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Performance Analysis and Channel Estimation Based on K-Means based Correlation

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***Abstract:** In this paper an efficient k-means based approach has been used for channel estimation and performance analysis. For experimentation 2×2, 3×3, 4×4, 5×5 systems (MIMO−OFDM) have been used. The parameter considered are subcarriers, spreading code length, timing jitters, channel variations and temperature correlation. The system is considered with the correlated timing jitters. First the subcarrier is considered according to the system with the variable spreading length along with the variable timing jitters. For finding the nearer subcarriers in the related frequency k-means algorithm have been applied. It is helpful in finding the related correlation. Additive white Gaussian noise (AWGN) and Rayleigh fading channel have been considered. The results clearly indicate that the improved performance has been obtained in case of increasing the systems or the subcarriers after the related similarity correlation through our approach. It is also found better in terms of different parametric variations.*

***Keywords:** AWGN, Rayleigh Channel, Channel Estimation, K-Means*

I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) provides a digital data encoding scheme with the frequency division multiplexing (FDM) approach in the multi carrier frequency system [1, 2]. Multiple inputs and multiple outputs (MIMO) provide the flexibility of multiple transmitter and receivers in the wireless communication system [3].

The current trend is providing the combination of OFDM-MIMO system to strength the channel capacity in the large extent to provide the better estimation. There are different sub channel and modulation techniques have been combined with different sub channels with quadrature amplitude modulation (QAM) or Phase-shift keying (PSK) andquadrature phase shift keying (QPSK)with the different transmission sources and receiver in the same sort of communication media and the set of the accessing system in the versatility of the hybridization approach [4−8].By applying the hybridization it will provide the better source and receiver synchronization. Intercarrier interference (ICI) can degrade the performance of the system like OFDM [9, 10].

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It is produced by the carrier frequency offset (CFO) [11-14]. It mitigates and degrades the performance based on the sub channels and produce the frequency fading and channel estimation through the communication system.

In this there are different time slots used for the data source and receiver communication.

Time-division multiplexing (TDM) provides the receiving and sending based on the time division synchronization [15]. Space-division multiple access (SDMA) provides high performance based on the spaitial multiplexing approach [16, 17].

Code division multiple access(CDMA)provides multiple access and provides parallel and synchronized communication system [18]. Multiple access interference (MAI) is the controlling factor of CDMA and provides proper data rates in the communication system.It also provides the way in the direction of different approaches which can be used and applied in the combination for degrading the fading synchronization [19, 20]. The main aim of this paper is to highlight and focus the aspects which are currently not covered in the previous literature and can be used in the enhancement of channel capacity and reducing the error rate in terms of bit error rate (BER). It also provides the generalized algorithm which provides the combination of OFDM-MIMO system to utilize the better aspects of the both system.

II. RELATED WORK

In 2017, Dalwadi and Soni [21] have presented a new channel estimation technique of MIMO-OFDM system. It is based on Kalman filter (extended). They have shown the improved bit error rate performance in their results. The have compared the Kalman filter (extended) with the traditional (first order and second order). They have evaluated based on the QPSK modulation technique and Rayleigh channel.

In 2017, Hayderet al. [22] proposed an efficient channel estimation approach for the massive MIMO systems. They have used sparse Bayesian learning (SBL) algorithm. The sparsity is controlled through the hyper parameter coefficients and the neighbours. They have suggested that the proposed approach has the capability of efficiently reconstruct original channel coefficients.

In 2017, Ghosh et al. [23] suggested the current demand of higher data rates, improved system capacity and service quality. They have suggested that the channel modelling and channel state information estimation can be important or these factors. But they have suggested that it is badly affected by channel fading. So they have suggested adaptive modelling. They have also evaluated the system performance.

In 2017, Venkatasubramanian et al. [24] suggested that the data rates improvement can be possible through the MIMO and OFDM system collaboration. The background used is frequency selective background.

Interleave division multiple access (IDMA) can be effective in the code division multiple access (CDMA).So authors has suggested that the hybridization of the IDMA with OFDM. Their results found to be effective.

In 2017, Nair and Jones [25] suggested MIMO and OFDM combined technology for the high rate data. It provides diversity gain which is capable in capacity improvement of communication system. OFDM is helpful in the transmission of high data rates. Channel state information (CSI)is also plays an important role in transmitting and receiver. So they have studied least square estimation (LSE), minimum mean square error estimation (MMSE) and new H-inf estimators. They have also designed H-in f estimator for the reduced complexity. Their results found to be effective.

