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ALGORITHMS & SIMULATION ON MSE PERFORMANCE OF SEMI-BLIND & PILOT BASED ESTIMATORS ALONG WITH THE CRB FOR MIMO-OFDM

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ABSTRACT
A major challenge in MIMO-OFDM systems is how to obtain the channel state information accurate and prompts for coherent detection of information symbols and in channel synchronization. In first part of paper formulates the channel estimation problem for MIMO-OFDM systems and proposes to pilot-tone based estimation algorithm and computation. Our proposed semi-blind estimator is based on the Gaussian maximum likelihood estimation (GML) criterion which treats that data symbols as Gaussian-distributed nuisance parameters of channel matrix. To assist in the estimation of the individual channels estimation, we adopt a superimposed training strategy at the relay. We have design the pilot vectors of the terminals and the relay to optimized estimated performances .We use simulation result to show that the proposed method provides improvement in channel estimation accuracy over the conventional pilot-based estimation on channel and it approaches the semi-blind Cramer Rao Bound (CRB) as Signal to Noise ratio (SNR) increases & the simulation results shows that the performance of the proposed estimators is relating to the derived Cramer rao lower bound (CRLBs) at moderate to high SNR. It is also shows that the overall BER performance of the AF TWRN is close to a TWRN. In this paper, we proposed a semi-blind channel estimator for OFDM-based AF TWRNs based on the Gaussian ML approach .And we used simulation studies to compare the proposed semi-blind estimator to the conventional pilot-based estimator and showed that the proposed estimator provides a substantial improvement in accuracy. The performance of the semi-blind algorithm closely approaches the derived semi-blind CRB as SNR increases. Finally, these performance gains can be achieved at a reasonable computational cost, which clearly establishes the merit and practicality of semi-blind channel estimation for AF TWRNs.

KEYWORDS: *Mean square error, least square, compressed sensing, channel estimation, block error rate. Multiple Input Multiple Output (MIMO).*

I. INTRODUCTION
In MIMO system, multiple numbers of transmitters at one end and multiple numbers of receivers at the other end are effectively combined to improve the channel capacity of wireless systems. This technology highly improves the spectrum efficiency, reliability of system & coverage Area.

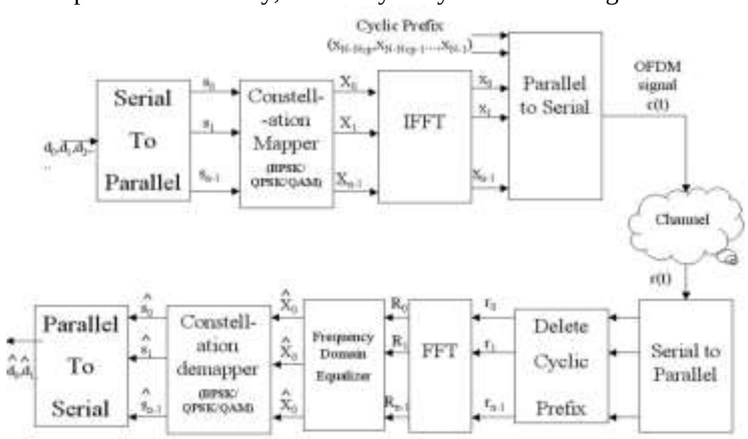


Figure 1: A simple MIMO-OFDM system

Relaying is the key technology to relate the communication between two user terminals, when there are large distances between them [1]. Unidirectional or one-way relaying supports in communication from a source to a destination user and has been studied in the literature [1]. In other way two-way relaying networks (TWRNs) the flow of information is bidirectional and the two users exchange data simultaneously with the relation of an intermediate relay node [2]. The comparison with one-way half-duplex relaying, bidirectional relaying is a spectrally more efficient relaying protocol [2]. Both amplify-and-forward and decode-and-forward protocols have been designed for TWRNs. If comparison to the DF protocol & AF protocol is widely adopted, as it requires minimal processing at the relay node [3] .The two phase communications in AF TWRNs, the two users firstly transmit data to the relay node than relay broadcasts its receive signal to both users in the second in phase1 the two users signals at the relay node under different propagation paths and may not be aligned in time and frequency. The superimposed signal broadcasted from the relay node is affected by multiple impairments examples are channel gains, timing offsets & CFO. The estimation and compensation algorithms have been applied to counter these impaired in unidirectional relaying networks [5], [6] the proposed algorithms can't be applied directly to (Two Way Relay Networks) TWRNs due to differences between the two system models. In TWRNs Fig. 1, each user can be exploited the knowledge of the self transmitting signal during on Phase 1 in order to detected the signal from the other user during On Phase 2. The blind [7] & semi-blind [8] methods have been proposed for channel estimating only in Amplify Forward in Two way Relaying Networks (AF-TWRNs). A particle filtering based method for estimating channel and timing offset is used in [9]. In training based methods, which are more for practical implementation [10], channel estimation [3], [12] or joint channel and CFO estimation [13] has been considered in the literature. The best of author's knowledge, estimation and decoding scheme channel parameters for two way Relaying Networks (TWRNs) in the presence of channel gains, timing offsets, and CFO is still an open research problem. In this paper, we can uses a complete synchronization estimation approach, i.e., joint estimation and compensation of channel gains estimating , timing offsets, and CFO for AF TWRNs is proposed. The reception of mixed in signals broadcasted from relay node, the user nodes first jointly estimate the impairments using known training signals and the proposed ML algorithm or differential evolution based estimators [14]. Subsequently, the users employ the proposed minimum mean-square error receiver in combination with the estimated impairments to decode the received signal. The contributions of this paper can be summarized as follows:

