CASE STUDY ON CHANNEL ESTIMATION TECHNIQUES FOR MIMO-OFDM SYSTEMS

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Abstract : MIMO-OFDM (Multiple Input Multiple Output – Orthogonal Frequency Division Multiplexing), is a latest wireless communication technology, it has gained huge reputation for its capability of high throughput and robust transmission in next generation mobile communications. Achieving the optimal transceiver design in such systems requires an accurate awareness of channel state information. This paper provides an analysis of various types of channel estimation methods for MIMO-OFDM systems.

IndexTerms **- MIMO-OFDM systems, Channel estimation techniques.**

I. INTRODUCTION

Wireless communication need tremendously high throughput and high transmission consistency to cope up with the quickly rising demand for multimedia applications like good quality video application. Present wireless systems are unable to sustain high data rates, because fading effect is very high in these technologies. In recent communication system, OFDM is highly significant modulation technique. It is useful in several aspects like, good spectral efficiency, robustness, frequency selective fading, less complexity, and it can be easily produced by using IFFT/FFT schemes. In recent times, there is lot of attention to exercise OFDM in combination with a MIMO transceiver system, named MIMO-OFDM system; which can raise the diversity gain and system capacity. MIMO as the term specify, that it uses multiple inputs at transmitter and multiple outputs at receiver, which is profitable rather than a single transceiver systems. MIMO systems are emerged to satisfy two important needs that are high throughput and bandwidth efficiency. This combination of MIMO-OFDM is a highly trustworthy technique, because OFDM is capable of maintaining immense number of antennas, since it makes simpler equalization in MIMO systems. In practice fading is treated as a drawback in wireless systems, but MIMO system uses the fading to raise the capacity of whole communication network. Since MIMO is a frequency-selective method, then OFDM converts such frequency-selective channels into parallel frequency-flat sub channels. MIMO-OFDM structure has been examined as the structural design for future generation wireless/ multimedia networks.

II. SYSTEM MODEL:

In transmitter section of OFDM, initially the transmitter converts message sequence into QAM symbols, and then evaluates IFFT on coded bits to translate them to time-domain, and send through a wireless medium. The received bit pattern is generally affected by channel characteristics. To retrieve the transmitted throughputs, the consequence of channel should be estimated and nullify in receiver section. So here each sub-carrier is treated as independent channel. Since subcarriers are statistically independent, this allows expressing received signal as product of transmitted throughputs and channel frequency response at the subcarrier. Finally channel is assessment is done at every subcarrier to extract transmitted bits. Typical MIMO-OFDM model is illustrated as

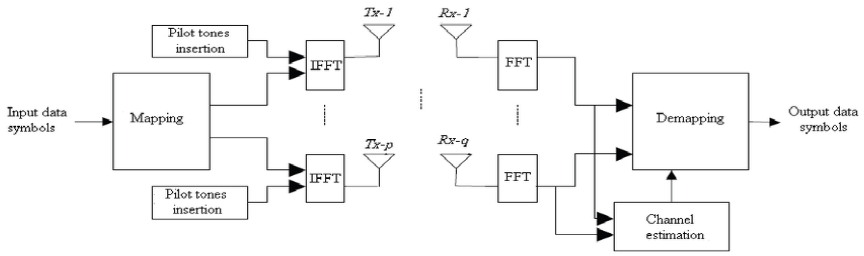

Fig1: MIMO-OFDM model

III. LITERATURE REVIEW:

An extensive literature has been reviewed related to channel assessment of communication channel. Some relevant work has been discussed as:

In 1995 V.D. Beek, Edfors.O [1], Magnus.S, Wilson.S.K and Borjesson.P.O are discussed OFDM channel assessment practice using time domain statistics, for large SNRs LS estimation process is adequate and for small SNRs they used minor variations to MMSE, LS estimators which allows a negotiation among estimator complexity and performance.

