A performance analysis of optimized semi-blind channel estimation method in OFDM systems

Sangirov Gulomjon*, Fu Yongqing*, Jamshid Sangirov**, Fang Ye* and Ahmad Olmasov***

*Information and Communication Engineering College, Harbin Engineering University, Harbin, 150001 China

**Samsung Electronics, South Korea

***Samarkand branch of Tashkent University of Information Technologies, Uzbekistan

gulomjons@hrbeu.edu.cn

***Abstract* — Nowadays, one of the effectively used technique in wireless communication area is an orthogonal frequency division multiplexing (OFDM). In OFDM systems, channel impairments due to multipath dispersive wireless channels can cause deep fades in wireless channels. Therefore, an accurate and computationally efficient channel state information necessary when coherent detection is involved in the OFDM receiver. Hence, it is essential to have a good channel estimation method for OFDM systems in wireless communication. And normally one of the good channel estimation methods is a semi-blind channel estimation. On the other hand, the semi-blind method requires a large number of processing operations. In order to avoid the high complexity of the existing method, the semi-blind channel estimation has been optimized. At the receiver side, we calculate subspace decomposition for blind channel estimation and further to improve channel estimation we use training based technique to estimate channel state information. Next, we combine these channel estimations as semi-blind channel estimation methods and we optimized semi-blind channel estimation by choosing an optimal technique for training based channel estimation.**

***Keyword*—Semi-blind channel estimation, OFDM, least square and scaled LS**

I. INTRODUCTION

In wideband digital communications the orthogonal frequency division multiplexing (OFDM) is used for splitting a high-rate datastream into number of lower rate streams that are transmitted simultaneously over a number of subcarriers for easy transmission. The OFDM technique is applicable in digital terrestrial multimedia broadcast (DTMB) [1], digital subscriber line (DSL) broadband internet access, wireless network, long term evolution (LTE) [2-3], and 4G the transmitter modulates the message bit sequences into phase shift keying (PSK) / quadrature amplitude modulation (QAM) symbol. And then it performs inverse discrete fourier transform (IDFT) on the symbols for conversion them from the frequency domain to time-domain signals. Usually, next step is the insertion of cyclic prefix (CP) in OFDM system. The reason for the CP is to avoid intercarrier interference (ICI) which occurs by a multipath channel. And it also provides good bandwidth efficiency on the receiver side. In our OFDM system, we use zero padding (ZP) instead of CP. Generally, the ZP replaces nonzero CP by zeros. The ZP-OFDM system has the same spectral efficiency as CP-OFDM system by the condition of the number of zero symbols equals the CP length. Lastly, the transmitter sends the time-domain signals out through a wireless channel.

In OFDM system, a wireless channel plays a big role for the transmission performance. That is why estimating the channel has a significant impact on the efficiency of the transmission performance. We observe one of efficient channel estimation methods that are widely utilized in OFDM systems is called a semi-blind channel estimation. The importance of using a semi-blind channel estimation method is a tradeoff between computational complexity and spectral efficiency. To accomplish channel estimation numerous works subspace decomposition methods have been proposed [4-6]. However, these methods use complex computational schemes that may also reduce spectral efficiency. To improve the spectral efficiency of the channel a subspace pursuit algorithm has been proposed estimation in [7]. This algorithm uses a combination of two algorithms to work for low pilot density, which makes the implementation complicated. A method improving the channel estimation with lower computational difficulty has been introduced in [8]. Nevertheless, it works well when there are few OFDM symbols. Consequently, for working out all symbols the computation amount will be increased. Another method proposed to decrease channel estimation error by subspace estimation bases on a block matrix [9]. But, the calculation and formation of a burst of stacked OFDM symbols create

Manuscript received on February 19, 2016. This work is a follow-up of the invited journal to the accepted out-standing conference paper of the 17th International Conference on Advanced Communication Technology (ICACT2015).

Gulomjon Sangirov is with Modern Communication and Information Systems Research group in the school of Information and Communication Engineering, Harbin Engineering University, Harbin, 150001, China (Corresponding author phone: +86-451-82568266; fax: +86-451-82530010 e-mail: gulomjons@hrbeu.edu.cn).