- We design a system model for having synchronization and set the channel parameters in AF TWRN.

- We assign Cramer-Rao lower bounds for joint estimation of multiple impairments at the user nodes for TWRN. These bounds can be applied to have the performance of synchronization and channel estimation in Amplify Forward in Two Way Relaying Networks (AF TWRN).
- We derive an Maximum Likelihood Estimation (MLE) based estimator for joint estimation of multiple impairments. A DE based algorithms is to be designed for the alternate of Maximum Likelihood Estimation (MLE) estimator to reduce the complexity with synchronize in AF TWRNs. Simulation results show that the mean square error performances of both ML and DE estimators are close to the CRLB at moderate to-high S/N ratios.
- We have an MMSE receiver for compensating the impairments and detecting the signal from the opposing user. The simulations are carried out to measure the estimated MSE and BER performances of the proposed transceiver structure. These results show that BER performance of an AF TWRN can be improved in the presence of practical synchronization errors. In fact, the application of the derive transceiver results in an overall network efficiency which is very close to the ideal network based on the assumption of knowledge of synchronization and channel parameters.

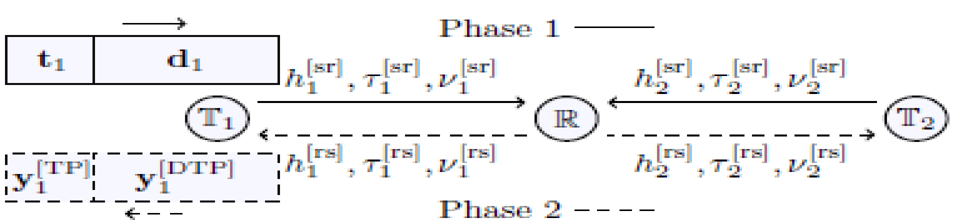


Figure.2: System Model for AF two-way relay network

II. PROBLEM IDENTIFICATION

Two-way relaying networks are designed for bandwidth efficient use of the available spectrum, since it will allow for data exchange between two users with the involvement of an intermediate relay node. Due to superposition of signals on the relay node, the received signal at the user terminals is affected by the multiple parameters like channel gains, timing offsets, and carrier frequency offsets which has needed to be estimated and compensating. Our proposed is semi-blind estimator is based on the Gaussian maximum likelihood (GML) criterion which treats that data symbols as Gaussian-distributed nuisance parameters on the channel estimation. To assist in the estimation of the individual channels, we can adopt a superimposed training strategy on the relay. We have designed the pilot vectors of the terminals and the relay to optimization to the estimation performance of channel. Moreover it we compare the semi-blind and pilot-based Cramer-Rao bounds (CRBs) to use as performance benchmarks because CRB gives a lower bound on the achievable estimation error.

We use simulation result to showing that the proposed method is providing improvement in estimation accuracy on the channel over the conventional pilot-based estimation and it approaches to the semi-blind Cramer-Rao bounds (CRB) as Signal to Noise Ratio (SNR) increases and the simulation results show performance of the proposed estimators is related to the derived CRLBs at moderate to high Signal to Noise Ratio (SNR). It is also show that the overall Bit Error Rate (BER) performance of the Amplify Forward in Two way Relaying Networks (AF-TWRN) is close to a TWRN. In this thesis, we proposed a semi-blind channel estimator for OFDM-based AF TWRNs based on the Gaussian ML approach

