Synthetic Data Pipeline for Pose Estimation

Members:

Nathan Pichette (npichette2018@my.fit.edu)

William Stern (wstern2019@my.fit.edu)

Stephane Baruch (sbaruch2019@my.fit.edu)

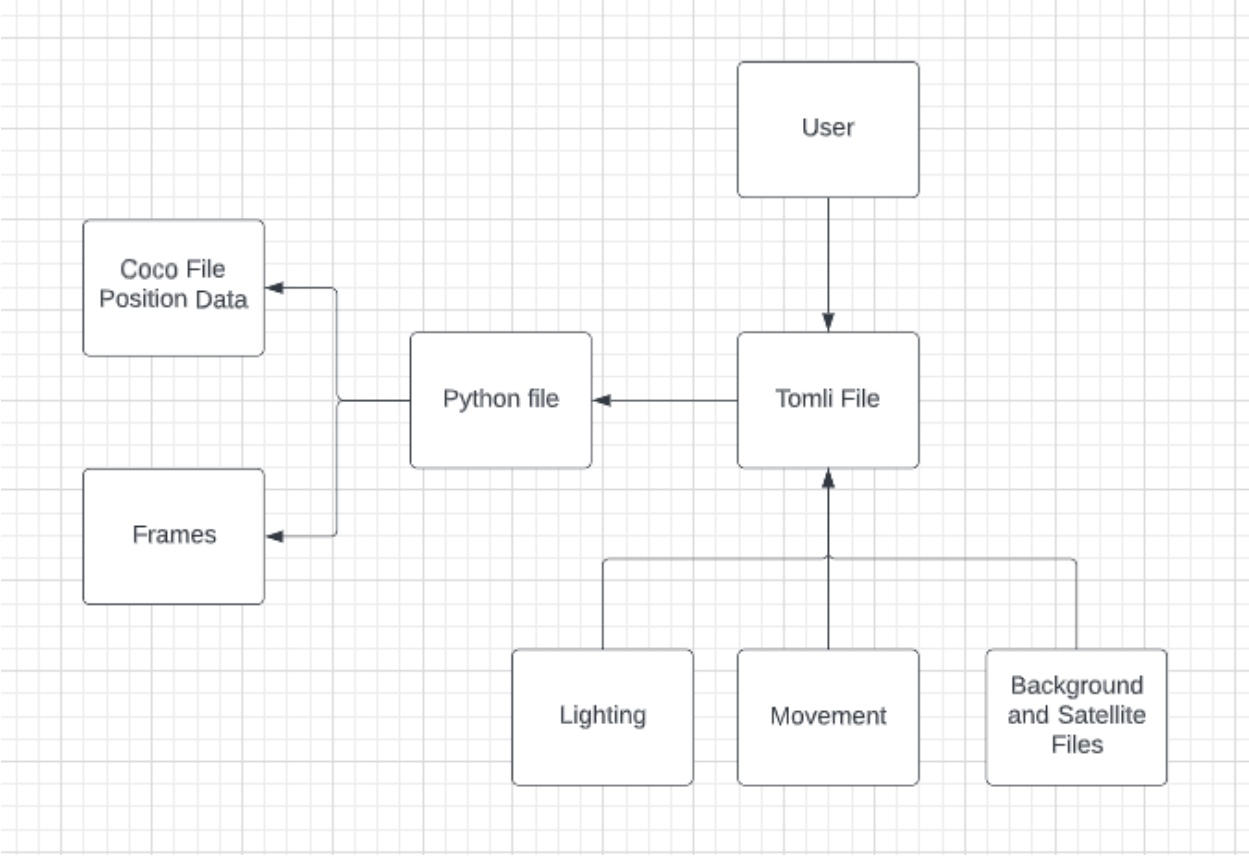
Hanibal Alazar (halazar2019@my.fit.edu)

Faculty advisor and Client: Dr. Ryan White rwhite@fit.edu

1. Meeting(s) with the Client for developing this Plan: 1/13/23
2. Goal and motivation: Create a program that can generate synthetic training data for training pose estimation for satellites in space where the user can modify different parameters such as lighting, satellite, and motion and create a benchmark neural network model using this data to estimate poses.
3. 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
4. Algorithms and tools (libraries/api/frameworks/languages) for the key features:
    - The animation software we use is blender. We interact with blender using the bpy python package. Everything in blender can be done using code using the bpy apis.
    - We also use the toml python package to read information from toml type files easily
    - In order to import python packages we use the the ensurepip package
5. Novel features: Discuss which features/functionalities are novel and why.
    - This program will allow for easy and automated creation of synthetic animated satellite data. Our system lists satellite position data that can be used to verify the

machine learning algorithms output. Our program can also be used to test low light conditions previously unworkable.

