Chapter 8

Conclusions and Scope of future work

8.1 Concluding Remarks

In this study, planar and three dimensional periodic orbits are computed in the frameworks of CRTBP and ERTBP and the effects of various perturbing forces on the parameters of these periodic orbits are analyzed. The analysis shows that the radiation and the oblateness of the primaries play a dominant role in the determination of locations of Lagrangian points. Further, the size, period, stability and other parameters of halo orbits are also affected due to perturbing forces of radiation pressure and oblateness of the primaries. Computation of halo orbits in different Sun-Planet systems shows that the mass factor of primaries play a vital role in the determination of location, size, period, amplitude, initial location and initial velocity of spacecraft moving in a halo orbit. So, it is necessary to consider various perturbing forces in the computation of periodic orbits as well as in a mission design.

The equations of motion of infinitesimal body moving in the ERTBP framework are non-autonomous as described by Szebehely (1967) and Danby (1962). In Szebehely (1967), the author has derived the equations of motion of the infinitesimal body in ERTBP framework by considering the true anomaly as an independent variable. These equations contain the independent variable explicitly. In this case, the integral of motion is quasi-integral. So, Jacobi constant does not exist. In Singh and Umar (2012a) and Sheth and Thomas (2022), the authors have considered the eccentric anomaly as independent variable and computed the equations of motion. To get an autonomous system, the equations of motion are averaged with respect to independent variable, eccentric anomaly (E). A comparison between potential functions of CRTBP and ERTBP shows that

1. The independent variable in CRTBP is time t while it is eccentric anomaly E in ERTBP.
2. The factor $1/\sqrt{1-e^2}$ is absent in CRTBP as $e = 0$ for CRTBP.

In this revised system, the integral of motion exists which facilitates the computation of PSS in ERTBP framework. Also, it simplifies the computation of halo orbits using analytical as well as numerical techniques.

It has been analyzed that the halo orbits shrink and their amplitude decrease due to non-zero value of eccentricity of the orbit of the primaries. Also, the variation in period and other parameters of halo orbits are observed due to non-zero value of eccentricity of the orbit of the primaries. Further, the study of first order interior and exterior resonant orbits shows that the value of eccentricity of the orbit of the primaries play a dominant role in the determination of parameters of resonant orbits. So, it becomes necessary to consider the actual value of the eccentricity of the primaries' orbit for more precise mission design.

8.2 Scope of future works

- In this study, the first order interior and exterior resonant orbits are computed using the PSS method in the Sun-Saturn system. It is possible to compute the higher order resonant orbits using the PSS. Further, by computing resonant orbits in various Sun-Planet systems, the effects of mass factor on parameters of resonant orbits can also be analyzed.
- Three–dimensional periodic orbits around collinear Lagrangian points (halo orbits) are obtained in ERTBP and the effects of solar radiation pressure on different parameters of these orbits are analyzed. Periodic orbits around triangular equilibrium points of ERTBP using Lie series solution will be obtained in future.
- In CRTBP and ERTBP, halo orbits are computed by considering constant masses of primaries and infinitesimal bodies. It would be interesting to compute halo orbits by considering the infinitesimal body with variable mass.
- Computation of halo orbits in relativistic ERTBP.
- In the study of periodic orbits, mainly two types of bifurcations are observed: tangential bifurcation and period multiplying bifurcation. Tangential bifurcation is useful for computing halo orbits. Using the period multiplying bifurcation, it is possible to obtain period-m, $(m = 2, 3, 4, 5)$ DROs in ERTBP.