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Signal Structure for Group Control of Space Vehicles of a Multi-Satellite Space System with Code Division of Channels

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Abstract. This article addresses the challenge of selecting signal structures (SS) for group control of spacecraft in a multi-satellite space system utilizing code division of channels (CDC). A comprehensive analysis of minimax ensembles of discrete pseudo-random sequences, including Gold, Kasami (small and large sets), Kamaletdinov sequences, bent-sequences, the combination of Kasami and bent-sequences, is conducted. However, none of these ensembles fully meet the requirements for volume, length, and correlation characteristics necessary for simultaneous control of multiple objects.

To overcome this limitation, the authors propose a formation algorithm that combines Gold sequences of length 127 and segments of the Kamaletdinov sequences, extracted from the Kamaletdinov sequences of length 930, using autocorrelation function (ACF) and mutual correlation function (MCF). By excluding sequences with $ACF R_{max} \geq 0.2$ and $MCF R_{max} \geq 0.23$, the maximum peaks of ACF and MCF are reduced by 52.6% and 56.1%, respectively. This leads to an overall improvement in correlation properties while reducing the ensemble of formatted sequences from 28896 to 15272. The resulting ensemble exhibits a 10% lower maximum ACF peak level and a 118-fold increase in volume compared to an ensemble of Gold sequences of the same length.

Based on these findings, it is concluded that the formatted ensemble is well-suited for the implementation of group control of spacecraft in a multi-satellite space system with code division of channels.

Keywords: spacecraft group control, multi-satellite space systems, signal-code constructions, minimax pseudo-random sequences, correlation properties

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