6. Technical Challenges:
    - We are very comfortable with Mac and Windows operating systems however, we must alter our program so that it is compatible with linux.
    - Since blender uses a custom version of python 3.5 with custom paths getting packages to work is sometimes very difficult. This also makes it difficult to work on different operating systems.
    - Most of us are not very familiar with neural networks so we will need to learn the basics and some of the neural network libraries such as pytorch and tensorflow.
7. Design: system architecture diagram



8. Evaluation: how to measure success? Some ideas:
    - Survey of Dr. White's machine learning team they will grade the ease of use and quality of output on a scale of 1-5
    - We will also evaluate the success of our synthetic data generation system based on the accuracy of how often the neural network that we create is able to predict the pose.
9. Progress Summary:

Task	Progress	To Do
1. Complex movement along path	70%	Change method so it is based on time instead of x
2. Enable movement interaction through configuration file	100%	
3. Implement compatibility among os	66%	Add linux compatibility
4. Extract poses as coco type annotations	100%	

10. Milestone 4 (Feb 13): itemized tasks:
    - Finish adding compatibility with linux
    - Verify that the rotation and position angles are actually correct.
    - Meet with Dr. White's team to get their opinions and test functionality for users.
    - Start learning neural networks
    - Add another function for flightpath in TOML file so we can support non-linear changes in x.
11. Milestone 5 (Mar 20): itemized tasks:
    - Implement a neural network that can estimate the pose of the satellite based on the synthetic data that we have been generating.
    - Generate a variety of data using different variables for training and testing
12. Milestone 6 (Apr 17): itemized tasks:
    - Improve neural network
    - Prepare to hand off the project to Dr. White's team
    - Create poster for Senior Design Showcase
    - Implement, test, and demo which features/modules
    - Test/demo of the entire system
    - Conduct evaluation and analyze results
    - Create user/developer manual
    - Create demo video
13. Task matrix for Milestone 4 (teams with more than one person)

Task	William	Nate	Stephane	Hanibal
Validate that the angles generated are correct	33%	0%	33%	33%
Meet with Dr. White's team to get their opinions and test functionality for users.	25%	25%	25%	25%
3. Start learning neural networks	0%	33%	33%	33%
Finish adding linux compatibility	50%	50%	0%	0%
4. Add another function for flightpath in the TOML file so we can support non-linear changes in x.	0%	0%	50%	50%

14. Description (at least a few sentences) of each planned task for Milestone 4:
    - Task 1: Dr. White wants us to test to make sure that the coordinates and angles of rotation that we are currently outputting are actually correct. This is because none of the neural networks will work properly at estimating poses if the poses that we are giving it for training are incorrect.
    - Task 2: We need to meet with Dr. White's team to demo our program. We will also survey them to see how easily they are able to use the program. We will also take some notes from them about additional features that should be added or changes that should be made.
    - Task 3: For the next milestone we are making a neural network for pose estimation using the synthetic data we generate. Some of us do not know much about neural networks so it would be nice to do some learning before then.
    - Task 4: We also need to finish making the program runnable on linux. It currently works on windows and mac os. Linux is important because many of the lab's computers and many gpu servers use linux.
    - Task 5: The user imputed functions in the code are currently based on the x axis. It would be a lot better to add a variable T and change the functions to be based on T. This would allow x to be based on a user imputed function too, and allow for non-linear x movement.
15. Approval from Faculty Advisor
    - "I have discussed with the team and approve this project plan. I will evaluate the progress and assign a grade for each of the three milestones."
    - Signature: _____ Date: _____