SIMULATION OF CONVOLUTIONAL ENCODER

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Abstract

Convolutional encoding is a Forward Error Correction (FEC) technique used in continuous one-way and real time communication links. Wireless devices such as hand phones and broadband modems rely heavily on forward error correction techniques for their proper functioning, thus sending and receiving information with minimal or no error, while utilizing the available bandwidth. Major requirements for modern digital wireless communication systems include high throughput, low power consumption and physical size. This paper presents the simulation of convolutional encoder using MATLAB. The performance and analysis has done by changing rates of convolutional encoder and error of binary symmetric channel.

Keywords: *Constraint Length, Convolutional Encoder, Data rates, Generator polynomials, Poly2trellis structure.*

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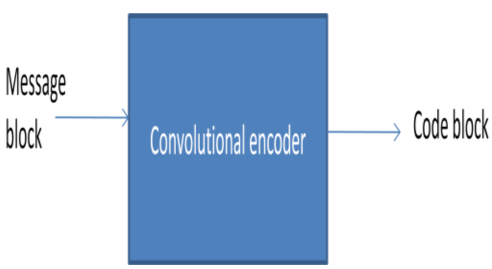
1. INTRODUCTION

Convolutional encoding is a method of adding redundancy to a data stream in a controlled manner to give the destination the ability to correct bit errors without asking the source to retransmit. Convolutional codes, and other codes which can correct bit errors at the receiver, are called forward error correcting (FEC). The ever increasing use of wireless digital communication has led to a lot of effort invested in FEC (Forward Error Correction).Convolutional codes are introduced in 1955 by Elias. Convolutional codes are one of the powerful and widely used class of codes, These codes are having many applications, that are used in deep-space communications, voice band modems, wireless standards(such as 802.11) and in satellite communications. Convolutional codes are plays a role in low-latency applications such as speech transmission.

1.1 Convolutional Encoder

The convolutional encoder maps a continuous information bit stream into a continuous bit stream of encoder output. The convolutional encoder is a finite state machine, which is a machine having memory of past inputs and also having a finite number of different states.



Convolutional codes are commonly specified by three parameters; (n, k, m).

n = number of output bits
k = number of input bits
m = number of memory registers

Where, n>k

The quantity k/n is called as code rate. it is a measure of the efficiency of the code . Commonly k and n parameters range from 1 to 8, m from 2 to 10 and the code rate from 1/8 to 7/8 except for deep space applications where code rates as low as 1/100 or even longer have been employed. here The quantity L is called the constraint length of the code and is defined by

$$\text{Constraint Length, } L = k\,(m-1)$$

The constraint length L represents the number of bits in the encoder memory that affect the generation of the n output bits. The constraint length L is also referred to by the capital letter K, which can be confusing with the lower case k, which represents the number of input bits. In some books K is defined as equal to product the of k and m. Often in commercial specifications, the codes are specified by (r, K), where r = the code rate k/n and K is the constraint length.

1.2 Generator Polynomials

Generator Polynomial is defined by-

$$g^{(i)}(D)=g_0^{(i)}+g_1^{(i)}(D)+ g_2^{(i)}(D^2)+\ldots\ldots+g_M^{(i)}(D^M)$$

Where, D = unit delay variable
M = number of stages of shift registers.

Example:-

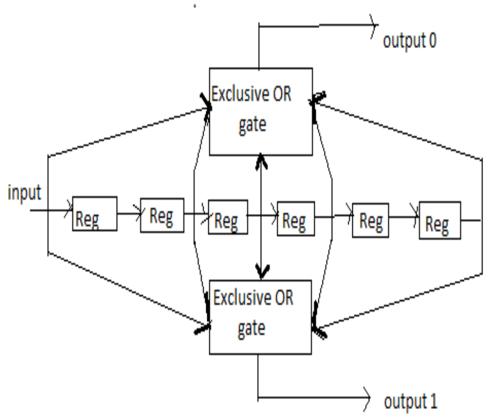


Fig-1: Convolutional Encoder

From above the generator polynomials codes are-

G1=133(OCT) and G2=171(OCT)

G1=x0+x2+x3+x5+x6
=1011011=133(OCT)

G2=x0+x1+x2+x3+x6
=1111001=171(OCT)

1.3. Poly2trellis

Syntax:

trellis=poly2trellis(ConstraintLength, CodeGenerator)

The poly2trellis function accepts a polynomial description of a convolutional encoder and returns the corresponding trellis structure description. The output of poly2trellis is suitable as an input to the convenc and vitdec functions, and as a mask parameter for the Convolutional Encoder, Viterbi Decoder in the Communications Blockset.

