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Comparative analysis of coding schemes for effective wireless communication

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ABSTRACT

Communication systems have recently focused on sending information efficiently and effectively from one sending point to another across a communication channel in the shortest amount of time. The main objective of this work is to compare the high-range coding scheme types, such as low density parity check (LDPC), turbo, and convolution, to see which works better and is more efficient. to establish a coding system with quadrature amplitude modulation (QAM) modulation and an additive white gaussian noise (AWGN) noisy channel to find which is more reliable and resilient for encoding and decoding. Because of this, digital media has to be sent over wireless channels and through satellites, requiring a connected network all the time, which has become a major concern over time. Furthermore, the high amount of data and efficiency are the focus points. After running the simulation, it was found that 64 QAM with a rate of 0.455 and an efficiency of 2.731 has a bit error rate (BER) of 0.001 and a 7.08 dB energy per bit Eb/No, and the 256 QAM simulation revealed that it has a BER of 0.001 and 11.88 dB Eb/No with a rate of 0.736 and an efficiency of 5.891. Over the AWGN channel noise, the simulation built a standard orthogonal frequency division multiplexing (OFDM) system, which used MATLAB

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1. INTRODUCTION

The sending and receiving of information via a channel are referred to as "communication signals". Orthogonal frequency division multiplexing (OFDM) is made up of subchannels that are different from each other. In order to use the spectrum more efficiently, there isn't much space between subchannels. Both subcarriers and subchannels work in different ways. To get high spectral efficiency, there isn't much space between sub-channels. To use the spectrum more efficiently, there isn't much space between sub-channels. Both subcarriers and subchannels work in different ways. To get high spectral efficiency, there isn't much space between sub-channels. A whole bandwidth may be split up into multiple subchannels, increasing spectral efficiency. It will be the heart of a wireless communication system, and there is a need for multiple-input, multiple-output antennas to support high-speed communication systems. In order to use the spectrum, and with sperated subchannels. So, it is the ingredient design of the waveform, and it is the most popular multicarrier modulation scheme that employs many standards. These strategies are used with the most recent broadcast and mobile communication platforms, such as the fifth-generation new radio (5G NR) simulations [1]–[3].

On the other hand, the use of convolution in 5G-NR can be translated into some specific applications where fast-convolution (FC)-based waveform generation and processing OFDM processing is the primary topic, with a concentration on the cyclic prefix (CP) on transmitter processing that is spectrally well-localized. Time-domain (TD) convolution can be accomplished in transform-based FC filtering solutions by element-wise multiplying (windowing) frequency-domain (FD) sequences. Since the FD window values may be used for estimating the subband frequency response, this method allows for unlimited subband bandwidths and center frequencies. In our previous endeavours, their ability to remove undesired spectral components from the signal [4]. By finding a coding scheme that has interleaves, called turbo code. to find the error correction decoding performance, such as packet codes and convolutional codes. Utilizing interleaving to identify a sequence with minimal correlation as the coding output. The decoder employs an iterative decoding approach by exchanging soft information among the component decoders. The initial coding form of the Turbo code encoder is parallel concatenated convolution codes (PCCC) [5].

In a communication system, when data is transmitted from the source to the destination, many things can get in the way and cause errors in the signal that is received. So, fixing the errors is needed to get back to the original message. Robert Gallagher came up with "Low Density Parity Check Codes" in 1963. He looked at the codes and showed that low density parity check (LDPC) codes can almost reach Shannon capacity on additive white gaussian noise (AWGN) and binary erasure channels. Using error-correcting codes and smart math techniques, transmission errors can be fixed. The name for this is channel coding. Source coding is a way to use codes to reduce the number of bits needed to represent the original data.

LDPC code is used in the plan to minimize the bit error rate (BER). The code to fix mistakes was simple, but not too simple. Concatenated binary LDPC codes have been added to the LDPC codes, which use irregular codes with different parameters that can work together in parallel or serially, with or without interleaves. Since it is more efficient to use irregular LDPC codes than regular ones, there was no error floor. So, the project's throughput was better because of this. On the other hand, the proposed method runs the simulation in the LDPC decoder up to 25 times, which makes it unsuitable for larger message bits [6].

Researchers assume that every row in the parity check matrix is linearly independent for standard LDPC coding. A (n,k)-bit blockcode remove the mistake from k information bits by providing n code bits. The blockcode is encoded as (n,k,d) with a minimum hamming distance of d. In the 5G simulation, it is unable to fix the same subcarrier N and fourier transformation (FFT) size for both coded and uncoded OFDM. The number of input signals mostly determines the values of subcarrier N and FFT size for the OFDM 5G simulation that does not use coding techniques [7].

By inspecting the output BER in an orthogonal frequency division multiplexing-based wireless communication system with quadrature amplitude modulation (QAM) modulation, and use a concatenated channel coding scheme with a LDPC. Convolutional codes are very effective for identifying and retrieving a digital image in a noisy and fading environment. Every QAM symbol has a set location in the constellation plane under QAM static mapping. to show how the QAM symbol's location will change randomly, allowing it to be mapped anywhere in the constellation plane [8].

In terms of performance, one of the studies compared Turbo and LDPC codes, as well as an LDPC that has a lower complexity with the same input length (a. d. R.=1/2). The result shows that at the code lengths studied, LDPC codes were much simpler than Turbo codes [9]. The sequential code is a coding technique that uses a number of different codes to achieve a large coding gain with less complexity [10]. OFDM is now often used in wireless communications to stop multipath fading and get high data rates. Using this multi-carrier modulation system, data is sent by splitting a single wideband stream into many narrowband bit streams that run together [11]. Employ three coding techniques (LDPC, turbo, and convolution) with OFDM. So, the BER analysis is the channel's esteemed performance. The main finding of this work is that by using the standard noisy channel AWGN, we can determine the effect of noise on the sending and receiving data, set the lowest bit error rate, and compare the three types of systems.

2. BACKGROUND

OFDM systems are quite efficient, but the inclusion of a CP and excessive out-of-band emission brought on by rectangular filtering induce a decline in their spectral efficiency. The OFDM is found to solve one of the main issues in cellular network uplink synchronization [12]. The prime objective of adding the CP to the data is to preserve or protect the input symbol's orthogonality. Within a certain time, frame from the phenomenon of noise by implementing OFDM system performance using different lengths of CP. More than 1/4 of the CP is preferred. The larger the CP, the better the BER values [13], [14].

