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Power Rotational Interleaver on an Idma System

Sugandha Sharma, Poonam Ahirwar, Shikha Chauhan, Subhra Upadhyay, M. Shukla
Department of Electronics Engineering, Harcourt Butler Technological Institute,
Kanpur, Uttar Pradesh, India
E-mail: sugandhasharma11486@yahoo.in, manojkrshukla@gmail.com

Abstract
In this paper we are proposing an interleaver design i.e. power rotational interleaver. The basic purpose of this design is to reduce the bandwidth occupied by the interleaver. This approach provides an efficient result for multiple users. The complexity of this design is same as that of master random interleaver while the bandwidth requirement is reduced up to a great extent. On the basis of simulation results it is concluded that the performance of power rotational interleaver is as good as that is of random interleaver.
Keywords: Master random interleaver, a posteriori probability, tree based interleaver.

1.INTRODUCTION

Interleave Division Multiple Access (IDMA) is a multiple access scheme which is proposed recently. This scheme relies on interleaving as the only means to distinguish the signals from different users so that is very important that the interleaver must be designed properly. In case of random interleaver it is required to transmit full interleaving matrix with the data from transmitting point to receiving point, due to which the data data to be transmitted get increased up to a great extent and hence the cost. Due to this problem different designs of interleavers were suggested such as power interleavers, orthogonal intereleavers,pseudo random interleavers, nested interleavers, shifting interleavers, 2-dimensonal interleaver, parallel interleavers, tree based interleavers etc..

Here a brief revision of interleavers in IDMA systems The details of the parallel interleaver design method, its receiver design and computer simulation results are presented and finally, conclusions are drawn.

2.IDMA SYSTEM

In IDMA system first the data is encoded then is spreaded same as we do in CDMA. The performance of CDMA systems is mainly limited by multiple access interference (MAI) and inter-symbol interference (ISI). IDMA can employ a very simple chip-by-chip iterative multi-user detection (MUD) strategy. The computational complexity of the MUD in IDMA systems is a linear function of the number of users. The MUD algorithm in IDMA systems is much simpler than that used in CDMA systems. IDMA aims at mitigating MAI and ISI with low complexity. This scheme relies on interleaving as the only means to distinguish the signals from different users. IDMA system adopts chip-by-chip iterative MUD technique which is different from CDMA. hence it is very important to design an interleaver properly At the receiving end the interleaving rule for the data of a particular user is determined with the help of iterative decoding. Each of the receivers performs an iterative interference cancellation operation. It consists of an elementary signal estimator (ESE) and a bank of K single-user a posteriori probability (APP) decoders (DEC). So the data can be deinterleaved accordingly and decode. The IDMA system needs to test its performance in terms of BER performance, memory requirement, complexity, power allocation, multiuser interference elimination ect. These factors can be estimated on MATLAB by C,C++ programming, modeling on simulink. On the basis of these programming and modeling test results there are few problems in this system sach as bandwidth requirement, memory collision etc.

However in this paper, we find out the IDMA system using the interleavers with poor cross correlation with a similar good BER performance as that using the random interleavers with fine cross correlation. The simulation results are given in this paper to verify this conclusion.

