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Analization of different Channels for Designing of Wireless Networks

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ABSTRACT
In today era Global System for Mobile Communication (GSM) is so much important for every cell phone users because mostly every network worked on the GSM system. The GSM platform is an extremely successful wireless technology and an unprecedented story of global achievement. The GSM platform is growing and evolving and offers an expanded and feature- rich voice and data enabling services. Wireless communication is the transfer of information over a distance without the use of enhanced electrical conductors or wires. The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometers for radio communications). When the context is clear, the term is often shortened to "wireless". It encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, Personal Digital Assistants (PDAs), and wireless networking.

In this research simulated the performance analysis in the MATLAB software for reducing Signal- to- Noise Ratio (SNR) for better performance. MATLAB software from Mathworks was used for the simulation. Rather than for simulation the program choose the random value of signal- to-noise ratio (SNR) in dB (Decible). In the GSM system transmitted the digital signal from source to user through the channel. The final output is represents the graphical form using BCH coding. In the GSM system for encoding the digital signal using a convolutional coding and for modulation using a QAM modulation.

General Terms
GSM Architecture and Logical Channels, Convolutional coding, BCH Coding, Viterbi Coding, QAM Modulation

Keywords
BCH Coding, Convolutional, Coding, Viterbi Algorithm, GSM System, SNR ratio

1. INTRODUCTION
In the year 1982, Conference of European Posts and Telegraph (CEPT) establish a GSM group to widen the standards for a pan-European cellular mobile system. After a few years in 1985, a list of recommendations to be generated by the group is accepted. Conference of European Posts and Telegraph (CEPT) to check executed field tests to the different radio techniques recommended for the air interference in 1986.

In 1987, the GSM group chosen Time Division Multiple access (TDMA) with Frequency Division Multiple Access (FDMA) for access method. The initial Memorandum of Understanding (MoU) is signed by telecommunication operators representing 12 countries. In starting duration each country generated its own system, so they create problems like roaming problem in other country and so on. After that to standardize cellular communication developed by CEPT (Conference of European Posts and Telecommunications). And these create the name Group Special mobile (GSM) system in late 1980s [7].

The Group Special Mobile (GSM) system included special features like international roaming and huge variety of different services. The European Telecommunications Standards Institute (ETSI) was given the responsibility of the GSM specifications in 1989. In 1992, first time the official GSM specifications launched in Europe. The several commercial GSM services start the coverage of main roads outside of Europe in 1993 [1]. Later than change the GSM group name from Group Special Mobile (GSM) system to Global System for Mobile Communication (GSM).

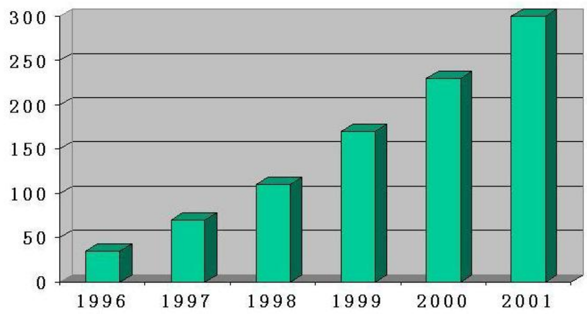

Figure 1.1 GSM Subscribers in the world in millions

2. GSM ARCHITECTURES AND LOGICAL CHANNELS
A GSM network is consists of fixed functional infrastructure and mobile subscribers. The GSM network broadly divided into three subsystems: Base Station Subsystem (BSS), Network Switching Subsystem (NSS), and Operation Support Subsystem (OSS). The Base Station Subsystem (BSS) controls all the base stations and base transceiver. The Network Switching Subsystem (NSS) is main part of the GSM architecture and this is controls all the MSC (Mobile Switching Centre). The Operation and Maintenance Support Subsystem (OSS) oversees the network operation and maintenance in proper way.

