Suresh Gyan Vihar University Journal of Engineering & Technology
(An International Bi-Annual Journal)
Vol. 1, Issue 1, 2015, pp 42-46
ISSN: 2395-0196

BER AND FER PERFORMANCE WITH LARGE BLOCK SIZE OF TURBO CODING IN DIFFERENT INTERLEAVER PARAMETER

AHMAD HASAN KHAN[1*], K C ROY[2]
[1]*Research Scholar, Suresh Gyan Vihar University, Jaipur.*
[2]*Professor, Electronics and Communication Engineering, Pacific University, Udaipur.*
**Crossponding Author, Email : khan_ah31@yahoo.in*

Abstract : In this paper we have considered the interleaver design problem for large block sizes in coding scheme, where the effect of trellis termination is considered. It is done by comparing the performance of different interleavers with a large block size used in turbo code. Finally, the performance of an optimized interleaver design based on simulated annealing scheme is considered in turbo code. We restrict ourselves for unpunctured code rate 1/3 in symmetric Turbo codes with encoder memory v=2 and generator (1; 5/7). In order to avoid the effects of trellis termination in coding, we have chosen a relatively large block size with $\tau = 1024$ bit.

Keyword : *Bit Error Rate, Frame Error Rate, Interleaver.*

INTRODUCTION

Turbo codes were introduced in 1993. Turbo codes play a major role in the error channel coding scheme in wireless communication. It becomes a popular area of communications research due to their performances, turbo codes are being accepted as standard by different organization in mobile communication. It is need to provide a good quality of service in communication system. In this paper we have consider the interleaver design problem for large block sizes in coding scheme, where the effect of trellis termination is considered. It is done by comparing the performance of different interleavers with a similar block size used in turbo code. As a performance basis, we have implemented a uniform interleaver by using a different type of random interleaver for every block simulation[1]. To confirm the validity of the statement in this type of interleaver that trellis termination do not have a significant effect at the chosen block size. We simulate the uniform interleaver with and without termination in turbo code scheme. To terminate the uniform interleaver we use the scheme that is proposed by the JPL team[2]. The Bit Error Rate (BER) and Frame Error Rate (FER) performance results for these two Turbo codes are shown respectively in Figures 1 and 2; all simulations were performed by using 10 iterations in coding system, with a target tolerance of ±10% at a confidence level of 95%. These tolerance limits are shown in the graphs. As expected, trellis termination does not significantly affect the performance of Turbo codes with encoder memory v = 2 at this block size of turbo code.

UNIFORM INTERLEAVER

As a performance basis, we have implemented a uniform interleaver by using a different type of random interleaver for every block simulation[1]. To confirm the validity of the statement in this type of interleaver that trellis termination do not have a significant effect at the chosen block size. We simulate the uniform interleaver with and without termination in turbo code scheme. To terminate the uniform interleaver we use the scheme that is proposed by the JPL team[2]. The Bit Error Rate (BER) and Frame Error Rate (FER) performance results for these two Turbo codes are shown respectively in Figures 1 and 2;