The CP was used instead of the ISI as the generations changed. The CP is added after modulation by taking the last block of the modulated inverse fourie transformation (IFFT) signal and adding it to the beginning as a guard interval to protect against ISI. The 4G long-term evolution (LTE) system's CP is hard-coded into the waveform, in contrast to 5G NR Release 15, where the waveform determines the CP [15].

Also, the most effective way to handle a process of big data value is by focusing on using OFDM. Using the BPSK modulation and processing serial in parallel to reduce the BER. Findings indicate that the design yields the best wavelet coefficient and the smallest average of the transmission. In LTE to have range flexibility and empower cost-effective responses for the wide carriers [16].

To make a clear picture of all channels and coding schemes used in high or low coding rates with the 4G and beyond, when it comes to block length and coding rate, it performs better when the coding rate is low and the message length is large. Other studies show that the NB-LDPC codes operate more efficiently and make greater use of the wavelength. The interleaver scrambled with the bit order of the coded blocks and outputs. Interleavers are used to break up encoded bit sequences, and error control technology has been used to remove random errors [17], [18]. According to them, the best error-correcting codes for the 5G enhanced mobile broadband (eMBB) scenario are polar codes and LDPC codes, and the best solution to the hardware performance issue at both decoders is to use a single process. Both of these sorts of codes are decoded using belief propagation (BP) methods. With only one decoder, both sorts of codes may now be decoded [19]. Part of the reason why LTE Turbo codes and binary LDPC codes don't work as well as they could in the short message length regime is that the iterative decoding method isn't the best [20], [21].

The belief propagation (BP) method is known for its effectiveness when it works to fix mistakes. But a lot of multiplication was needed to change the variable numbers. Which makes it hard for hardware to do what it needs to do. the hard decision, which came from the method of bit flipping (BF). This method is not very hard to understand, but its performance is getting worse and worse. Several variations of these characteristics have been suggested in the sources as ways to make them better [22].

While this study shows the encoding techniques for LDPC and also for the turbo code. Where LDPC codes are based on the generator matrix value of the original code word to be identified. The hard-decision decoding algorithm is used in LDPC decoding. And they found that Turbo code is faster in both incoding and decoding. While LTE is completely based on turbocode, which is based on MIMO [23], [24].

The telecom network utilizes new technologies to spread and progress them as more people have access to new mobile technologies. The third generation partnership project (3GPP) has thus standardized long term evolution advanced (LTE-A) [25], improving the performance objectives outlined in the previous standard. LTE-A sets a performance goal of 1 GB/s transmission rate in the downlink. 5G LDPC codes are designed to have high throughput, variable code rate and duration, and hybrid automated repetition requests. They also have strong error-correcting capabilities [26]. The 3GPP assessment summary is available. In 5G cellular communications, LDPC coding has been employed for user data, which focuses on low latency [27].

OFDM in practical use (DFT) is applied to put the linear combination of the orthogonal sinusoids of the DFT forms into an orthogonal set basis. The transform simply establishes a relationship between the input signal and the sinusoidal base as well as each of the sinusoidal basis functions. If the insertion signal has energy at the appropriate frequency, the correlation will peak there. An input signal is converted into a collection of orthogonal subcarriers using the DFT. The DFT of the orthogonal basis functions, or the OFDM transmitter, is subjected to this conversion.

3. METHOD

It is challenging to decrease bit error rates in non-linear code, for example, in order to improve efficiency. This approach aims to decrease noise while enhancing performance. To get back the data that was sent at the receiver, you need to know how the encoder and decoder are set up and the channel state information (CSI) of the OFDM. The primary goal is to use an LDPC code to determine the BER performance of OFDM modulation in the AWGN channel. A comparison was conducted to investigate the observed low BER between LDPC code, convolutional code, and turbo code. It will be capable of identifying better code rates like LDPC, turbo, and convolutional to achieve higher efficiency and a reduced rate of bit errors by using MATLAB simulation with less overhead.

The following strategy was used in this study to fix the issue:

- Use a LDPC code to analyze the impact of OFDM modulation on the BER in the AWGN channel.
- To determine the impact of coding on the BER level, compare the LDPC code with the convolutional code, turbo code, and other codes with the objective of achieving the lowest BER.
- Establish a coding system that is strong, stable, and has the lowest BER when compared to current OFDM systems. Such a technology needs to maximize channel capacity and allow for more effective communication.

The work being presented uses 3GPP TS 38.214 and takes into consideration the usage of current OFDM with 5G networks. The currently used system employs LDPC, turbo, and convolution with OFDM as basic channel codes. If Turbo and convolution codes were supported by 5G wireless communication, they would be backwards compatible with 3G and 4G, saving money for the cellular communications industry. They may upgrade components to suit new generations rather than replace them.

The primary contribution of this paper is the analysis of three the coding techniques (LDPC, turbo, and convolution) employed, with the most effective method used in the new 5G being OFDM, and the BER is the analysis of channel performance. LDPC schemes use the bit-filping algorithm for hard decisions and the sum product algorithm for soft decisions. Turbo code using interleaving and the Pseudo random method, and the last one is the simplest algorithm that uses the vetirbi algorithm, which is effective for small amounts of bits. Establishing a reliable channel that impacts the least amount of AWGN introduces x as input and n as noise that is present in the actual modulation. With QAM modulation that has the benefit of having better anti-noise and using the hole bandwidth. The coding method that provides the lowest BER will be used to determine the predicted channel [28].

3.1. OFDM usage in 5G

OFDM is the most efficient communication technology due to its superior capability in reducing multipath fading and managing multiuser access. Wireless network applications, circumstances, and shortcomings for 5G and future generations include a diverse set of novel and atypical requirements. The rapid proliferation of new devices, applications, and services such as massive machine-type communications (MMTC), eMBB, and ultra-reliable low-latency communications (URLLC) makes it challenging for a single radio technology to cater to all their needs simultaneously upon release. A flexible frame structure that is multi-numerological and utilizes OFDM. It proposes parameterizations as a possible solution to this problem. This kind of modulation is anticipated to greatly influence the suitability of the OFDM waveform for meeting the diverse requirements of 5G services [29].