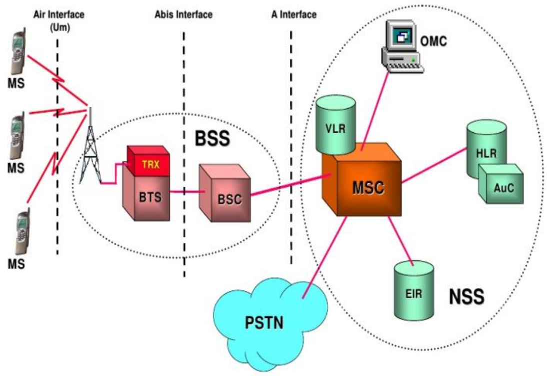

Figure 2.1 Architecture of GSM Network

GSM logical channel includes user data and signaling data. User data includes the some services like that voice, fax, and email messages and the signaling data useful for Synchronization purpose between transmitter and receiver. GSM logical channel is divided mainly two types: Traffic Channel and Control Channel. Traffic channel includes user data and control channel includes control or signaling data [9].

2.1 GSM Traffic Channels (TCHs)

GSM Traffic Channels (TCHs) transmit the digitized speech or user data. Traffic channels work on two types of speech and data: Full- Rate and Half- Rate. When traffic channel work on full- rate, then data is included within single time slot per frame and when traffic channel works on half- rate, then data is sent alternate frames on the same time slot [5].

Full- Rate TCH and Half- Rate TCH divided in some types. Full- Rate Speech Channel (TCH/FS) transmits the speech codes on 13 kbps data rate. Full- Rate Data Channel transmitted the data on 9.6 kbps, 4.8 kbps and 2.4 kbps data rates and it is denoted by TCH/F9.6, TCH/F4.8 and TCH/F2.4. Half-Rate Speech Channel (TCH/HS) transmits the digitized speech codes on 6.5 kbps data rate. Half- Rate Data Channel transmitted the data on 4.8 kbps and 2.4 kbps data rates and it is denoted by TCH/H4.8 and TCH/H2.4.

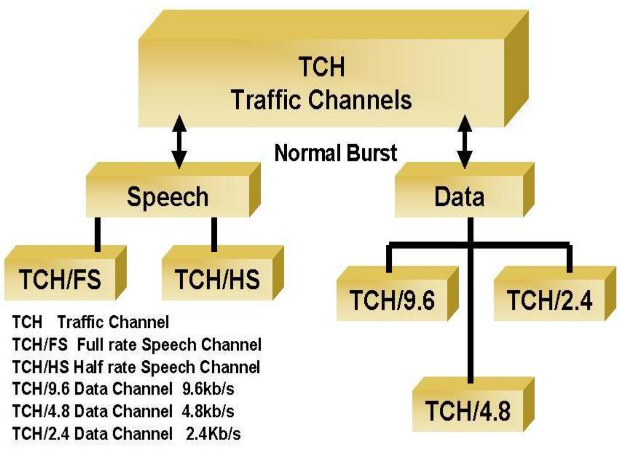

Figure 2.2 Types of GSM traffic Channels

2.2 GSM Control Channel (CCH)

GSM Control Channel transmitted the signaling data for synchronization between mobile station and base station. There are mainly three types: Broadcast Channel (BCH), Common Control Channel (CCCH) and Dedicated Control Channel (DCCH). All control channels includes many logical channels.

