Performance Analysis of Twin Concatenated Coding Scheme for Communication System

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Abstract: This study examines how well the Twin concatenation strategy for error-correcting capabilities performs with the BCH code. Low complexity BCH codes are the main focus. The quantity of mistakes introduced into the transmission channel has a significant impact on the quality of digital transmission. The Bose-Chaudhuri-Hocquenghem (BCH) codes are frequently employed in storage and communication systems. In next-generation wireless networks, low-latency communication is one of the most crucial application situations. The time needed for a packet to be transmitted through a channel is a common definition of latency in communication-theoretic studies. However, due to the strict latency requirements and complexity-restricted receivers, the time needed for packet decoding must be taken into account in the overall delay analysis through precise modeling. The new Twin CC algorithm has been proved to perform better than the current approach.

Keywords – BCH Coding, Turbo Coding, FEC, Interleaver**.**

I. INTRODUCTION

Over the past 20 years, wireless network coverage has significantly increased. A costly, cumbersome, and slow technology that was only sometimes added to traditional networks gave rise to a wireless network [1]. Almost every location that needs a mobile Internet connection today uses wireless networks, including homes, public areas, schools, businesses, and governmental institutions [2]. User mobility and inexpensive network construction are the core benefits of wireless communication networks. These benefits are countered by a variety of drawbacks, such as higher energy needs than wired networks, slower speed, reliability, and security. The data Latency, channel capacity, output/throughput, available system capacity, received signal level, and signal-to-noise ratio, are the major performance metrics examined from the standpoint of wireless communication system performance. The wireless communication systems used a wide range of diverse elements, such as structural blocks, functioning systems, etc. The core components of the wireless communication system are access nodes.

II. LITERATURE REVIEW

Wireless networks' latency is a key performance indicator. The amount of time it took for a message to reach the destination node after it was transmitted from the source node is known as latency [6]. Milliseconds are used to measure latency. Both delays on communication line devices and time delays on line-connected nodes are included. One side latency (the period between a message/data being sent from an originating node and being received by a receiver node) and bidirectional latency, also known as round-trip delay, must be distinguished [7]. Round-trip latency includes the time it takes for packets (messages) to travel from a source node to a destination node and back again. A processing time on a receiver node is also included. In computer networks, duplex latency or even return-trip time (RTT) [13] is most frequently employed because it can be measured from a single site (node). Data transmission quality is unaffected by latency. On the other hand, a piece of information linking to the network's quality of work might be considerably impacted by high latency [12]. Since a greater level of latency/delay results in a longer response time. Bad perception of service quality develops with rising delay values. Although some network applications can operate with higher latency levels without experiencing any issues, the majority of apps are largely latency-sensitive. The instability of latency is another issue that it causes. Instability in the system is another issue related to the latency element of the communication system. Flexible load during transmission time periods, basically on active blocks, can be brought on by instability. Other factors include a method that sends each packet separately and through a variety of transmission channels. This instability results in "tearing visuals" and other related problems for real-time applications [8]. Utilizing a jitter buffer at the receiver side can compensate for latency instability. Since this approach has a supplementary system jitter block buffer delay, it is often only utilized to balance minor delay discrepancies. Under ideal circumstances, the value of jitter is less expected to be 30ms in one direction. The bit_error_rate (BER) is one of the factors that has a negative impact on latency [10]. The fraction of the number of incorrect bits acknowledged to the total number of bits transferred over a specific period of time is what determines it. Lower throughput and increased latency are caused by higher BER values, which also increase the likelihood that a packet won't be delivered. BER is calculated as follows: errors/bits transmitted. Higher signal-to-interference ratio or signal-to-noise ratio (SNR) values can result in lower BER values (SNR). SNR stands for the ratio of a signal's strength to background noise [11]. Decibels is the unit used to figure it. The communication system networks are designed to operate with a considerably lesser SNR - characteristically around 55 dBm. Whereas narrowband broadcast, which has SNR in the tens, and FM radio has about 70 dBm. There is an exponential link between SNR and delay, according to certain published studies.

$$SNR_{dB} = 10 \log_{10}(P_{signal} / P_{noise})$$

SNR is a measure of the relationship between signal strength and outside interference. Better signal quality and less interferences are indicated by higher SNR values. From the foregoing, it follows that latency is a significant factor influencing the signal and data transmission quality in wireless networks. Here, two coding schemes that approach bit error rate performance and have the best performance in our situation are introduced, such as twin BCH coding and twin-turbo coding. The simulation findings are then cited.

