Minimum time control of the attitude reorientation for a launcher

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We investigate the minimal time problem for the guidance of a launcher, whose motion is described by its attitude kinematics and dynamics but also by its orbit dynamics. To analyse the problem, we formulate the control system as a bi-input control-affine system with its control taking values in an Euclidean disk. Then, based on a refined geometric study of the extremals coming from the application of the Pontryagin maximum principle, we reveal the existence of singular arcs of second-order in the optimal synthesis. Next, we show that these singular arcs cause the occurrence of a chattering phenomenon (the Fuller's phenomenon), i.e., of an infinite number of switchings when trying to connect bang arcs with a singular arc. Finally, based on this preliminary theoretical analysis, we implement efficient direct and indirect numerical methods, combined with numerical continuation, in order to compute numerically the optimal solutions of the problem.