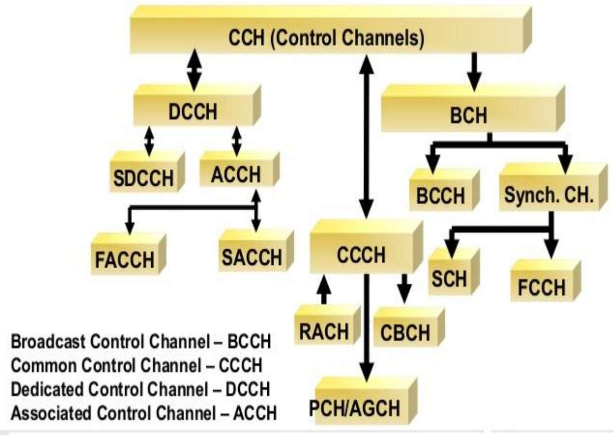

Figure 2.3 Types of GSM Control Channels

3. IMPLEMENTATION

3.1 Convolutional Coding

In Convolution codes, the encoding operation may be viewed as the discrete- time convolution of the input sequence with the impulse response of the encoder. The encoder encodes the message with a sliding window, with a length equal to its own memory. A convolutional code is a type of error-correcting code that generates parity symbols via the sliding application of a Boolean polynomial function to a data stream. The sliding application represents the 'convolution' of the encoder over the data, which gives rise to the term convolutional coding. The sliding nature of the convolutional codes facilitates trellis decoding using a time-invariant trellis. Time invariant trellis decoding allows convolutional codes to be maximum-likelihood soft-decision decoded with reasonable complexity.

Convolutional encoder that takes one bit in the input and returns two bits in the output. We can describe it by the impulse response (or the generator polynomial) of each of the two paths. The impulse response is defined as the response of a path to a symbol 1 applied to its input, with each flip-flop initially set to zero.

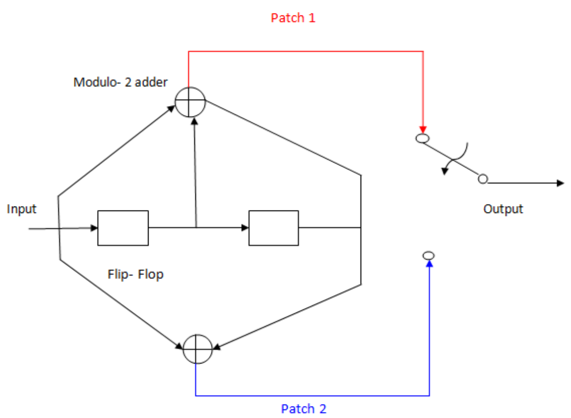

Figure 3.1 Example of Convolutional Coding

The convolutional error used for internal error correction. The convolutional encoder for each k input bits provide the n output bits. The ratio of k input bits and n output bits (k/n) explain the rate of convolutional encoder. The GSM convolutional encoder provides 2 bits for each input bits. The output bits of convolutional codes depend on the current input bits and also depend on the previous input bits. The number of previous input bits which govern the output is termed the constraint length.

3.2 BCH Coding

In coding theory, the BCH codes form a class of cyclic error-correcting codes that are constructed using finite fields. BCH codes were invented in 1959 by French mathematician Alexis Hocquenghem, and independently in 1960 by Raj Bose and D. K. Ray-Chaudhuri. The acronym BCH comprises the initials of these inventors' surnames.

One of the key features of BCH codes is that during code design, there is a precise control over the number of symbol errors correctable by the code. In particular, it is possible to design binary BCH codes that can correct multiple bit errors. Another advantage of BCH codes is the ease with which they can be decoded, namely, via an algebraic method known as syndrome decoding. This simplifies the design of the decoder for these codes, using small low-power electronic hardware. BCH codes are used in applications such as satellite communications, compact disc players, DVDs, disk drives, solid-state drives and two-dimensional bar codes [4].

Higher order co-efficient of the generator polynomial are at the left. For example, if we are interested in constructing a (15, 7) BCH code from the table we have (111 010 001) for the coefficients of the generator polynomial. Hence

$$g(X) = 1 + X^4 + X^6 + X^7 + X^8 \quad (1)$$

Table 1 Coefficients of Generator Polynomial in BCH code for Different Values of (k, n)

n	k	t	Generator Polynomial
7	4	1	1011
15	11	1	10011
15	7	2	111010001
15	5	3	10100110111
31	26	1	100101
31	21	2	11101101001
31	16	3	1000111110101111
31	11	5	101100010011011010101
31	6	7	11001011011110101000100111

3.3 Viterbi Algorithm

The Viterbi algorithm is a dynamic programming algorithm for finding the most likely sequence of hidden states this is called the Viterbi path – that results in a sequence of observed events, especially in the context of Markov information sources and hidden Markov models. The Viterbi algorithm is named after Andrew Viterbi, who proposed it in 1967 as a decoding algorithm for convolutional codes over noisy digital communication links. It has, however, a history of multiple inventions, with at least seven independent discoveries, including those by Viterbi, Needleman and Wunsch, and Wagner and Fischer [18].