3.2. Additive white gaussian noise channel and its effects

It's possible to think of adding white noise or wideband that has a known spectral density and amplitude following a gaussian distribution as an AWGN channel model. With x being the input and y being the output signals, respectively, and n being the additive white gaussian noise, the equation Y=x+n can be used to describe any wireless system that works in an AWGN channel. In this case, the AWGN channel model is problematic because it doesn't take into account fading, frequency sensitivity, or dispersion. Additional noise, radiation from hot objects (black observation), temperature vibrations of ions in antennas, and other natural events are some of the things that can cause gaussian noise. One thing that might be very helpful for many satellites and deep space communication lines is to use this channel as a model. It's possible for factors like received signal strength and noise power to alter channel capacity.

Coding is the process of embedding signal constellation points in a higher-dimensional signaling space than what is required for communications. If a channel uses gaussian noise and adds noise, the equation can be used to figure out the channel's capacity. When noise is present in the actual modulation, noise causes changes in the phase and amplitude of the modulated OFDM signal when there is AWGN noise (n), which takes into consideration the distorted signal. This is how it is technically executed. Coding is present to reduce the error rate by finding the distance between points, which can be extended by moving to a higher-dimensional space, which improves error correction and detection, as discussed in [30].

3.3. Quadrature amplitude modulation

When integrating coding schemes with QAM modulation, the goal is often to enhance the robustness of the communication system, especially in the presence of noise. In the encoding data, the coding schemes add redundancy to the transmitted data, which can help in error detection and correction, and the digital data to be transmitted is first encoded using error-correcting codes. Common error-correcting codes include LDPC codes, convolutional codes, and turbo codes. Then symbol mapping encoded data is then mapped to QAM symbols. The number of bits represented by each QAM symbol depends on the modulation order. In our work, it is 64 and 256 QAM. Higher modulation orders allow for more bits to be transmitted per symbol, increasing the data rate but also making the system have more errors. The QAM modulator translates the mapped symbols into analog signals with both amplitude and phase components. The modulated signal is then transmitted through the communication channel. At the receiver, the received signal is demodulated to obtain the QAM symbols. Due to noise, errors may occur during transmission. The error-correcting codes are employed to detect and correct errors introduced during transmission. The level of error correction depends on the design and capability of the coding scheme [31].

4. RESULTS AND DISCUSSION

There is a convolutional code in Figure 1 regarded as the interleaving-free. which is a simpler version of the Turbo code. To achieve the same result, both a QAM modulator and a soft decision decoder will be used. The process flow diagram for the Turbo code is shown in Figure 2, which illustrates how the input bits pass across the noise channel from the input to the Turbo encoding using the OFDM system, where the QAM modulation is used. The procedure then switches to the output from the input to determine how the system is doing and how often errors are occurring.

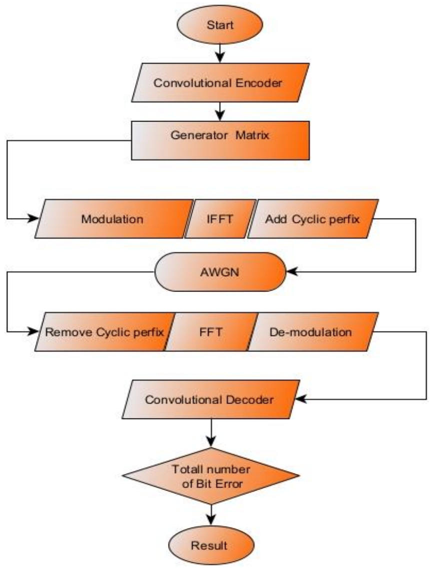

Figure 1. Convolution flow chart

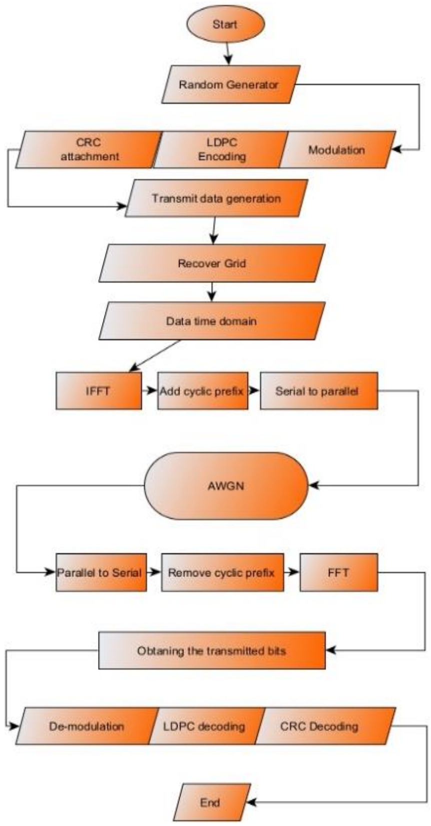

Figure 2. Turbo flow chart

Figure 3 illustrates the procedures required for running the LDPC code with OFDM over AWGN to count bit error rates. Random bit generation and transmission to the LDPC encoder, followed by OFDM modulation, is how bits are produced. The procedure will then proceed over the AWGN channel. The LDPC decoder will be installed to test how the system will perform with various QAM modulation sizes.

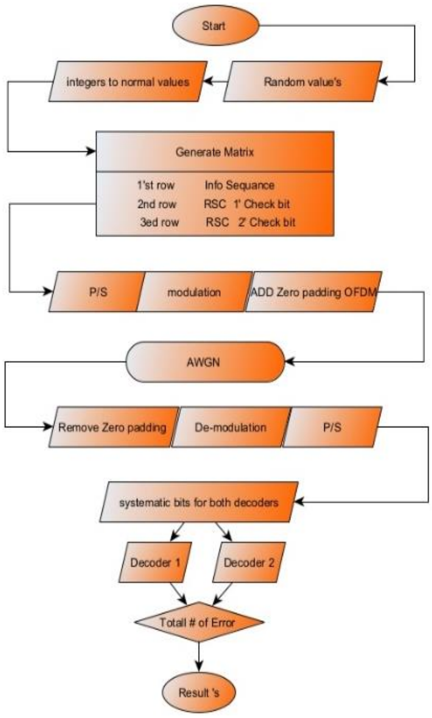

Figure 3. LDPC flow chart

4.1. Comparison of OFDM coding for encoder and decoder using 64 QAM

A 64 QAM modulation simulation is used to look into how LDPC, turbo, and convolution codes act in an OFDM system over an AWGN channel. The result of convolution reached a 0.390-bit error rate of 9.94 energy per bit Eb/No. Also, the a-bit error rate of Turbo code is 0.054 at a 9.92 Eb/No ratio. While the LDPC has a lower BER of 0.001 with rates of 0.455 at 7.08 Eb/No. The designed LDPC has a reduced BER at the lowest Eb/No compared to other codes, as seen in Figure 4.

