Station-Keeping Maneuvers for a Geostationary Satellite using Linear Quadratic Regulator

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During the life of geostationary satellite, many chances of station-keeping maneuvers are required and fuel optimization is needed. In this paper, we approach numerically the station-keeping maneuvers from an elliptical orbit to a close circular geostationary orbit with the support of optimal control theory and their results are presented. This paper assumes control variables are not bounded and thrust accelerations are continuous all over the interval, and some state variables are specified at a fixed terminal time. To minimize the fuel or energy due to transfer a system from an arbitrary initial state to the target set with a good accuracy at a terminal time, and to keep this system within an acceptable deviation from a reference condition, E/W and N/S station-keeping maneuvers are realized by Linear Quadratic Regulator(LQR). Backward and forward numerical integration method for LQR is presented to solve the system differential equations and the Euler-Laglange differential Equations, involving the initial and final boundary conditions. Futhermore, LQR solutions for E/W and N/S station-keeping maneuvers is compared with nonlinear solution which is numerically solved by shooting method, and compared with analytic solution calculated by delta-V method, to testify whether LQR method is compatible with above analytic solution and nonlinear solution, in view of fuel optimization.