In 2017, Sherinand Abhitha[26] suggested that the time variation of channel in OFDM produces inter carrier interference(ICI). They have proposed a low complexity iterative method called operator perturbation technique (OPT) for the hybridization of the MIMO-OFDM. They have proposed a linear time-varying channel model. They have used time-domain synchronous-OFDM.They have simulated there results with the QPSK model. They have suggested that the proposed approach has the capability of efficiently reconstruct original channel coefficients.

In 2017, Inkamchua et al. [27] suggested that the hybridization of MIMO-OFDM has the advantages of the spectral efficiency, link reliability and diversity. They have proposed the channel estimation method by using comb-type pilot symbol. Their results found to be effective.

In 2017, Munshi et al. [28] provided the analysis of the performance of variants of MIMO OFDM systems. They have used under the classical and Bayesian channel estimation. Their results show the effectiveness of Bayesian channel estimation in comparison to the traditional technique.

In 2018, Ladaycia et al. [29]proposed new channel estimation. It is based on EM technique. It is used for MIMO. Then decomposition of the MIMO system has been applied based on the paralysations relay. They have suggested that it provides the reduced cost through this EM version.

In 2018, Kong et al. [30] proposed an adaptive structured-generalized orthogonal matching pursuit (AS-gOMP) algorithm. It utilized the is MIMO-OFDM system characteristics along with the time domain. They have used the PN sequence properties as it is helpful in partial channel prior information retrieval. The remaining sets can be extracted from the generalized orthogonal matching pursuit (gOMP) algorithm. Their results support the reduced BER rates.

III. PROPOSED WORK

In this paper an efficient k-means based approach has been presented to evaluate the correlation between different channel estimator systems to check the bit error rate (BER) and signal to noise ratio (SNR) performances. Figure 1shows the working flowchart of our approach.

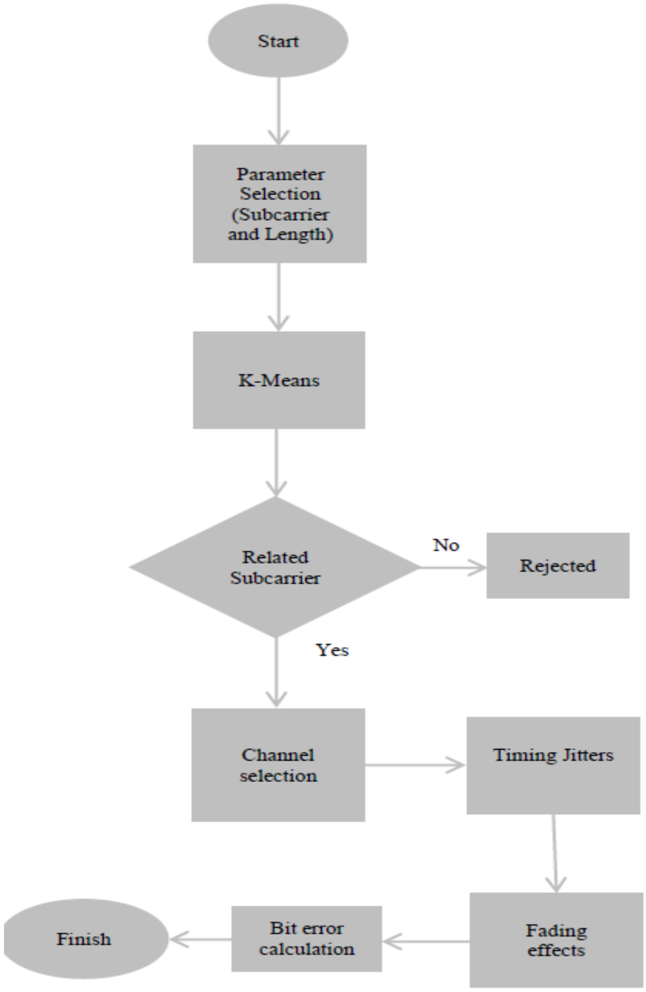

Figure 1: Working Flowchart

Our approach is divided into the following parts:

1. System identification
2. Parameter selection
3. K-means algorithm
4. Channels
5. Performance

The first part of our approach shows the system identification. In our case we have used 2×2, 3×3, 4×4, 5×5 systems. The parameter selection shows the parameter used for the simulation and performance comparison. The first parameter is the selection of the subcarrier according to the system selection. In our approach it varies from 16-1024 subcarriers.