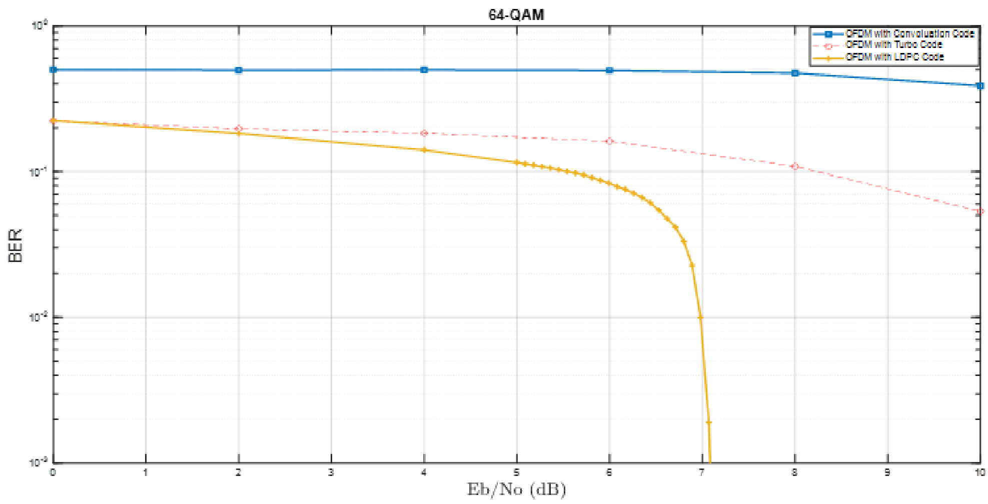

Figure 4. Comparing three types of coding with 64 QAM modulation over an AWGN channel with LDPC rate of 0.455

4.2. Comparison of OFDM coding for the encoder and decoder using 256 QAM

The 256 QAM modulation simulation looks at how convolutional, turbo, and LDPC codes work in an OFDM system with an AWGN channel. The convolution result comes with a 0.054 at a 17.95 Eb/No bit error rate. Where Turbo code has a 17.50 Eb/No BER of 0.001. and the LDPC of 0.001 has a lower BER at 11.88 Eb/No, with rates of 0.763. Configuring LDPC is straightforward and results in a reduced BER at the minimal Eb/No compared to other codes, as seen in Figure 5.

In the graphs of QAM above, the modulation looks like it is becoming more stable in the used system. When 5G QAM is used to allow more data, a system's performance improves alongside an increase in subcarriers (64 and 256). It is clear that 5G technology needs a lot of bits to be sent in order to provide a fast data rate, which is a significant benefit when using 5G. The throw-put increases as the modulation order increases. Increased noise resilience is the price. Compared to other modulation methods, it offers higher spectrum efficiency, which is why it is used. The BER of LDPC, turbo, and convolution codes for 64 QAM at 7 Eb/No is 0.001, 0.128, and 0.484, respectively, in that order. It has an 11.90 Eb/No at LDPC, turbo, and convolution, 0.001, 0.187, and 0.481 BER, respectively, in that order. A lot of individuals claim that the point of using QAM in 5G is to send more data bits more quickly so that the system works better. Table 1 shows more data that supports the results that were found.

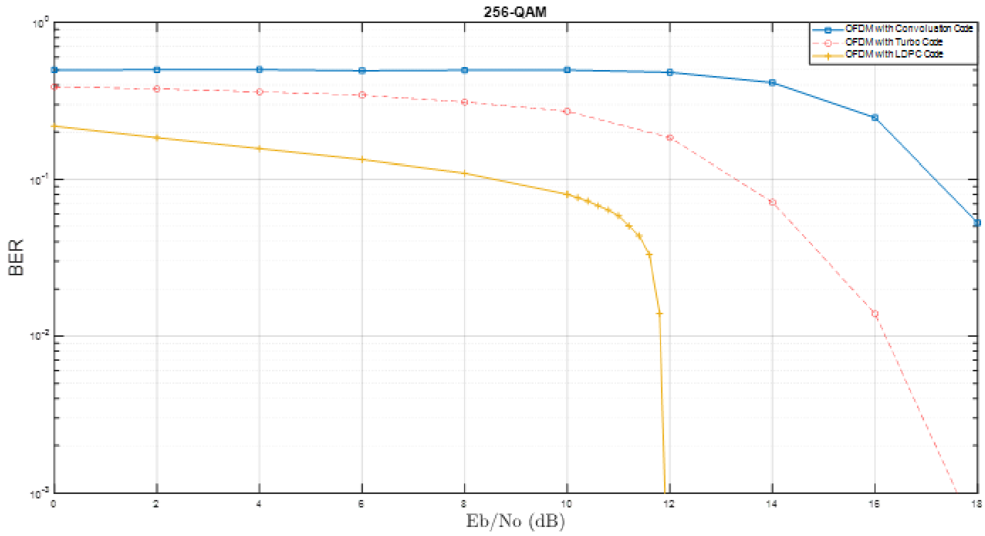

Figure 5. Comparison between three types of coding using 256 QAM modulation over an AWGN channel with LDPC rate of 0.736

Table 1. Comparison of the three coding techniques using QAM modulations

Code type	Eb/No	BER	Eb/No	BER	Eb/No	BER	Modulation type
	LDPC		Turbo		Convolution		
Code rate	466/1024		1/3		1/3		64
1	4	0.140	4	0.183	4	0.498	
2	5	0.116	5	0.172	5	0.496	
3	6	0.082	6	0.161	6	0.494	
4	7	0.001	7	0.128	7	0.484	
Code rate	754/1024		2/3		2/3		256
1	6	0.133	6	0.344	6	0.494	
2	8	0.109	8	0.311	8	0.498	
3	10	0.080	10	0.272	10	0.499	
4	11.90	0.001	11.90	0.187	11.90	0.481	

Figures 6 to 9 describe how the LDPC, convolutional, and turbo are compared in terms of BER performance over an AWGN channel that is used with an OFDM setup. The low error rate (0.001) for each code rate is at a different Eb/No (dB). The amount of rate over the compared coding scheme types in each figure shows that LDPC is more efficient than turbo and convolutional and has the lowest BER.