Yongqing Fu is with Modern Communication and Information Systems Research group in the school of Information and Communication Engineering, Harbin Engineering University, Harbin, 150001, China (e-mail: yongqingfu @hrbeu.edu.cn).

Jamshid Sangirov is with Samsung Electronics, South Korea (e-mail: jamshid@kaist.ac.kr).

Fang Ye is with Modern Communication and Information Systems Research group in the school of Information and Communication Engineering, Harbin Engineering University, Harbin, 150001, China (e-mail: fangye@hrbeu.edu.cn).

Ahmad Olmasov is with telecommunication engineering research group at Samarkand branch of Tashkent University of Information Technologies.

[10] Huo W., Wang Z., and Li S., “A simple subspace-based semi-blind channel estimator for precoded OFDM systems”, *International Conference on Wireless Communications, Networking and Mobile Computing (WiCom)*, pp. 41-44, 2007.
[11] Biguesh Mehrzad and Alex B. Gershman, "Training-based MIMO channel estimation: a study of estimator tradeoffs and optimal training signals", *IEEE Transactions on Signal Processing* , vol. 54, no. 3, pp. 884-893, 2006.
[12] Gao Feifei and A. Nallanathan, “Subspace-based blind channel estimation for SISO, MISO, and MIMO OFDM systems”, *In IEEE International Conference on. Communications (ICC'06)*, p. 3025-3030, 2006.

Gulomjon Sangirov received the M.S. degrees in Information and Communication Engineering from Harbin Engineering University in 2012. And he is studying Ph.D. in College of Information and Communication Engineering in Harbin Engineering University, China currently. His research interests are Channel Estimation in MIMO-OFDM and Quasi-Cyclic-LDPC coding.

Yongqing Fu received the MS degree in electrical engineering from National University of Defense Technology, Changsha, China in 1985. He held the posts of Lecturer (1988-1995), Associate professor (1995-2000) and Professor (since 2000) in the Electrical Engineering Department, Harbin Engineering University. He was a visiting Professor of Electrical and Computer Engineering Department, University of Manitoba, Canada in 2002 and also Electrical and Computer Engineering Department, University of California, San Diego, the USA in 2009. He is the author of four books, more than 100 articles, and more than 10 patents. His research interests include the weak signal detection, chaotic communication and signal processing, cognitive radio system, image coding, marching and feature extraction and circuit and electronic system. Prof. Fu is the Vice director of the Northeast Electric Theory Association (since 2003), and he is a reviewer for the Journal of China Universities of Posts and Telecommunications (since 2006).

Jamshid Sangirov received the M.S. degrees in Information and Communication Engineering from Yeungnam University in 2006. He got his Ph.D. in Information and Communication Engineering at Korean Advanced Institute of Science and Technology (KAIST) at 2013. He worked with the RFIC Design Team, at Teltron Inc., Korea, from 2010 to 2011. From 2013 he is with Samsung Electronics. His research interests are analog/RF/VLSI and high-speed Integrated Circuit design.

Fang Ye received her Ph.D. degree in Communication and Information System from Harbin Engineering University in 2006. From November 2007 to November 2008, she has been as a visiting scholar in the school of electronics and computer science, University Of Southampton, U.K. Since December 2008, she is an associate professor of the school of Information and Communication Engineering in Harbin Engineering University, China. Her research interests include LTE technologies, adaptive radio resource allocation technology, and UWB signal processing. She is a member of IEEE and Association for Computing Machinery (ACM).

Ahmad Olmasov received the M.S. degrees in Tashkent University of Information Technologies, Tashkent, Uzbekistan in 2007. And he started working with Samarkand branch of Tashkent University of Information Technologies. Currently, he is a lecturer in the department of telecommunication engineering at Samarkand branch of Tashkent University of Information Technologies. His research interests are Mobile communication, channel coding in high throughput wireless communication and MIMO-OFDM.