Research on Sequence Design for 4th Generation Mobile Communications

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ABSTRACT

Nowadays, 4th generation (4G) mobile communications have been received much more attention due to the up-going requirement for large system capacity, high transmission rate and ubiquitous services etc. Besides Orthogonal Frequency Division Multiplex (OFDM) and Multi-In Multi-Out (MIMO) technologies, CDMA technology is also expected to be facilitated with 4G characteristics, which leads to the crucial task of the sequence design for CDMA system. Up to date, sequences with Zero Correlation Zone (ZCZ) have been successfully applied in many communication systems, especially in S-CDMA (Synchronized CDMA) and QS-CDMA (Quasi-Synchronized CDMA). With the zero correlation zones in the correlation functions, the systems enjoy low interference. Moreover, the set of complementary sequences which has ideal correlation functions of sequence groups can be considered as the special form of ZCZ sequence set employed in the single carrier CDMA systems as well as Multi-Carrier (MC) CDMA systems. Recently, with the success of LAS-CDMA, the ZCZ sequences and ZCZ sequence sets become more and more celebrated. This thesis is devoted to carry out the research of novel ZCZ sequences and ZCZ sequence sets.

The first contribution presented in this thesis is sequence set with Three Zero Correlation Zones (T-ZCZ), which is intended to handle the restrictions of the number of complementary sequences in MC-CDMA system. Specifically, the algorithms for generating T-ZCZ sequences are discussed. The theoretical bound of T-ZCZ sequence set is calculated. Some applications of T-ZCZ sequence set are also presented. Meanwhile, the performance in the CDMA system is evaluated. The result shows that the T-ZCZ sequences have the same performance as the complementary sequences in interference cancellation, while the number of the T-ZCZ sequences is considerably larger. That means the system capacity can be drastically increased by T-ZCZ sequences.

Another contribution in MC-CDMA system is “Two-Dimensional Combined Complementary Sequence (TDC)”, whose row and column vectors are both complementary sequences. This kind of structure achieves PAPR (Peak-to-Average Power Ratio) reduction as well as interference cancellation. In the thesis, the algorithm to generate TDC sequences and the detailed structure of the corresponding MC-CDMA system are stud-

ied. The BER (Bit Error Rate) performance of the uplink and downlink is also analyzed and evaluated.

Due to the importance of the complementary sequences, the research on the pertinent generating algorithm is launched. Comparing with the previous algorithm which can generate the set of complete complementary sequences of length $N^n N(n, N \in Z^+)$, we present an algorithm which can produce the set of complete complementary sequences with shorter length $2^m N(m, N \in Z^+)$. The sequence set with short length can be applied in some special cases that long sequence is not appreciated, such as infrared communications.

Additionally, we give an algorithm for the generalized LS sequences derived from the set of complete complementary sequences. Compared with LS sequences , which derived from Golay complementary pairs, the new generalized LS sequences enjoy more categories and sequences. The LS sequences can be classified as the special form of the generalized LS sequences.

At last, the application of ZCZ sequences in Wireless Local Area Network (WLAN) is discussed. In WLAN, we use CCK modulation enhanced by pseudo-periodic sequences instead of the common traditional CCK modulation. The enhanced CCK with ZCZs shows good performance against multi-path interference.

In summary, throughout this thesis, novel sequences are designed for the incoming 4th generation mobile communications, especially for the enhanced CDMA system capable of efficient interference cancellation.

Key Words: ZCZ, T-ZCZ, complementary sequence, CDMA, MC-CDMA