The system is selected according to the system that is 2^n Spreading code length has been considered with the correlated timing jitters for the variations in the BER performance. Where n denotes the number needs to achieve the subcarrier capacity.

Then we have applied k-means algorithm for finding the related subcarrier so that the error can be reduced as by the distance algorithm, efficient cluster can be chosen and selected. Then Additive white Gaussian noise (AWGN) and Rayleigh fading channel have been considered. The main benefit in case of AWGN as the real representation with the existing channels.

Channel condition variations are the main advantage of using the Rayleigh fading channel. For modulation quadrature amplitude modulation (QAM).The performance comparison has been done through BER. It is represented by the following formula:

$$\text{BER} = \frac{NOE}{NBS}$$

NOE shows the errors numbers and NBS shows the number of bits sent.

Algorithm

Step 1: First select the systems.
Step 2: Then parameter has been selected.
Step 3: Initial centroid determination.
Step 4: For similarity calculation Euclidean distance algorithm has been applied
Euclidean distance

$$J(c)=\sum_{j=1}^{k}\sum_{i=1}^{n}||d_i^{(j)} - c_j||^2$$

$d_i - c_j$ is the Euclidean distance.
K is the number of cluster in k-means.

Where k is the number of cluster and n is the number of cases
Step 5: Then it is recalculated based on different cycles

$$c_i = \left(\frac{1}{n_i}\right)\sum_{j=1}^{n_i} d_i$$

Step 6: Final assignment and recalculation is completed.
Step 7: Channel estimation along with the parametric variations has been performed.
Step 8: Performance calculation.

IV. RESULT ANALYSIS

In this section result analysis have been presented along with the parametric variations and comparative study. The system is selected according to the subcarrier. Other parameters are spreading code length, correlated timing jitters and it is compared based on the BER and SNR performance. AWGN and Rayleigh fading channel have been considered. The representations used in the results are as follows:

1. Circle-dash line shows the BER which are affected by the Jitters.
2. Star-dash line shows the BER which are affected by the correlated Jitters.
3. +-dash line shows the zero jitters. Means it is uncorrelated.
4. X-dash line shows the ideal BER.

Figure 2 shows the BER performance evaluation (2×2 system) in case of Subcarrier4 and 5. Figure 3 shows the BER performance evaluation (3×3 system) in case of Subcarrier6 and 7. Figure 4 shows the BER performance evaluation (4×4 system) in case of Subcarrier8 and 9. Figure 5shows the BER performance evaluation (4×4 system) in case of Subcarrier10]. The results clearly indicate that the improved performance has been obtained in case of increasing the systems or the subcarriers and the performance after the similarity correlation is better.For the validations of the result we have also considered temperature variance with different variations and correlations. It clearly shows the improve performance and k-means performance based on the increasing number of subcarriers. Figure 6 shows the SNR performance in case of Subcarrier4 and 5. Figure 7 shows the SNR performance in case of Subcarrier 6 and 7. Figure 8 shows the SNR performance in case of Subcarrier 8 and 9. Figure 9 shows the SNR performance in case of Subcarrier 10.The results obtained by our approach provides a better way for the efficient system correlation and channel estimation with less error.

