



**University
of Victoria**

Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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**“Efficient Pilot-Data Transmission and Channel Estimation in Next
Generation Wireless Communications”**

Department of Electrical and Computer Engineering

Thursday, April 27, 2017
12:30 P.M.
Engineering Office Wing
Room 430

Supervisory Committee:

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(Supervisor)
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Abstract

To meet the urgent demand of high-speed data rate and to support large number of users, the massive multiple-input multiple-output (MIMO) technology is becoming one of the most promising candidates for the next generation wireless communications, namely the 5G. To realize the full potential of massive MIMO, it is necessary to have the channel state information (CSI) (partially) available at the transmitter. Hence, an efficient channel estimation is one of the key enablers and also critical challenges for 5G communications. Dealing with such problems, this dissertation investigates the design of efficient pilot-data transmission pattern and channel estimation in massive MIMO for both multipair relaying and peer-to-peer systems.

Firstly, this dissertation proposes a pilot-data transmission overlay scheme for multipair MIMO relaying systems employing either half- or full-duplex (HD or FD) communications at the relay station (RS). In the proposed scheme, pilots are transmitted in partial overlap with data to decrease the channel estimation overhead. The RS can detect the source data by exploiting the asymptotic orthogonality of massive MIMO channels. Due to the transmission overlay, the effective data period is extended, hence improving system throughput. Both theoretical and simulation results verify that the proposed pilot-data overlay scheme outperforms the conventional separate pilot-data design in the limited coherence interval scenario. Moreover, a power allocation problem is formulated to properly adjust the transmission power of source data transmission and relay data forwarding which further improves the system performance.

Additionally, this dissertation proposes and analyzes an efficient HD decode-and forward (DF) scheme, named sum decode-and-forward (SDF), with the physical layer network coding (PNC) in the multipair massive MIMO two-way relaying system. As comparison, a joint decode-and-forward (JDF) scheme applied to the multipair massive MIMO relaying is also proposed and investigated. In the SDF scheme, a half number of pilots are saved compared to the JDF scheme which in turn increases the spectral efficiency of the system. Both the theoretical analyses and numerical results verifies such superiority of the SDF scheme. Further, the power efficiency of the proposed schemes is also investigated. Simulation results show that the signal transmission power can be rapidly reduced if the massive antenna arrays are equipped on the RS and the required data transmission power can further decrease if the training power is fixed.

Finally, this dissertation investigates the general channel estimation problem in the massive MIMO system which employs the hybrid analog/digital precoding structure with limited radio-frequency (RF) chains. By properly designing RF combiners and performing multiple trainings, the performance of the proposed channel estimation can approach that of full-chain estimations depending on the degree of channel spatial correlation and the number of RF chains which is verified by simulation results in terms of both mean square error (MSE) and spectral efficiency. Moreover, a covariance matching method is proposed to obtain channel correlation in practice and the simulation verifies its effectiveness by evaluating the spectral efficiency performance in parametric channel models.