

Performance Enhancement of Serially Concatenated Codes by BPSK and QPSK techniques

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Abstract- In this paper, the performance improvement of serially concatenated convolutional system with different arrangements of Recursive Systematic Convolutional codes (RSC), Reed-Solomon (RS) encoders has been discussed. Using these techniques the bit error rate changes with different arrangements of encoders and code rates. Also use of different generator polynomials has been investigated on bit error rate.

Keywords – Latency, Bit Error Rate, RSC-RS

I. INTRODUCTION

There are many advantages of Digital communication over analog communication. The main function of digital communication system is to transfer digital data from the transmitter to receiver efficiently and reliably. Efficient design of a digital communication system that enables reliable services is challenging. “Efficient design”[1] refers to the efficient use of primary communication resources, which are power and bandwidth. The reliability of digital systems is usually measured by the required signal-to-noise ratio (E_b/N_0) to achieve a specific error rate. Bandwidth efficient communication system with perfect reliability[2], using as low a SNR as possible is desired. In order to enable a comparison between the reliability of different communication systems, SNR is usually expressed as E_b/N_0 , E_b is the average energy per information bit and N_0 is the one-sided noise power spectral density (PSD)[5]. The basic requirement of channel coding is to reduce the bit error rate and recover the signal equivalent to the original signal[7]. To obtain the efficient signal we add some bits to the signal and these bits are called redundancy bits, according to the pattern of these bits we can detect and correct the given signal.

The first type is block codes using algebraic decoding, like BCH codes, Hamming codes, and Reed-Solomon (RS) codes which are used in variety of applications.

Second type is convolutional codes which are generated sequentially[1] via passing the information sequence through a linear shift register. Today, convolutional codes are widely used for example in Global System for Mobile communications (GSM), Universal Mobile Telecommunications System (UMTS), satellite communications, dial-up modems and many other applications. The main reason for this popularity is the existence of efficient decoding algorithms like Maximum Posteriori Algorithm (MAP) & Viterbi. The third type is concatenated codes which consist of block and/or convolutional codes and which uses soft iterative decoding. Particularly, invention of turbo codes, serially concatenated convolutional codes (SCCC) and parallel concatenated convolutional codes (PCCC) have revolutionized the area of channel coding i.e. The performance, is very close to Shannon's limit in terms of bit error rate (BER)[3]. In block coding, message is divided into blocks, each of k bits, called data words. Add r redundant bits to each block to make the length $n = k + r$. The resulting n -bit blocks are called codewords[4]. It is important to know that there is a set of datawords, each of size k , and a set of codewords, each of size n . With k bits, there can be created a combination of 2^k datawords with n bits, there can be created a combination of 2^n codewords. Since $n > k$, the number of possible codewords is larger than the number of possible datawords. The block coding process is one to one; the same datawords is always encoded as the same codeword hamming code It is the simplest single error correcting coding scheme. Thus is known as hamming single bit code. This method detects the error as well as its position too. These codes have a minimum distance of 3.

In 2013 S. Vikrama presented a paper, "Design of Convolutional Codes for varying Constraint Lengths". In this paper, the design of Convolutional codes are basically encoders which are very important for extremely low error probabilities used at high data rates of wireless communication applications.

In 2013 K. Byun shown that RS-CC system performs better than RSC system for BPSK modulation in terms of BER.

II. PROPOSED ALGORITHM

3.1 RSC-RS Serially Concatenated Convolution Codes.

In this section simulation setup of RSC and RS is described here we take RSC as outer encoder and RS as inner encoder. The resulting coded sequence is modulated using BPSK/QPSK and transmitted through a channel with AWGN noise. On the receiver end, the received bits are demodulated and then decoded by the SCCC decoder. For the decoding of RSC code the viterbi decoding technique and Berlekamp-Massey decoding has been used.

