CHAPTER 7

CONCLUSION AND FUTURE SCOPE
Conclusion are drawn by reasoning, but doesn’t make it certain until and unless the mind discovers it by the different ways of using some experimental methods which provide the reasoning that will defend the conclusions made. Hence the analytical and simulation studies made and reported in the previous Chapters are utilized to draw a set of conclusions and its remarks which are included in the following section along with future scope of the work and open problems for further research.

7.1. CONCLUSION

The study as a whole has focused on several relevant aspects of signal transmitting methods for MIMO Communication link with partial CSI conditions. The study reported in the previous Chapters contributes in the area of semiblind channel estimation schemes using frequency spectral and time domain analysis based robust adaptive pilot assisted methods, applicable with the MIMO communication link with different coding schemes. This study has focused on the adaptive pilot scheme for the channel tracking of the MIMO communication link and the design and modification of precoders to make robust to imperfect CSI conditions.

It was found that the statistical behavior made by the analysis shown the information theoretical analysis difficult for which the APASBCE scheme has been derived with low MSE and adaptive power distribution using the waterfilling methods to raise the weights of the information signal. The lower bound characteristics have been taken in consideration in Chapter 3, for the analysis the information signal at high SNR conditions which further, has been analyzed for increasing the power distribution with each \( k \) user and then estimating and storing the received data using the MMSE and ML estimator simultaneously when inverting the matrix for the computation purpose. After introducing the new pilot scheme which is sent in the form of bunches in the frequency component of the transmitting symbols from the transmitting antenna and adaptively reduces with the increase in the number of iterations, under the assumption of imperfect CSI at both ends. The MMSE design is formulated as a non-convex optimization problem subject to a total transmit power constraint. To resolve the optimization
problem, further, the precoder and decoder modification algorithms have been developed in Chapter 4. The MMSE estimator provides the weight vectors using the proposed APASBCE scheme which has been formulated using the Gauss-Markov model producing the inaccurate estimates at the initial conditions. The minimum MSE and raised BER have been found using the proposed APASBCE scheme with less requirements of pilot symbols. The optimized positioning of the pilot symbol with optimized MSE has been formulated to reach the reduced and accurate number of stabilized channels by choosing the optimized path with minimum path metric or gain. This analysis directs to remain the segment size less than 1 to ensure the power distribution equally so that to identify the estimates properly. This further, leads the analysis to see the affect of correlation coefficients of the antennas available at the transmitter and receiver side both of the MIMO antenna system. Conclusively the lower MSE found with the help of the proposed scheme has shown better results as compared with the results available in the literature as shown in Chapter 2 and 3.

Further, in Chapter 4, the discussion has been made for the improvement of the MIMO system by implementing and modifying the precoder and decoder which shows the coupling effect of channel estimation error and channel correlation and finding the optimized precoder for the reduction of the MSE and uniform distribution of the power in the transmitted symbols. The uplink and downlink minimum average sum MSE transceiver optimization problems have been formulated with the partial CSI conditions. The optimum transmit covariance matrix structure has been obtained for the lower bound conditions which provides insight on how the imperfect channel estimation and channel correlation jointly affect the actual mutual information. The method to determine the optimum transmit covariance matrix reveals the close relationship between the maximum mutual information design and the minimum total MSE design.

The optimized solution for this has been formulated using the optimized solution for the global maximum of the lower bounded capacity and global minimum for the MSE with the help of the Karush-Kuhn-Tucker conditions. Further, these precoders and decoders have again been formulated to work with the space-time block codes. The improved results using modified precoder and decoder with different antenna configurations have been shown in this Chapter following the received constellation and the mutual information relationship between the transmitting and receiving antenna configurations with the help of the eigenvector knowledge of transmit covariance and optimized capacity achieving eigenvalues of the transmit covariance matrix. By implementing the modified precoder and decoder algorithm with proposed APASBCE scheme for the partial channel state information in multiple iterations, the tightness of the ergodic capacity bounds and the effects of channel estimation error and channel correlation have been formulated in this Chapter. By comparing the numerical results, in terms of coded BER, all the
algorithms proposed in this thesis shown that, as expected, the algorithm that maximizes the cut-off rate outperforms the others.