Viterbi path and Viterbi algorithm have become standard terms for the application of dynamic programming algorithms to maximization problems involving probabilities. For example, in statistical parsing a dynamic programming algorithm can be used to discover the single most likely context-free derivation (parse) of a string, which is commonly called the Viterbi parse. The algorithm has found universal application in decoding the convolutional codes used in both CDMA and GSM digital cellular, dial-up modems, satellite, deep-space communications, and 802.11 wireless LANs. It is now also commonly used in speech recognition, speech synthesis, diarization, keyword spotting, computational linguistics, and bioinformatics. The Viterbi algorithm provides an efficient way of finding the most likely state sequence in the maximum a posteriori probability sense of a process assumed to be a finite-state discrete-time Markov process. Such processes can be subsumed under the general statistical framework of compound decision theory. For obtaining shortest path of the Viterbi algorithm, represents the Markov process in a simple way.

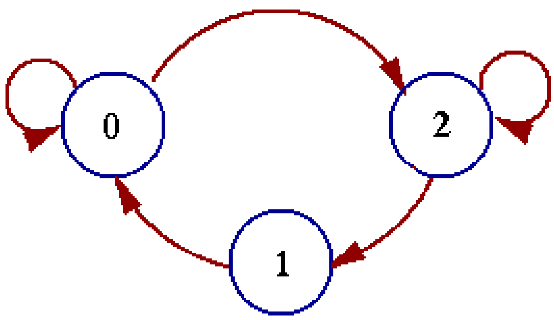

Figure 3.2 State Diagram of a Three- State Process

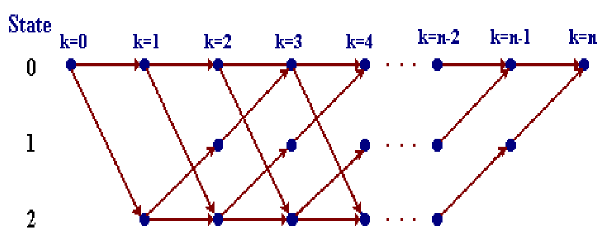

Figure 3.3 Trellis for the Three- State Process

3.4 QAM Modulation Technique

QAM modulation technique stands for Quadrature Amplitude Modulation.QAM modulation technique mostly used for modulating a data signals at a carrier. QAM mostly used because its more advantages compare to other modulation techniques like that PSK and so on. Quadrature Amplitude Modulation, QAM is a signal in which two carriers shifted in phase by 90 degrees are modulated and the resultant output consists of both amplitude and phase variations. In view of the fact that both amplitude and phase variations are present it may also be considered as a mixture of amplitude and phase modulation [20].

When QAM transmitted the digital signal on the radio communications applications then it is capable to transmit the higher data rates comparison to other modulation techniques such as amplitude modulation techniques and phase modulation technique. It is also possible that the phase shift keying (PSK) and amplitude keying combined together in a modulation form that is also called as Quadrature Amplitude Modulation (QAM). The basic way in which a QAM signal can be generated is to generate two signals that are 90° out of phase with each other and then sum them. This will generate a signal that is the sum of both waves, which has certain amplitude resulting from the sum of both signals and a phase which again is dependent upon the sum of the signals. If the amplitude of one of the signals is adjusted then this affects both the phase and amplitude of the overall signal, the phase tending towards that of the signal with the higher amplitude content.

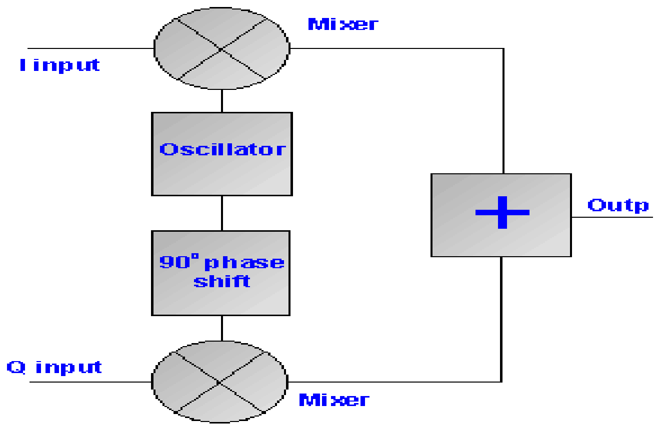

Figure 3.4 Block diagram of QAM modulator

If the amplitude of one of the signals is adjusted then this affects both the phase and amplitude of the overall signal, the phase tending towards that of the signal with the higher amplitude content.