To assist in the estimation of the individual channels, we employed to the superimposed training at the relay. We have a comparison between CRB based techniques such techniques are pilot based estimation, pilot based CRB, semi blind estimation and semi blind CRB. We found that SNR increase along with x-axis and Mean Squared Estimation (MSE) level decreases along with y-axis and semi blind CRB technique provides better result as compared to the other CRB based techniques. We have comparison in semi blind estimation random & optimal pilot, LSE estimation random& optimal pilot. In which semi-blind channel estimate random pilot provide better result as compare to other technique. As we increase SNR along X-axis Mean Squared Estimation (MSE) get reduces with along Y-axis. We have compared pilot based estimate & CRB, Semi blind estimate & CRB along by using Gaussian and Quadrature Phase Shift Key(QPSK) modulation technique. In which semi blind estimation provide us better result as compared to other techniques. As we increase SNR along X-axis MSE get reduce along with Y-axis. Comparison between BER & SNR, In which bit error rate get reduce along Y-axis as we increases SNR along X-axis. The resulting GML estimates were obtained numerically using the BFGS algorithm. We also derived conditions for the optimality to the training pilots and provided examples of pilot vectors that satisfy them. As performance benchmarks, we derived the semi-blind and pilot-based CRBs.

Then we used simulation studies to compare the proposed semi-blind estimator to the conventional pilot-based estimator and showed that the proposed estimator provides a substantial improvement with accuracy in estimation. The performance of the semi-blind algorithm closely approaches the derived semi-blind CRB as SNR increases. Finally, these performance gains can be achieved at a reasonable computational cost, which clearly establishes the merit and practicality of semi-blind channel estimation for Amplify Forward in Two way Relaying Networks (AF-TWRN).

III. SYSTEM MODEL & PROPOSED WORK

The channel estimation problem for MIMO-OFDM systems and proposes to pilot-tone based estimation algorithm and computation. A complex equivalent baseband Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing MIMO-OFDM signal model is presented by matrix represented. To choosing L equally-spaced and equally-powered pilot tones from no. of sub-carriers (N) in one OFDM symbol, a down-sample version of the original signal model has been obtained. Furthermore, this signal model is transformed into a linear form to solvable to LS (least-square) CRB estimation algorithm. Based to the resultant model of a simple pilot-tone design is prepossessing into the form of a unitary matrix, whose row stands for different pilot-tone sets to frequency domain and whose column represented distinct transmitted antennas to spatial domain. Analysis and synthesis of the pilot-tone design in dissertation, our estimation algorithm can be reduced by the computational complexity inherit in Multi input multi output systems t , and it is proved an optimal channel estimator into the sense of achieved the minimum MSE (mean squared error) to channel estimation for a definite or fixed power of pilot tones in Algorithm(1). In the second part, this dissertation in two-way relaying networks are design for bandwidth efficient use of the available spectrum, since it allow for data exchange between two users with the involvement of an intermediate relay node on receiving side. Since superposition of signals on the relay node, the received signal (Rx) at the user terminals is affected by multiple channel parameters like channel channel gains, channel timing offsets and carrier frequency offsets which needed to be estimated and compensating . Our proposed semi-blind channel estimator is based on the Gaussian maximum likelihood estimation (GML) and least squred Estimation (LSE) criterion which treats that data symbols as Gaussian-distributed nuisance parameters of channel matrix by Algorithm (2). To assist in the estimation of the individual channels estimation, we adopt a superimposed training strategy at the relay. We have design the pilot vectors of the terminals and the relay to optimized estimated overall performance MMSE of LSE MIMO OFDM channel estimation and signal to noise ratio of the system by given Algorithms (3).

IV. FLOW CHART & ALGORITHMS

Algorithm1:

In these algorithm we evaluate MSE performance of semi-blind and pilot based estimators along with the semi blind and pilot based CRB plotted v/s k for SNR=15DB channel

Step1: Defining sweep parameters like SNR,Nt,Nr and parameter K.

Step2:Set SNR=15,Nt=2,Nr=2 K=[1 , 10 , 20 , 30 ,40 , 50],Nb=[1 , 10 , 20 , 30 ,40 , 50].

Step3: Defining initial value of other parameter of OFDM like MSE_CHAN_SIM, MSE CHAN_CRB,BLIND_CHAN_SIM&BLIND_CHAN_CRB

Step4: Set i=1 to length(Nb);

