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# DYNAMIC PROGRAMMING AND AUTONOMOUS APPROACH TECHNOLOGY IN ON-ORBIT MAINTENANCE FOR MICRO SATELLITE CONSTELLATION

**Abstract**

Space technology is an enormous systems engineering. In order to benefit human life better, especially provide space communication, meteorological, remote sensing services to undeveloped countries, one of the development trends is to design and use micro satellite constellations with different functions which can provide space service to various countries. This method reduces the system project's cost, so that undeveloped countries can afford the service charge for ground application.

While realizing micro satellites' advantages, we should also recognize that micro satellites' lifetime is shorter than common satellites', and they are not capable to de-orbit actively because of restriction of development cost, period and maneuver capability. Obviously if there isn't any appropriate measure, there would be lots of uncontrolled space debris which would cause security threat to normal satellites.

To solve this potential issue, a reasonable and effective method is to use on-orbit maintenance spacecraft which have the capability to implement orbit maneuver and capture. They can retrieve failed satellites, and use autonomous descending method to make failed satellites destroyed in the atmosphere.

This paper focuses on autonomous rendezvous and docking (ARD) control technology which is the premise to clean up space debris. In the ARD mission with a failed micro satellite in a constellation, the safe corridor to specific capture position is spinning because the failed satellite's attitude revolves slowly in the space. Meanwhile the active spacecraft has to avoid other satellites in the constellation when approaching. This is the core issue in on-orbit maintenance which includes revolving safe corridor and several obstacles in maneuver space.

The main work of this paper includes three parts. Firstly, the safe approach corridor suitable for failed satellite is designed using ellipse cissoids method. Secondly, considering the rotation character of safe corridor the dynamic programming of approach path is achieved according to the satellite safety envelope in the constellation. Thirdly, relative attitude and orbit dynamic equations including failed satellite's rotation character are derived, and autonomous path tracking and docking is realized using attitude and orbit coupled control method. The relative dynamics of revolving object, safe approach corridor, and safety envelopes of normal satellites are combined effectively, and ARD with revolving object is realized in various restrictions. This is the most remarkable innovation of this paper. The technology proposed in this paper could ensure we can take full advantage of micro satellite constellation in the future.