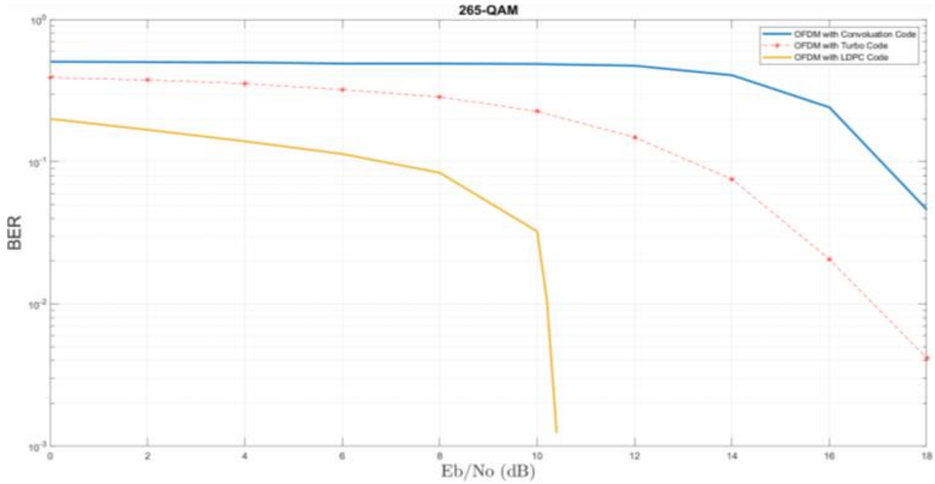

Figure 6. Comparison of three coding schemes using 256 QAM modulation over an AWGN channel using multiple LDPC rates

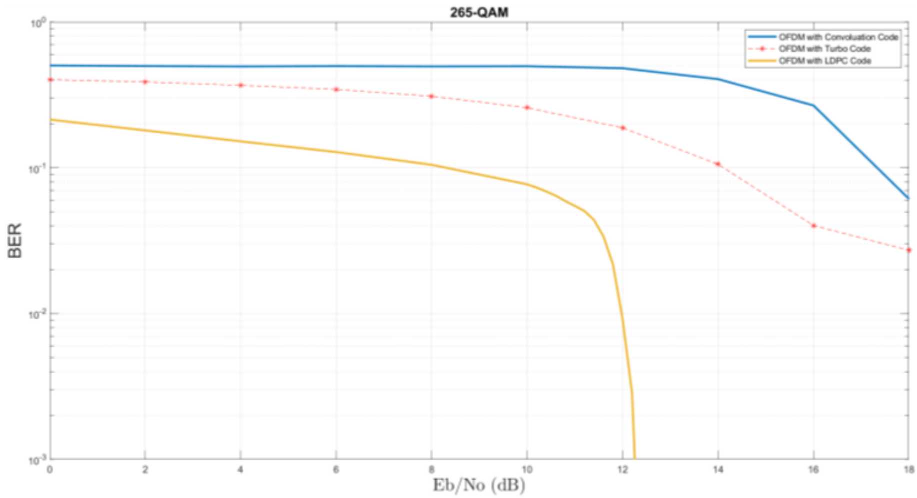

Figure 7. Comparison of three coding schemes using 256 QAM modulation over an AWGN channel using multiple LDPC rates

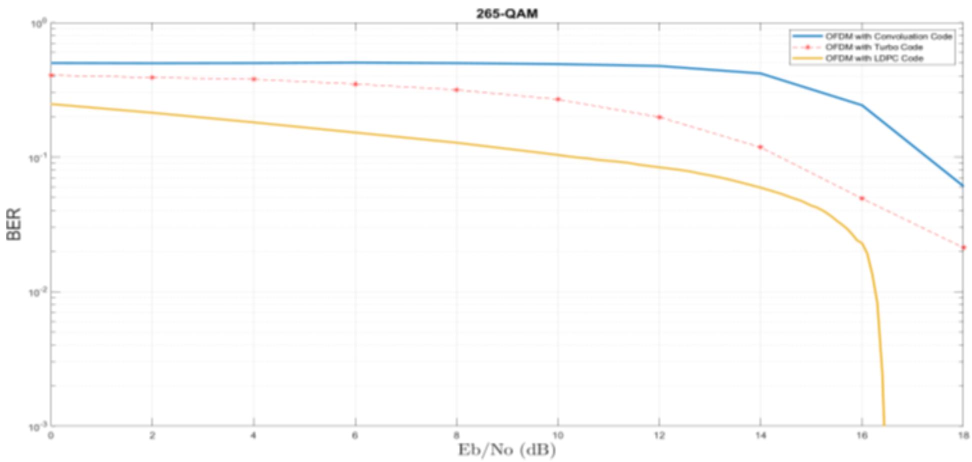

Figure 8. Comparison of three coding schemes using 256 QAM modulation over an AWGN channel using multiple LDPC rates

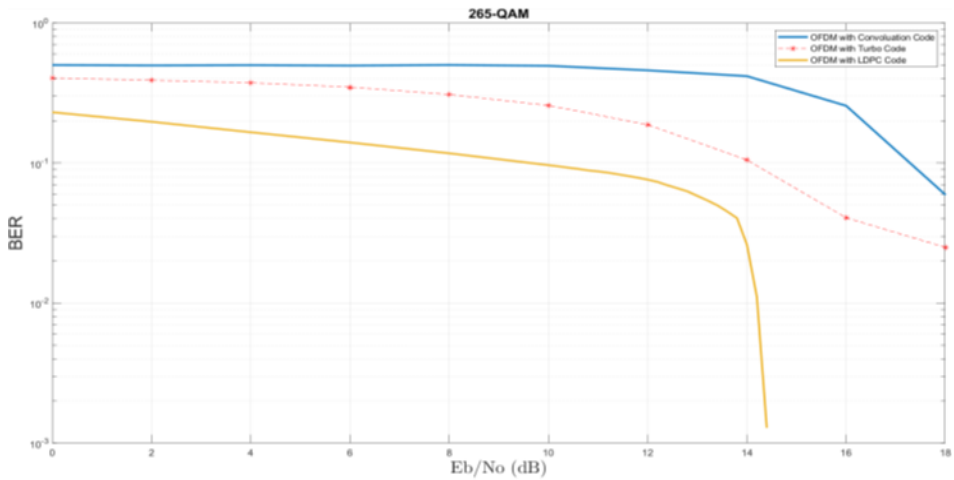

Figure 9. Comparison of three coding schemes using 256 QAM modulation over an AWGN channel using multiple LDPC rates

