Paper ID: 24021
student

SPACE OPERATIONS SYMPOSIUM (B6)
New Operations Concepts, Advanced Systems and Commercial Space Operations (2)

Author: Mr. Huan Huang
National University of Defense Technology, China, marshal-huanghuan@163.com

Prof. Leping Yang
National University of Defense Technology, China, ylpnudt@163.com
Mr. Yuanwen Zhang
National University of Defense Technology, China, zyw1983nudt@163.com
Dr. Yanwei Zhu
National University of Defense Technology, China, zywnudt@163.com
Mr. Hou-jun Ao
National University of Defense Technology, China, aopeter@163.com

COOPERATIVE CONTROL OF SPACECRAFT FORMATION IN SPACE-BASED RADIOGRAPHY USING ROBUST CYCLIC PURSUIT APPROACH

Abstract

With the increasing requirements of fault detect and on-orbit operation for disabled spacecraft, it is of great significance to conduct proximity inspection and obtain the technical information about the target's external geometry, internal structure and characteristics to ensure an effective follow-up operation, which represent a promising aspect of space situational awareness. Enlightened by the radiography technology for nondestructively detect the target's interior, we put forward the idea of space-based radiography to examine the residual propellant or detect the fault of an on-orbit target spacecraft. Naturally, a ray source and a detector spacecrafts are used to construct a collinear formation with the target, and they would synchronously rotate around the target to get full perspective imaging. However, in contrast to ground radiography system, space-based radiography has farther relative distance and lower ray intensity due to the safety and energy considerations, it is necessary to ensure the ray source and detector maintain formation flight in a cooperative manner while being capable of keeping accurate relative attitude/orientation to acquire enough rays for imaging precision. With above consideration in mind, several formations with relative attitude constraints considered are proposed under 6-DOF nonlinear coupled dynamic model, and then the cyclic pursuit approach is utilized to design the decentralized cooperative controllers for each formation pattern. Here the cyclic pursuit approach is explored to settle the multiple spacecrafts 6-DOF coordination problem, and the corresponding parameter tuning method would be improved and derived accordingly. In addition, considering the influences of external disturbances and uncertainty, a feedback compensation based on extended state observer would be introduced to enhance the robust capability. Finally, numerical simulations are carried out to examine the feasibility of space-based radiography, and verify the validity and performance of the proposed cyclic pursuit controller with certain robust capability.