

MULTI USER DETECTION TECHNIQUES FOR DS-CDMA

Sanjeev Chauhan, Vinay Kumar, Vivek Kanwar

Abstract— DS-CDMA is a commonly used method in a lot of important applications. This system suffers from multiple access interference (MAI) caused by direct sequence users and near far effects. Multi user detection schemes are used to detect the users in the presence of MAI and near-far problem. In this paper, the study of MUD suboptimal techniques, linear suboptimal detector and nonlinear suboptimal detector. Linear detectors are Decorrelator detector, MMSE detector.

Index Terms— DS – CDMA, MAI, MUD, MMSE, SIC, PIC, HIC

I. INTRODUCTION

CDMA has become an emerging technology for wireless technology because it provides many attractive features over the other multiple access schemes: time division multiple access (TDMA) and frequency division multiple access (FDMA) to meet the high capacity and performance requirements for emerging personal communication services (PCS) [1]. CDMA is a multiplexing technique where many users at the same time asynchronously access the same frequency band by spreading their information with pre-assigned code sequences [19]. DS-CDMA is the best known spread spectrum technique and it is relatively simple to implement. A narrow band carrier is modulated by a code sequence; the code sequence is generated by a pseudorandom generator that has a fixed length. For direct sequence, the amount of ratio of chip per bit of information at the receiver; the information is recovered by multiplying the signal with a generated replica of the code sequence. In DS-CDMA, a unique code which is also called a signature sequence is assigned to each user [2]. DS-CDMA is considered as the third generation of cellular mobile, indoor wireless personal communication system, such as frequency reuse, soft hand off, increased capacity and

multipath combating [16]. CDMA suffers from multiple access interference problem (MAI). MAI gives rise to irreducible error even in the absence of thermal noise, while near far problems arise since high power users destroy the communication of low power users [3]. (MUD) Multiple user detector technology exploits the characteristics of the MAI by removal of the multiple user interference from each user's received signal before making data and it offers significant gain in capacity and near far resistance [4]. MUD has the potential to significantly improve the performance and capacity of DS-CDMA system. The MUD is classified as optimal and suboptimal detectors [13]. The optimum MUD complexity, suboptimal alternatives are able of resolving the detrimental effects of MAI [17]. Suboptimal MUD algorithms can be classified into linear and non-linear algorithms. Most commonly known linear detectors are Decorrelator and MMSE. Non-linear can be classified as interference cancellation schemes are SIC and PIC, HIC [6]. Non-linear MUD techniques estimate the interference caused by each user on the others, re-spread and cancel from the received signal [8]. Interference cancellation MUD attempts to remove MAI and improve system capacity of DS-CDMA system. This is done through MUD techniques like SIC and PIC, HIC [18].

II. DECORRELATING DETECTOR

Verdi's seminal work published in 1986 proposed and analyzed the optimal detector or the minimum likelihood sequence detector is much too complex for practical DS-CDMA systems [11]. Therefore, over the last decade most of the research has focused on finding suboptimal multiuser detection solutions. This is more achievable to implement [12]. The decorrelating detector applies the inverse of the correlation matrix to the output of the matched filter in order to decouple the data in the synchronous hand; consider of the

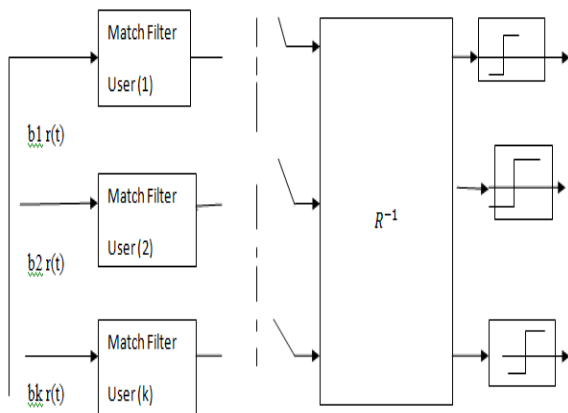
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Sanjeev Chauhan, Electronics and Communication Engineering, Shoolini University, Solan H.P, Solan, India.

Vinay Kumar, Electrical and Electronics Engineering, Shoolini University, Solan H.P, Solan, India

Vivek Kanwar, Electronics and Communication Engineering, Shoolini University, Solan H.P, Solan, India.

bank of k Matched Filter the cross correction matrix [3]. The decor relating detector has a matched filter for each use signature code than calculated the inverse of this correlation matrix.



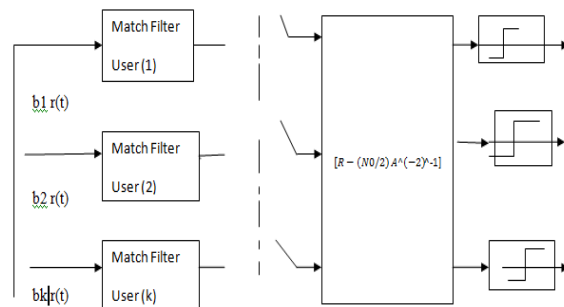
(Fig. A) -Decorrelator Detector for DS-CDMA system.

