CHAPTER 6

RESULT AND CONCLUSIONS

The diversity technique to improve the quality of received signal has been discussed. The different types of the diversity and resolvable path have been described. The diversity combining method can improve the bit error rate performance of the communication link. It discusses that when a mobile moves from one base station to another base station, the mobile station receives the signal from both stations simultaneously and combine these signals to improve performance.

A high performance handoff algorithm can achieve many of the desirable features by making appropriate tradeoffs. However, several factors such as topographical features, traffic variations, propagation environments, and system-specific constraints complicate the task of handoff algorithms. Different system deployment scenarios present different constraints on handoff procedure. Handoff algorithms with a specific set of parameters cannot perform uniformly well in different communication system deployment scenarios since these scenarios impose distinct restrictions and specific environments on the handoff process. These system structures are expected to co-exist in future wireless communication systems and warrant a substantial study. The issues involved in the design and analysis of handoff algorithms were thoroughly described. In particular, different handoff criteria were analyzed. Both the conventional and emerging approaches for designing handoff algorithms were discussed. Several merits have been discussed and used to quantify the handoff related system performance. A brief account of handoff performance measures was given.

Chapter three of fading & diversity in multiple antenna systems various models are explained. The various types of diversity specific concepts are explained. Comparison of channel capacities of single input single output, single input multiple output, multiple input single output, multiple input multiple output are discussed in section 3.6.
The simulation of performance of SIMO channel capacity vs. SNR is done in MATLAB and results shown in fig 3.8 and explained in tabular form in tables 3.1,3.2,3.3, 3.4 for N=1 & M=2,3,4,5. These tables explained that the if value of M increased then capacity of channel increases. The figure 3.9 performance simulation for MISO channel is done & explains with the help of tables 3.5, 3.6, 3.7, 3.8 for N=2,3,4,5, M=1 respectively. In figure 3.10 performance simulation for MIMO is done by taking multiple input value N=2, 3, 4, 5 and multiple output value M=2, 3, 4, 5.

We can see for the same capacity vs. SNR graph and tables the capacity is higher for the MIMO compare to SIMO and MISO.

Multiple antenna system different diversity types effects are simulated by MATLAB. The BER analysis for BPSK modulation in Rayleigh channel with selection diversity is shown in fig. 3.11 using MATLAB. Result is drawn that 16 dB improvement over 10⁻⁴ BER points is achieved.

Fig 3.12 explains BER Vs. SNR simulation by taking equal gain combining diversity channel for BPSK modulation. The result shows that 16 dB improvement over 10⁻⁴ BER points.

Fig 3.13 explains the BER Vs. SNR for maximal ratio combining diversity channel for BPSK modulation. The result shown 18 dB improvement over 10⁻⁴ BER points.

Fig 3.15 explain the simulation for BER and Eb/No comparison of one transmitter and two receiver with maximal ratio combining with STBC and it show that later one has 3dB poorer performance.

Fig. 3.17 explains the simulation and comparison of 2 transmitters and 2 receiver antenna system with maximal ratio combining with STBC.

By comparing simulation result for the BER performance is much better in MIMO STBC then one transmitter and 2 receiver MRC case.

In the chapter four space time block codes system, its performance under classical maximal ratio receive combining (MRRC) scheme, under new diversity scheme, under transmit & receive diversity is discussed by simulation. Fig 4.8 shows that simulation of
SNR (dB) gain Vs. Number of receiver antenna under equal gain combining diversity scheme, from the figure one can observe that SNR gain increase as number of receiver antenna increases but this increment is not linear. Fig 4.10 explains the SNR improvement Vs. Number of receiver antenna under maximal ratio combining scheme and it also shown that increment in SNR gain is not linear. In this chapter various transmitter diversity with STBC for various number of transmitter and receiver combination under MIMO scheme is discussed.