As there are advantages and disadvantages of using QAM it is necessary to compare QAM with other modes before making a decision about the optimum mode. Some radio communications systems dynamically change the modulation scheme dependent upon the link conditions and requirements - signal level, noise, data rate required, etc.

Table 2 Different Types of Modulation with Data capacities

MODULATION	BITS PER SYMBOL	ERROR MARGIN		COMPLEXITY
OOK	1	1/2	0.5	Low
BPSK	1	1	1	Medium
QPSK	2	1/√2	0.71	Medium
16 QAM	4	√2/6	0.23	High
64 QAM	6	√2/14	0.1	High

3.5 Channel Encoding

Coding system protect all the data or speech using a several techniques of digital data transmission. The main objective of channel coding theory is discovering the codes for fast and immediately transmission. Channel coding for finding the errors in code words and then correct the codes as so possible, this are included more valid code words [21]. All codes are performed different work in these areas so that in different applications used a different- different code words. During of transmission properties of codes depends on probability of error. Shannon's noisy channel coding theorem tells that adding controlled redundancy allows transmission at arbitrarily low bit error rate (BER). Using controlled redundancy of error control coding (ECC) detect the errors in code words and after than correct the errors of codes. Error Control Coding works on the requirements of the system and the channel nature. Channel encoder for error detection and correction does block coding and block coding contains both Convolutional coding and interleaving.

3.6 Signal- to- Noise Ratio (SNR)

Signal to Noise Ratio measure the signal strength related to background noise and it is mostly time written SNR or S/N in analog and digital communication. Unit of Signal- to- Noise ratio is dB (decibels). When input of signal strength in microvolts is V_s and the noise level, also in microvolts is V_n, then the signal- to- noise ratio, S/N, in decibels is given by the formula:

$$\frac{S}{N} = 20log_{10}(V_s/V_n) \qquad (2)$$

When V_s is equal to V_n, then signal- to- noise ratio (SNR) is equal to zero (0). When, SNR= 0, in this time signal is essentially unreadable since the noise level severely competes with it. When the signal strength (V_s) is greater than the level of noise (V_n) then ideally SNR is positive. If signal strength is less than the level of noise then signal- to- noise ratio is negative. In any condition, when signal- to- noise ratio is negative then reliable communication is not taking the steps to increase the signal level and decrease the noise level on the destination or receiving terminal.

4. RESULT ANALYSIS

In this research work mostly explained of a GSM traffic channel was performed. Rather than for simulation the program choose the random value of signal- to- noise ratio (SNR) in dB (Decible). In the GSM system transmitted the digital signal from source to user through the channel. The final output is represents the graphical form using BCH coding.