III. Forward error correction (FEC) technique

Virtually all modern digital transmission systems have error-control codes, often known as error-correcting codes or channel codes. Communication Network coding is performed by adding measured redundancy into the sent digital data sequence, permitting the receiver to make more accurate decisions on the received data messages and even rectify some transmission faults. Claude E. Shannon showed the hypothetical presence of good error-correcting codes in his famous 1948 article that pioneered the area of Information Theory, allowing data to be communicated effectively error-free at speeds up to the outright maximum system capacity (typically computed in bits per second) of a transmission channel, and with unexpectedly lesser conveyed power.

There are many error detection and repair approaches that have been created over time to send and receive data in a consistent and accurate fashion. The most effective of these approaches ensure that the recipient correctly understands the material with the fewest number of retransmissions. Bose, Chaudhuri, and Hocquenghem are the authors of the BCH Code [7]. Multiple faults can be detected and corrected by the BCH code. BCH Code is a Hamming Code that has been modernized. The possible BCH codes for $m>=3$ and $t<2^m-1$.

Block length: $n=2m-1$

Parity check bits: $n-k<=mt$

Minimum distance: $d>= 2t+1$

$$c(x) = x^{(n-k)}.m(x) + p(x)$$

where n and k represent bits for messages and codewords, respectively. When examining the error sites produced by the parity-check polynomial p, the t stands for the error-correcting capabilities (x).

Similar to Hamming codes, BCH codes are more broadly applicable for multiple-bit error correction. BCH codes outperform Hamming codes because of the bursty nature of the connection, which causes multiple errors in a codeword to happen more frequently than in a binary symmetric channel. However, in order to get better results, they need a lot more redundancy.

The semi-concatenated BCH and Interleaver are employed in this Twin BCH Encoder system. As illustrated in the diagram, the semi-concatenated BCH and Interleaver combination employed in Twin means duplicate manner (2). The input data is split into two equal strings at the transmitter side and sent to the individual parts of the twin mechanism. The output of the twin string is once more summed up before transmission. The encoded received data string is split into two equal strings at the receiver end before entering the decoder part. After decoding, the result is summed again to recover the original data string.

IV. TWIN_TURBO ENCODING:

Many FEC techniques, such as checksum, Low-Density Parity Check (LDPC), Cyclic Redundancy Code, and Turbo codes, are employed in wireless transmission systems to decrease error and offer accurate information message delivery. The turbo codes have the best performance since they reach the Shannon channel capacity.

To minimize errors when transmitting a message across a communication channel, turbo codes are utilized. They accomplish this by identifying and fixing these errors. Due to their excellent performance which reaches the Shannon limit of the channel capacity, they are often used in applications that need to transmit information reliably over a noisy channel.

Turbo codes are composed of two components: a turbo encoder on one side of the transmitter and a turbo decoder on the other. Two iterative Systematic Convolutional (RSC) codes are concatenated in parallel using an Interleaver to create the Turbo encoder circuit [4-5]. The Interleaver is used to randomize the input sequence in order to improve the error correction effect by separating error bursts. Fig. 1 depicts the turbo encoder structure.

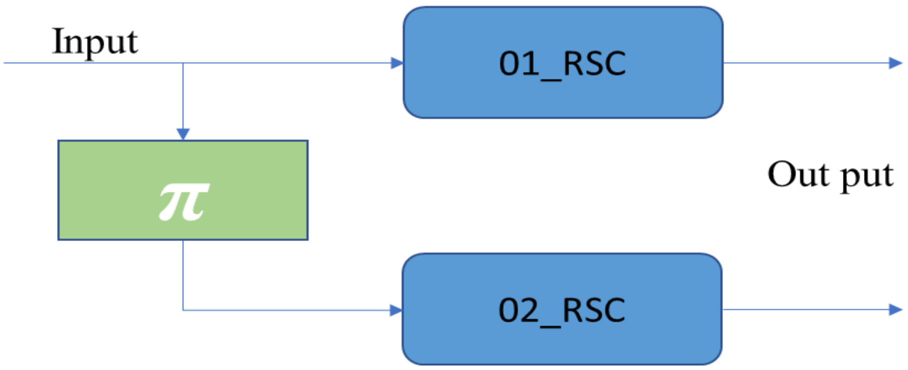

Figure 1: Turbo Encoding Scheme

The turbo decoder is an essential component of the wireless telecommunication system's receiver. The performance of error identification and correction is improved by exchanging estimation information between the two convolutional decoders that make up the turbo decoder.