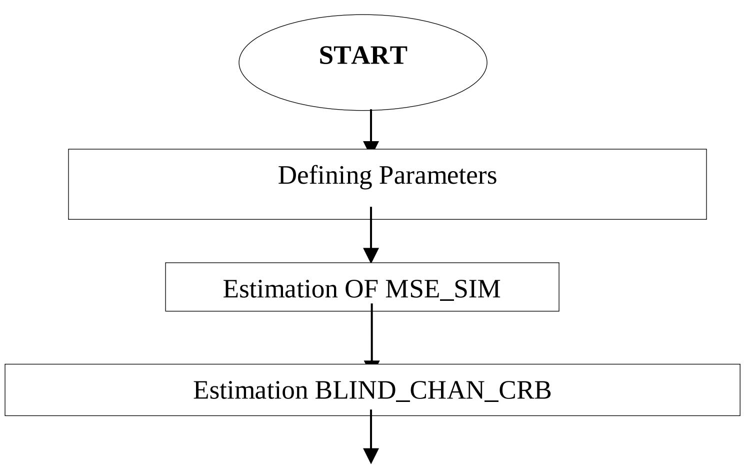
Set MSE_CHAN_SIM (1,i)= chan.MSE_Simulation

Set_MSE_CHAN_CBR(1,i)=Chan.MSE_Theory

Set BLIND_CHAN_SIM (1,i)= 10^(-3.3918-(0.0061*Nb(i))

Set BLIND_CHAN_CRB (1,i)= 10^(-3.4004-(0.0085*Nb(i))

Step5: simulation output graph between SNR v/s K.



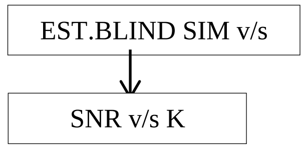


Fig 3: Flow Chart of Algorithm MSE performance of semi-blind and pilot based estimators along with the semi blind and pilot based CRB plotted v/s k for SNR=15DB channel

Algorithm 2:

In this algorithm we evaluate performance of LSE MIMO OFDM channel with comparison in between MSE_CHAN_CRB_random, MSE_CHAN_SIM random, MSE_CHAN_SIM delta20, MSE_CHAN_ SIM delta 15, MSE_CHAN_CRB_delta 15, MSE_CHAN_CRB_delta20.

Step1: Defining sweep parameters like SNR vector, SNR length,Nt,,,Nr parameter K & delta.

Step2: Set value of variable SNR_DBV, SNR_DBVL,Nt & Nr

Step3: Set value of parameter MSE_CHAN_CRB_random, MSE_CHAN_SIM random, MSE_CHAN_SIM delta20, MSE_CHAN_ SIM delta 15, MSE_CHAN_CRB_delta 15, MSE_CHAN_CRB_delta20.

Step4: formula applied as written in algorithm 1.

Step5: simulation output graph having comparison between above parameter.

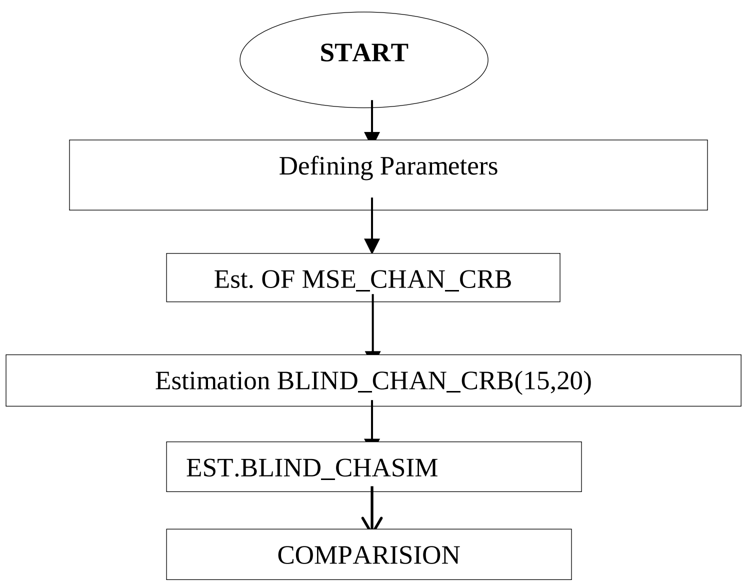


Fig 4: Flow Chart for Algorithm LSE MIMO OFDM channel with comparison in between MSE_CHAN_CRB_random, MSE_CHAN_SIM random, MSE_CHAN_SIM delta20, MSE_CHAN_ SIM delta 15, MSE_CHAN_CRB_delta 15, MSE_CHAN_CRB_delta20.

Algorithm 3:

In this algorithm we evaluate overall performance MMSE of LSE MIMO OFDM channel estimation v/s signal to noise ratio(db),delta(delay time) and K(data symbols block)

Step1.Defining sweep parameters like SNR_DBV (vector of SNR value in DB),SNR_DBVL(length of Snr vector)length Nt.Nr, nmonte carlovalue.

