ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 5, Issue 4, April 2016**

# Channel Estimation in MIMO System for Effective Communication: A Survey of Techniques

Parminder Kaur[1], Karamjit Kaur[2]

PG Student, Dept. of ECE, Punjabi University, Patiala, Punjab, India[1]

Assistant Professor, Dept. Of ECE, Punjabi University, Patiala, India[2]

**ABSRACT:** The aim of this survey paper is to review the work that has previously been done in the field of channel estimation in MIMO-OFDM system. With the continuous growth and the improvement of communication system, our aim is to review the current best techniques available for channel estimation and provide a comparative analysis. In order to achieve this objective, a simulation has been performed for using various channel estimation techniques. The main emphasis is laid on selection of a channel through which the signals are to be transmitted. This paper reviews the different types of channel estimation in MIMO system by varying the pre-coding and modulation techniques.

**KEYWORDS***:* Error rate, Interference, MIMO, Channel estimation.

## I. INTRODUCTION

In wireless communication systems, the time-varying nature of the channel and frequency selectivity in a multipath scenario is investigated as one of the major challenges. For error-free transmitted signal equalization, demodulation, decoding and a host of other baseband processing applications, the procurement of exact and upto date channel knowledge is very essential. As a result, channel estimation remains an important block in the signal processing stages at the receiver of both the existing and the growing wireless communication systems. In the recent years, attempts have been conducted towards creating efficient channel estimation techniques.
Diversity improves the standard of a wireless communications without raising the power or bandwidth of transmitted signal. In transmit diversity there are multiple transmit antennas, and the transmit power is divided among these antennas. The implementation of multiple antennas at the transmit and receive side, multiple input-multiple output (MIMO), results increase in the capacity of the wireless systems that is increase in the diversity gain which means quality of signals and multiplexing gain refers the transmission capacity. However, an important assumption was made with respect to this capacity increase that is all channels between the transmit and receive antennas are exactly known. In practice, the estimation of these channels is necessary which is the focus of this paper.
In channel, it is required to transmit the data from transmitter to receiver but sometimes noise is added to the data that has to be transmitted and that noise is called the interference .To reduce the computational complexity, used the latest channel estimate to approximate the IAI (inter antenna interference) effect, exploited the correlation of channel parameters at adjacent subcarriers to remove IAI. In this standard LS method was applied to obtain the new channel estimates from IAI cancelled data. So the purpose is to reduce the interference by estimating the channel.

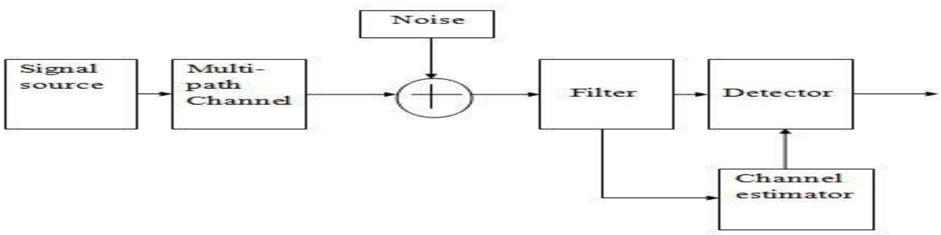


Figure 1: Block diagram for noise corrupted system

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

Vol. 5, Issue 4, April 2016

The various methods for channel estimation which can be used in different technologies of wireless communication Systems can be categorized into three classes.[1]

- The pilot-assisted (training-based) channel estimation methods.
- Blind and semi-blind channel estimation schemes.
- Decision directed channel estimation techniques.

The channel can be estimated by the different techniques like Least-square (LS), Minimum mean square error (MMSE) etc. These are the equalizers used to balance the Inter-symbol Interference. The Least Square algorithm, proposed by Widrow and Hoff, is a popular method for system identification. In MMSE, the goal of the equalizer design is to minimize the average mean square error(MSE) between the transmitted symbol and its estimate at the output of the equalizer. MMSE estimation performs much better than the LS but is more complex than LS for the MIMO system.[2] The optimal low rank MMSE estimation can be used to reduce complexity.

## II. LITERATURE SURVEY

In the literature survey, various channel estimation techniques are considered, which offer different trade-off in terms of performance and a priori required knowledge of the channel statistics.

- **Kuo Guan Wu and Chang[3]**: This study proposes a recursive LS estimator to enhance the DDCE performance in transmit-diversity OFDM systems. Wu and Chang proposed a regularized LS estimator to improve the DDCE performance in transmit-diversity OFDM systems. The proposed method incorporates the latest channel estimate as a priori information to reduce the error propagation problem of the standard LS method. The regularization parameter derived to be adapted with the MSE of the latest estimate and that of the current standard LS estimate. At lower SNR values when the standard LS method effected more intensily from the error propagation problem, the proposed method improves the channel estimation performance remarkably.
- **Y.Li[4]**: Li proposed that Channel parameter estimation is an important task in OFDM systems. They presented criteria for optimum training-sequence design for OFDM systems with multiple transmit antennas and have also simplified the channel parameter estimators developed previously. Using the design criteria, training sequences can be constructed that optimize as well as simplify the channel estimation during the training period. The simplified estimator has identical performance to that in, but with much lower complexity.
- **Ran et al.[5]:**Ran et al. proposed that the system concept and results of a decision-directed channel estimation technique. The performance enhancement of the decision directed channel estimation (DDE) compared with the purely preamble-based method is analyzed. On the one hand, the DDE method uses the decisions at the output of the demodulator, which leads to a rather low complexity and a delay of only a single OFDM symbol. As a whole the DDE method shows a good performance increase with only low computation complexity`.
- **Lyman et al.[6]:** Lyman proposed that how close the predicted value of fading envelope must be to the true value when the receiver emerges from the fade in order to recover correct tracking. Also, they wish to know how to approximate adaptively. The flat spectral shape was chosen as a simple special case. It is hoped that the method they used to solve this prediction problem can be extended to band limited processes of arbitrary spectral shapes. they also hoped to extend their approach to more complex carrier tracking and adaptive equalization problems .
- **Kalyani and Giridhar[7]**: They identified the DDCT problem as an outlier contaminated estimation problem and proposed GM and M estimators, which are adequate in reducing error propagation. DDCT of modest computational complexity is possible over large frame lengths even at high fade rates, provided one uses the mathematical theory appropriate for tackling the problem.
- **Hlaing Minn et al.[8] :** In this paper the author investigated a less complexity channel estimation for an OFDM system with space–time coding in time-varying, multipath fading channels. In particular, the approach was to reduce the complexity in the matrix inversion required for every OFDM data symbols. The method is developed based on a channel with relatively small delay spread. By decoupling the channel responses from different transmit antennas, much complexity reduction is obtained. This modified approach brings about a substantial improvement without any added complexity.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 5, Issue 4, April 2016**

