Literature Survey on Channel Estimation & Equalization Techniques

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Abstract— The paper discusses the related works of channel estimation and equalization techniques in MIMO wireless communication providing a survey of researches and development in these fields. Moreover, the paper gives exquisite study of various methods of estimation and equalization for better reliable communication system.

Key words: MIMO, ISI, Channel Estimation and Channel Equalization

I. INTRODUCTION

Communication system experiences many change in its journey from simple sign gesture communication to way long wireless communication. In most recent year, MIMO technique assured to increase evolution of high data rates due to its embryonic increase in spectral efficiency and simultaneously providing the same data to multiple users [1]. MIMO is a new emerging technology that makes use of multiple wireless transmitters and receivers to transfer data at high rate. The increases in number of transmit and receive antennas leads to more efficient system by increasing the capacity of a given channel.

In wireless system, multipath fading and time varying nature of the channel is a major challenge. For error less communication channel estimation and equalization techniques are important for creating an efficient system. It is necessary to have a channel for transferring data from transmitter to receiver. But sometimes it happens that the channel is corrupted by some noise called interference, causing disturbances in the communication system. To remove this interference it is important to estimate channel [2].

Wireless communication is simple, flexible and most efficient system with high endurance to noise. With advancement in wireless communication it is observed that data transmission will be more efficient with the use of multiple antennas at transmitter and receiver, following multiple paths. Multipath propagation is a phenomenon in which signals are transmitted following multiple paths for high rate of data, causing Intersymbol interference. In ISI one signal gets interfered with subsequent signals that results in overlapping of signals [3]. This can be reduced using equalization technique which works as a filter to compensate the effect of ISI. Basically two types of equalization techniques are used widely: Linear and non-linear equalization methods, eliminating the effect of ISI, resulting a better communication system.

II. LITERATURE SURVEY

Georgi Ilier et al, "Channel Equalization using Adaptive Filtering with Averaging" [4], this paper presents the channel equalization technique based on adaptive filtering with averaging (AFA). Paper concludes that the main parameter highlighted is rate of adaptation which is examined and then distinguished with Least Mean Square (LMS) and Recursive Least Mean Square (RLS) equalization techniques. With AFA the performance and convergence rate of LMS equalizer is observed much better when compared with RLS equalizer.

Navdeep Singh Randhava, "An overview of Adaptive Channel Equalization Techniques and Algorithms" [3]. This paper gives a brief study of equalization and also describes the adaptive filter equalization and its various algorithms with their applications that are in practice. Main point of concern is the 2 basic algorithms i.e. LMS and RMS which are discussed briefly over others.

Rohit Negi, "Pilot Tone Selection for Channel Estimation in a Mobile OFDM System" [5]. OFDM is basically a scheme used as a digital carrier modulation method whose channel estimation undertakes transmission of pilot tones. The paper describes the issues regarding these pilot tones and their transmission. Conclusion observed is that transmitting each symbol carrying few pilot tones is way more efficient process than to clamp these pilot tones in one symbol.

Feng Tong et al, "Channel Estimation Based on data reuses LMS Algorithm for shallow water Acoustic Communication" [6]. The interest of researchers and scientists attempted to design underwater acoustic modems for marine environmental monitoring and inspection process or to observe sea bottom exploitations which is the major concern to attract attention. There are some terms such as multipath frequency dependent noise, distortion and Doppler shift which are the main issues to be discussed while designing an underwater acoustic modems. In order to reduce these hurdles while designing of modems. ISI data reuse LMS algorithm is integrated with BSE-DFE structure to form channel equalizer for better communication link.

Ashraf A. M. Khalaf, "Improvements in the Channel Equalizer Performance using Modified LMS & BP Algorithms" [7]. Paper provides comparison among different channel equalization problem. Comparison draws a conclusion that MLMS algorithm when compared with conventional LMS algorithm for noise free condition, it shows weak effect and MBP algorithm shows far better performance than conventional BP.

Sanjana T. et al, "Comparison of Channel Estimation & Estimation Techniques for OFDM Systems" [8]. OFDM systems are analyzed with channel estimation and channel equalization for phenomenon such as delay, distortion, fading etc., to provide proper transmission of signal via wireless channel, enhancing the performance of the system. This paper concluded that wiener filter estimation and one tap equalization techniques were better for OFDM systems with reduced complexity.

Vaishnavi B. Niranjane et al, "Adaptive Channel Estimation technique for MIMO-OFDM" [9]. This paper describes that for high data transmission and reliable communication MIMO is combined with OFDM. The paper provides comparative study of LMS & RMS estimation of MIMO-OFDM based system which results that RLS has

highest complexity but better performance at low SNRs as compared to others.

Kussum Bhagat et al, "Performance Evaluation of Channel Estimation Techniques in OFDM based Mobile Wireless System" [10]. Main issues that affect the OFDM system is channel estimation which is described in this paper. Channel estimation strategies and its simulated results using MATLAB provides performance of LSE and MMSE which is compared on the basis of BER and MSE parameters resulting that MMSE is complex but gives better performance.

Paresh Naik et al, "Comparative Performance of MIMO Channel Estimation Techniques" [11]. The authors implemented 2x2 MIMO system using BPSK and QPSK modulation techniques. The obtained results are compared on the basis of BER & SNR parameters using channel estimation algorithms like zero forcing, MMSE and Alamouti code. The steady state that better performance of Alamouti code channel estimation algorithm is obtained when compared with other estimation algorithms.