Step2.Set value of variable SNR_DBV,SNR_DBVL,Nt,Nr

Step3.Set value of parameter MMSE_CHAN_SIM_random,MSE_CHAN_CRB_random,MSE_CHAN_BER with LSE channel estimation BLIND_CHAN_SIM,BLIND_CHAN_CRB at the values 9,20 for delay time and data symbols block.

Step4. Formulate these values by Monte carlo counter loop for K and δ defining in step1.

Step5. Simulation output graph having comparison between above parameter.

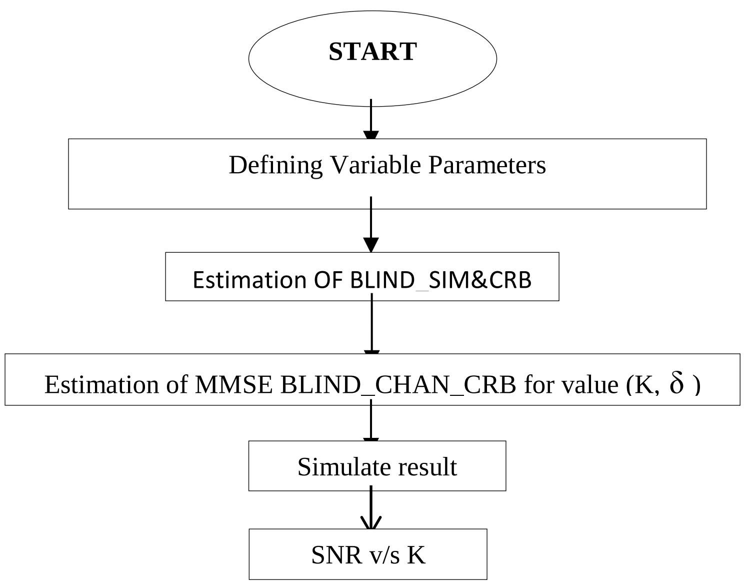


Fig 5: Flow Chart for Algorithm MMSE of LSE MIMO OFDM channel estimation v/s signal to noise ratio(db),delta(delay time) and K(data symbols block)

V. SIMULATION RESULT

The performance of the semi-blind algorithm closely approaches the derived semi-blind CRB as SNR increases. Finally, these performance gains can be achieved at a reasonable computational cost, which clearly establishes the merit and practicality of semi-blind channel estimation for AF TWRNs.

In this section, we investigate through simulations the performance of the proposed semi-blind algorithm and compare it to that of the pilot-based LS estimator.

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S.No	Parameters	Value
1	Signal to noise ratio (SNR)	15db
2	No of Transmitters (Nt)	2
3	No of receivers (Nr)	2
4	Data sample blocks (K)	1-50
5	No of bits (Nb)	1-50

Table 1 For simulation Parameters MSE performances of the semi-blind and pilot-based (LS) estimators along with the corresponding semi-blind and pilot-based CRBs plotted versus K for the cases of Gaussian-distributed and QPSK-distributed data symbols.

