CIE 425 Project 1 Part 2 Report

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Introduction

Noise is inevitable in communication systems. It acts against the main purpose of communication systems which is the reliable transmission of information. The problem has been extensively studied in Information Theory. In particular, Channel Coding is the information theoretic way of counteracting noise by introducing systematic redundancy to the transmitted information such that the transmitted message can be recovered with a high probability from the received bits. The idea of channel coding came to life with the development of one of the most influential results in Information Theory which is Shannon's Channel Capacity Theorem. It states that reliable (error-free) communication in a channel can be achieved if the rate of transmission of information is lower than the channel capacity. Convolutional Codes were introduced by Peter Elias in 1955. The main issue of using them was that the decoding process is complicated and inefficient. It was not until Andrew Viterbi introduced Viterbi Algorithm for decoding convolutional codes which made the use of convolutional codes in practical applications feasible.

Theory

Convolutional coding is accomplished by sliding a Boolean window or more on the input stream which is equivalent to the discrete convolution process which gives rise to the name convolutional coding. Each Boolean window is called a generator polynomial.

Example:

Input stream: $s = [1\ 0]$

Generator Polynomial 1: $G_1 = [1\ 0\ 1]$

Generator Polynomial 2: $G_2 = [0\ 0\ 1]$

Encoding Process:

$$s * G_1 = [1\ 0\ 1\ 0]$$

$$s * G_2 = [0\ 0\ 1\ 0]$$

$$c = [1\ 0\ 0\ 0\ 1\ 1\ 0\ 0]$$

where c is the output codeword.

One of the major advantages of convolutional codes is that economic maximum likelihood decoding can be performed as the trellis diagram is time-invariant in contrast to other block codes.

Results and Discussion

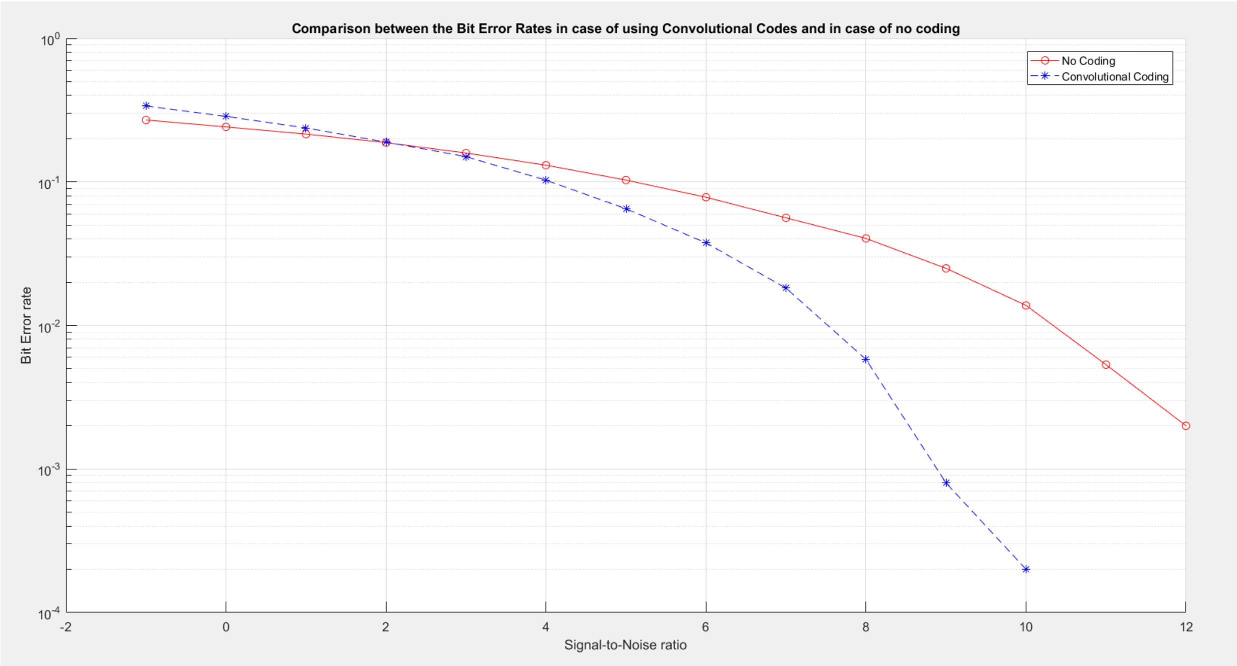

Fig (1) Bit error rate in case of using convolutional codes and in case of no coding

Generally, the performance in case of using convolutional codes is much better and it becomes the BER rate decreases significantly by increasing SNR. The error probability is much lower. However, the use of coding for low SNR values does not improve the performance which is expected as the channel is almost useless in such cases.

	Error
Error at 0dB with coding	0.92308
Error at 5dB with coding	0.89316
Error at 10dB with coding	0.00071225
Error at 0dB without coding	0.9188
Error at 5dB without coding	0.93661
Error at 10dB without coding	0.74715

Fig (2) Errors in Recovering the text file for different SNR values in case of using convolutional codes and in case of no coding

The results in Fig (2) confirm our observations about Fig (1). Coding is of no help when the SNR is small (around 0 dB). The performance improves with the increasing SNR and becomes significantly better than the case of no coding at high SNR values.

Conclusion

The redundancy introduced by Convolutional codes increases the probability of recovering the transmitted message correctly. As the SNR increases, the performance of convolution codes improves and the error rate can be come negligible at high SNR values ($SNR > 5\ dB$). However, at low SNR values, the error rate does not improve by coding.