Trellis=poly2trellis (ConstraintLength, CodeGenerator)

Performs the conversion for a rate k/n feedforward encoder. Constraint Length is a 1-by-k vector that specifies the delay for the encoder's k input bit streams. Code Generator is a k-by-n matrix of octal numbers that specifies the n output connections for each of the encoder's k input bit streams.

2. PERFORMANCE ANALYSIS OF CONVOLUTIONAL ENCODER

2.1 Rate 1/2 Convolutional Encoder

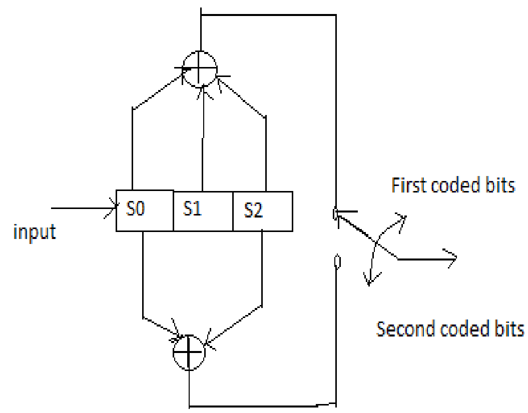


Fig-2(a): trellis= poly2trellis (3, [7 5])

From the above diagram it shows 3 shift-registers where the first one takes the incoming data bit and the rest, form the memory of the encoder. When we perform Exclusive ORing we get the generator polynomials as-

G1=111=7 and G2=101=5, it shows

trellis =poly2trellis(3,[7 5])

If suppose input code is 11, we have-

First Step: Initially if S0=0 S1=0 and S2=0 then the coded bits are-

First coded bit= 0 XOR 0 XOR 0 = 0
Second coded bit = 0 XOR 0 = 0

Thus, if input=0 then output=00 ,it shows output for rate ½ convolutional encoder.

Second Step: If input =1 , shift registers perform shifting and we get S0=1 S1=0 and S2=0

First coded bit= 1 XOR 0 XOR 0 = 1
Second coded bit = 1 XOR 0 = 1

Thus, if input=1 then output=11

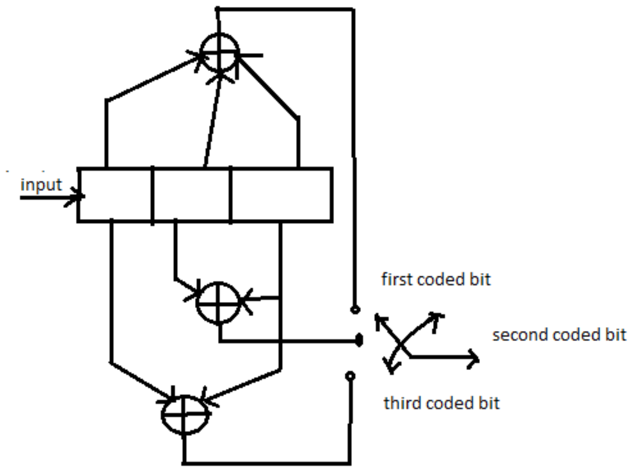
Third Step: Similarly if input=1, then S0=1 S1=1 and S2=0

First coded bit= 1 XOR 1 XOR 0 = 0
Second coded bit = 1 XOR 0 = 1

Thus, if input= 1 then output=01

Same performance has done by using different poly2trellis, constraint length and data rates of convolutional encoder.

2.2 Rate 1/3 Convolutional Encoder



g1 = 111, g2 = 011, g3=101

Fig-2(b): trellis = poly2trellis (3, [7 3 5])

2.3. Rate 2/3 Convolutional Encoder

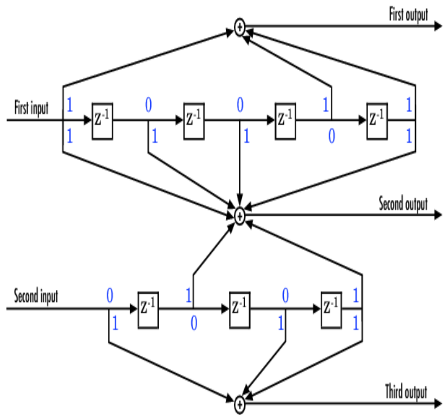


Fig-2(c): trellis=poly2trellis ([5 4], 23 35 0; 0 5 13)

