Optimal Control, Active Satellites and Space Situational Awareness
最佳控制、主動式衛星、太空交通環境認知

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Abstract

The topic of Space Situational Awareness (SSA) has become an important field of study over the last several years, highlighted by the growing number of nations with orbital assists, the documented growth in space debris, and the occasional collision of satellites in orbit. I will discuss several open questions that need resolution in this field, related to the tracking and identification of Earth satellites, modeling of non-gravitational perturbation effects, coupling between attitude and orbital dynamics, and the characterization of both space debris and active satellites.

In the characterization of active satellites one can bring together classical techniques from the field of optimal control with strategic issues related to SSA. We will outline the connections between these topics and show how optimal control leads naturally to the concept of a control metric to measure the distance between two satellites in terms of the propulsive effort needed to connect two orbital states. With this concept in hand, we will provide explicit examples of its application and introduce additional motivating questions for its future use.

摘　　要

過去幾年由於越來越多國家發射衛星進行太空探索、數量日漸增多的太空碎片、以及偶有所聞的衛星相撞，太空交通環境認知 (SSA) 議題已經成為重要的研究領域之一。在演講中，我會觸及本領域中若干需要解決的開放式問題，尤其是關於繞地衛星的追蹤與辨識、非重力擾動效應的模擬、姿態和軌道動力學的耦合、以及太空碎片和主動衛星的特性。

　　在主動式衛星的特性中，我們可以將傳統的最佳化控制技巧，引入和 SSA 相關事務的策略擬定中。本次演講將大概介紹這些主題的相關性，並展示最佳控制技術如何自然地導出控制測度的概念，用以量測兩個衛星的「距離」-- 這邊的「距離」並非幾何上的意義，指的是將兩個軌道狀態連結所需的燃料。在此概念之下，本演講將舉出一些範例，說明此技術的應用場景，並提出未來其他的應用，以供大家思考。