Research Progress of Dynamics and Control Evolution of Flexible Spacecraft

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1. Introduction

The dynamics and control evolution of spacecraft have not been researched widely. The research on the dynamics and control evolution of spacecraft primarily addresses the interaction mechanism of different parts of spacecraft. In this paper, several aspects of dynamics and control evolution will be discussed.

2. Body of abstract

This paper discusses the dynamics and control evolution of flexible spacecraft. First, the conception of evolution is introduced. Second, factors such as the flexible structure vibration induced by movement of spacecraft, environmental disturbances, the robust control system of spacecraft, the composite control system of spacecraft, the coupled dynamics interaction of spacecraft, dynamics parameters variation during the implementation of the mission, and attitude dynamics and control during spacecraft attitude maneuvers are discussed. Finally, future research suggestions are provided.

3. Research Progress of Dynamics and Control Evolution of Flexible Spacecraft

Flexible structure vibration induced by movement of spacecraft.

Most of the previous studies pay more attention to a specific condition of spacecraft movement; they tend to develop only one type of technology and address vibration problems. One important factor is the stability of the control system. However, the dynamics evolution of structure vibration has not been researched.

Disturbances lead to reduce performance of spacecraft.

Most of the previous-cited researchers considered environmental factors, flexible structure vibration, actuator effectiveness fault as uncertainty and external disturbance in the attitude control system. The interactions among uncertainty, disturbance and the attitude control system are usually not considered as main factors in the attitude control system. However, the interactive mechanism among attitude control, uncertainty and external disturbance was infrequently researched. Furthermore, the uncertainty, external disturbance and attitude control evolution of spacecraft have not been researched.

Robust control system is right way to improve the performance of spacecraft.

The previous studies show that robust control was an important aspect of spacecraft attitude control. Previous research was more likely to focus on control strategy design. To improve the effectiveness of the control algorithm, many scholars tended to apply intelligent control theory. Furthermore, a flexible appendage is a key factor of controller design. However, the dynamic evolution of structure vibration has not been researched.

Composite control system is important form of style for improving the performance of spacecraft

In the previous studies, most researchers considered control strategy design as a very important aspect of the composite control of attitude, maneuver and vibration suppression. They tended to design control algorithms for the composited control system that were based on the control theory. However, the interaction mechanism between attitude control and flexible structure vibration was little researched. Furthermore, the dynamics and control evolution of spacecraft have not been researched.

Coupled dynamics interaction has an important influence on the control of spacecraft.

In the previous literature, most researchers considered multi-field coupling and rigid-flexible coupling as a very important aspect of the coupled dynamics interaction of spacecraft. They usually understood the mechanism of coupling, but the interaction mechanism evolution in multi-field coupling has not been researched widely.

Dynamics parameters variation during the implementation of mission

In the previous literature, the dynamics parameters of systems were usually the key factor of spacecraft dynamics and control systems. Parameter variations made control systems more complex, but the interaction mechanism of parameter variations was not widely researched. Furthermore, the control parameters evolution of control system has not been systematically researched.

Attitude dynamics and control during spacecraft attitude maneuver

In the previous literature, many factors were considered with respect to the attitude control system. Most previous studies considered specific conditions, but the interaction mechanism evolution of attitude control and dynamics was not

considered. In addition, if the interaction mechanism evolution could be revealed, the attitude dynamics and control system could be understood from a macroscopic point of view.

4. Recommended Future Research

It is well known that the dynamics and control of flexible spacecraft have contributed to spacecraft development. This field of research has helped us find and solve many scientific problems. With the development trend towards large-sized spacecraft, there are many challenges for future development. For example, the main feature of huge spacecraft in the future will be one that is strongly nonlinear, the evolution of the dynamics and control of huge spacecraft will become more complex, and it will be a challenge to reveal the evolution mechanism of large spacecraft. However, this is the foundation of the coordinated control of spacecraft which will be a key factor in the success of high-precision control and high reliability. As a result, future spacecraft is evolving as a multidisciplinary research subject and it is necessary to research the multidisciplinary evolution mechanism of the dynamics and control of spacecraft.

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