The outputs of the turbo encoder are used as the inputs for the turbo decoder. Up until the required iteration number is touched or all faults are fixed, the two decoders communicate information back and forth. The outcome of another decoder is deinterleaved during the final iteration of decoding, and it is then sent to the hard-decision unit for conversion to binary form (1s and 0s) and comparison with the original sent message.

The concatenated Turbo code with Interleaver is employed in this Twin Turbo Encoder system. The Twin meaning duplicate method of using the Turbo code and Interleaver combo is depicted in the figure. (3). The input data is split into two equal strings at the transmitter side and sent to the individual parts of the twin mechanism. The output of the twin string is once more summed up before transmission. The encoded received data string is split into two equal strings and decoded at the receiver end, prior to the decoder section. After decoding, the result is summed again to recover the original data string.

V. SYSTEM IMPLANTATION AND SIMULATION RESULTS

A. SYSTEM I: Twin BCH_Interleaver scheme

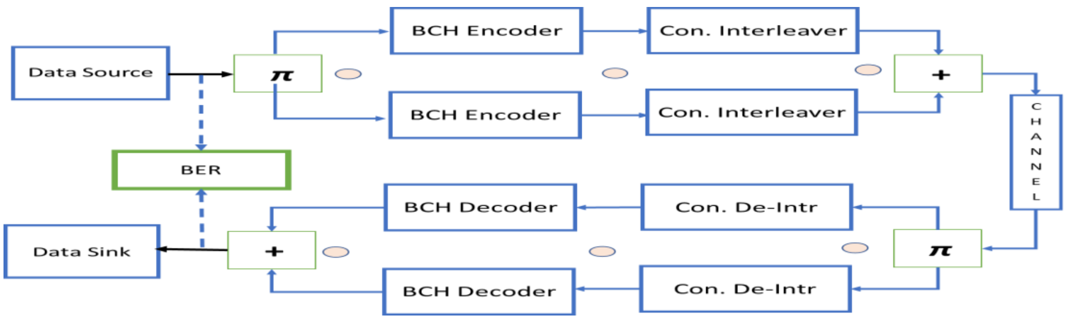

Figure 2: Twin BCH_Interleaver scheme

System	BER	% Improvement
BCH_Con_Intr_Codes	0.55	--
Twin_BCH_Intr_Codes	0.2583	46.96363636

Table 1: Simulation result of Twin BCH_Interleaver scheme.

B. System II: Twin_Turbo Encoding

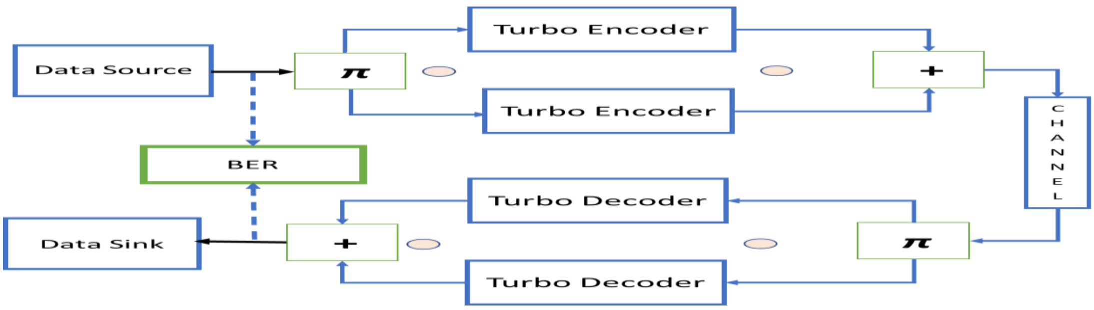

Figure 3: Twin_Turbo Encoding scheme

System	SNR	0.1	0.2	0.3	0.4
Turbo Coding	BER	0.0507813	0.0195313	0.0262044	0.00760324
Twin_Turbo Coding		0.0429688	0.0219727	0.0174561	0.00709886