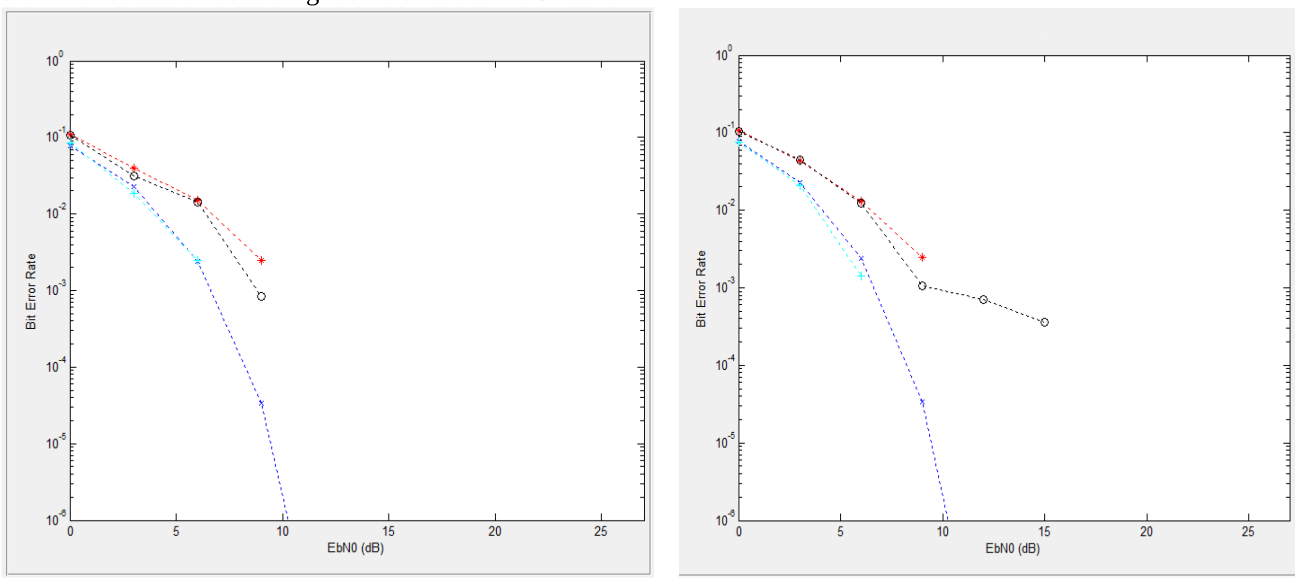

Figure 2: BER Performance Evaluation (2×2 system) [Subcarrier−4 and 5]

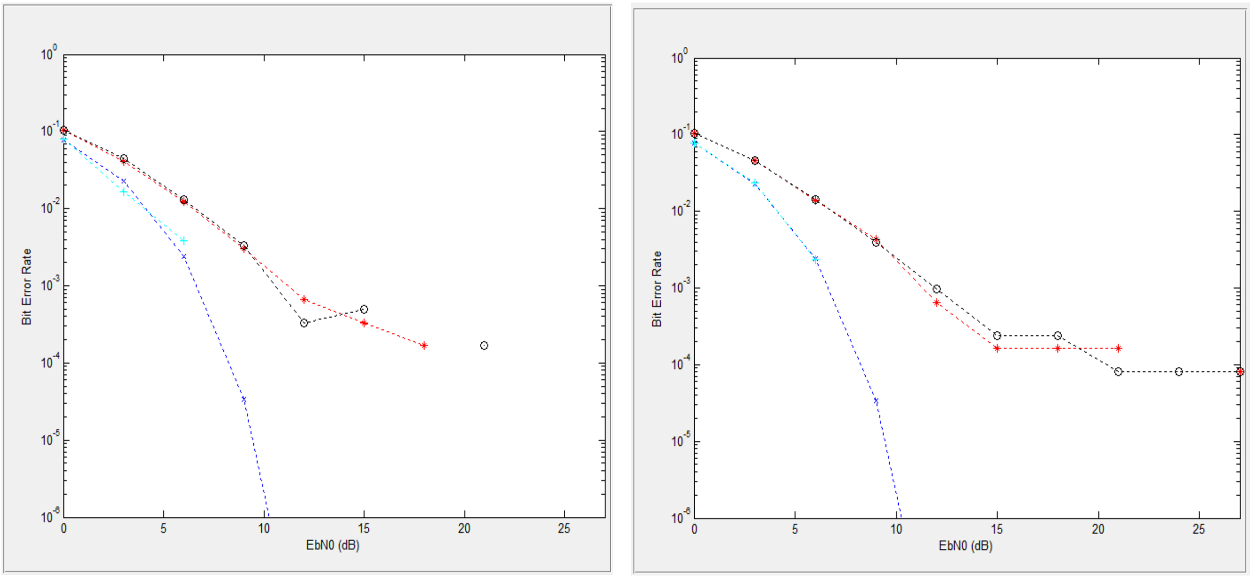

Figure 3: BER Performance Evaluation (3×3 system) [Subcarrier−6 and 7]