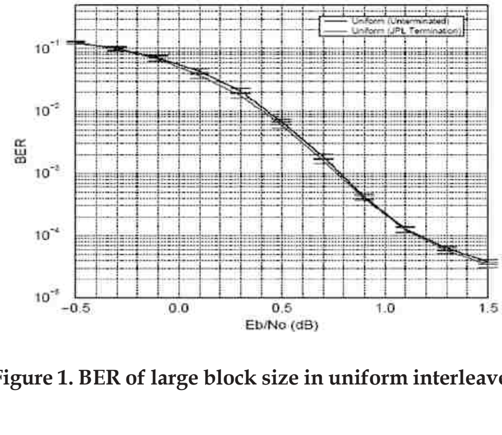

Figure 1. BER of large block size in uniform interleaver

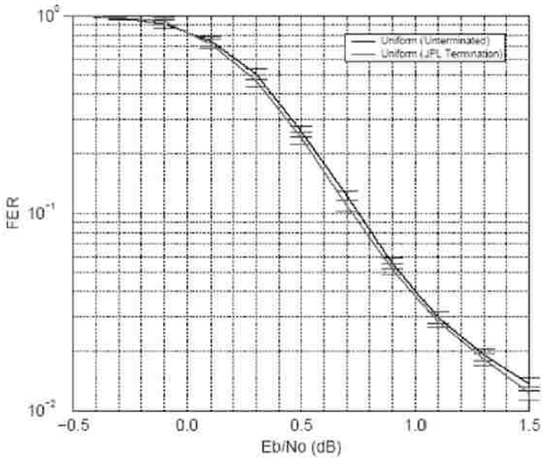

Figure 2. FER of large block size in Uniform interleaver

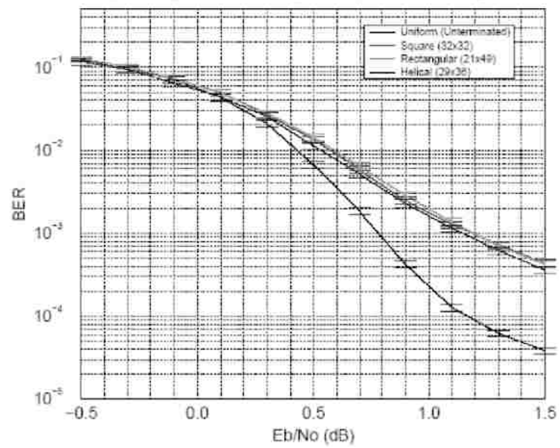

Figure 3. BER of large block size in Regular interleavers

all simulations were performed by using 10 iterations in coding system, with a target tolerance of ±10% at a confidence level of 95%. As expected, trellis termination does not significantly affect the performance of Turbo codes with encoder memory v = 2 at this block size of turbo code.

REGULAR INTERLEAVERS TYPE

It is clear that interleavers with a high regularity give poor performance in Turbo coding system. It is clear in Figures 3 and 4 where we simulate the Turbo codes with Square, Rectangular, and Helical interleavers. For comparison point of view, the performance of a uniform interleaver is also shown in the graphs. Note that the Rectangular and Helical interleavers satisfy all the restrictions detailed by Ramsey, Barbulescu & Pietrobon, respectively.

In Rectangular Type**:** The interleaver with R = 21 rows and C = 49 columns, R + 1 and C are relatively prime and R + 1 < C.The interleaver spread is greater than 5v.Additionally, R and C are both odd, so that the interleaver is odd-even.

In Helical Type : The interleaver with R = 29 rows and C = 36 columns and R and C are relatively prime. We know that C is a multiple of v + 1 and the RSC code's feedback polynomial is full. It makes the interleaver simile. This allows the same tail bit to be used with both the interleaved and non-interleaved sequences in coding. In our implementation, we use the Tail Not Interleaved scheme proposed by Barbulescu, which is shown to give better results in coding scheme.

If C is even, so that the interleaver is odd-even. This allows the same interleaver to be fairly compared with other interleavers in a study of punctured Turbo codes. It is clear that the BER performance of turbo code improvement of the Helical interleaver over the Square and Rectangular interleavers is minimal, and it can probably be attributed mostly to the termination. Its FER performance is significantly better, though still far from the uniform interleaver in turbo code.

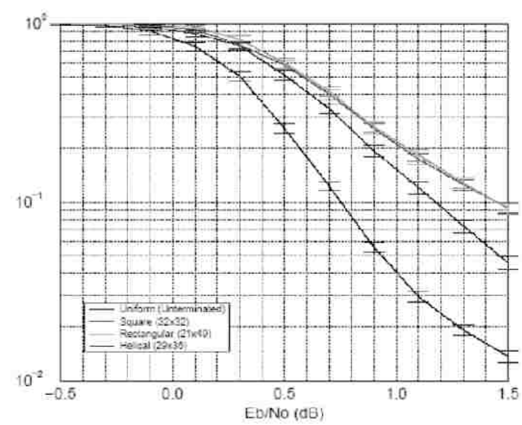

Figure 4. FER of large block size in Regular interleavers

RANDOMIZED INTERLEAVERS TYPE

The interleaver basically used by Berrou & Glavieux, 1996.it is essentially a Square interleaver with pseudo random perturbations. Its performance is significantly better than a regular Square interleaver with the same dimensions. A comparison between the Berrou-Glavieux interleaver and the Square interleaver is shown in Figures 5 and 6. For comparison, the performance of a uniform interleaver is also shown in the graphs.

