Ming LIU Ph.D.

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Education

Ph.D.	Electrical Engineering, March 2011	Institut National des Sciences Appliquées (INSA) Rennes, France	
	Title: "*Analysis and Optimization of the Asian Mobile and Terrestrial Digital Television Systems*"		
	Mention: **très honorable** (*with highest honors*)		
Master	Information and Communication Engineering, June 2007	Xi'an Jiaotong University, Xi'an, China	
Bachelor	Information Engineering, July 2004	Xi'an Jiaotong University, Xi'an, China	

Employments

1/2017 – present	*Associate Professor, Ph.D. supervisor*	School of Computer & Information Technology, Beijing Jiaotong University, Beijing, China
1/2015 – 12/2016	*Lecturer*	School of Computer & Information Technology, Beijing Jiaotong University, Beijing, China
4/2011 – 1/2015	*Postdoctoral Researcher*	Institute of Electronics & Telecommunications of Rennes (IETR), France

Main Research Experience

- **Reliable transmission techniques in the massive MIMO systems for 5G**, *National Science Foundation of China,* **PI**
  01/2016 – 12/2018

  Project Objective: Researching key physical layer techniques for reliable and scalable massive MIMO system

  - **Physical layer security technique to prevent pilot contamination attack**

    The pilot contamination phenomenon is seen as the bottleneck of the performance of massive MIMO, but also contains serious information security breach. We research different methods to detect the pilot contamination attack from active eavesdroppers. A simple detection method based on the transmission of random symbols from mobile terminals is proposed. As the number of receive antennas goes large, the distribution of the phase differences of received random symbols converges to a set of finite regions. Once contaminated by the active attackers, the phase difference distribution is disturbed, which is exploited to detect the existence of active attacker. In a further study, we research to use random matrix theory to characterize the distribution of the eigenvalues of the random symbols which also converges to a series of sectors. The boundary of the sectors can be determined by a theoretical way. This property is employed to detect the active attackers.

  - **Massive uplink connections in massive MIMO system**

    The random access of massive concurrent Internet-of-Thing devices becomes a major challenge for the future mobile communication network. We seek the possibility of exploiting the great spatial degrees of freedom brought by the massive MIMO technique. The small-scale fading channels of concurrent users sharing the same band is converted to a scalar form after the simple Maximal Ratio Combining (MRC). The overlapped users' symbols are then recovered using the iterative interference canceller as long as the received powers of different users exhibit significant difference. The random access of multiple concurrent users is turned into a power allocation problem. It is proved that the proposed random access scheme can support around 300% system overload ratio.

- **5G End-to-End performance optimization for hybrid service scenarios**, *Nokia Bell Labs project*, **technical leader**
  04/2017 – 03/2018

  Project Objective: Proposing radio resource management strategy for future mobile communication networks

  - **Ongoing research works**
    - Investigate traffic characteristics of future wireless networks in typical application scenarios
    - Research the method of radio resource management with more flexible manners and finer granularity
    - Evaluate the proposed schemes on calibrated simulation platform

- **Machine-to-machine communications via cellular networks**, *Orange Labs project*, **researcher** *06/2014 – 01/2015*

  Project Objective: Proposing energy-efficient solutions to deliver M2M communications over the GSM system

  - **Evaluation of physical layer performance of the GSM/GPRS/EDGE systems**

    The MATLAB based simulation chain contains main features of GSM with different Modulation Coding Schemes (MCS) and channel models. The implemented receiver algorithms include the optimal maximum-likelihood sequence estimation (MLSE) detector, the sub-optimal reduced-state sequence estimation (RSSE) and decision-feedback detectors, as well as the linear detectors.