Harsha S. Eshwaraiah et al, "Cooperative Particle Swarn Optimization Based Receiver for Large dimension MIMO-ZPSC systems" [12]. This paper discusses heuristic based algorithm carrying out both channel estimation and equalization in frequency selective fading. Improvement in MSE and BER of the receiver is analyzed with iterations between channel equalization and estimation. It is concluded that in a proposed MIMO-ZPSC system BER performance of CPSO based receiver with estimated CI results better than the perfect CI.

Xiadong Wang et al, "Blind Equalization & Multiuser Detection in Dispersive CDMA Channel" [13]. Blind demodulation is a major problem in multiuser information symbol in CDMA having high rate in presence of both Multiple Access Interference (MAI) & Intersymbol Interference (ISI) which is considered in this paper. In this the authors applied the blind MIMO channel identification and equalization theory to recover the multiuser information symbols by using subspace based techniques for both forward and reverse link.

Mohd. Mejbaul Haque et al, "Performance Analysis of MIMO-OFDM for 4G Wireless Systems under Rayleigh Fading Channel" in Vol. 8, 2013 [14], discussed most reassuring technique to provide high data rate and better performance in different channel conditions is MIMO-OFDM. For MIMO systems, Alamouti space time block coding scheme is used in 4G technology due to its simple decoding technique. An estimated performance of Alamouti space time block coding is discussed in this paper on the basis of parameter like channel model, channel capacity, coding scheme and diversity gain. It is examined that for higher values of SNR i.i.d channel capacity performs better than that of correlated channel capacity, which is increased by adding no. of antennas to the system.

Harshal Nigam and Mithilesh Kumar, "Design and Performance Analysis of MIMO-DSSS System for 2.4 GHz ISM Band Wi-Fi Application using Microstrip Antennas" [15]. This paper describes a new technique to evaluate performance of 2x2 MIMO-DSSS system using practical antennas where the system is operating at 2.4 GHz ISM band frequency. These antennas were designed using CST Microwave studio. For this system it is shown that BER is proportional to SNR. This paper also concludes that this system can be used for IEEE 802.11n Wi-Fi family which operates on 2.4GHz ISM band frequency.

Kuo Guan and Chang, "Adaptively Regularized Least Squares Estimator for Decision-Directed Channel Estimation in Transmit Diversity OFDM Systems" in IEEE wireless communication 2014 [16], describes the DDCE performance enhancement in transmit diversity OFDM systems using regularized recursive LS estimator. To reduce the problem of error propagation of standard LS estimator through their method authors associates latest channel estimate as a prior information. With MSE of latest channel estimate and with that of current LS estimate regularized parameter remarkably improves the performance of channel estimation at lower values of SNR when error propagation affected the standard LS method.

Y.G. Li, "Simplified Channel Estimation for OFDM systems with Multiple Transmit Antennas" in IEEE trans. Wireless communication Vol. 1 [17], discusses the task of channel parameter estimation in OFDM systems. They proposed the designing criteria with the help of that training sequences can be determined to optimized and simplify the channel estimation with less complexity.

Md. Masud Rana et al, "Adaptive Channel Estimation Techniques for MIMO OFDM Systems" [18] paper describes comparison between normalized least mean square (NLMS) and recursive least square (RLS) adaptive channel estimator in MIMO-OFDM. It is observed that in order to achieve better performance RLS CE method shows good behavior as compared to NLMS CE. Also demonstrated that the increase in transmitter /or receiver provides high performance rate.

B.Pradheep T Rajan et al, "A Survey on Channel Estimation Schemes for MIMO Systems" [19]. This survey paper presents the analysis and performance of pilot based and semi-bling channel estimators in MIMO system. It is also concluded that the performance of estimators depends on various factors like no. of transmit and receive antennas, received signal strength and the channel parameters.

Ajay bahadur Singh et al, "A Review Paper on Channel Estimation Techniques Used in OFDM System" [20]. This paper covers the work previously done relevant to various channel estimation in OFDM system. The comparisons among various channel estimators prove that in simulated channels, blind channel estimation is much better and robust as compared to pilot aided system.

Chandra R. Murthy et al in his paper "Training-Based and Semi-blind Channel Estimation for MIMO Systems With Maximum Ratio Transmission" [21], verifies the two channel estimation techniques i.e. training based conventional least mean square estimation (CLSE) scheme and close form semi-blind (CFSB) scheme for estimating transmit and receive beamforming vectors of a flat fading channel matrix. Performance of both CLSE and CFSB are improved in terms of SER and channel power gain.

Shah Urvik R. et al, "Comparison and Analysis of Channel Estimation Techniques in performance for Wireless OFDM System" [22]. The author discusses various algorithms using channel estimation for OFDM system in order to certify the performance of various techniques in time

as well as frequency domain to figure out the SNR of each subcarrier.

Jyoti Dhiman et al in paper, "Comparison between Adaptive filter Algorithms (LMS, NLMS and RLS)" [23] examines SNR and computational complexity of least mean square (LMS), Normalized least mean square (NLMS),Time varying least mean square (TVLMS), Recursive least square (RLS) and Fast Transversal Recursive least square (FTRLS) algorithms. The author constructed a table showing that RLS is best suited algorithm in terms of SNR improvement.

III. CONCLUSION

This survey paper gives a brief study on various works already done by researchers to develop in the field of Channel estimation and equalization techniques. Moreover, we mentioned the techniques and algorithms that give better performance under various factors such as SNR, computational complexity, BER, channel parameters etc. The survey also accounts equalization technique with emerging algorithms like time-varying LMS; training based conventional least mean; cross form blind equalization etc. The survey provides you to explore various advancements in channel estimation and equalization to establish a reliable and efficient communication system.

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