Definition of the problem:

For decades the number of debris in space has been growing. Whether it be from payloads, broken satellite pieces or asteroids, debris poses a threat to people aboard the ISS, functioning satellites and impending launches into space (Wall). Traveling 10~20 times faster than a bullet, a piece of debris has the ability to disable a satellite, potentially affecting national security, navigation, communication, and more (Matney). While tracking debris from the ground is mostly effective in mapping out debris fields, the growing abundance of debris requires more angles of detection. There are multiple other uses for having satellites themselves be able to detect when they are in the presence of debris, like debris avoidance or even capturing the debris. Finding an effective and efficient way of tracking debris will save $58 million in US satellite damages alone (Foust).

Computational plan:

Our plan starts with a high-fidelity orbit simulation with a massive amount of simulated debris orbits. The debris orbits will be simulated from a real debris dataset. The dataset contains the orbital characteristics which will then be translated into a position versus time csv file using a python conversion program (“Chapter 5: Planetary Orbits”). Once all of the orbits are generated, they will be loaded into a graphical portion where the computer vision machine learning algorithm will be taking pictures of the simulation from the perspective of a satellite in orbit and outputting the class and position of the debris on the screen. The most likely type of machine algorithm we will use is You Only Look Once or YOLO. It specializes in fast object detection with minimal false alarms (Wang and Liao).

Progress:

We have generated the csv files for the earth, moon, and sun as they rotate relative to each other as well as the position versus time for roughly 14 thousand pieces of debris. Additionally, we have set up the 3D environment that will be used to train our neural network, and are working on adding the debris orbits into it. In terms of the neural network itself, we have done the necessary research in order to begin implementing it upon the completion of generating our training dataset.

Expected results:

We expect to see that YOLO will effectively track the debris in space over time with a high degree of accuracy. Given the range of debris types and sizes(including rocket bodies, lost tools, and aluminum slag) we estimate that this model will have an adequate variety of categories to identify for some practical use, while also being lightweight enough to run in real time.

Work Cited

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