- **K.-G. Wu and J.-A. Wu [9]:** Wu proposed a low complexity algorithm for decision-directed channel estimation in transmit-diversity OFDM systems. The proposed algorithm cancels IAI to separate the estimation of each channel response by exploiting the correlation of subcarrier channel coefficients to decouple the data. They also employed the latest estimate of channel response to eliminate residual IAI.
  It has been explained that the Adaptive least squares (ALS) adaptive is an algorithm which finds the filter coefficients that minimize a weighted linear least squares cost function relating to the input signals. This is in contrast to other algorithms such as the least mean squares (LMS) that aim to reduce the mean square error. In the derivation of the ALS, the input signals are considered deterministic, while for the LMS and similar algorithm they are considered stochastic. However, this benefit comes at the cost of high computational complexity.
- **Chuang, and Sollenberger[10]:** Chuan and Sollenberger studied delay, permutation, and space–time coding transmitter diversity combined with two branch receiver diversity for OFDM used in high-rate data wireless networks. Space–time coding transmitter diversity is the best approach. Space–time coding transmitter diversity is the best approach for providing high peak data rates. The physical layer performance difference of each approach has a different impact on the network's performance. The delay transmitter diversity system using QPSK modulation with interference suppression is the most robust and provides Quality of service (QoS) with a low retransmission probability. Downlink beam forming is also shown to be an effective method for increasing both throughput and QoS when the environment grants this method. Wireless networks using downlink beam forming together with adaptive antenna arrays can provide higher capacity than those employing delay or space–time coding transmitter diversity systems with two transmitter and two receiver antennas. Space–time coding will perform well in environments with large angular spread, such as microcells, and can support higher peak-rate data transmission in those environments.

## III. CONCLUSION

On the basis of literature survey, it is found that MIMO-OFDM systems have the potential to fulfill the needs of the future wireless communication systems. MIMO systems with multiple antennas at the transmitter and receiver improve the spectral efficiency and energy efficiency largely. The capacity is also shown to increase linearly with the number of transmit and receive antenna. But the biggest challenge is the interference introduced by the channel that make it difficult for the receiver to detect the exact transmitted signal. For this reason the need for channel estimation arises.

## REFERENCES

[1] O. Edfors, M. Sandell, J.J. Van de Beek, S. K. Wilson and P. O. Boriesson, "Analysis of DFT-based channel estimators for OFDM." *Vehicular Technology Conference*. (July 1995).

[2] K. Bhagat and J. Malhotra, "Peformance evaluation of channel estimation techniques in OFDM based mobile wireless system," *International Journal of Future Generation Communication and networking*, vol. 8, No. 3(2015), pp. 53-60.

[3] Kuo-Guan Wu and Min-Kuan C. Chang, "Adaptively regularized Least-Squares estimator for decision-directed channel estimation in transmit-diversity OFDM systems, "*IEEE Wireless Commun.*, vol. 3, NO. 3, JUNE 2014.

[4] Y. (G.) Li, "Simplified channel estimation for OFDM systems with multiple transmit antennas, "*IEEE Trans. Wireless Commun.*,vol.1,pp. 67–75, Jan. 2002.

[5] J. Ran, R. Grunheid, H. Rohling, "Decision-directed channel estimation method for OFDM systems with high velocities," in *Proc. 2003 IEEE VTC*, vol. 4, pp. 2358– 236.

[6] R. J. Lyman and William W. Edmonson, "Decision-directed tracking of fading channels using linear prediction of the fading envelope," in *Proc. 1999 Asilomar Conf. Signal Process., Syst., Comput.*, vol. 2, pp. 1154–1158.

[7] S. Kalyani and K. Giridhar, "Mitigation of error propagation in decision directed OFDM channel tracking using generalized M-estimators," *IEEE Trans. Signal Process.*, vol. 55, no. 5, pp. 1659–1672, May 2007.

[8] H. Minn, Dong In Kim and V.K. Bhargava, "A reduced complexity channel estimation for OFDM systems with transmit diversity in mobile wireless channels,"*IEEE Trans. Commun.*, vol. 50, no. 5, pp. 799–807, May 2002.

[9] K.-G. Wu and J.-A. Wu, "Efficient decision-directed channel estimation for OFDM systems with transmit diversity," *IEEE Commun. Lett.*,vol. 15, no. 7, pp. 740–742, July 2011.

[10] Y. Li, J. C. Chuang, and N. R. Sollenberger, "Transmit diversity for OFDM systems and its impact on high-rate data wireless networks,"*IEEE J. Sel. Areas Commun.*, vol. 17, pp. 1233–1243, July 1999.