Synthetic Data Pipeline for Pose Estimation

Members:

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Date of Meeting with the Client for developing this Plan: 8/29/2022

Goal and motivation: Generate videos of a satellite using 3D animation software with varying light and motion conditions for machine learning

Approach (key features of the system):

- The user can easily generate a lot of satellite training data for use in neural networks. Currently to create 3D training data the lab currently has to manually load the data into a 3D animation software and hand animate each scene. This takes hours of time which could be spent working on the model. Once this project is completed all the user would need to do is type out a few parameters and hit run and this program will automatically generate a video scene. These scenes can then be passed to the neural network for training.
- The user can configure things like the type of satellite, the flight path of the satellite, lighting, background, and various other things. Currently each of these things need to be changed manually in a 3D animation software by a user. It could require hours to work just to change one of these parameters. Once this program is completed all the user needs to do is change a line in a parameter file.
- The user can generate a lot of videos for use in machine learning at one time. The user will be able to give the software different lighting conditions, satellites, and backgrounds. Then the program will be able to automatically create different combinations of the settings to create a lot of training data with very little work.

Novel features/functionalities:

- This will be the first program that will allow for easy and automated creation of synthetic animated satellite data.

Technical Challenges:

1. We would need to learn how to use tools new to us such as Blender and Nvidia Omniverse and how the 3D data works in these programs and learn the API for both of these
2. Lean how to make a well documented object-oriented program
3. We need to figure out how to take advantage of different hardware such as CPU or GPU without compatibility errors.

Milestone 1 (Oct 3):

1. Discover how to read in different types of CAD models for different satellites in Blender and Nvidia Omniverse.
2. Go through Nvidia Omniverse and Blender API documentation to learn how to interface with these programs using Python.
3. Create basic demos using both tools and test rendering through the API.
4. Compare Blender and Nvidia omniverse to evaluate which tool or combination would be best for generating 3D data for this project.
5. Create Requirement Document
6. Create Design Document
7. Create Test Plan

Milestone 2 (Oct 31): itemized tasks:

1. Add motion to the 3D rendered models given a manually-created path
2. Test operation of the motion for the 3D graphics
3. Demo any given 3D model and manually-created path, simulate motion of model along the path with a black background
4. Simulate the rotation and physics of a 3D model
5. Test rotation usage on model
6. Demo the model rotating given specific paths
7. Implement lighting features to adjust brightness in different environments
8. Test lighting features
9. Demo lighting
10. Create demo containing paths, rotation, and lighting
11. Create Requirement Document
12. Create Design Document
13. Create Test Plan

Milestone 3 (Nov 28): itemized tasks:

1. Test outputting a mp4 from 3D animation software.
2. Discover how to customize the background using the API.
3. Add functionality to generate path of motion based on user inputed coordinates.
4. Create automated testing suite to make sure all features are working properly
5. Make program that allows a user to easily modify all previous features via a configuration file
6. Make software compatible with different hardware such as GPU or CPU.
7. Create Requirement Document

8. Create Design Document
9. Create Test Plan

Task matrix for Milestone 1 (teams with more than one person)

Tasks	William	Nathan	Stephane	Hanibal
Read in CAD models	Omniverse	Omniverse	Blender	Blender
3D software API	Omniverse	Omniverse	Blender	Blender
Demos	Omniverse	Omniverse	Blender	Blender
Compare and select 3D software	Omniverse	Omniverse	Blender	Blender
Requirement Document	write 25%	write 25%	write 25%	write 25%
Design Document	write 25%	write 25%	write 25%	write 25%
Test Plan	write 25%	write 25%	write 25%	write 25%

Approval from Faculty Advisor:

> "I have discussed with the team and approved this project plan. I will evaluate the progress and assign a grade for each of the three milestones."
>
> Signature: _____ Date: _____