- **High-speed data transmission in low-cost optical fiber systems,** *IETR internal project,* **researcher** *06/2013 – 01/2015*

  Project Objective: Proposing high-efficiency, low-complex transmission schemes for the Polymer Optical Fiber (POF) systems

  - **Proposal of a high performance PN-ZP-DMT transmission scheme**

    The proposed PN-ZP-DMT scheme is based on the DMT technique and combines the advantages of PN- and ZP-based guard intervals. It employs the pseudo-noise (PN) sequences to obtain accurate channel estimation, and reduces the transmission power through the use of zero padding (ZP) guard intervals. The proposed scheme achieves a transmission data rate of 1.5 Gbps over a 50-meter experimental POF system, which represents the highest transmission rate reported in the literature.

- **STBC design for distributed MIMO systems,** *French "M3" & European "ENGINES" projects,* **researcher** *04/2011 – 12/2013*

  Project Objective: Proposing effective MIMO encoding and decoding algorithms for future broadcasting system

  - **Proposal of a new form of the 3D MIMO codeword**

    I proposed to permute the positions of information symbols so that the orthogonality is 'concentrated' in the first 4 information symbols. The resulting new 3D MIMO codeword is therefore fast-decodable. It is among the least complex STBCs with the same code rate and diversity. The new code is robust to the 'near-far problem' in distributed MIMO.

  - **Proposal of a short version 3D MIMO code**

    The new code has the coding rate of 2 (full-rate, 4 information symbols within 2 channel uses). It requires much less complexity than 3D MIMO code with negligible performance loss. It achieves best trade-off between performance and complexity with different channel coding configurations.

  - **Proposal of a new fast-decodable DjABBA code**

    The new code is full-rate, full-diversity for 4×2 MIMO transmission. It requires lowest ML decoding complexity among the fast decodable STBCs. The proposed codeword possesses highest coding gain and has best BER performance among STBCs.

  - **Proposal of an ML decoders for original and new 3D MIMO codes**

    The simplified decoder is realized by a four-level tree-search followed by four parallel decisions, yielding a complexity order of 4:5. It provides the ML performance and requires less processing time than the classical sphere decoder with Schnorr-Euchner enumeration.

- **Channel estimation for PN-OFDM based systems,** *French "Mobile TV World" project,* **researcher** *10/2007 – 03/2011*

  Project Objective: Proposing high performance channel estimation techniques for the PN-OFDM based systems

  - **Proposal of several PN-correlation-based channel estimation techniques**

    I proposed the time domain channel estimation techniques exploiting the unique correlation properties of m-sequences. I also proposed several improved estimators which reduce estimation error floor caused by the imperfect correlation results of PN sequences. The proposed PN-based channel estimation methods achieve good performance in typical channel conditions with low implementation complexity.

  - **Proposal of an iterative data-aided channel estimation technique with low complexity**

    I proposed an iterative data-aided channel estimation technique which is used in combination with PN-based estimation to handle the harsh channel conditions (such as the cases of SFN). In contrast to the classical 'Turbo channel estimation', data symbols are directly rebuilt based on the soft information output from the demapper to reduce complexity. The rebuilt 'soft'

data symbols serve as training sequence for a second channel estimation. The data-aided channel estimation results are refined using moving average or Wienner filtering techniques. The PN-based and data-aided channel estimation results are combined according to their estimation accuracies and the resulting new channel estimation will be used to decode the information in the next iteration. The overall system performance is significantly improved with only a few iterations.

Skills

Telecom	massive-MIMO, OFDM, space-time coding, iterative process, channel estimation, signal processing, random access, transceiver design, system optimization, machine-to-machine (M2M) communications, optical fiber communications, physical layer security
Systems	GSM, GPRS, EDGE, LTE, DVB-T/T2/NGH, DTMB
Tools	MATLAB, C, C++, Agilent Advanced Design System (ADS)
Language	English (fluent), French (fluent), Chinese (mother tongue)

