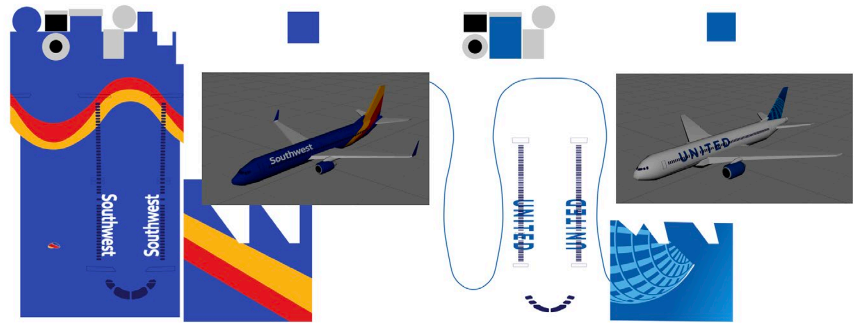


Figure 1
Screenshot of E75L modeling work in Maya.

Figure 2
Airline Texture (left to right): SWA for B739, UAL for B772



The final model combines the terrain, tracks (see TRACK PROCESSING), and airplanes into one scene at 100:1 feet scale.

METHODS - TRACK PROCESSING

The SFO surface data was obtained from the Sherlock Data Warehouse [4] and converted into Maya using a Sherlock to Maya Converter program in Java. This program smooths noisy data, converts the Sherlock latitude and longitude data to x and y points, and imports those points as curves in Maya. Noisy data was handled by skipping over inaccurate track points and adjusting the altitude of aircraft on the ground. Sherlock latitude and longitude data was converted to x and y points by using great circle conversions [5] to calculate the distance and angle of a track point relative to the center of the airport, then converting that to x and y using trigonometry. The points were then imported into Maya by using the Sherlock altitude data as the z axis and adding MEL code into the Maya ASCII file.

The program also creates a Maya script file to animate the aircraft in Maya. When the script file is run with the new aircraft and vehicles curves in Maya, it imports the aircraft and vehicle models into the scene, attaches them to their respective curves, and animates them by setting keyframes along each curve.

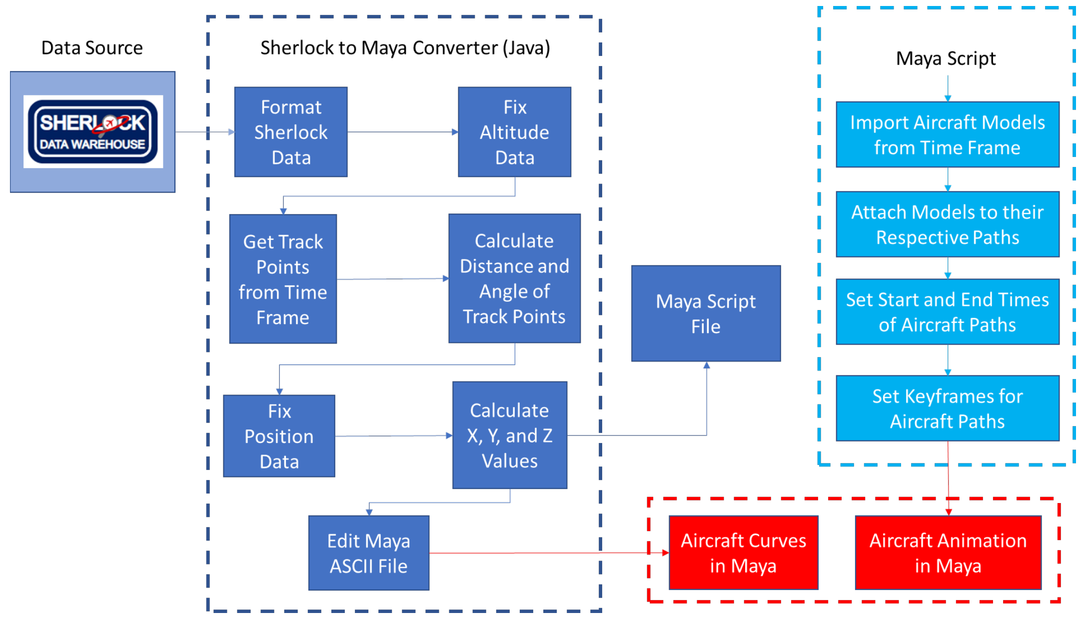


Figure 3
How the Sherlock Data is processed and converted into an animation in Maya.