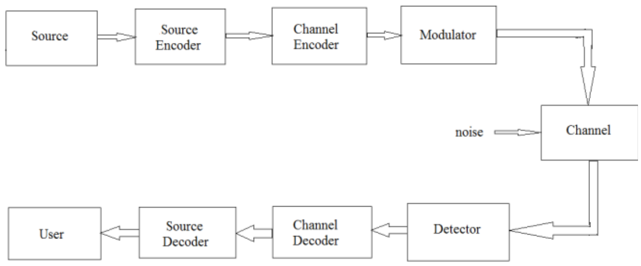

Figure 4.1 Block Diagram of transceiver of GSM System

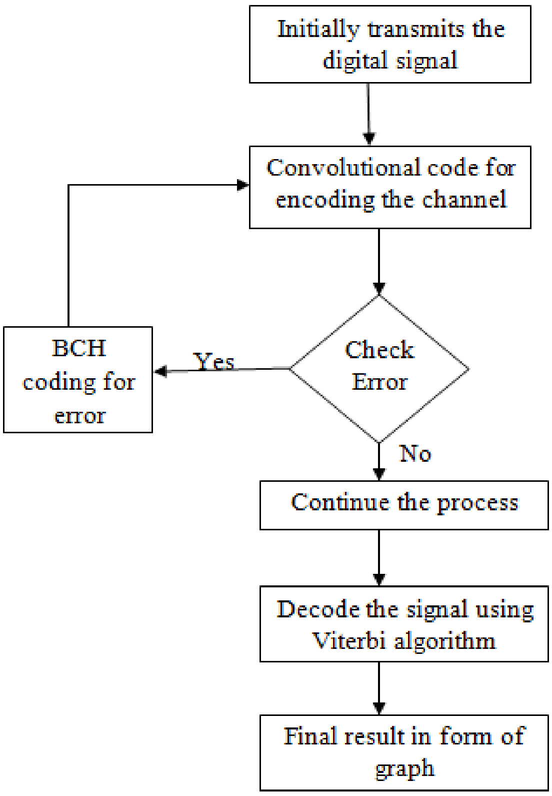

Figure 4.2 Flow Chart of Proposed Work

In the research work choose random values of SNR (Signal-to- Noise Ratio) for simulation the program and these SNR values are 2 dB, 7 dB, 12 dB, 20 dB and 48 dB. The outputs are taken in graphical form using MATLAB R2013a software between probability of bit error rate and signal- to noise ratio.

Case I represents the graphical form between the probability of bit error rate and SNR. The practical value of signal- to-noise ratio (SNR) is 2 dB. The system is simulating the program taking the value of SNR is 2 dB by MATLAB software. In the graphical form blue lines represents the error is present using the convolutional coding and after than green line represents the error correction using the BCH coding and after reduce the errors in the signal green lines below the 0.5.

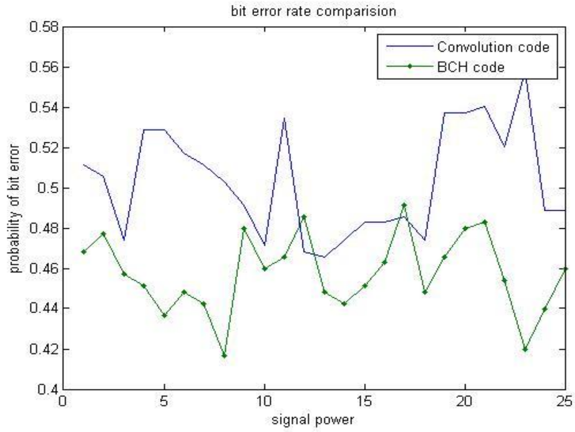

Figure 4.3 Output When SNR value is 2 dB

Case II represents the graphical form between the probability of bit error rate and signal- to- noise ratio. When increase the SNR value then practical value of signal- to- noise ratio (SNR) is 7 dB. The system is simulating the program taking the value of SNR is 7 dB by MATLAB software. In the graphical form also after error correction green lines below the 0.5 and blue lines is mostly above the 0.5.

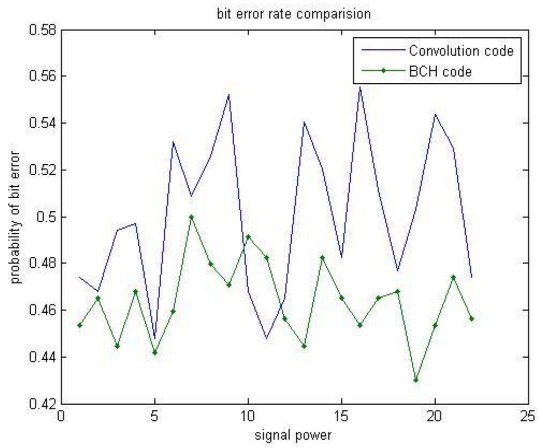

Figure 4.4 Output when SNR value is 7 dB

Case III represents the graphical form between the probability of bit error rate and signal- to- noise ratio in figure 5.5. When increase the SNR value over the 7 dB then practical value of signal- to- noise ratio (SNR) is 12 dB. The system is simulating the program taking the value of SNR is 12 dB by MATLAB software. In the graphical form also after error correction green lines below the 0.5 and blue lines is mostly above the 0.5. In the graphical representation blue lines represents the errors in the signal with convolutional coding and blue lines represents the after the error correction using BCH coding.