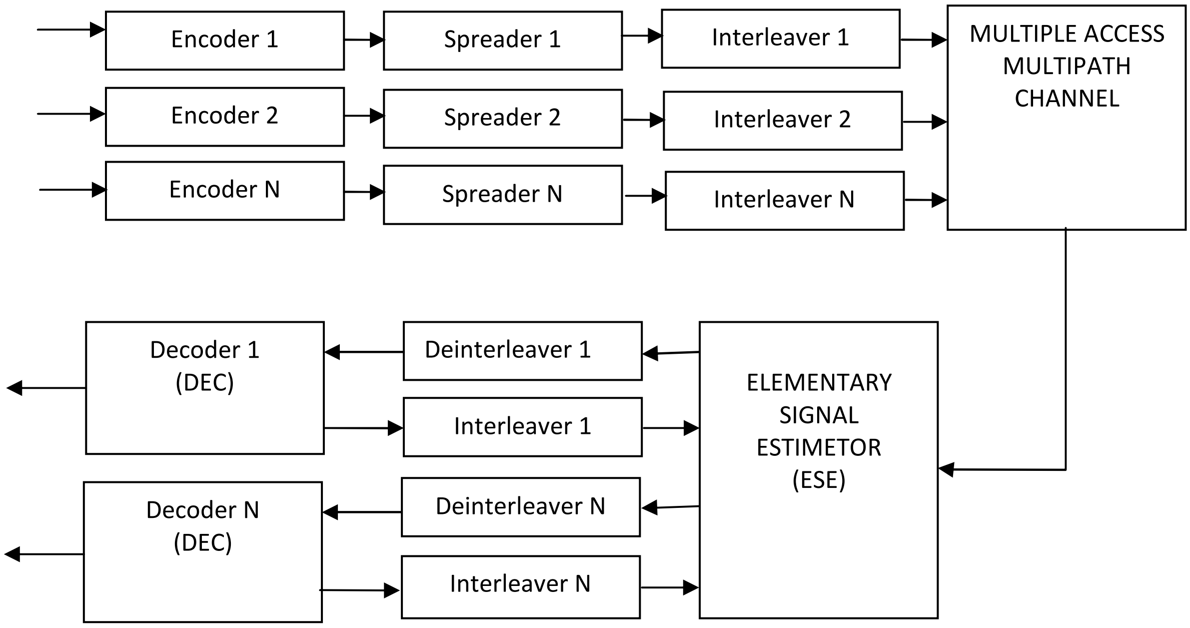

Fig. 1. IDMA transmitter and receiver

3. POWER ROTATONAL INTERLEAVER

In conventional designs of interlevers we need to send some additional data in the transmitting channel in order to obtain the interleaving rule at the receiver which needs some additional bandwidth. In order to reduce this bandwidth requirement the power rotational design is proposed here. In this design it is also ensured that there is no memory collision in the scrambling process of spreaded data.

3.1 Design Algorithm

Let us consider

n= number of users

N= length of spreaded data for each user

So we have a matrix of order (n x N). fill the data of each user in a separate matrix of order (p x w) in row wise fashion. where

$$p \times w = N$$

Generate an random sequence of length w which consists of each number among 1 to w. then divide each element of this random sequence with p and take remainder for each element. Generate a column permutation rule in a rotational manner and scramble the data of the user separately. For the next user the initial random sequence is generated from the initial random sequence using master random interleaver concept. Then perform row wise scrambling in the same fashion on this column wise scrambled data matrix.

For example let us consider n=4, N=24, p=4 hence w=6

Then the initial data matrix will be as given below

	w					
p	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24

The random sequence generated for column permutation rule is

5	3	4	1	6	2

After taking remainde of each element with p the remaining array will be

1	3	0	1	2	2

The the coumn permutation rule can be generated in the following way

	w					
p	1	3	0	1	2	2
	2	0	1	2	3	3
	3	1	2	3	0	0
	0	2	3	0	1	1

Then the scrambled data matrix will be as given below

	w					
p	7	20	3	10	17	18
	13	2	9	16	23	24
	19	8	15	22	5	6
	1	14	21	4	11	12

For row permutation rule we need to generate a random sequence again as given below

4	3	6	2	1	5

Then the row permutation rule can be generated by shifting the random sequence by i steps with respect to sequence of previous row. Where the i is the number of row being accessed.

	w					
p	4	3	6	2	1	5
	5	4	3	6	2	1
	2	1	5	4	3	6
	4	3	6	2	1	5

Then the finally scrambled data matrix will be

	w					
p	10	3	18	20	7	17
	23	16	9	24	2	13
	8	19	5	22	15	6
	4	21	12	14	1	11

For the next user the initial sequence for column permutation rule will be generated using master random intreleaver concept
User1:{5,3,4 ,1,6,2}
User2:{6,4,1,5,2,3}
User3:{3,5,6,2,4,1}
Similarly the initial sequence for row permutation rule will be generated using same concept
User1:{4,3,6,2,1,5}
User2:{2,6,5,3,4,1}
User2:{6,1,4,5,3,2}
The above mentioned approach ensured the reduction in bandwidth requirement and removal of the problem of memory collision.

3.2 Receiver Design
In this design we need to send the scrambled data and the data of length equal to 2w in the bandwidth to achieve the scrambling rule at the receiving end for the purpose of descrambling of the data matrix. At the receiver we need an additional block for the generation of scrambling rule for each user with the help of the data of length N can be generated from the received data signal. The basic advantage here is the memory collision is avoided.

4. MATLAB Simulation Results
For simulation in this paper BPSK channel is assumed with size of information bits for each user 128 bits. 500 different blocks were generated per user for different values of Eb/No.In the following figure the performance of three interleaver designs are compared random interleaver, treebased interleaver, power rotational interleaver. This is the result for 16 users and p=4.