After indicating figures and seeing that LDPC's efficiency is better than turbo and convolutional codes. Which have a minimum BER, the values have to be discussed as results. See Table 2 for more details. Figures 10 to 12 show an OFDM system over an AWGN channel compared to LDPC code, convolutional code, and turbo code. The pictures show which system has a low BER and better performance. Table 3 also shows the LDPC for each code rate that has a low error rate of 0.001 at different Eb/No (dB) values in more detail. LDPC is more efficient than turbo and convolutional codes and achieves a lower BER.

Table 2. Comparison of three types of coding

	Eb/No	BER	Eb/No	BER	Eb/No	BER	Modulation type
	LDPC		Turbo		Convolution		
LDPC Code Rate	Code rate/1024		2/3		2/3		
711	10.4	0.001	10.4	0.173	10.4	0.482	256 QAM
797	12.3	0.001	12.3	0.171	12.3	0.468	
885	14.4	0.001	14.4	0.084	14.4	0.369	
948	16.3	0.001	16.3	0.042	16.3	0.175	

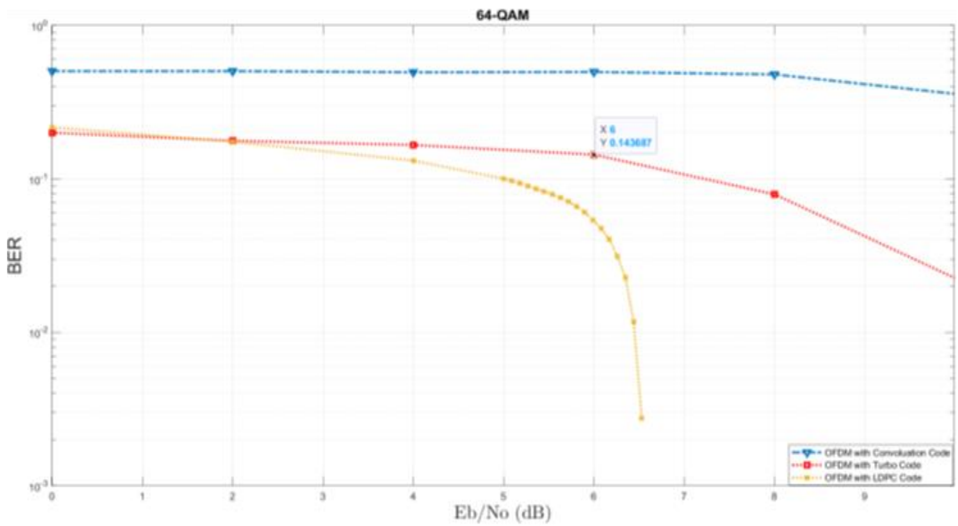

Figure 10. Comparison of three types of coding with 64 QAM modulation over an AWGN channel with LDPC different rates

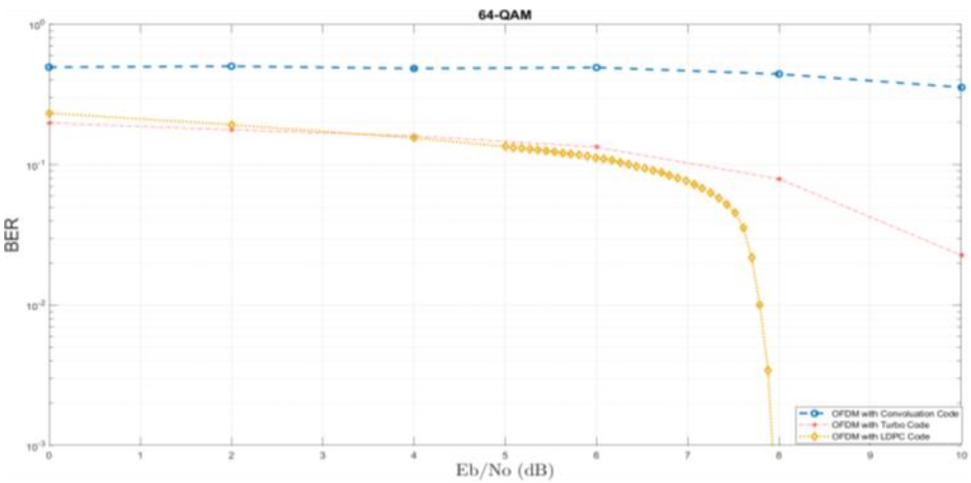

Figure 11. Comparison of three types of coding with 64 QAM modulation over an AWGN channel with LDPC different rates

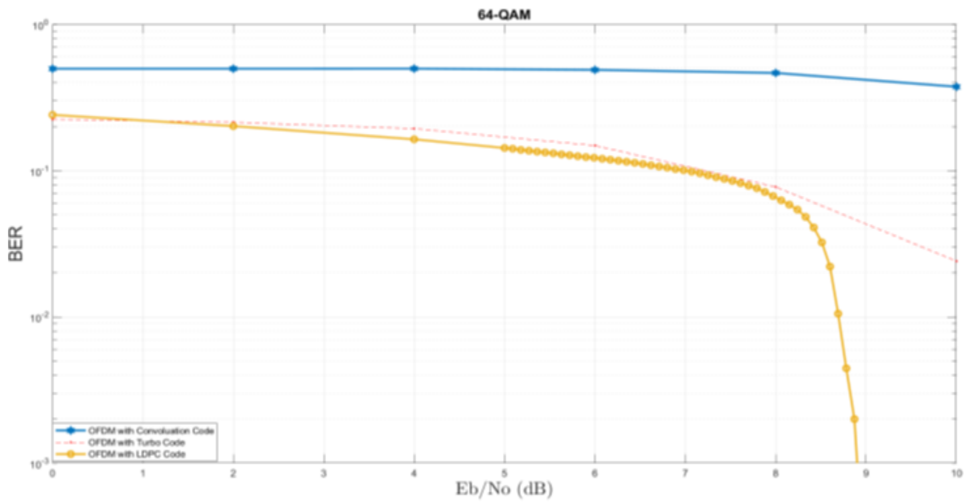

Figure 12. Comparison of three types of coding with 64 QAM modulation over an AWGN channel with LDPC different rates