Table 2: BER at various SNR values for Twin_Turbo coding scheme

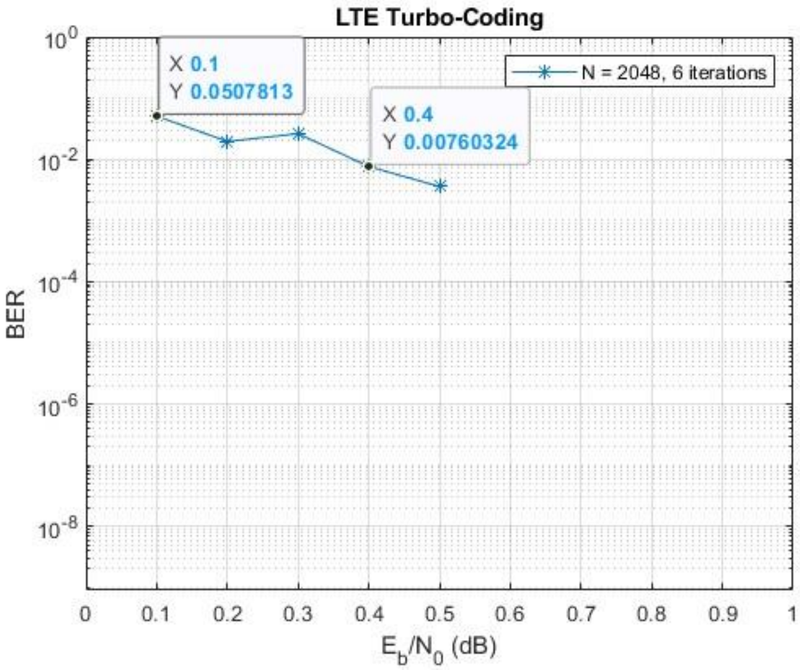

Figure 4: BER performance for Turbo coding scheme

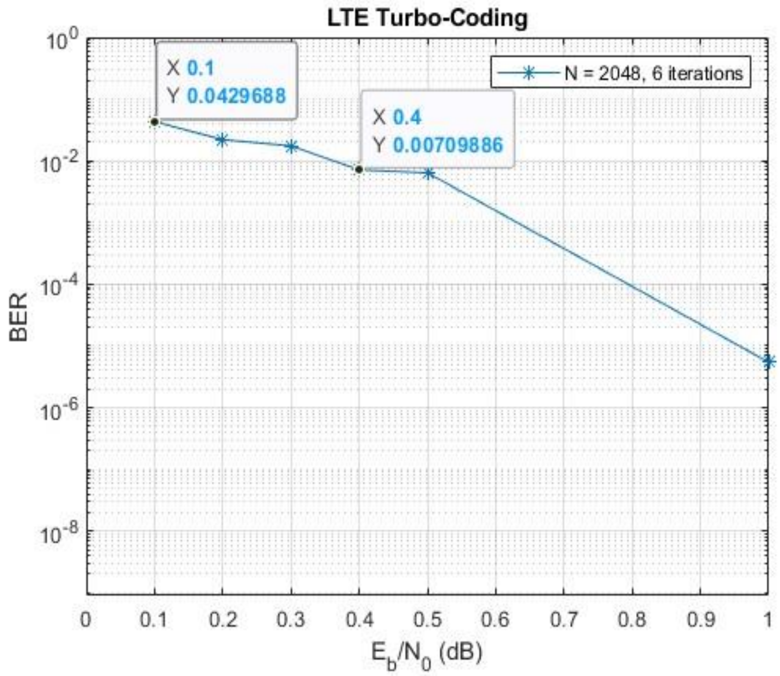

Figure 5: BER performance for Twin_Turbo coding scheme

VI. CONCLUSION

This paper proposed a technique of Twin Concatenation of FEC as well as turbo coding schemes. The System (I), "Twin_BCH_Intr_Codes" scheme shows a 46 % error performance improvement over the "BCH_Con_Intr_Codes" scheme. The System (II), "Twin_Turbo_Coding Codes" scheme shows a 33 % error performance improvement over the "commTurboCoding_EbNo" scheme. The "Twin" scheme results in reducing the overloading of the communication system. This is much more desirable in the latest communication technology, where tremendous data is being generated and need to be processed with less latency. Paper presented an efficiency improvement in the prevailing system without increasing the FEC coding complexity.

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