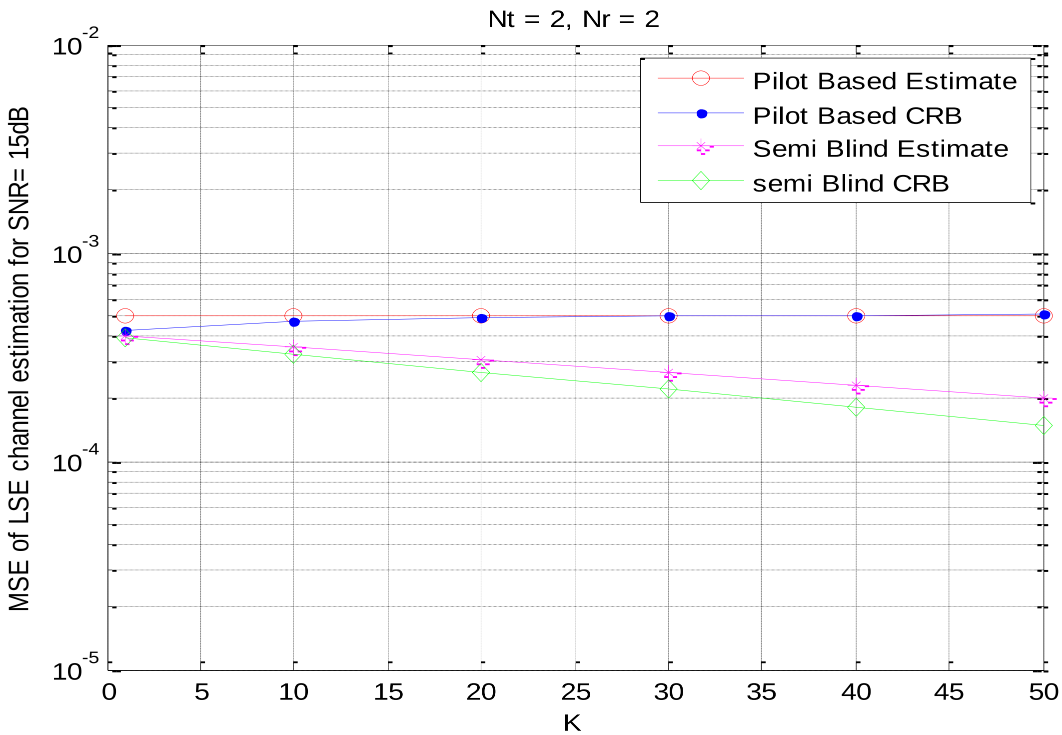

Fig: 6 MSE performances of the semi-blind and pilot-based (LS) estimators along with the corresponding semi-blind and pilot-based CRBs plotted versus K for the cases of Gaussian-distributed and QPSK-distributed data symbols.

In above Fig 6, we have a comparison between CRB based techniques such techniques are pilot based estimation, pilot based CRB, semi blind estimation and semi blind Cramer-Rao Bound (CRB). We found that Signal To Noise (SNR increase along with x-axis and Mean squared estimation (MSE) level decreases along with y-axis and semi blind CRB technique provides better result as compared to the other CRB based techniques.

S.No	Parameters	Value
1	Signal to noise ratio (SNR)	15db
2	Signal to noise ratio (dbVL)	3-15db
3	No of Transmitters (Nt)	2
4	No of receivers (Nr)	2
5	Data sample blocks (K)	9
6	No of bits (Nb)	1-50
7	Delay time(δ)	20

Table 2 For estimation parameters for MSE performance of the LS estimator and the semi-blind estimator versus SNR (L = 10, N = 32) for three scenarios: 1) optimal pilots (κ = 9, δ = 20), 2) suboptimal pilots (κ = 9, δ = 15) and 3) randomly generated pilots.

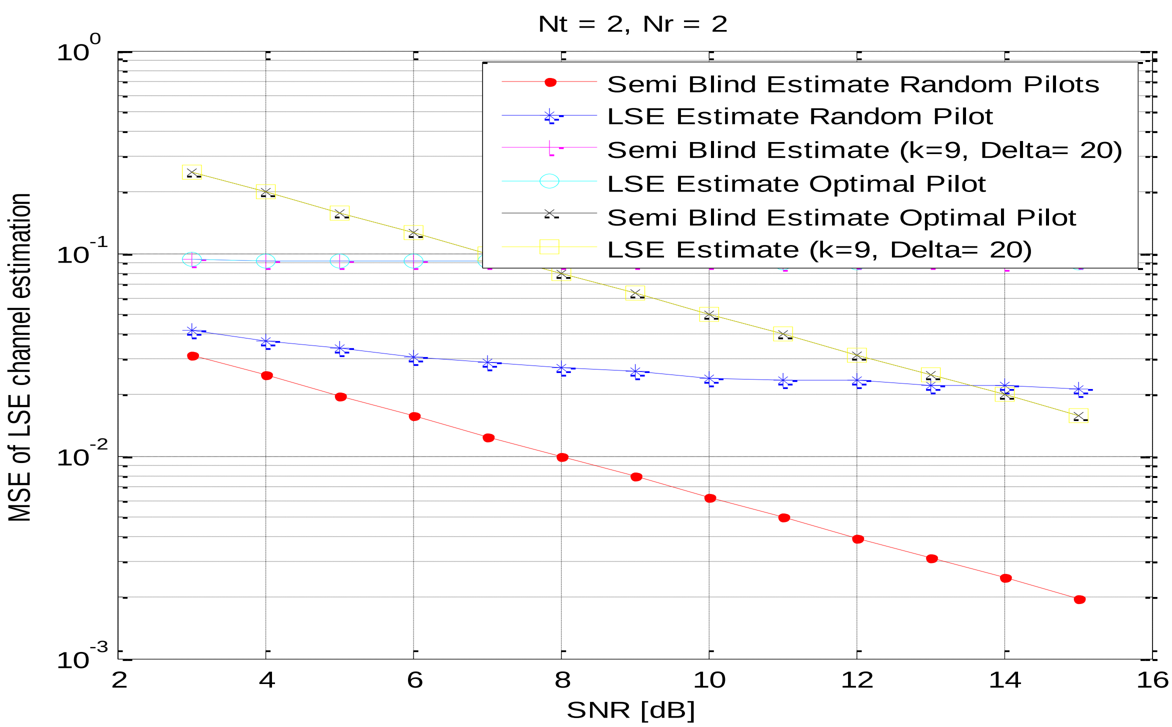

Fig: 7 MSE performance of the LS estimator and the semi-blind estimator versus SNR (L = 10, N = 32) for three scenarios: 1) optimal pilots (κ = 9, δ = 20), 2) suboptimal pilots (κ = 9, δ = 15) and 3) randomly generated pilots.

