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ON THE STATIONARITY AND OPTIMALITY CONDITIONS IN AN OPTIMAL CONTROL PROBLEM RELATED TO AUTONOMOUS OBJECTS GROUP TARGET ORBITING WITH CARRIER OBJECT SUPPORT

Abstract

Optimal control problems related to group control are very important to applications and theoretical investigation due to progress in groups of autonomous objects, including small satellite constellations. To analyze the evolution of group control strategies and their dependence on problem parameters one has to obtain and analyze optimality conditions in the general cases to investigate the widest range of problem formulations. Thus, we need to work with the general theory of optimality conditions. What is more, since the formulation of group control problems depends on different object dynamics and objects number, we need to reduce new problem formulation to classical ones. In this work, we focus on the following problem class (interesting from modern Earth remote sensing and space communication point of view). We consider an object ("carrier") moving from start to end set ("orbit") and launching "payload" objects at decoupling times. Depending on the problem background, payloads might be controlled/uncontrolled. To describe system dynamics, we use a system of ODEs consists of two subsystems: the "carrier" subsystem and several "payload" subsystems. They are determined on "main" and "nested" time intervals ordered w.r.t. start times. The start time of each "nested" interval is in fact time of corresponding payload decoupling. Our goal is to find program controls minimizing problem cost. To do this, we perform replication of variables and reduce our optimal control problem to classical form, then rewriting stationarity conditions and quadratic form in original time. We also provide some examples of our conditions application.