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RADIO PULSAR NAVIGATION METHOD BASED ON SYNTHETIC APERTURE AND SPACECRAFT FORMATION TECHNOLOGY

Abstract

It is very difficult to navigate spacecrafts far away from the Earth autonomously. In the seventy's of last century, with the discovery of pulsar, X-ray pulsar navigation technology has become the focus of autonomous navigation. Because shorter wavelength leads to higher precision, researches of pulsar navigation are most focus on X-ray currently. NICER team will process a test of X-ray pulsar navigation in the International Space Station during 2017. Pulsars release more energy on the radio band, and we can catch the pulse signal by a few minutes observation usually. At the same time the radio pulsars suitable for navigation are more. If we apply radio pulsar navigation method on spacecrafts directly, spacecraft must carry a huge disk antenna (dozens of meters diameter), and we must overcome the difficulty to launch this huge antenna, deformation of the antenna on orbit, and attitude control of the spacecraft. This paper presents a radio pulsar navigation method based on synthetic aperture and spacecraft formation technology. The principle of synthetic aperture is applied in pulsar radio observations (similar to VLA), and a number of small dish antenna are arranged in spacecraft formation composed of several small spacecraft. By controlling the relative position among the formation and the direction of all the antennas accurate, these small dish antennas will act as a ground base big radio dish antenna; then spacecrafts get the Time of Arrive(TOA) in radio band, and obtain their position by pulsar navigation method. In this paper, we demonstrate the general design of the small spacecraft formation synthetic aperture radio pulses navigation system firstly. Then we introduce the control method of relative position and the directions on all the small antennas in details. Synthetic aperture radio pulsar TOA observation scheme and navigation method are discussed finally.