The received waveform is applied to one matched filter the decorrelator detector is assign for one user each decorrelator detector is matched to the signal waveform of different user receiver consist of bank of filter matched to signal waveform assign to the user and a multi user deflection[4].Main advantage of decorrelator detector is it ready the MAI signal and no need of receiver power knowledge and its performance is independent of the power of interfering user so that is solve the near far problem. Operation of decorrelator increase linearly with the number of active user. Zero forcing block linear equalizer required protects channel estimation. It has better BER performance and required accurate channel estimation [14].In this absence of background noise we get error free performance. In the presence of background noise decision is effected due to noise [20]. Decorrelator provides substantial capacity gain. It does not need to estimate the received amplitude. And has a probability of error independent of the signal energies. The decorrelator has received the most attention of any multi-user detector due to its many advantages [10].

III. MINIMUM MEAN SQUARE ERROR (MMSE)

This detector implements the linear mapping which minimizes the mean square error between actual data. And soft output of matched filter detector [10] MMSE detector

instead tries to minimize the square of the residual noise plus interference. As the background noise goes to zero the MMSE detector convergence in performance to the decor relating detector [2].MMSE detector provide better probability of error performance then the decor relating detector multi users detection [9].MMSE detector minimize both noise and MAI and an Adaptive MMSE replace the old bank of matched filter by a bank of MMSE filters [14].The structure of the MMSE detector is simple than the structure of decor relating detector an important disadvantage of estimation of the received amplitude and its disadvantage is that its performance depends on the power of the interfering user [4].



(Fig. B) - MMSE Detector for DS-CDMA system.

IV. SERIAL INTERFERENCE CANCELLATION (SIC)

SIC cancel the interference estimates on user by user basis. SIC it is important to cancel the strongest signal before detection the other signal [6].In sic overtire user signal is estimated and the signal with largest power is regenerated and subtracted related and process is continues until all user signal have been recovered [1].It cancel stronger interference and require only a minimal amount of additional hardware and has the potential to provide significant improvement over the conventional detector [14]. The strongest signal has the minimum MAI cancelling the strongest signal has the most benefit cancelling the strongest signal has the most reliable cancellation [5]. SIC scheme is similar to implement in hardware but more robust in cancelling is interference (SIC) [7]. Main disadvantage of sic is the most projecting of which is that since the IC project serially a delay of the order of computer stage is requested to complete the multi user detection .

V. PARALLEL INTERFERENCE CANCELLATION (PIC)

PIC cancels the interference of all user simultaneously; an estimate of the interference effect of the number of user on the first user is obtained and cancelled simultaneously. To process is repeated many times to obtain a better estimate. Single user PIC is not near-far resistant or power control and multi processing is required [14]. PIC also called multiple interference cancellation algorithm improve the parallel technique typically require more than one iteration per user since the first iteration generate very noisy estimates for all user with sub squares iteration becoming increasingly more accurate. PIC receiver has work better than SIC when all of the user are received with equal strength main advantage of PIC enjoy over SIC is latency and drawbacks of lower power uses will have their BER very high and hardware complete of receiver is high[8].

VI. HYBRID INTERFERENCE CANCELLATION (HIC)

HIC combining many positive features of SIC and PIC in HIC scheme offer considerable at the cost of some BER degradation [14]. the main purpose of hybrid IC is that instead of cancellation all k users either in sense and parallel and partially is sense when k is the total number of user and the number cancelled in parallel and series at each stage is detected by P and S. The signal of p stronger user S are chosen to perform PIC between then the P is most reliable are chosen their signal reconstructed in order to subtracted then from the buffered version of receiver signal and remaining user are arranged according to their strength and one by one. Users are detected, subtracted and ultimately using this SIC the entire user are detected. HIC perform in an optimal way when compared with SIC and PIC [1]. This technique is simple faster and reliable this scheme improves the performance and reduces the complexity [8].

VII. CONCLUSION

In this paper give a background on the fundamental concept of linear and non-linear detector. It is concluded that MMSE is much better approach for MUD with respect to older approaches as deco relating and matched techniques. Recently some researcher worked on collaboration of intelligent systems with mud techniques as ANN with matched. As MMSE is better approach than matched so further enhancements can be done on MMSE collaboration with some other approaches to get more better results.

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Sanjeev Chauhan Pursuing M.Tech in electronics and communication engineering Shoolini University (Solan)



Mr. Vinay Kumar is Assistant Professor in Electrical and Electronics Engineering Shoolini University (Solan).



Mr. Vivek Kanwar is Assistant Professor in Electronics and Communication Engineering Shoolini University (Solan).