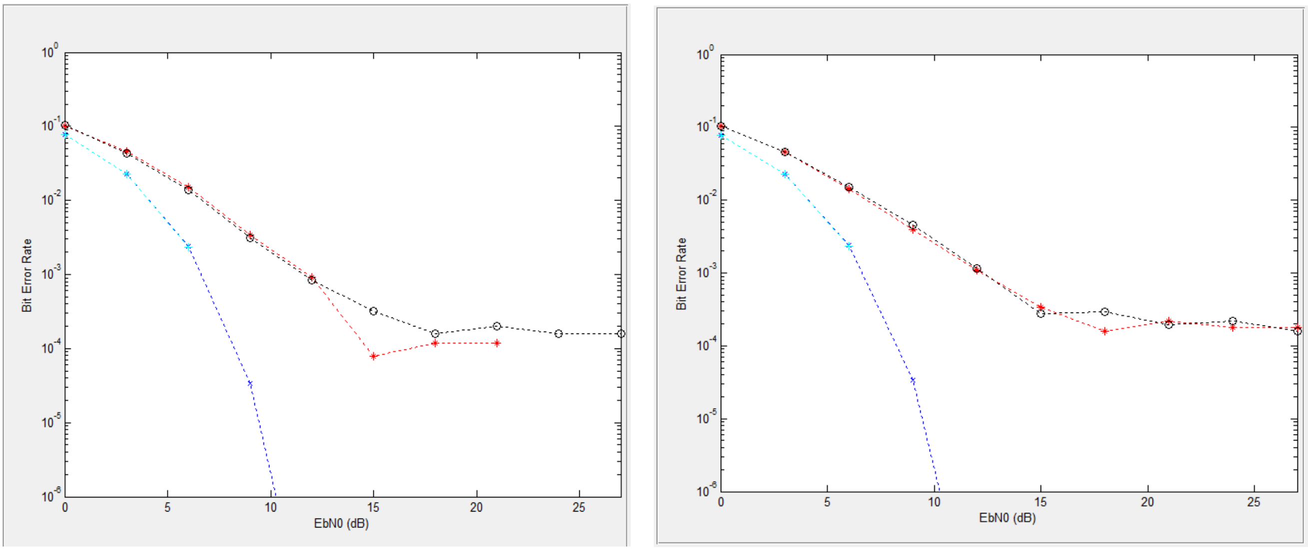

Figure 4: BER Performance Evaluation (4×4 system) [Subcarrier−8 and 9]

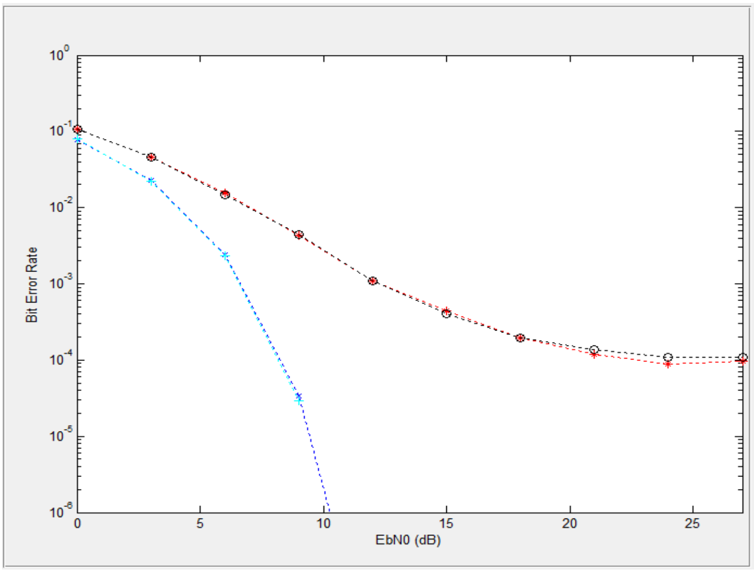

Figure 5: BER Performance Evaluation (4×4 system) [Subcarrier−10]

