CHAPTER 7: Analysis of Pilot and Blind Channel Estimation Techniques

In this paper the channel estimation methods for OFDM systems in view of pilot arrangement and blind estimation are examined. Various channel estimation methods are utilized so as to judge the physical impacts of the medium present. In this paper, analysed and executed different estimation methods for MIMO OFDM Systems, for example, Least Squares (LS), Minimum Mean Square Error (MMSE), Constant Modulus Algorithm (CMA) and linear Pre-coding.

7.1 Introduction:

In the literature, numerous channel estimation plans are found and relies on upon if the channel is steady, gradually or fast time varying. Generally, channel estimation is accomplished by transmitting training sequences through the channel. In any case, when the channel is changing, even gradually, the training sequence should be transmitted occasionally keeping in mind to update the channel estimates. Henceforth, the transmission efficiency is decreased [95]. The demand is increasing for high bit rate advanced mobile communications makes blind channel identification proof and equalization very alluring, since they don’t need training sequence.

This paper examines and compares both pilot based and blind channel based estimators for OFDM structure. The essential target of the proposed work is to help in further improvement of blind channel estimation methods by giving a critical review of the current systems. Such examination will be of incredible help in contrasting and
investigating the execution of new strategies in identified with the methods existing in the literature. The proposed method was coded in MATLAB environment.

Another offset that also encounter in OFDM is symbol time offset (STO) [98]. The STO can also be attributed the difference in frequencies between the transmitter oscillator and the receiver oscillator. Figure 7.1 and Figure 7.2 presents the effect of CFO and STO.

Figure 7.1: A 16 QAM Constellation under the effect of CFO
Figure 7.2: A 16 QAM Constellation under the effect of STO.

From the Figures 7.1 and 7.2 it can be observed that the pilots or dynamic which keep rotate around the centres. In the view of such situation the perfect phase estimation of the signal cannot be obtained. This is also complicated by the fact the phases, time varying are not constant over a symbol period. When the offset is high the phase changes over one OFDM symbol remains higher and the estimation becomes much more difficult.

The above discussions impress the fact that offset in terms of CFO or STO can reduces the performance of the OFDM system by inducing phase noise and subsequently phase errors. It also be inferred that the CFO can reduce the BER of channels even at higher SNR’s and can also induce phase noise which can degrade the performance of the
system by inducing phase errors. All these factors have cumulative effect on channel estimation much more difficult and challenging. Especially estimation a channel in the presence of phase noise is much more difficult and complex as the channel estimation techniques and also accounts for the phase errors. OFDM can be understood being extremely sensitive to synchronization errors especially the carrier frequency offset.

7.2 Types of channel estimation techniques:

The channel estimation techniques can be classified into many different types [96] falling under two main categories like

a) Pilot based channel estimation

b) Blind channel estimation.

The Figure 7.3 illustrates the plot of an actual channel that has been estimated based on pilot based approach. The performance of two pilot based approaches namely LS and MMSE is illustrated here. The LS based estimation method arrives at an estimation of the system by minimizing the squared error between the estimation and detection. While in the case of MMSE the estimator tries to minimize the mean of the squared error. Figures 7.4 and 7.5 depicts the plot of channel estimated using the LS method and MMSE method respectively. This estimation has been done for the channel depicted using Figure 7.3. These pilot based approaches are effective as long as the information about the training sequence is available with the receiver.
Figure 7.3: Plot of Actual Channel
Figure 7.4: The Plot of Channel Estimated Using LS
Figure 7.5: The Plot of Channel Estimated Using MMSE
The performance of the LS and the MMSE estimators is compared in regard to mean square errors and depicted using the Figure 7.6.

When both the estimators are compared in terms of complexity the MMSE based estimator is more complex when compared to LS based estimator. In the case of LS based estimator it can be considered as a basic algorithm which gives regular results that can be used practically with any scheme of channel estimation techniques. The LS estimator is usually expressed as specific ratio between the input data sequence and the output.
Figure 7.7: Blind Channel Estimation Based on CMA for QAM based frequency Response

The Figure 7.7 depicts the constant modulus approach based estimation, which is one of the blind estimation techniques. The first part of the Figure is magnitude estimation; by using CMA approach the estimated magnitude follows the actual magnitude. The second part of the Figure is phase estimation; the estimated phase follows the actual phase.
The Figure 7.8 depicts the precoding approach based estimation, which is one of the blind estimation techniques. The first part of the Figure is magnitude estimation; by using precoding approach the estimated magnitude follows the actual magnitude. The second part of the Figure is phase estimation; the estimated phase follows the actual phase.
7.3 Conclusion:

A MATLAB based outline for execution investigation of pilot based channel estimation strategies and blind channel estimation procedures is actualized. The results for various systems are observed. The acquired results demonstrate that blind channel estimation can be utilized as a part of future wireless communications particularly, when considering the spectrum efficiency, low complexity and the received signal powers are at low levels. The execution of LSE with MMSE estimator is additionally examined. It is watched that MMSE estimation is better that LSE estimator in low SNRs; though at high SNRs, execution of LSE estimator is tantamount to that of the MMSE estimator.