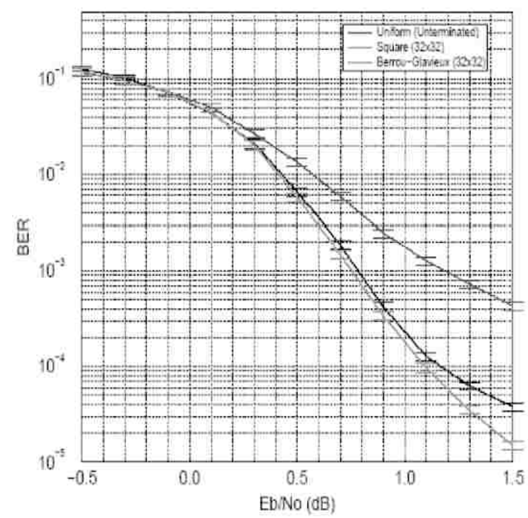

Figure 5. BER of large block size in Randomized interleavers

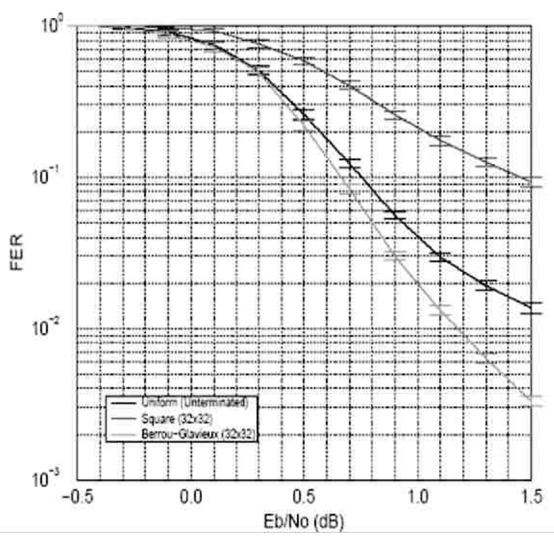

Figure 6. FER of large block size in Randomized interleavers

BARREL-SHIFTING INTERLEAVER

Before creating the optimized interleaver, we identify two parameters that do not improve performance in turbo code. The first parameter is increasing the distance between a bit's position in the input and its position in the interleaved stream of coding

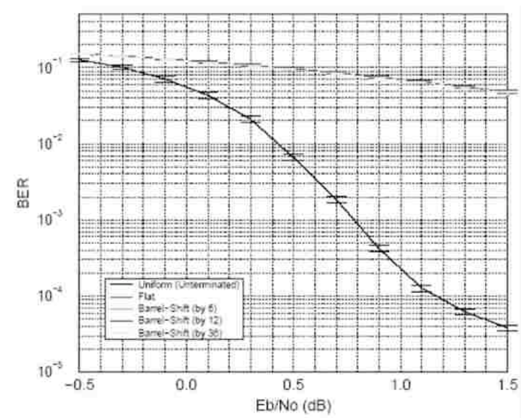

Figure 7. BER of large block size in Barrel-shift interleaver

The barrel-shifting interleaver[3] specifies this distance (ξ) while keeping everything else the same as in the input stream. We compare the Bit Error Rate performance of this interleaver for various values of ξ with help of flat interleaver and a uniform interleaver. It is note that how the performance of turbo code is very poor for such an interleaver type and increasing ξ has negligible effect in coding system. It is also note that how the performance of this interleaver is practically identical to that of a flat interleaver. It is also be considered as a special case barrel shift interleaver with ξ = 0. The FER performance of interleaver is not shown because the flat and barrel-shifting interleavers have a FER of 100% within the SNR range considered in coding scheme.

ONE-TIME PAD INTERLEAVER

The second interleaver is considered as the one time pad interleaver (OTP) interleaver[4], where the input stream is not permuted in time domain, but rather has a random sequence added to it.