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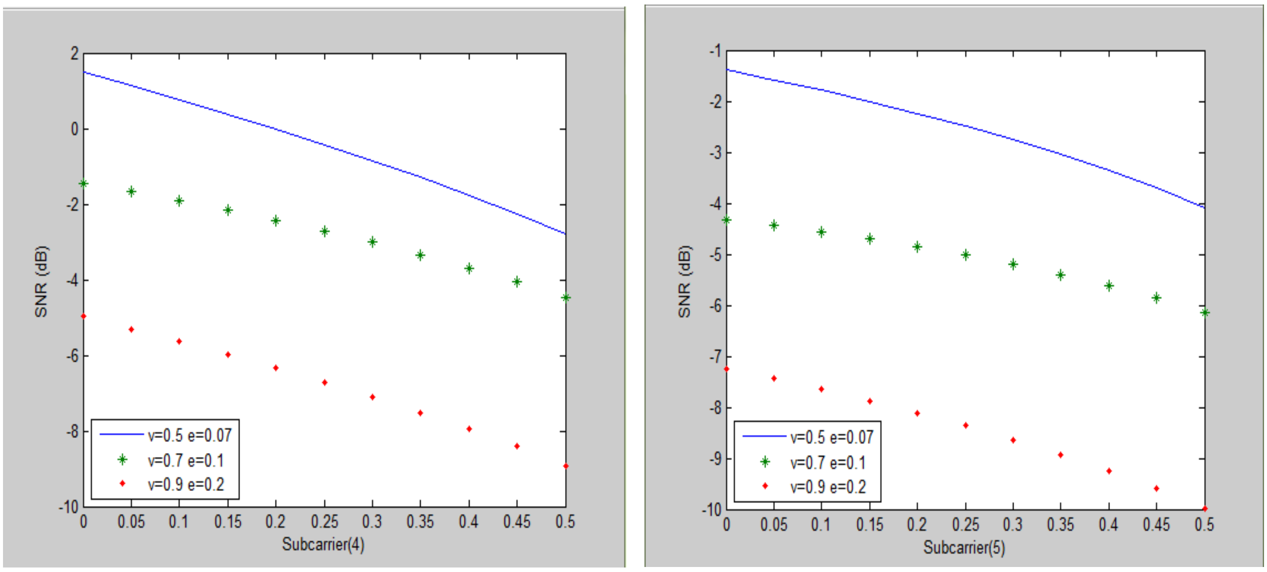

Figure 6: SNR Performance [Subcarrier−4 and 5]

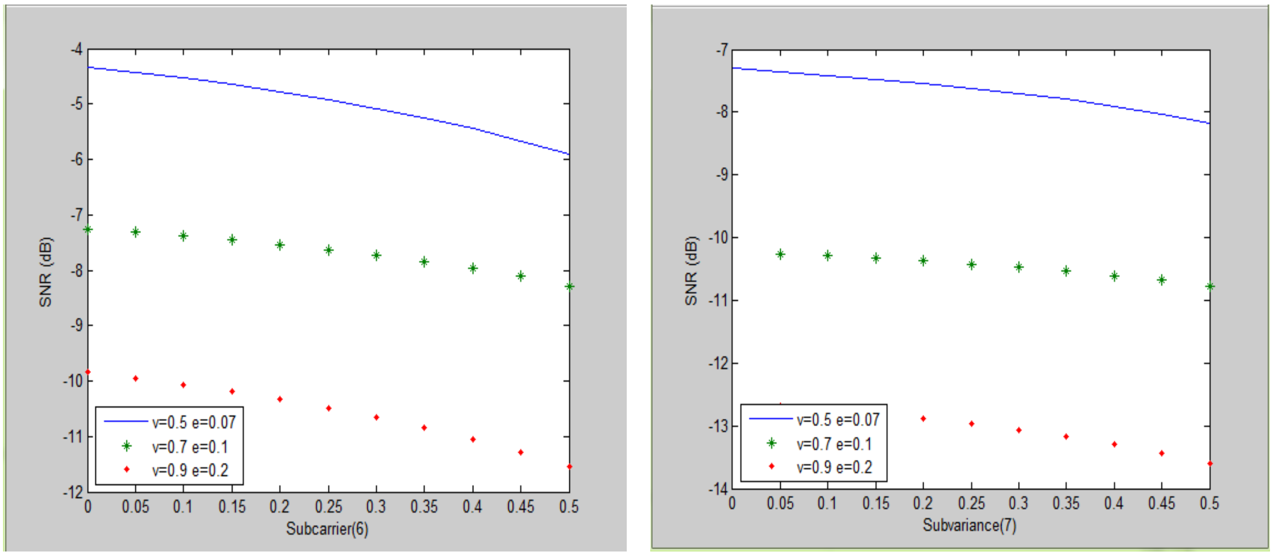

Figure 7: SNR Performance [Subcarrier−6 and 7]