In above Fig 7, we have comparison in semi blind estimation random & optimal pilot, Least Squared estimation (LSE) estimation random & optimal pilot at Data block Symbols (K=9) ,delay (δ=20,15) and we took No. of subcarriers (N) = 32 . In which semi blind estimate random pilot provide better result as compare to Optimal Pilots and Sub-

Optimal Pilots techniques. As we increase Signal To Noise Ratio (SNR) along X-axis Mean Squared Estimation (MSE) performance get reduce along Y-axis for Semi-Blind Estimation Random Pilots.

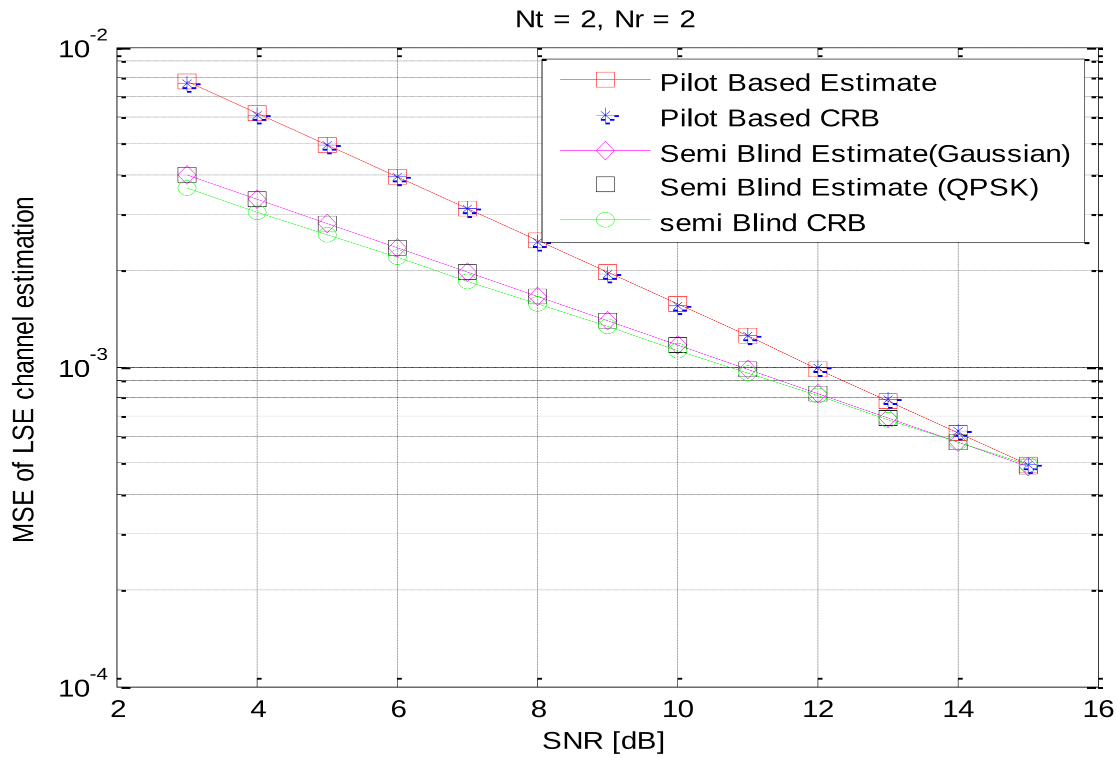

Fig: 8 MSE performances of the semi-blind and pilot-based (LS) estimators along with the corresponding semi-blind and pilot-based CRBs plotted versus SNR for the cases of Gaussian-distributed and QPSK-distributed data symbols.

In above Fig 8 , we have compare pilot based estimate & Cramer-Rao Bound (CRB), Semi blind estimate & Cramer-Rao Bound (CRB) along by using Gaussian and QPSK modulation technique. In which semi blind estimate provide better result as compare to other technique. As we increase Signal to Noise Ratio (SNR) along X-axis Mean Squared Estimation (MSE) get reduce along Y-axis.