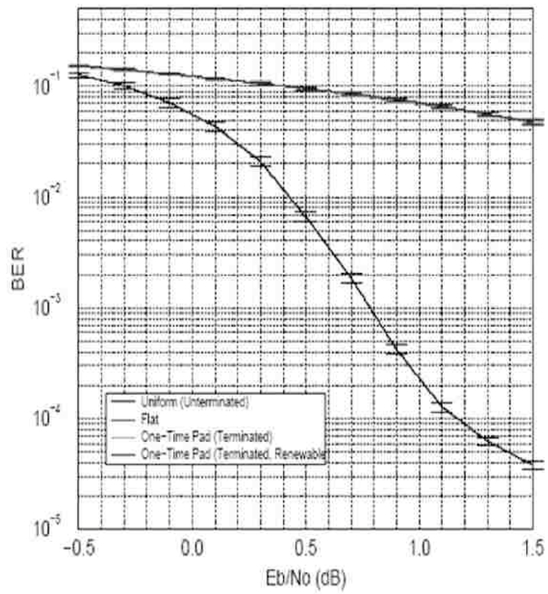

Figure 8. BER of large block size in One-time pad interleaver

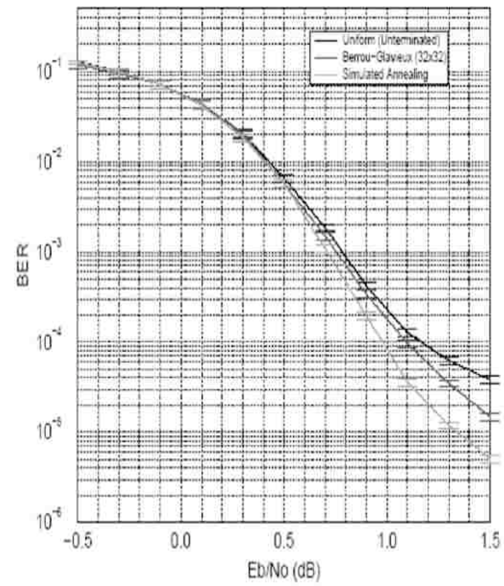

Figure 9. BER of large block size in Optimized interleavers type

The performance of a random One Time Pad interleaver is compared to a flat type and a uniform type interleaver. The average performance of all OTP interleavers, computed by using a renewable One Time Pad interleaver is also included in the graph. As for the barrel-shift interleaver, the performance of the One Time Pad interleaver is very poor. It is being practically identical to the flat interleaver type. This means that it is not the lack of correlation between input and interleaved sequences in coding that gives a Turbo code its good performance in coding scheme.

OPTIMIZED INTERLEAVER

The performance of Simulated Annealing interleaver of Turbo code is shown in Figures 9 and 10. For comparison purpose, codes of the uniform interleaver and the Berrou - Glavieux interleaver are also shown in figure. It is seen from the graphs, optimized interleaver improves performance of the Turbo code in the form of both BER and FER. We can achieve a BER of 10^{-5} at $E_b/N_0 = 1.35$ dB in this type of interleaver.

Other energy functions from the origin of IODS points based on the radial distance have also been tried, with very similar results. It is seen that the combinatorial restrictions imposed on the interleaver structure in coding scheme do not allow significantly better interleavers design to be constructed. If there is anything further to be gained in interleaver design for Turbo codes. The other factors need to be considered such as puncturing of coding, higher-order distance statistics in coding scheme.

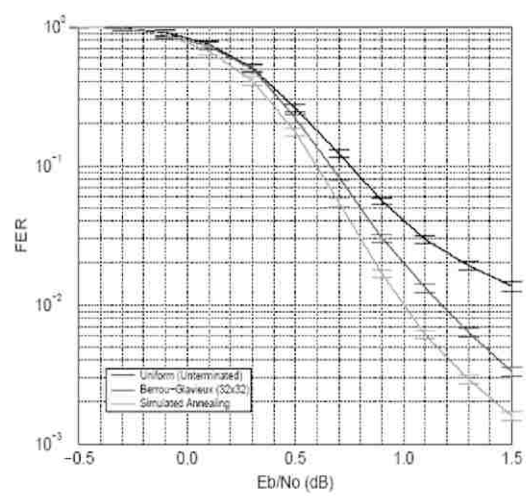

Figure 10. FER of large block size in Optimized interleavers

CONCLUSION

It is seen from the graphs, optimized interleaver improves performance of the Turbo code in the form of both BER and FER. We can achieve a BER of 10^{-5} at $E_b/N_0 = 1.35$ dB in this type of interleaver. It is clear that the BER performance of turbo code improvement of the Helical interleaver over the Square and Rectangular interleavers is minimal, and it can probably be attributed mostly to the termination. Its FER performance is significantly better, though still far from the uniform interleaver in turbo code.

REFERENCES

[1] Berrou, Claude, Glavieux, Alain, & Thitima-jshima, Punja. 1993 (may). Near shannon limit error-correcting coding and decoding: turbo-codes. pp. 1064–1070 : proceedings of the IEEE international conference on commun-ications.

[2] Blackert, W. J., Hall, Eric K., & Wilson, Stephen G. Turbo code termination and interleaver conditions. Electronics letters, 2082–2083, 1995.

[3] Berrou, Claude, & Glavieux, Alain. 1996. "Near optimum error correcting coding and decoding: turbo-codes". IEEE transactions on commun-ications, 44 (10), pp. 1261–1271, 1996.

[4] Andrews, Kenneth S., Heegard, Chris, & Kozen, Dexter. "A theory of interleavers". Technical report tr 97-1634. Department of computer science, Cornell University, 1997.

[5] Andrews, Kenneth S., Heegard, Chris, & Kozen, Dexter. Interleaver design methods for turbo codes. pp. 420 proceedings of the IEEE international symposium on information theory, 1998.