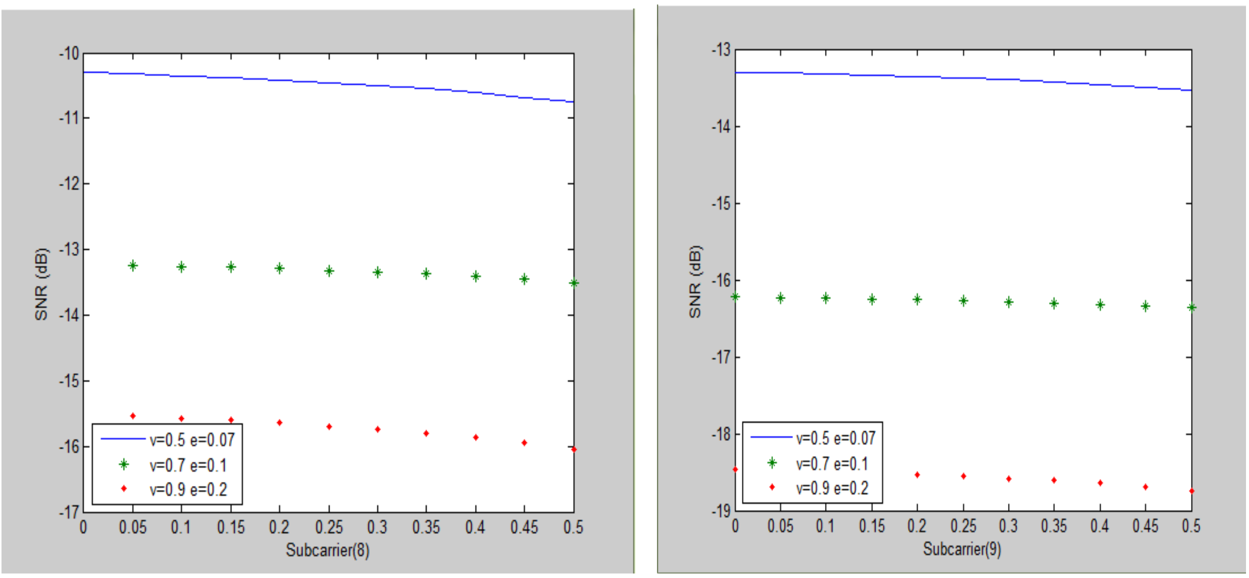

Figure 8: SNR Performance [Subcarrier−8 and 9]

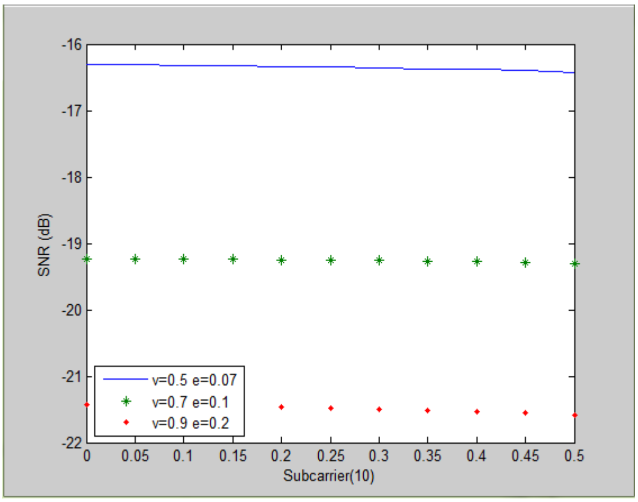

Figure 9: SNR Performance [Subcarrier−10]

V. CONCLUSION

In this paper an efficient approach for channel estimation has been presented. Our approach provides the performance computability of different parametric variations. The parameters are the channel subcarrier, length, jitters and the channel modes with affecting parameters. It is evaluated on different systems. For performance comparison BER and SNR has been calculated for evaluating the performances. Use of k-means algorithm also improves the related correlation so the error is reduced. The results in case of BER and SNR clearly shows with different system subcarriers our approach has less error rates with increasing system capacity. It is also checked with different time and temperature correlation variations.

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