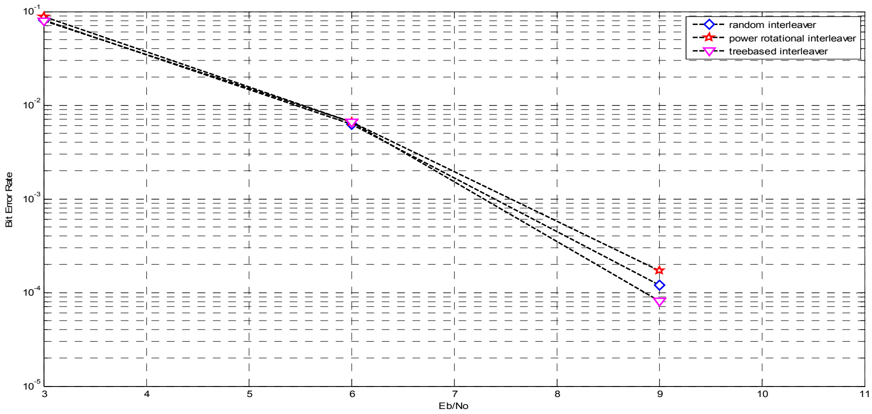

Fig. 2. Comparison of BER performance of power rotational interleaver with random interleaver and tree based interleaver

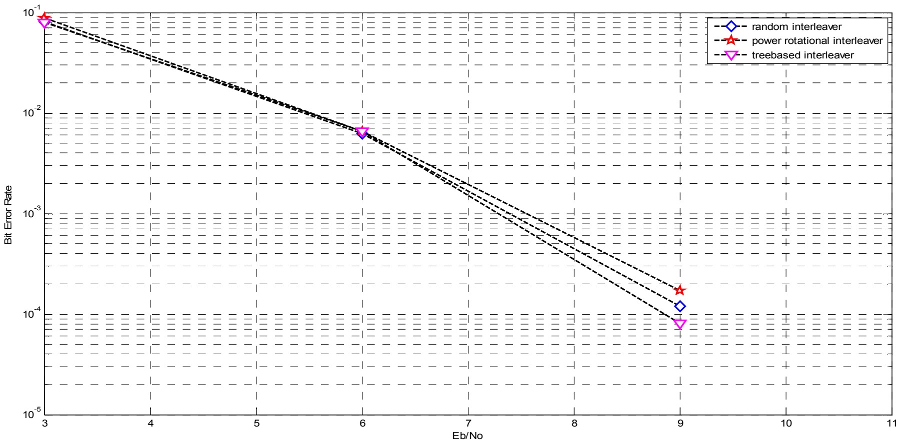

Fig. 3. Comparison of BER performance of random interleaver, treebased interleaver and power rotational interleaver for 64 user

On the basis of above simulation results it can be concluded that the power rotational interleaver provides approximately same ber performance as that of random interleaver and tree based interleaver.
In the followin result a comparison among the memory requirement of random interleaver, master random interlever, treebased interleaver and power rotational interleaver is given.