S.No	Parameters	Value
1	Signal to noise ratio (SNR)	15db
2	No of Transmitters (Nt)	2
3	No of receivers (Nr)	2
4	Data sample blocks (K)	1-50
5	No of bits (Nb)	1-50

Table 3 Estimation of parameters for 3 MSE performances of the semi-blind and pilot-based (LS) estimators along with the corresponding semi-blind and pilot-based CRBs plotted versus SNR for the cases of Gaussian-distributed and QPSK-distributed data symbols.

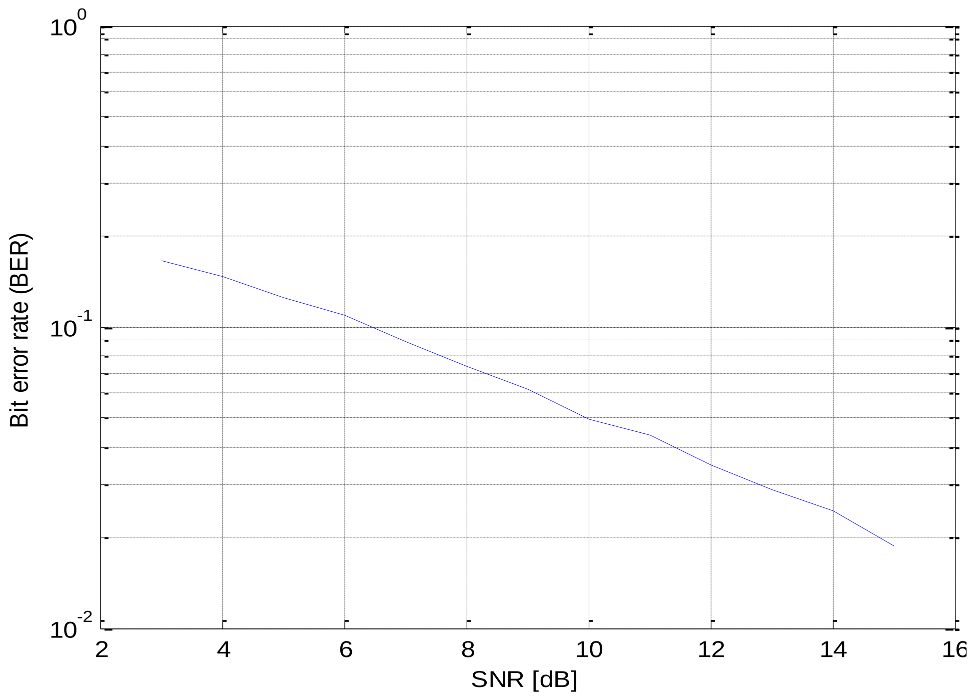

Fig: 9: Bit error rate (BER) v/s SNR

VI. CONCLUSION & FUTURE WORK

we proposed a semi-blind channel estimator for OFDM-based Amplify and forward in Two-Relaying Networks (AF-TWRNs) based on the Gaussian Maximum likelihood (ML) approach. To assist in the estimation of the individual channels, we employed superimposed training at the relay. We have a comparison between Cramer Rao's Bound (CRB) based techniques such techniques are pilot based estimation, pilot based CRB, semi blind estimation and semi blind CRB. We found that Signal to Noise Ratio (SNR) increase along with x-axis and MSE level decreases along with y-axis and semi blind Cramer Rao's Bound (CRB) technique provides better result as compared to the other CRB based techniques. We have comparison in semi blind estimation random & optimal pilot, Least Squared Estimation (LSE) estimation random & optimal pilot. In which semi blind estimate random pilot provide better result as compare to other technique. As we increase Signal To Noise Ratio (SNR) along X-axis Mean Squared estimation (MSE) get reduce along Y-axis. We have compare pilot based estimate & CRB, Semi blind estimate & CRB along by using Gaussian and QPSK modulation technique. In which semi blind estimate provide better result as compare to other technique. As we increase SNR along X-axis Mean Squared estimation (MSE) get reduce along Y-axis. Comparison between Bit Error Rate (BER) & (SNR), in which bit error rate get reduce along Y-axis as we increase SNR along X-axis. The resulting GML Gaussian Maximum likelihood estimates were obtained numerically using the BFGS algorithm. We also derived conditions for the optimality of the training pilots and provided examples of pilot vectors that satisfy them. As performance benchmarks, we derived the semi-blind and pilot-based CRBs. We then used simulation studies to compare the proposed semi-blind estimator to the conventional pilot-based estimator and showed that the proposed estimator provides a substantial improvement in accuracy. The performance of the semi-blind algorithm closely approaches the derived semi-blind CRB as SNR increases. Finally, these performance gains can be achieved at a reasonable computational cost, which clearly establishes the merit and practicality of semi-blind channel estimation for Amplify and forward in Two-Relaying Networks (AF- TWRNs).

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