Table 3. Three coding types comparison

	Eb/No	BER	Eb/No	BER	Eb/No	BER	Modulation type
	LDPC		Turbo		Convolution		
LDPC Code Rate	Code rate/1024		1, 2 and 3		1, 2 and 3		
438	6.46	0.002	6.46	0.125	6.46	0.492	
517	7.90	0.001	7.90	0.181	7.90	0.446	64 QAM
567	8.85	0.001	8.85	0.046	8.85	0.424	

4.3. Comparison between the simulated coding techniques

Three distinct modulations and approaches are used to discuss the connection between BER and Eb/No by generating scatter plots from Excel data. Figures 13 and 14 illustrate this correlation. By randomly choosing variables from a comparable segment of a MATLAB simulation. To determine how using various modulation orders will affect the BER over the AWGN channel, detailed in Table 4. The three simulated coding schemes are compared using average BER, by taking various samples, as shown in Figures 15 and 16.

The average BER was found to be the lowest when comparing all three coding schemes, as seen in the figures. LDPC is the most efficient encoding and decoding technology when compared to Turbo and convolution codes. Figures 17 to 19 present a comparison of BER at 64 and 256 QAM modulations. The comparison shows distinct behavior for LDPC compared to Turbo and convolution coding, as the BER for

LDPC stays almost the same for 64 QAM and 256 QAM. The BER for LDPC increases with bit density at lower densities. This behavior is different from Turbo and convolution. In addition, channel characteristics affect the BER values as a result of interaction with the transmitted data during the coding process. Thus, using the same channel parameters for both low and high densities would result in a somewhat different BER response. By taking the ratio of the average LDPC values upon Turbo and LDPC upon convolution that were chosen at random, the LDPC ratio to Turbo code present that the BER of LDPC is about 0.71 in the highest range and about 0.39 in the lowest range, which is 0.30 less than Turbo code.

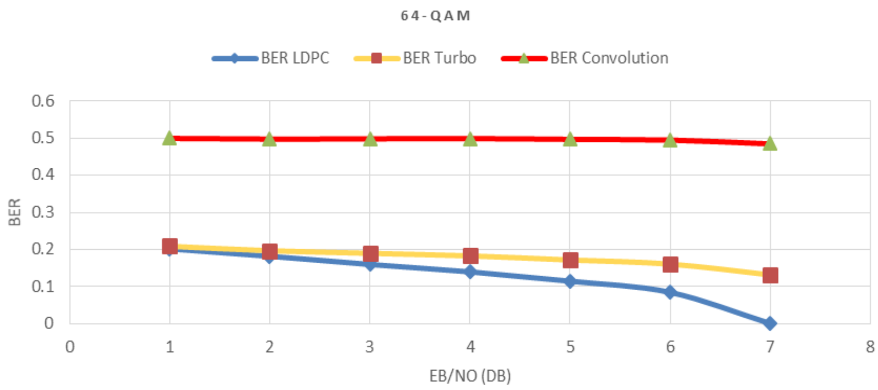

Figure 13. Comparison of scattered results of three types of coding with 64 QAM modulation

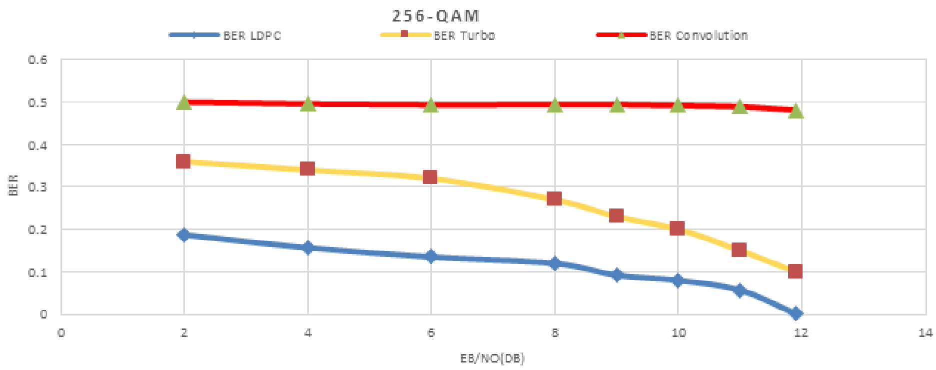

Figure 14. Comparison of scattered results of three types of coding with 64 QAM modulation

Table 4. Parameters for the three coding techniques using QAM modulations

	Convolutional	Turbo	LDPC
Code rate	1,2/3	1,2/3	466,754/1024
Generation	Up to 4G	Up to 4G	Up to 5G
Modulation	64 and 256 QAM	64 and 256 QAM	64 and 256 QAM
		Convolutional code	
		Trellis structure	
Key parameter	constraint length	Generators (Octal)	Type
Matdeintrlv	7	[171 133]	Poly2trellis
Modulation	QAM	Eb/No 7.0	BER 0.484
		Turbo code	
		Trellis structure	
Key parameter	Rate	Connection type	Iterations
Pseudo-random interleaver	1/3	Parallel	5 iterations
Modulation	QAM	Eb/No 7.0	BER 0.128
		LDPC code	
		Trellis structure	
Key parameter	Rate	Break type	No of transmitted bits
Pseudo-random interleaver	745/1,024	Tinner graph for (SPA)	42,000
Modulation	QAM	Eb/No 11.90	BER 0.001