In 2003 Y. Li and H. Wang [2], are discussed pilot designs and channel parameter evaluation for MIMO-OFDM system. The proposed techniques effectively used in extremely high throughput wireless systems.

In 2004 M. Shin, H. Lee, & C. Lee [3], are proposed a cyclic comb type pilot array for MIMO-OFDM channel assessment to overcome the drawback of conventional channel-estimation techniques. Simulations showed that the developed cyclic pilot structure gives more signal-to-noise ratio gain than the conventional method.

In 2005 Yantao. Q, S.Yu, and Lijun Zhang [4] are proposed an iterative LS assessment for MIMO-OFDM systems. Compare to common LS assessment, this method can gives better estimation accuracy, and filtering in time domain decrease AWGN, ICI considerably. MIMO-OFDM system with this technique also works well in mobile situations.

In 2007 Feng.S, N.Hu, Bin.Y, and W.Wu [5], are presented two DCT based pilot symbol aided channel evaluation methods. Proposed methods diminish the aliasing effect in DFT based estimation. From simulation results, it can be observed that performances of the intended methods based on DCT are improved than DFT based methods.

In 2011 Z.Jie and Huang.L [6] are discussed a superior DFT based estimation method. The traditional DFT process will cost energy outflow in multipath channel with non sample time delays. The discussed method uses symmetric property to extend the LS estimate in frequency domain, and evaluate the changing rate of the leakage energy, and selects useful paths by the changing rate.

In 2011 R. S. Ganesh, and J. Jayakumari [7], are proposed a estimation method for a Rayleigh fading channel. The channel assessment is done with traditional LS, MMSE methods. From simulation they concluded that MMSE estimation has high quality performance than LS channel estimation.

In 2012 Andreas.M, D.Auras and Gerd.A [8] are proposed ASIC based Decision Directed estimation method, here channel variations are tracked by using decoder , in addition power dissipation, timing trade-offs are also analyzed.

In 2015 Seda Ustun Ercan and Cetin Kurnaz [9] are discussed MIMO-OFDM system channel evaluation using two methods: ICA and comb type structure. It is observed from simulation that assessment performance changes with channels frequency selectivity.

IV. ESTIMATION TECHNIQUES:

Pilot tones are used to assess channel, these symbols should be well-known to transceiver. In this paper numerous channel assessment practices are discussed as:

4.1. PILOT STRUCTURE:

Based on pilot's arrangement, pilot structures are categorized as
i) Block type ii) Comb type and iii) Lattice type.

4.1.1. BLOCK TYPE: In Block type, assessment is completed by transmitting OFDM symbols along with pilots periodically at all subcarriers. These pilot tones are also used to realize interpolation in time for estimating channel along with time axis. The block-type structure is adequate for frequency selective channels. In case of fast-fading channels, to track the channel variation by diminishing the symbol duration it might cause too much overhead.

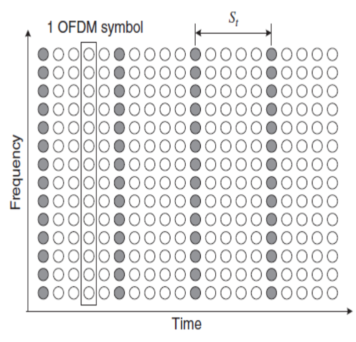

Fig2: Block-type pilot arrangement.

4.1.2. COMB TYPE:

In Comb type pilot structure, pilots are present at periodically located subcarriers for every OFDM symbol. These pilot tones are also used to realize frequency domain interpolation for estimating channel along with frequency axis. The comb-type structure is adequate for fast-fading channels.

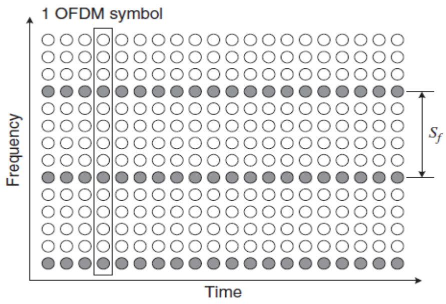

Fig3: Comb-type pilot structure.

