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AERSP 304 Project 1

3/3/2023

Discussion of MATLAB Results

Chart

Description automatically generatedChart, diagram

Description automatically generated with medium confidence

Figure 1 Figure 2

Figure 1 and figure 2 are the plots of the trajectories of a space craft at Lyapunov Orbit at Lagrange point 2 in a body frame and inertial frame respectively. The body frame plot was calculated in MATLAB using numeric analysis from the given equation (7) and (8) utilizing ODE45 in MATLAB. From the body frame, the inertial frame can be found for each time step with the DCM CNB.

Diagram

Description automatically generatedA picture containing chart

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Figure 3 Figure 4

Figure 3 and figure 4 are the plots of the trajectories of a space craft at Lyapunov Orbit at Lagrange point 4 in a body frame and inertial frame respectively. The body frame plot was calculated in MATLAB using numeric analysis from the given equation (7) and (8) utilizing ODE45 in MATLAB. From the body frame, the inertial frame can be found for each time step with the DCM CNB.

Chart, line chart, histogram

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Figure 5

Chart, line chart, histogram

Description automatically generated

Figure 6

Figure 5 and figure 6 depict the departure from the nominal Lyapunov Orbit at Lagrange point 2 when the space craft is slightly perturbed at its initial position. Utilizing a similar method to figures 1, 2, 3, and 4 the given equations (7) and (8) were used to calculate the trajectory for the perturbed conditions utilizing MATLAB’s ODE45. The trajectory of δx was calculated by subtracting the perturbed position and velocity from the nominal position. Taking the magnitude of those position and velocity vectors and plotting them against time yields the plots above (figures 5 and 6). We can see that Lagrange point 2 is unstable, as the small difference in initial position ends up leading to large departures in both the velocity and position as time gets further from t = 0.

Chart, line chart

Description automatically generated

Figure 7

Chart, line chart

Description automatically generated

Figure 8

Figure 7 and figure 8 depict the departure from the nominal Lyapunov Orbit at Lagrange point 2 when the space craft is slightly perturbed at its initial position. Utilizing a similar method to figures 1, 2, 3, and 4, the given equations (7) and (8) were used to calculate the trajectory for the perturbed conditions utilizing MATLAB’s ODE45. The trajectory of δx was calculated by subtracting the perturbed position and velocity from the nominal position. Taking the magnitude of those position and velocity vectors and plotting them against time yields the plots above (Figure 7 and 8). We can see that Lagrange point 4 is stable as the departure values for the position and velocity are small. Beyond that, we can also see that the oscillation of the departure position is decreasing in magnitude as t moves further away from t=0.

Chart

Description automatically generated

Figure 9

Chart

Description automatically generated

Figure 10

The graphs above show the magnitude of the position vector (Figure 9) and the magnitude of the velocity vector (Figure 10) from the perturbed motion and the linearized model for Lagrange point 2. For long time scales, the linearized model diverges drastically from the real motion but can work as a very close approximation at shorter time scales. This drastic divergence is due to the instability of the Lagrange point.

Chart

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Figure 11

Chart, line chart

Description automatically generated

Figure 12

The graphs above show the magnitude of the position vector (Figure 11) and the magnitude of the velocity vector (Figure 12) from the perturbed motion and the linearized model for Lagrange point 4. The linearized model stays very close to the real motion but slowly starts to diverge as time progresses. For this stable Lagrange point, a linearized model could be used to closely approximate the real motion for a longer time span than unstable points.