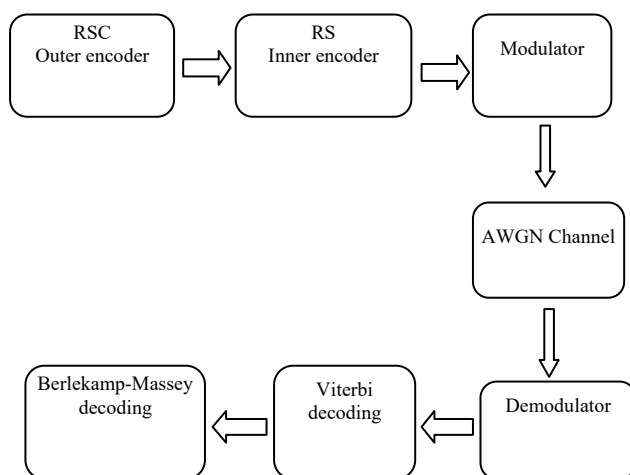


Figure 1. System Model

III. RESULTS

The RSC-RS concatenated system setup has been simulated using MATLAB software as described in section ii and it is found that for different values of code rates the bit error rate has been changed for different signal to noise ratio. It is also observed that by using different modulation techniques latency of the RSC-RS system also changes apart from the different code rate different different combinations of the encoder also play vital role in error reduction.

A. Change In Latency Of RSC-RS System With Different Modulation Techniques

Latency of the RSC-RS system in Figure 2 shows different results for different modulation techniques. We have used two modulation techniques BPSK and QPSK and it is noted that the transmission time for QPSK is more as comparison to the time taken by using BPSK technique. The RSC-RS system using BPSK system gives latency 4.2374 seconds while RSC-RS system using QPSK system gives latency 10.7139 seconds. so BPSK modulation techniques gives less latency for RSC-RS system as compared to QPSK

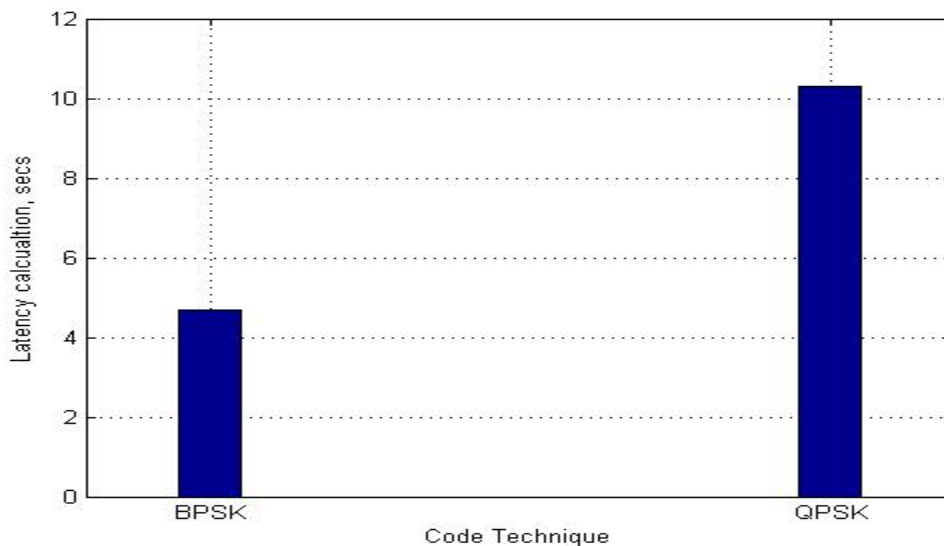


Figure 2. Latency analysis

B. RSC System: BER Using BPSK and QPSK Techniques.

In this section the bit error rate of recursive systematic code is examined using QPSK and BPSK modulation techniques code rate is kept same in both the cases and bit error rate is recorded at different signal to noise ratio after investigation it is noted that the Bit error rate in case of QPSK modulation is higher than BPSK modulation