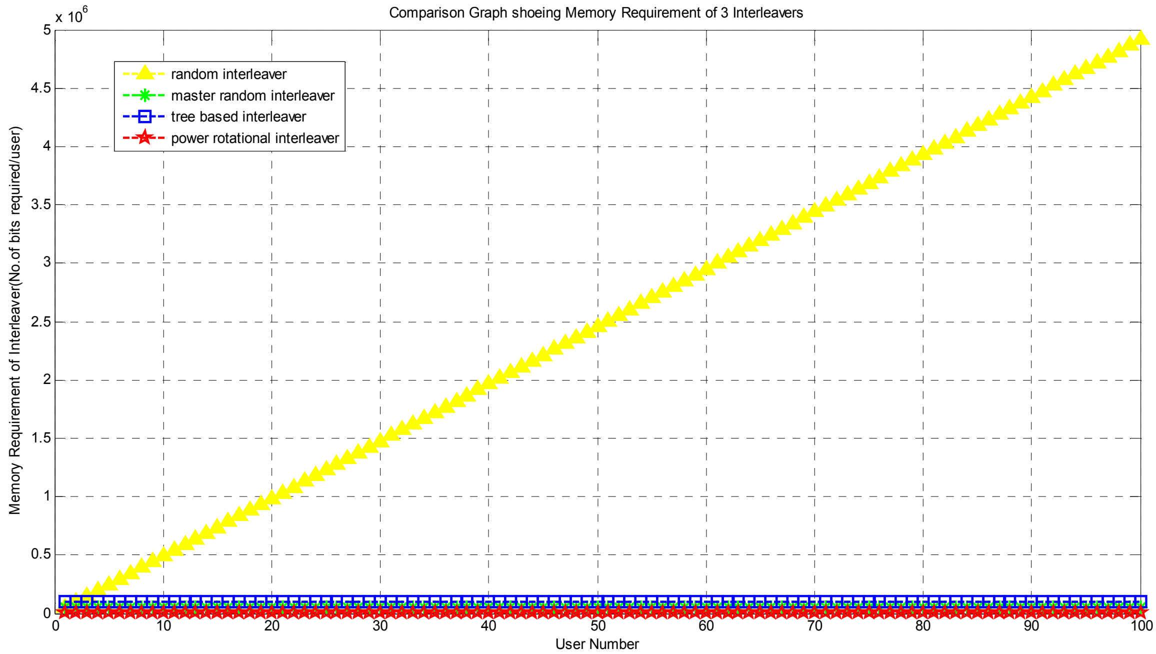

Fig. 4. Comparison of memory requierment of power rotational interleaver with respect to other conventional interleaver design

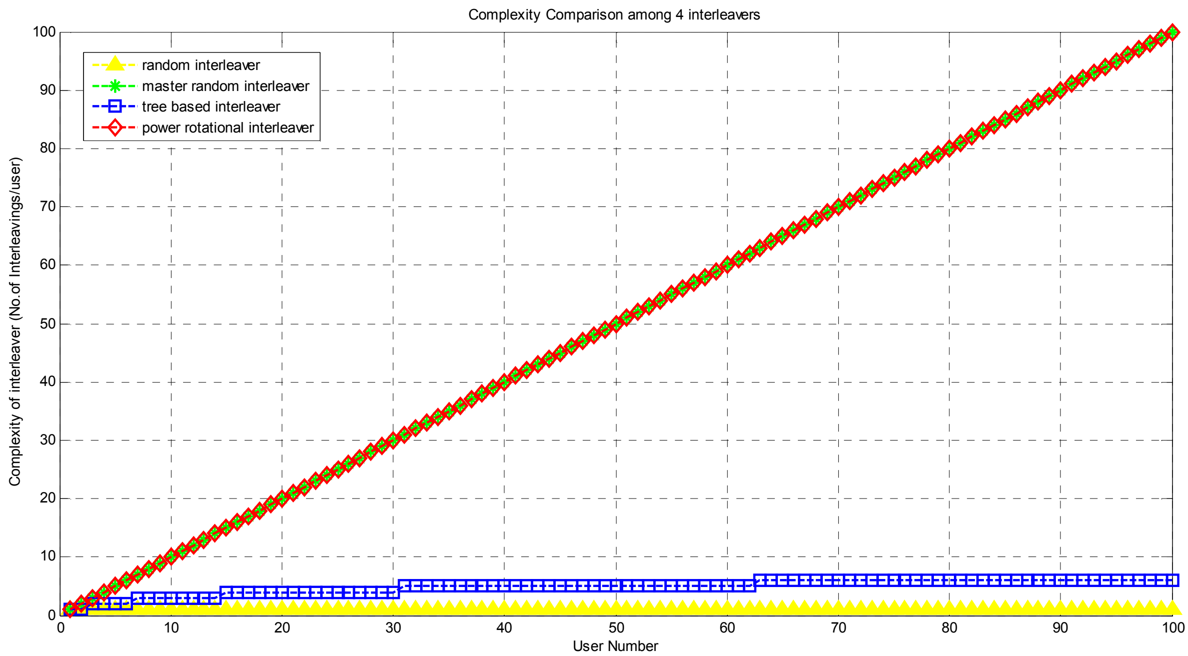

Fig.5. Comparison of complexity of power rotational interleaver with that of random, master random, treebased interleaver

Analyzind the results, it can be concluded that the power rotaional interelaver requires lesser mamory (bandwidth) than the random , master random, treebased interlever. And the complexityof this design is same as the master random interleaver.

5. Conclusions

In this paper we have proposed the design algorithm of power rotational interleaver. This method is exceptionally good in terms of bandwidth requirement while there is multiple number of users in limited bandwidth because in this approach the bandwidth required is approximately negligible as compared with the other conventional interleaver designs . hence its memory requirement lesser than the conventional design of interleavers.The simulation results show that the BER performance of the proposed power rotational interleavers is very similar to that of the random interleavers. Thus, a real IDMA system can be built with this proposed parallel interleaver design method.

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