Chapter 5

Interference Mitigation for Satellite: Terrestrial Heterogeneous Coexistence Cognitive MIMO System Based on Digital Beamforming

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ABSTRACT

For the coexistence and increasing interference of satellite-terrestrial network and terrestrial wireless network, we analyze a typical scenario where the GEO satellite-terrestrial network and the 4G mobile communication network coexist heterogeneously. Besides, a multi-user cognitive system model that secondary satellite terminals interfere the primary MIMO 4G base stations is also proposed, with whose general signal processing is deduced. Meanwhile, DBF technology in 4G base station system is adopted to minimize the cognitive interference caused by multi-antennas and multi-users. And we propose an OBW-FAI. Weight vector is only related to the azimuth of the interferences, thus the proposed algorithm does not need real-time and repeat calculations, and has small complexity. Finally, the numerical simulation results verify that the proposed system and algorithm can effectively reduce interference between satellite-terrestrial network and terrestrial wireless network to a certain extent.

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INTRODUCTION

Cognitive Radio (CR) has been widely studied and applied, which is the most effective technology to solve the serious shortage of spectrum resources and utilization in wireless communications recently (Haykin, 2005). There are typically two main approaches for CR to access the licensed spectrum. One is that secondary users will access the spectrum after sensing free band of primary users. Once the primary users are back to their spectrum, and secondary users need to release the spectrum. The other one is that secondary users share the spectrum with primary users without influence on communications of primary users when secondary users sense that primary users are using the spectrum. Currently, the second method has been widely studied, so how to ensure the quality of service (QoS) of primary users, as well as the interference of secondary users have no impact on minimum signal to interference plus noise ratio (SINR) of primary users has become research hotspots and issues.

BACKGROUND

Currently, the existing anti-jamming technologies can be implemented in frequency, time, spatial domain and anti-jamming technology integrated frequency domain, time domain and spatial domain. Anti-jamming technology in spatial domain is mainly implemented by smart antennas whose key technology is digital beamforming (DBF) technology. DBF can dynamically produce a variety of desired beams in the digital domain. When the antenna is in a receiving state, it is ensured that the gain in the direction of expected signal is not affected. Moreover, adaptive zero of antenna pattern is aligning to interference signal in order to suppress interference (Wang, Pan, & Song, 2013). This technique has been widely employed in wireless communication because of properties above.

In the field of cognitive radio, some researchers have applied DBF technology to various fields, such as interference control (Yiu, Vu, & Tarokh, 2009), maximize the channel capacity (Luan, Gao, Zhang, Li, James, & Lei, 2012), SINR balancing (Cumanan, Musavian, Lambotharab, & Gershman, 2010) and so on. However, it is still a challenge to employ the DBF under the condition of the secondary user and the primary user sharing the spectrum. In addition, the channel capacity of cognitive Multiple Input Multiple Output (MIMO) system has also been investigated widely (Akin & Gursoy, 2013; Z. Li, J. D. Li, Liu, & Shen, 2014), but few studies focus on cognitive systems based on DBF-MIMO.

With the recent people’s increasing communication needs of 5W (Whoever, Wherever, Whenever, Whomever and Whatever), particularly in the field of disaster prevention and mitigation, satellite communication has become more important than ever. And the utilization of satellite communication has also been gradually improved. Satellite network is a typical resource-constrained network. How to improve satellite network intelligently and efficiently through cognitive technology? The key point is a currently hot research direction. University of Surrey, Luxembourg University and other six universities in European Union (EU) carried out the “Cognitive Radio for Satellite communications (CoRaSat)” project (CoRaSat, n.d.), aiming to use satellite spectrum flexibly and intelligently through cognitive radio, and some research results have been achieved (Liolos, et al, 2013). China Aerospace Science and Industry Corporation (CASIC) (Li, 2007), Maritime Satellite TT&C Department of China (Liu & Zhu, 2008), Shanghai Engineering Center for Micro-satellites (Ma, Chen, Liu, & Liang, 2010), China Academy of Space Technology (CAST) (Liu, Bi, Sun, & Liu, 2012), China Academy of Space Technology (Xi’an) (Chen, Qiu, & Wang, 2012) and the China Electronics Technology Group Corporation (CETC) carried
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