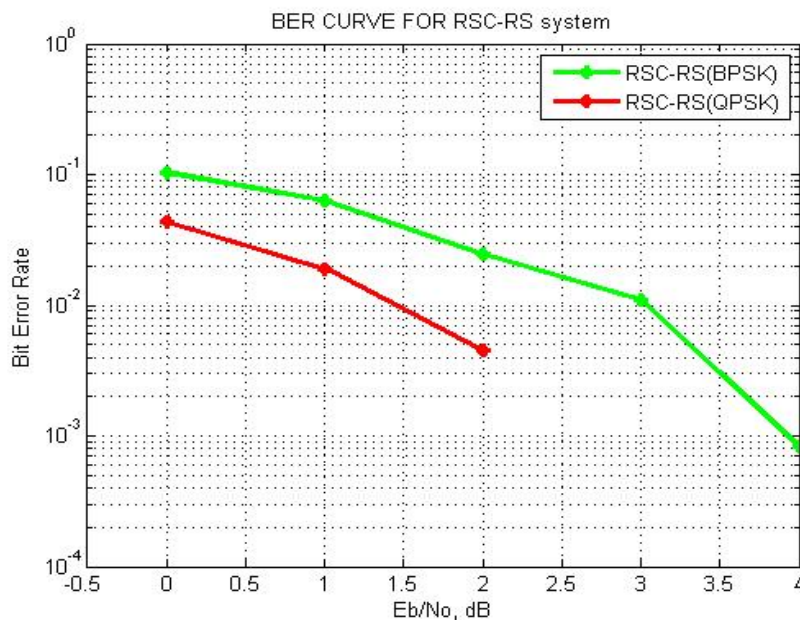


Figure 3. BER for RSC using BPSK & QPSK

C. RSC-RS System: BER Using BPSK And QPSK Techniques.

In this part the system comprises serially concatenated code system of RSC-RS codes is used. Bit error rates of RSC-RS system is calculated at different values of signal to noise ratio for the two modulation techniques BPSK and QPSK keeping code rate constant. The results shows that the RSC-RS system using QPSK System have lower value of Bit error rate So QPSK modulation gives better results in terms of BER of RSC-RS system than BPSK. Code rate can be increased or decreased by using puncturing without increasing the complexity of the hardware.

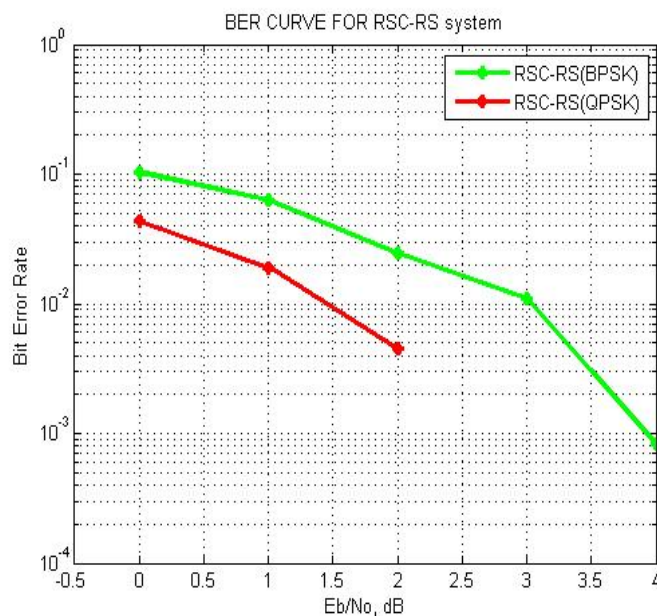


Figure 3. BER for RSC-RS using BPSK & QPSK

D. RSC-RS System: BER Using Code Rate RS (255,242)

The Bit error rates of RSC-RS system is calculated at different SNR, using QPSK modulation techniques and different code rates. RSC System with base rate $\frac{1}{2}$ and other punctured values $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$ are used while RS System code rate used is (255,242). The RS (255,242) and RS (1/2) has lowest BER, In other punctuated rates BER increases as puncture rate increases. i.e. for low punctured rate overall code rate will be less and BER is less. But as puncturing rate decreases the BW requirement increases at the cost of improved BER this is due to the increase of redundancy.

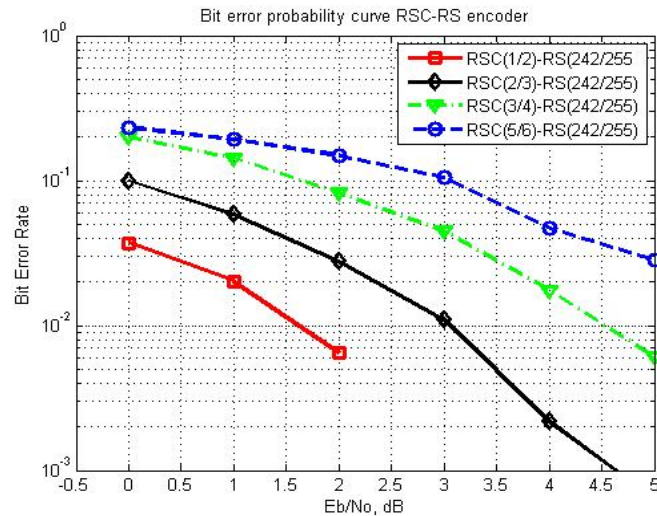


Figure 4. BER for RSC-RS using BPSK & QPSK (RS (255,242))

E. RSC-RS System: BER With Code Rate RS (255,233)

In this part the code rate of RS (255,233) is changed and RSC with base cod rate $\frac{1}{2}$ is used while $\frac{2}{3}$, $\frac{3}{4}$ & $\frac{5}{6}$ are other puncturing code rates. As shown in figure the BER in case of RSC (1/2) –RS (255,233) is lowest than other punctured code rates. Although if we make parallel comparison of RSC (1/2) - RS (255,233)& RSC(1/2)-RS (255,245) first system got better BER than the latter. BER goes on increasing as we increase code rate.