For direct sequence CDMA transmitter model discussed and various coding sequences are discussed. The performance simulation of CDMA under Rayleigh fading and AWGN is done and shown in fig. 4.16. By comparing the two graphs one can observe that 25 dB degradation due to multiple channel effect in Rayleigh fading channel as compared to AWGN channel. Capacity (Kbps) Vs. SNR simulation for MISO is shown in fig. 4.17. The result drawn from figure that number of inputs i.e. Value of N gets increased then capacity also increased.

In chapter five the probability of bit error rate has been investigated and the probability of bit error rate have been analyzed without diversity and with diversity for different value of the threshold. The Figure 5.3 shows the probability of bit error rate versus signal to noise ratio without the diversity. These result shows that the probability of bit error rate decreases as the signal to noise ratio increases. The probability of error is high in this case because of single receiving path and no diversity is used. The Figure 5.4 shows the probability of bit error rate for lower threshold value i.e. Th = -4. The Probability of bit error rate decreases with increase in signal to noise ratio but this value is less than the case of without diversity. This value is less because of the two branch diversity and the switching take place at the threshold value. The two branch diversity give good results because of any one of them may have good signal strength. Further, figure 5.5 shows the probability of bit error rate with signal to noise ratio for increased value of the threshold. The probability of bit error rate improved due to higher value of signal to noise ratio at higher threshold value. Next is the figure 5.6 which shows the probability of error with
signal to noise ratio by applying fuzzy logic at the threshold value. The probability of bit error rate improves further because of adaptive nature of threshold value. Thus fuzzy logic application has improved bit error rate substantially.

In this work, we have analyzed an effective fuzzy logic control switched diversity (FLTC) scheme, which can be considered to be used in mobile units. To achieve a simplified design of FLTC, which is a key element of the FLTC, the efforts have been made in selecting the most significant fuzzy IF-THEN rules and determining the parameters of the associated membership functions. Eventually, we find that there are in fact only six IF-THEN rules are considered for analysis and the resulted fuzzy threshold control has a very simple form. Results show that the proposed FLTC can achieve a significant improvement in system performance in terms of both the diversity gain and BER over various channel conditions.

**Suggestions for possible future work**

To improve the received signal quality and link performance, there are measures which can be used independently or in tandem. These are equalization, diversity, channel coding. Equalization compensates for inter symbol interference (ISI) created by multipath within time dispersive channels. If the modulation bandwidth exceeds the coherence bandwidth of the radio channel, ISI occurs and modulation pulses are spread in time into adjacent symbols. An equalizer within a receiver compensates for the average range of expected channel amplitude and delay characteristics.

Diversity is another technique used to compensate for fading channel impairments, and is usually implemented by using two or more receiving or transmitting antennas. Base stations may transmit multiple replicas of the signal on spatially separated antennas or frequencies. Channel coding is used by the receiver to detect or correct some of the errors introduced by the channel in a particular sequence of message bits. There are three general types of channel codes: block codes, convolution codes, turbo codes. MIMO systems will need to function reliably in interference limited environment in order to be
effective. CDMA systems are designed to operate in an interference free environment and for this reason it is used in modern cellular systems.

Future work should include the simulation of MIMO system with CDMA and to study their effects on bit error rate. The combination of MIMO and CDMA can further improve the system transmission rate over the traditional CDMA system. Multiuser MIMO CDMA systems are considered where each user has multiple transmit antennas, different transmit antennas of the same user use the same spreading code. Matched filter method and de-correlating detector method are used to detect the signals with Gaussian Noise. Further OFDM technique may also be attempted to using diversity techniques discussed here to improve the performance of the digital system.

**Scope for future work:**

- We have used soft handoff using two base stations for capacity analysis. We can analyze using more than two base stations involved in soft hand to see the effect of bit error rate performance of communication Network.
- In our analysis, we have assumed path loss exponent value of four. The similar analysis can be done by assuming other path loss model like Hata model etc.
- Work can be extended to analyze the effect of other cell interference.
- Soft handoff algorithm can be implemented after careful selection of parameters.
- Combination of other schemes like channel borrowing during handoff process can be analyzed for QoS parameters.
- Various parameters used in this algorithm can be calculated and loaded into look-up tables to facilitate dynamic threshold allocation.