AE 8148 Spacecraft Dynamics and Control
Assignment 4
Due: April 28, 2021 (email submission)

In the file `A4orbits.mat` are the initial conditions (X0m,X0L2) and periods (Tpm,TpL2) of a lunar distant prograde orbit and an L2 Lyapunov orbit, with the state vector written as $X = [x, y, x', y']^T$. Figure 1 shows the two orbits. Both orbits have the same Jacobi constant. Note that the lunar distant prograde orbit (DPO) is one of a family of orbits about the moon. If you are interested to see what this family looks like, you can grow this family by decreasing the initial x-coordinate. Note that you will need to keep the increments in x_0 very small, since there are more than one family passing through the x-axis at the same location (eg. L_2 Lyapunov orbits). If you make the increments in x_0 too large you may find the single shooting differential corrector jumping to another family. Note, the growth of this family is only if you are interested. It is not required for this assignment.

1. Generate a free transfer from the Lunar DPO to the L_2 Lyapunov orbit, using the respective unstable and stable manifolds for the DPO and Lyapunov orbits. You will need to select an appropriate surface of section. To generate the stable and unstable manifolds you can take $\epsilon = 2.6 \times 10^{-4}$ (see the notes), which physically corresponds to a displacement of roughly 100km for the position part of the initial condition perturbation.

2. Generate a free transfer from the L_2 Lyapunov orbit to the Lunar DPO, using the respective unstable and stable manifolds for the Lyapunov and DPO orbits.

3. Using the transfers obtained in Questions 1 and 2 as starting point, use a multiple-shooting differential corrector to generate a new periodic orbit about both the Moon and L_2, as shown in Figure 2. Note, you do not need the Lunar DPO or L_2 Lyapunov orbits for this question. You may use the provided differential corrector in file `pcrtbpmultshoot.m`. Note that you will also need the files `pcrtbplvl1.m` (the Level 1 differential corrector) and `pcrtbp_dyn_stm.m` for it to run. However, note that the way the differential corrector includes constraints to ensure a periodic orbit is obtained. These constraints assume that the first and last patch points lie on the x-axis. So, if you use it, choose your patch points accordingly (or modify the constraints).

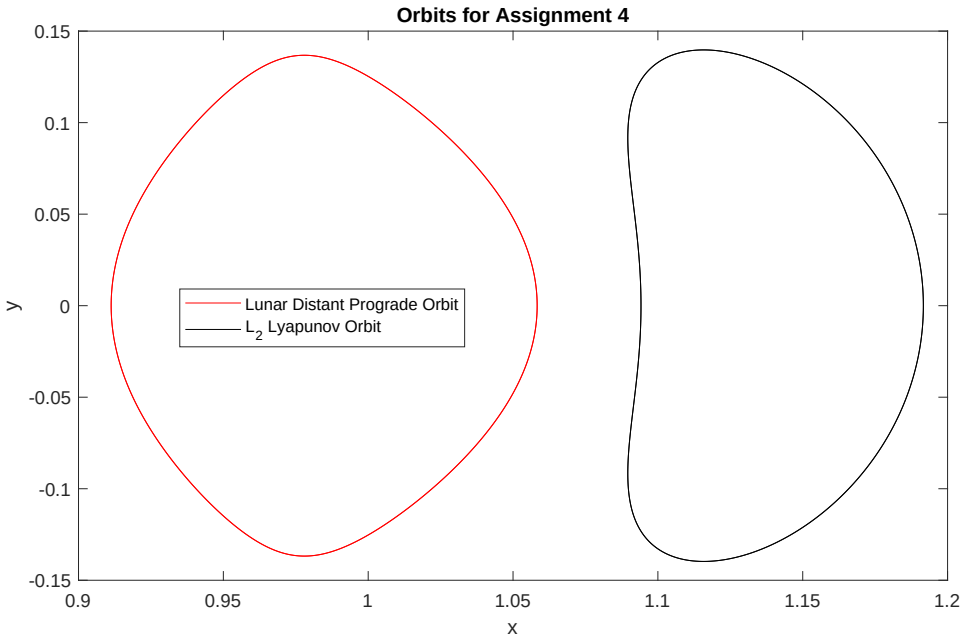

Figure 1: Orbits about Moon and L2

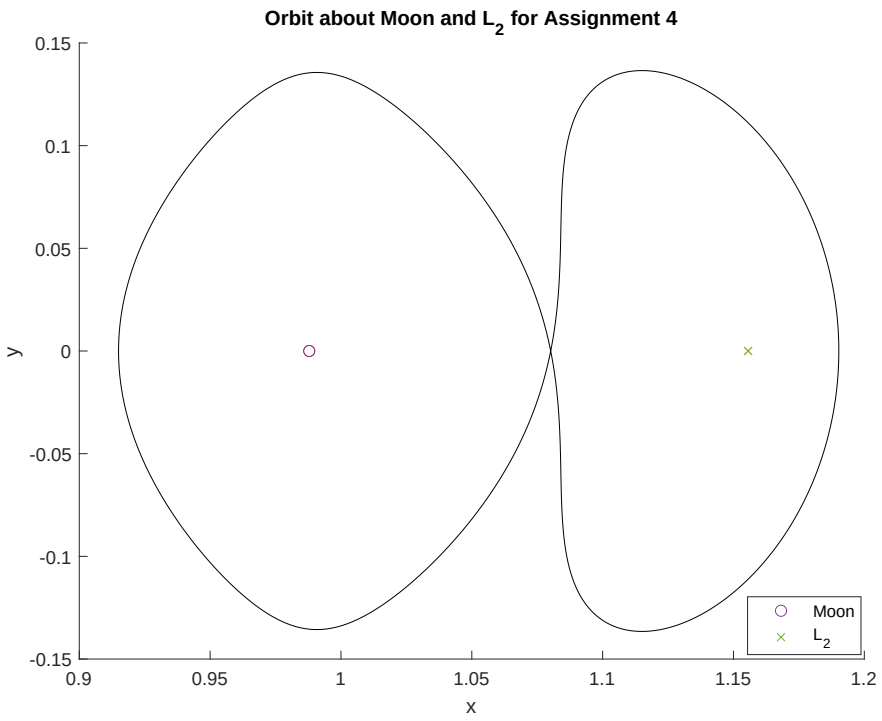

Figure 2: New orbit about Moon and L2