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3. SIMULATION

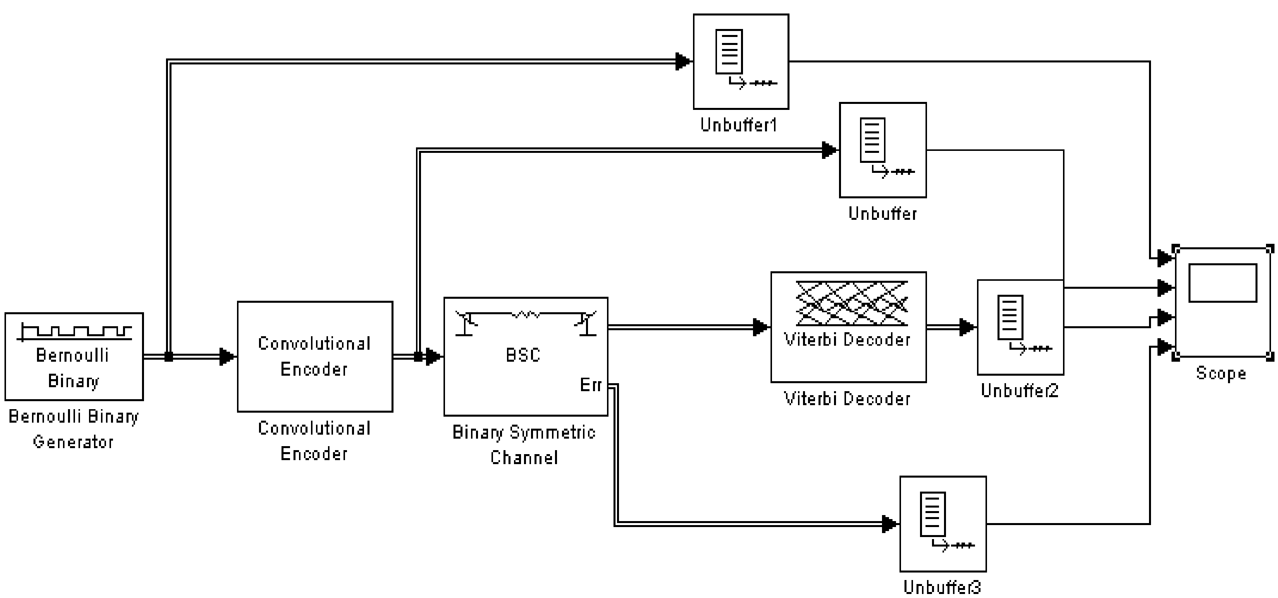

Fig-3: Simulink Model

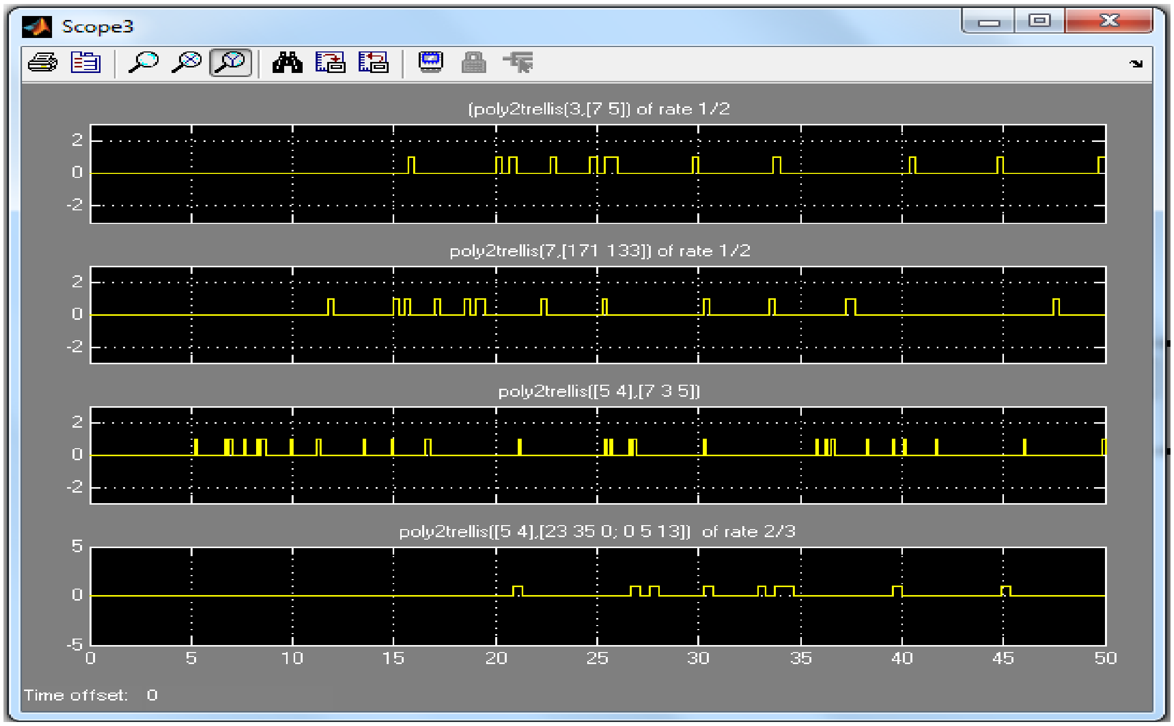

Fig-3(a): Simulation results by changing encoder with same BSC error

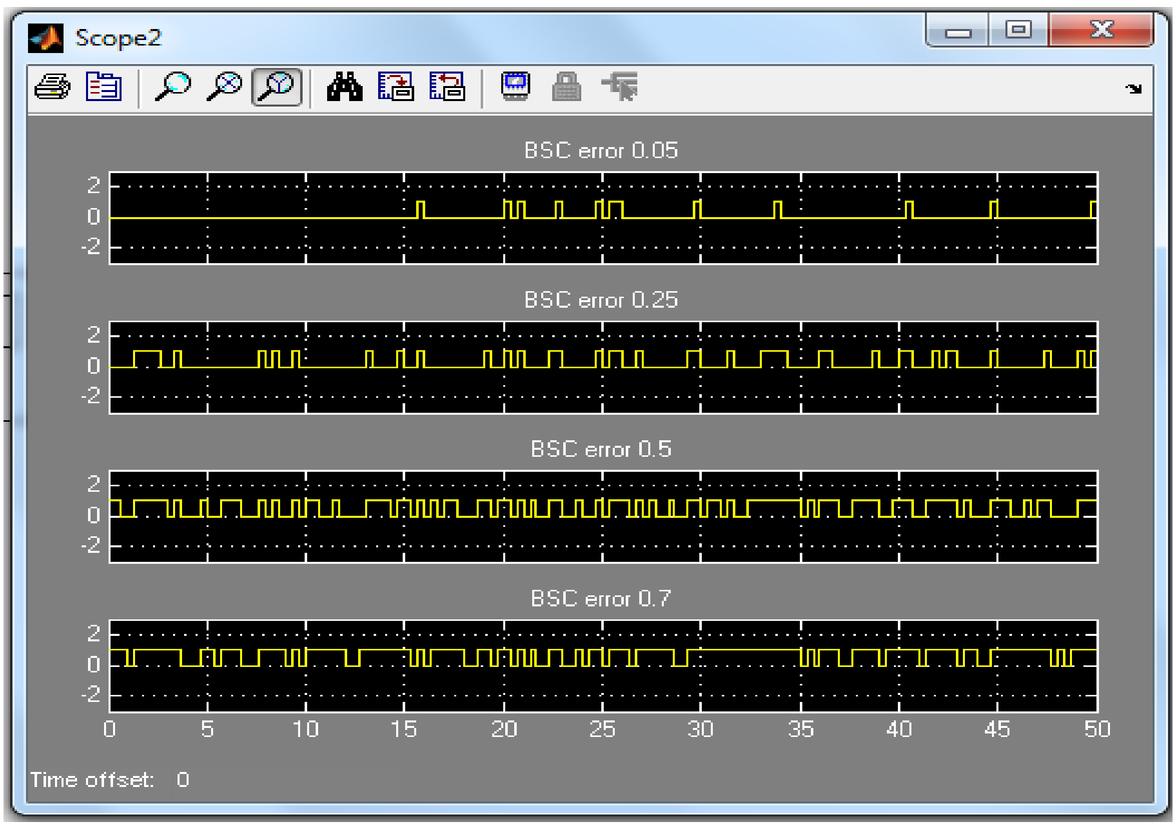

Fig-3(b): Simulation results by changing error of BSC with same encoder

4. CONCLUSIONS

Simulation has done by using MATLAB .When signal to noise ratio changes the change in the output of convolutional encoder occurs. From the above results,[3(a)] by keeping signal to noise ratio constant and by changing data rates of convolutional encoder it can be seen that rate 2/3 gives better result than 1/2 and 1/3 and [3(b)] by keeping date rate 1/2 and changing signal to noise ratio it shows that with the minimum S/N ratio it gives better result.

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BIOGRAPHIES

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