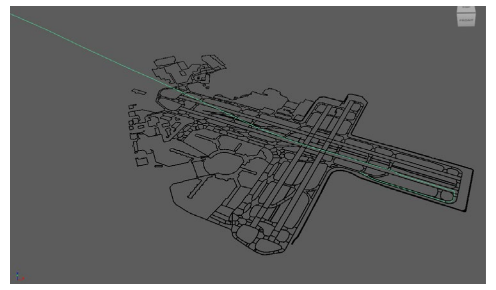


Figure 4
Screenshot of one aircraft curve in Maya, with no keyframes, and on a wire frame model of SFO.

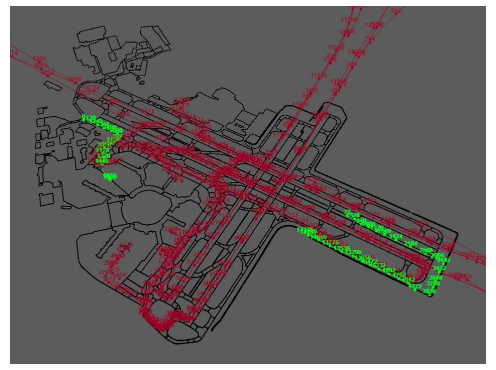
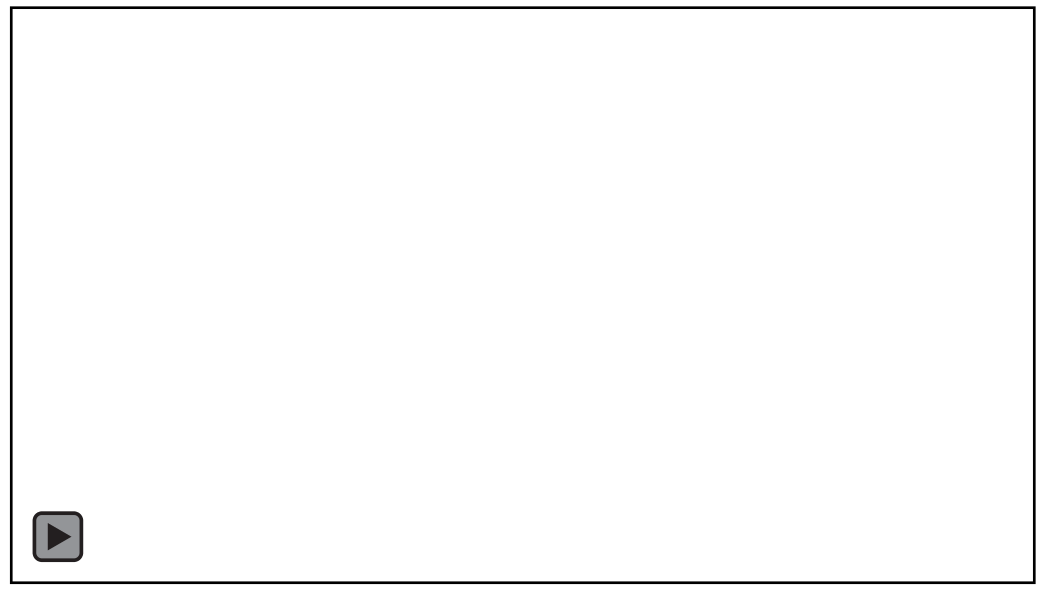


Figure 5
Screenshot of 10 minutes worth of airplane curves with keyframes in Maya and on a wire frame model of SFO.

RENDERED VIDEO



The animation was exported frame by frame from Maya and imported into Adobe Premiere Pro where it was compiled into a 24 FPS video. In the future, video demos can be replaced by real-time Omniverse rendering.

Figure 6
Rendered video of project with multiple different camera angles.
Embedded into digital version of poster.

CONCLUSION

Digital Twin increases situational awareness and understanding for pilots, passengers, and controllers by creating a 3D visualization of numerical flight data. If implemented with other modules and ran in real time, it can help simply airport management by keeping track of vehicles and airplanes digitally, allowing workers outside of the control tower to easily access the current state of the airport. The model can also be implemented to increase safety awareness, utilizing historical data to find problems before they occur.