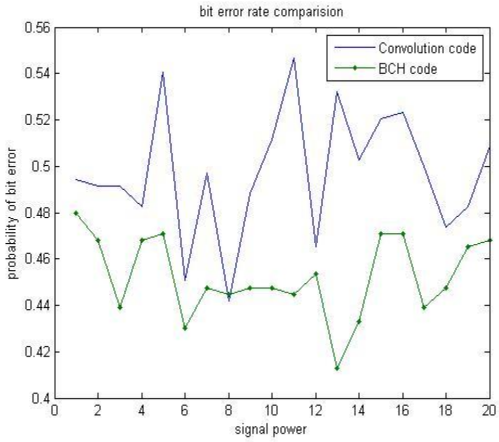

Figure 4.5 Output when SNR value is 12 dB

Case IV represents the graphical form between the probability of bit error rate and signal- to- noise ratio. When increase the SNR value over the 12 dB then practical value of signal- to-noise ratio (SNR) is 20 dB. The system is simulating the program taking the value of SNR is 20 dB by MATLAB software. In the graphical form also after error correction green lines below the 0.5 and blue lines is mostly above the 0.5. In the graphical representation blue lines represents the errors in the signal with convolutional coding and blue lines represents the after the error correction using BCH coding.

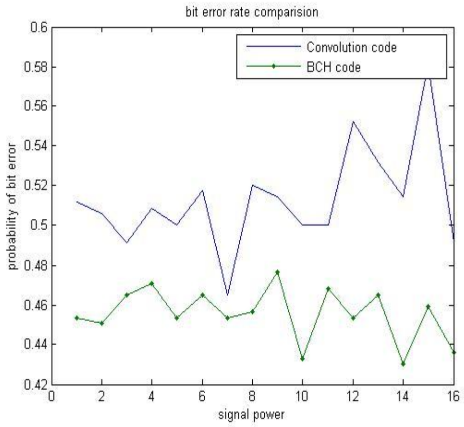

Figure 4.6 Output when SNR value is 20 dB

Case V represents the graphical form between the probability of bit error rate and SNR. When increase the SNR value over the 20 dB then practical value of signal- to- noise ratio (SNR) is 48 dB. The system is simulating the program taking the value of SNR is 48 dB by MATLAB software. In the graphical form also after error correction green lines below the 0.5 but taking the straight line and blue lines is mostly above the 0.5 and also these taking the straight line. In the graphical representation blue lines represents the errors in the signal with convolutional coding and blue lines represents the after the error correction using BCH coding.

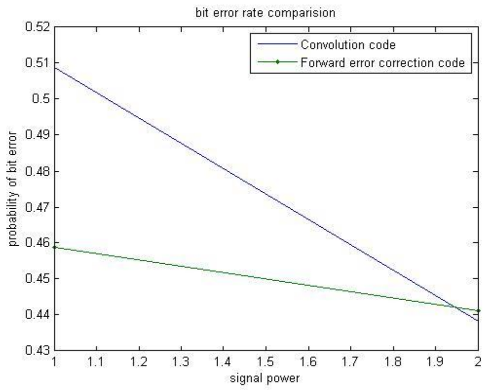

Figure 4.7 Output when SNR value is 48 dB

5. CONCLUSIONS

The MATLAB software is better run under the practical conditions with the value of SNR (Signal- to- Noise Ratio) is 2 dB in the research work. In my research work using a random value of the signal- to- noise ratio and these SNR values are 2 dB, 7 dB, 12dB, 20dB and 48dB simulate the program in MATLAB R2013a software. When increase the SNR value then more error is created in the transmitted signal with the convolutional coding and after the error- correction using BCH coding error of the signal is reduce the below 0.5. When we have taking the SNR value is 48 dB then in the graph only present a straight lines before error- correction and after the error- correction using BCH coding.

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