Kommunikationstechnik

Qinwei He

Spectral Efficiency Enhancement Technologies for Future Reliability-Aware Wireless Communication Systems

SHAKER VERLAG

Spectral Efficiency Enhancement Technologies for Future Reliability-Aware Wireless Communication Systems

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Dedicated to my life-coaches,
my late grandfather, Longbin He
and my late father, Qi He.
I owe it all to you.
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Abstract

Spectral efficiency and reliability are considered as two major concerns for future wireless systems. Although various technologies have been proposed and examined to enhance the spectral efficiency effectively, the reliability performance of them has not yet been investigated thoroughly.

In this thesis, we contribute to improving the dominating spectral efficient technologies concerning their reliabilities in two aspects. On the one hand, we aim at satisfying different reliability requirements from the network level of wireless communication systems, i.e., obtaining optimal resource allocation schemes. On the other hand, we focus on developing the data transmission and reception techniques for these technologies so that their reliabilities can be enhanced, i.e., reducing error probabilities. For each aspect, two essential technologies are studied and evaluated.

In the network level, power-domain non-orthogonal multiple access and Sparse Code Multiple Access (SCMA) are considered. For the former, we achieve a closed-form suboptimal power allocation expression from the derived symbol error rate to satisfy the reliability requirements of each user. We show that the proposed solution is extremely close to the optimal one. For the SCMA network, a convex optimisation problem regarding resource allocation is formulated considering reliability and low latency demands. We propose an algorithm to solve the problem effectively and achieve a higher network sum-rate compared to the conventional scheme.

In the data transmission and reception part, Multiple-Input Multiple-Output (MIMO) and two Orthogonal Frequency Division Multiplexing (OFDM) variants are examined. By merging a new lattice reduction scheme into the successive interference cancellation detection, a better error performance can be achieved for the MIMO system. As for the two OFDM variants, a better decision rule and wavelet transform are introduced to each scheme accordingly to reduce their error probabilities.

List of Publications

Publication included in Chapter 3 regarding power-domain non-orthogonal multiple access:

[J1] Q. He, Y. Hu, A. Schmeink,"Closed-form symbol error rate expressions for non-orthogonal multiple access systems," *IEEE Trans. Veh. Technol.*, pp. 1-14, May 2019.

Publication included in Chapter 4 regarding sparse code multiple access:

[J2] Q. He, Y. Hu, A. Schmeink, "Resource allocation for ultra-reliable low latency communications in sparse code multiple access networks," *EURASIP J. Wireless Commun. Netw.*, vol. 282, no. 1, pp. 1-9, Dec. 2018.

Publication included in Chapter 5 regarding multiple-input multiple-output system:

[J3] Q. He, Y. Hu, A. Schmeink, "A Seysen's algorithm based incremental lattice reduction," *Trans. Emerg. Telecommun. Technol.*, vol. e3596, Mar. 2019.

Publications included in Chapter 6 regarding orthogonal frequency division multiplexing systems:

[C1] Q. He, A. Schmeink, "A better decision rule for OFDM with subcarrier index modulation," in *Proc. 21st Int. ITG Workshop on Smart Antennas,* Berlin, Germany, Feb. 2017.

[C2] Q. He, C. Schmitz, A. Schmeink, "BEP of Fourier Transform and Discrete Wavelet Transform based OFDM," in *Proc. IEEE Int. Symp. Wireless Commun. Syst. (ISWCS) 2013,* Ilmenau, Germany, Aug. 2013.

Publications not included:

[J4] T. T. Nguyen, S. T. Le, Q. He *et al.*, "Multicarrier approaches for high-baudrate optical-fiber transmission systems with a single coherent receiver", *IEEE Photon. J.*, vol. 99, no. 99, pp. 1–1, Feb. 2017.

[C3] Q. He, A. Schmeink, "Comparison and evaluation between FBMC and OFDM systems," in *Proc. 19th Int. ITG Workshop on Smart Antennas*, Ilmenau, Germany, Mar. 2015.

[C4] G. Zhang, Y. Hu, Q. He *et al.*, "Type-II quasi-cyclic LDPC codes with girth eight from Sidon sequence," in *Proc. IEEE Inform. Theory Workshop (ITW) 2018,* Guangzhou, China, Nov. 2018.

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