In addition, Digital Twin is a great tool for public relations and marketing, allowing people from all backgrounds to visualize airports and flight track data. Further work and research on the topic can be done to incorporate Digital Twin technology with real-time data to visualize the current state of airports (other than SFO) and or implement into a website for ease of access outside of rendered videos and modeling applications.

RESULTS

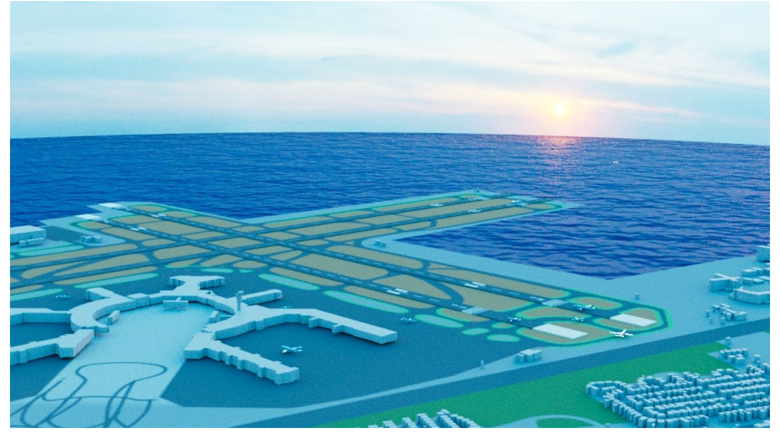


Figure 8
View from on top of plane arriving at SFO

Figure 7
View towards the ocean in complete SFO model.

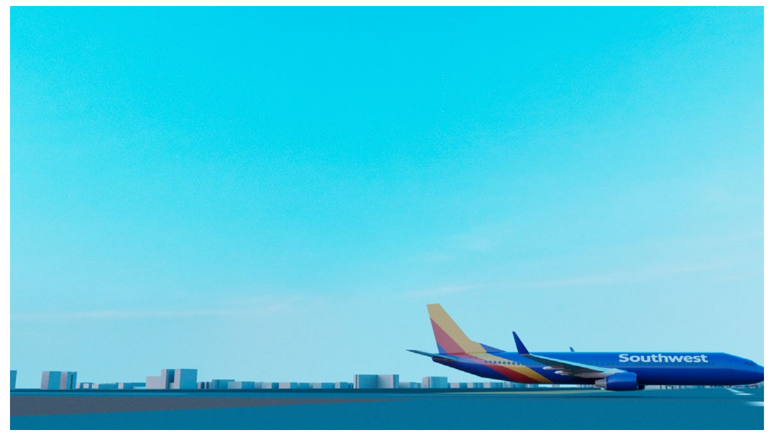


Figure 9
View from on the tracks, showcasing SWA airplane.

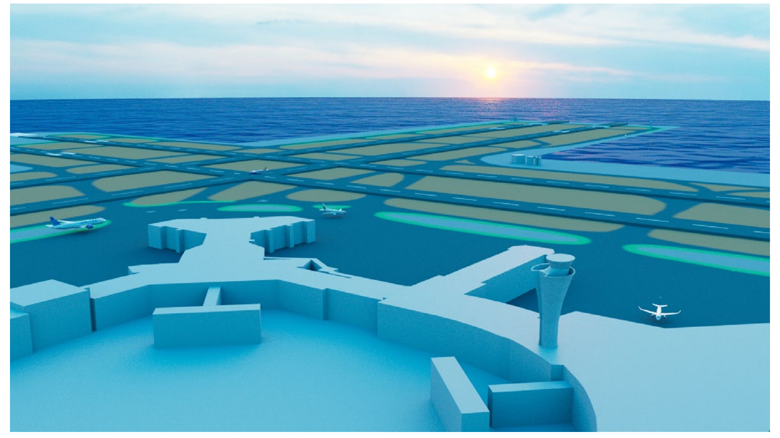


Figure 10
View including SFO control tower.

REFERENCES

[1] airnav.com/airport/KSFO
[2] BlenderGIS (github.com/domlysz/BlenderGIS)
[3] skybrary.aero
[4] sherlock.opendata.arc.nasa.gov/sherlock_open/Home
[5] movable-type.co.uk/scripts/latlong.html

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