Teaching & Advising

Teaching	Undergraduate course in BJTU "Assembly language & computer interface" (64 hours, 2017 fall) Teaching qualification in French universities ("La qualification aux fonctions de maître de conférences", section 61, in the field of computer science, automatics & signal processing)
Master students	Xiaoyi Wang (2015-2017), Qing Wang (2015-2018, co-advised with Prof. Zhangdui Zhong), Li Xu (2016-2019), Nian Liu (2017-2020), Yawen Zheng (2017-2020), Lanlan Wei (2017-2019), Baigong Xu (2017-2019), Junxia Zhang (2018-2021), Xiaoyi Han (2018-2021), Jiaxin Ren (2018-2021)
Ph.D. student	Participate in the direction (together with Prof. Maryline Hélard and Prof. Fabienne Nouvel) of the research of Miss Rida El Chall, Ph.D candidate in INSA-Rennes, on the subjects of low-complexity soft-input soft-output MIMO detector and turbo receivers

Award

2017	Excellent Master thesis prize of School of Computer & Information Technology of Beijing Jiaotong University (for my student Xiaoyi Wang's thesis)

Selected Publications

- L. Peng, **M. Liu**, M. Hélard & S. Haese, "PN-PAM Scheme for Short Range Optical Transmission over SI-POF--An Alternative to Discrete Multi-Tone (DMT) scheme," *Journal of the European Optical Society*, 13:21, 2017.
- R. El Chall, F. Nouvel, M. Hélard & **M. Liu**, "Performance and complexity evaluation of iterative receiver for coded MIMO-OFDM systems," *Mobile Information Systems*, 2016.
- **M. Liu**, J.-F. Hélard, M. Hélard and M. Crussière, "Towards the next generation TV broadcasting-improved perfor-mance using distributed MIMO," *Wireless Personal Communications*, 84(4):2635-2649, 2015.
- R. El Chall, F. Nouvel, M. Hélard and **M. Liu**, "Iterative receivers combining MIMO detection with turbo decoding: performance-complexity trade-offs," *EURASIP Journal on Wireless Communications and Networking*, 2015.
- L. Peng, M. Hélard, S. Haese, **M. Liu** & J.-F. Hélard, "Hybrid PN-ZP-DMT Scheme for Spectrum-Efficient Optical Communications and its Application to SI-POF," *IEEE Journal of Lightwave Technology*, 32(18): 3149–3160, 2014.
- **M. Liu**, M. Crussière, M. Hélard & J.-F. Hélard, "Achieving low-complexity maximum-likelihood detection for the 3D MIMO code," *EURASIP Journal on Wireless Communications and Networking*, 20, pp.1-16, 2014.
- **M. Liu**, M. Hélard, M. Crussière & J.-F. Hélard, "Distributed MIMO coding scheme with low decoding complexity for future mobile TV broadcasting," *IET Electronics Letters*, 48(17):1079–1081, 2012.
- **M. Liu**, M. Crussière & J.-F. Hélard, "A novel data-aided channel estimation with reduced complexity for TDS-OFDM systems," *IEEE Transactions on Broadcasting*, 58(2):247–260, 2012.
- Q. Wang, Z.Y. Zhao, D.S. Miao, Y.T. Zhang, J.Y. Sun, **M. Liu** & Z.D. Zhong, "Non-Orthogonal Coded Access for Contention-Based Transmission in 5G," in *Proc. 2017 IEEE 86th Vehicular Technology Conference (VTC2017-Fall)*, Toronto, Canada, 2017.
- X.Y. Wang, **M. Liu**, D. Wang & C.J. Zhong, "Pilot Contamination Attack Detection using Random Symbols for Massive MIMO Systems," in *Proc.2017 IEEE 85th Vehicular Technology Conference (VTC2017-Spring)*, Sydney, Australia, 2017.
- M. Maaz, M. Hélard, P. Mary & **M. Liu**, "Performance Analysis of Time-Reversal Based Precoding Schemes in MISO-OFDM Systems," in *Proc. IEEE 81st Vehicular Technology Conference (VTC-Spring 2015)*, Glasgow, Scotland, May 2015.

A full list of publication can be found in *https://scholar.google.com/citations?user=3SIYuGkAAAAJ*