| | |
|---|---|
| Title | 電力制約通信のためのConstruction A及びD'格子 |
| Author(s) | 周, 帆 |
| Citation | |
| Issue Date | 2021-12 |
| Type | Thesis or Dissertation |
| Text version | ETD |
| URL | http://hdl.handle.net/10119/17602 |
| Rights | |
| Description | Supervisor:KURKOSKI, Brian Michael, 先端科学技術研究科, 博士 |

# Abstract

Lattices have the potential to provide reliable and power-efficient data transmission in the next-generation wireless communications. Information theory has provided remarkable insights into lattices and their applications for practical communication systems. The benefits of lattices for communications are: 1) high code rate 2) higher transmit power efficiency than conventional quadrature amplitude modulation constellations and 3) they form an essential component of compute-and-forward relaying, which provides high throughput and high spectral efficiency.

This dissertation addresses the designs and methods of nested lattice codes with good coding properties, a high shaping gain, and low-complexity encoding and decoding. Construction D' lattices based on quasi-cyclic low-density parity-check (QC-LDPC) codes are for coding and thus contribute to reliable data transmission. Construction A lattices based on convolutional codes are used to satisfy the channel power-constraint and provide shaping gain. These constructions have group property and provide high code rates.

Two encoding methods and a decoding algorithm for Construction D' coding lattices that can be used with shaping lattices for power-constrained channels are given. The multistage decoding algorithm uses successive cancellation by employing binary decoders of the component binary codes that form a Construction D' lattice. An indexing method for nested lattice codes is modified to avoid an integer overflow problem at high dimension. Convolutional code generator polynomials for Construction A lattices with the greatest shaping gain are given, as a result of an extensive search. It is shown that rate 1/3 convolutional codes provide a more favorable performance-complexity trade-off than rate 1/2 convolutional codes. For a given dimension, tail-biting convolutional codes have higher shaping gain than that of zero-tailed convolutional codes and truncated convolutional codes. A design for QC-LDPC codes to form Construction D' lattices is presented, where their parity-check matrices can be easily triangularized, thus enabling efficient encoding and indexing when formed a nested lattice code. The resulting QC-LDPC Construction D' lattices are evaluated using four shaping lattices: the $E_8$ lattice, the $BW_{16}$ lattice, the Leech lattice and the best-found convolutional code lattice, showing a shaping gain of approximately 0.65 dB, 0.86 dB, 1.03 dB and 1.25 dB at dimension 2304.

**Keywords:** Construction D' lattices, Construction A lattices, nested lattice codes, QC-LDPC codes, shaping gain