Chapter 5 shows the implementation of the proposed APASBCE scheme and precoder and decoder algorithm modified specifically for STBC with different configurations of the MIMO antenna system using space time block coding for different code rates in semiblind channel environment, i.e., with partial CSI information. STBC with higher code rates, i.e., more than 1 have also been tried since they are capable of sending more information with requirement of less bandwidth at the transmitter end. The mitigation has been performed and shown in this Chapter using QPSK and 16-QAM modulation schemes and rotating the constellation angle of the modulating signal for maintaining the high code rates of the different code rate values for different types of space time block codes used in MIMO system with partial CSI conditions. The improved results have been compared in the Chapter and found that these are showing better performance as compared to the available results from the existing literature as shown in Chapter 2 and 5.

Similarly Chapter 6 shows the implementation of the proposed and modified schemes in Chapter 3, 4 and 5 with the conventional filter based type channel estimation schemes and the now going orthogonal frequency division multiplexing. With both the separate conditions, the results were found better as compared with some of the existing results available in the literature for the partial CSI conditions.

The first section of this Chapter deals with the filter based semiblind channel estimation scheme with assumption of forced missed data for which the proposed scheme will be implemented. This method shows that how the missed data can be recovered with the help of the APASBCE scheme application using forward backward averaging method and the expectation maximization scheme. The proposed scheme has been simulated and compared with the existing CAPON, MUSIC and APES schemes for the channel estimation with partial CSI and found the better results as compared to these schemes.

Similarly the second section of this Chapter gives the basic idea of the OFDM system and then the implementation of the proposed APASBCE scheme for the MIMO antenna systems with partial CSI which finally forms the MIMO-OFDM system. The comparative analysis has been done with the proposed scheme implemented in MIMO-OFDM system for the BER and found that the proposed implemented scheme with partial CSI is reaching very close to the perfect CSI conditions. The simulation results shown the better result as compared with the said results available in the literature which are mentioned in Chapter 6.

Finally the block diagram of the system has been shown in Figure 7.1 which shows the changes made throughout the thesis with the yellow coloured highlighted blocks.
7.2. FUTURE SCOPE OF THE WORK

“No one ‘discovers’ the future. The future is neither a discovery nor a destiny. The future is a decision based on a continuous effort starting from the past, motivated by the present which certainly leads success thereafter. In the long run it is the cumulative effect that matters. One can do much efforts and can move mountains”. Initiated by this thought, all the reported work in this thesis leads to their respective extensions that will strengthen their impact and role in real life applications. The desired and expected extensions are termed here as the future scope of the reported work which can be outlined as –

The proposed algorithm of the pilot assisted semiblind channel estimation scheme has been considered for the slow fading channel environment due to the use of the frequency and time segments both at the same instance for one transmitted signal, which further, can be analyzed for the fast fading channels. Moreover the adaptive nature of the APASBCE scheme can be made more robust by considering two or more simultaneous channels for the estimation purpose so that if one channel fades or losses due to some reason, they may use the other being utilized.

The designs in Chapter 3 and 4 have considered the error free partial CSI conditions for the transmitter as feedback state which is not justified by the insensitivity of system performance to reasonably small delays. Therefore, the error in the feedback should be considered and modeled accordingly. Also the robustness can be improved by considering the worst case optimization for designing the precoders and decoders.

The designs in Chapter 5 have considered about the use of different space time block codes with different code rates on which the data rate depends. These designs use more than two antennas at the transmitter and receiver side. It is well known that the cost of antenna is low and the digital processors are
also getting cheaper, multiple radio frequency chains can be used to enhance the data rate drastically. It has already been seen in Chapter 2 that the antenna selection is low cost low complexity option to capture many of the advantages of MIMO system, therefore the multiple RF chains can be considered for the future scope. Also, the STTC can also be tried to see the effect of the partial CSI environment with the proposed APASBCE scheme.

The designs in thesis comprise of the MIMO antenna designs for the single user case mostly, for improved signal quality and better coverage without using co-located antenna arrays. Now the multiuser conditions can also be considered for the future development work in the environment of the partial channel state conditions considering different types of fading environment, i.e., slow and fast both by considering set of relay nodes. These nodes can be treated as virtual antenna array and probably the system may increase the mutual information and minimize the MSE.