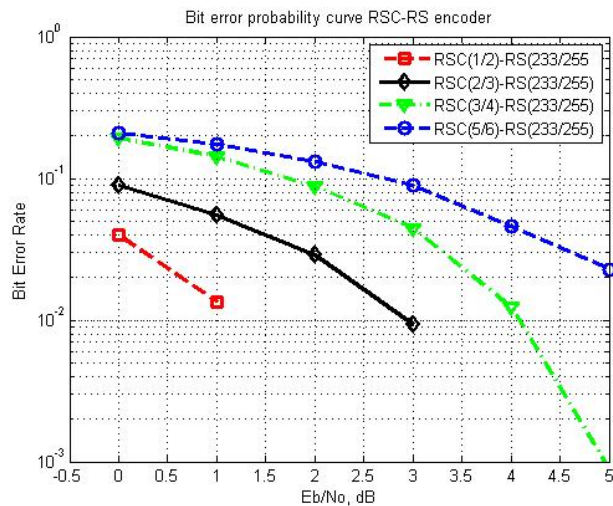


Figure 5. BER for RSC-RS using BPSK & QPSK (RS (255,233))

F. RSC-RS System: BER Using Code Rate RS (245,195)

Now in this case the code rate of RS System is again changed, RS(255,195) RSC with ways rate $\frac{1}{2}$ is employed and $\frac{2}{3}$, $\frac{3}{4}$ & $\frac{5}{6}$ are other punctured rates for RSC. Here RSC (1/2) code rate has least value of BER and as we go on increasing punctured code rates BER goes on increasing but BW Consumption is lowered at high puncturing rates. In this part the interesting fact is that the BER of RS (255,195) system with different RSC punctured rate is lowered in the previous two results, i.e. RSC(1/2)-RS(255,195) has lowered BER than RSC(1/2)-RS(255,245), but here BW consumption of the channel is increases.

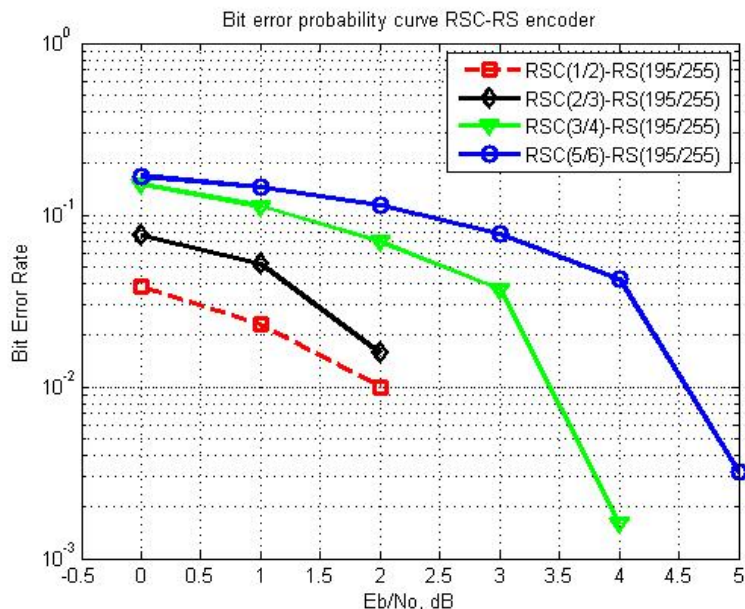


Figure 6. BER for RSC-RS using BPSK & QPSK (RS (255,195))

IV. CONCLUSION

In this research the main focus was in serially concatenated conventional codes. It is noted that at different code rates the BER changes and BER goes on decreasing with the decrease in code rate and BER of RSC-RS system is low in QPSK modulation technique as compare to BPSK technique. But with reduction of code rate BW requirement increases but QPSK system needs less BW. But in case of latency QPSK system needs more transmission time than BPSK modulation technique.

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