4.1.3. LATTICE TYPE:

In Lattice type, pilots are interleaved in time and frequency axes within a given periods, these pilot tones are also used to realize frequency and time interpolations for estimating channel in frequency and time axes.

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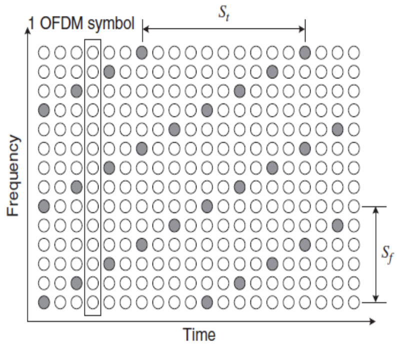

Fig4: Lattice-type pilot arrangement.

4.2. Training Symbol-Based Channel Estimation:

Another method of estimation is training symbol based method, which provides good performance, but suffers with training symbol overhead. Two types of methods are used to asses channel under this category they are:

i) Least-square (LS) and

ii) Minimum-mean-square-error (MMSE) technique.

4.3. DFT-Based Channel Estimation:

The DFT-based channel assessment process is developed to get better output of LS or MMSE estimator by nullify the consequence of noise outside the maximum channel delay. Note that the maximum channel delay L should be known in advance. Mostly this practice is used for reduction of noise.

4.4. Decision-Directed Channel Estimation

The Decision directed channel evaluation update the channel coefficients, which does not cause overhead of the pilot. As show in below figure, the DD technique uses detected signal as feedback to follow the possible time-varying channels, while subsequently use the channel evaluation to detect the signal.

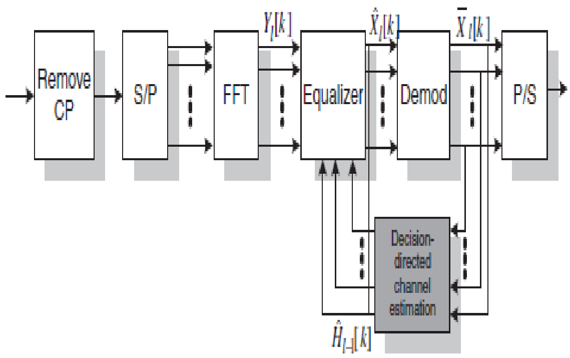

Fig5: Model of an OFDM receiver with decision-directed channel estimation.

4.5. Advanced Channel Estimation Techniques:

The following Advanced methods are used to accomplish channel evaluation, they are discussed as

4.5.1. Channel Estimation Using a Superimposed Signal:

Consider a superimposed signal which adds a training (pilot) signal of low power to data signal at the transmitter. Then the superimposed signal is used at receiver for channel assessment without losing a data. In this approach, however, a fraction of power allocated to the training signal is wasted.

4.5.2. Channel Estimation in Fast Time-Varying Channels:

The time-varying channel may demolish the orthogonality among subcarriers at the receiver, it results Inter-Channel Interference. This method nullifies consequence of ICI in time varying channels.

4.5.3. EM Algorithm-Based Channel Estimation:

The EM-based channel assessment is an iterative technique for finding maximum likelihood (ML) estimates of a channel. It is a type of semi-blind method, since it can be accomplished when training bits are not available.

4.5.4. Blind Channel Estimation:

In a blind channel assessment process, the assessment is based on received data, without any known transmitted sequence.

V. CONCLUSION:

At the receiver of MIMO-OFDM System, Channel estimation is a major concern. To retrieve the transmitted throughputs, the channel effect should be estimated and remunerated in the receiver. In this paper, diverse channel assessment process are reviewed and discussed. Training Symbol-Based Channel evaluation methods namely LS, MMSE are reported as the better techniques for channel assessment than other. However both the methods suffer from the computational difficulty of pilot tones placements for superior channel estimation performance.

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