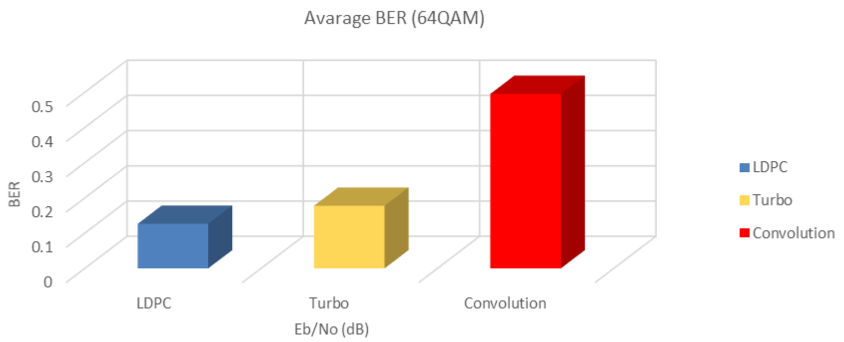

Figure 15. Comparison of three types of coding with 64 QAM modulation

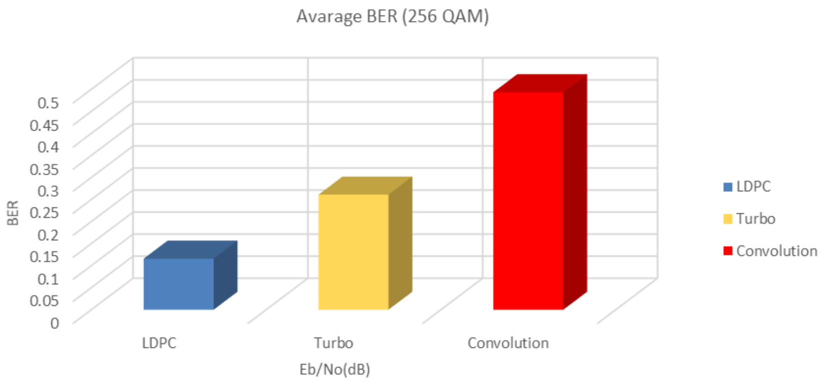

Figure 16. Comparison of three types of coding with 256 QAM modulation

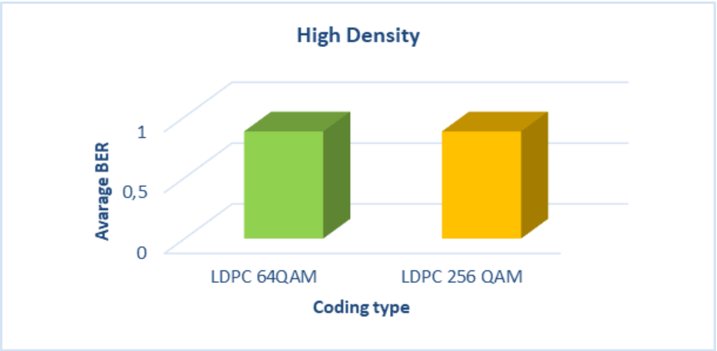

Figure 17. High density LDPC values with QAM modulation

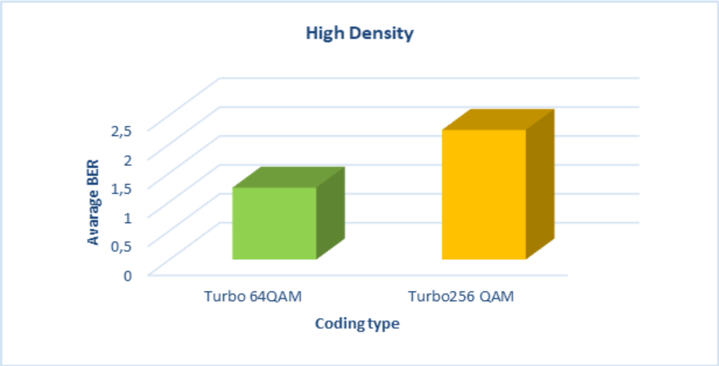

Figure 18. High-density turbo values with QAM modulation

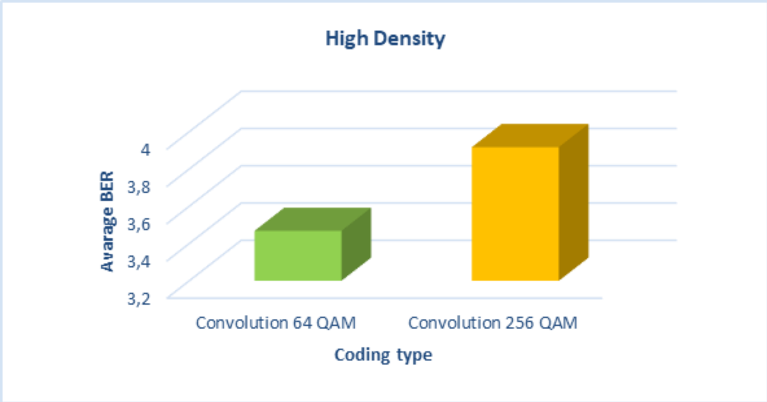

Figure 19. High-density convolution values with QAM modulation

The correlation between LDPC and Turbo coding (α), is given by (1):

$$BER(LDPC) = \alpha BER(Turbo) \quad (1)$$

Where $0.39 \leq \propto \leq 0.71$

the BER of the LDPC is around 0.26 in the maximum range and about 0.15 in the lowest range. according to the ratios of LDPC and convolution, which is 0.11 off from the convolution code. The correlation between LDPC and convolution codes (β), is given by (2).

$$BER(LDPC) = \beta BER(Convolution) \quad (2)$$

Where $0.15 \leq \beta \leq 0.26$

According to Shannon's second theorem (noisy channel coding), which gives the minimum value to get an infinitely low BER. The three coding types that were used to reduce BER and study the effect of noise on the signal, as this is a simulation, need to be validated using actual communication and electrical tools. This study suggests that it is acceptable to use this code to obtain a better BER using simulation, which is a popular strategy.

5. CONCLUSION

The results of the reorganization and simulation showed that an OFDM system that uses LDPC encoding and decoding may have a lower BER than an AWGN channel. In these tests, different rates for 3GPP TS 32.214 LDPC least-significant codes are used in different region types to see how well they meet the needs of the 5G project simulation. The rates differed from those used over an AWGN channel and were evaluated against other encoding techniques (Turbo, convolution) in limited settings. These rates were used for LDPC least-significant codes across different region types by measuring BER performance over 5G specifications using MATLAB. The main findings are described: after many tests at different rates, new results were obtained using LDPC coding, which may become an official reading in the future. Firstly, the simulated results demonstrated higher efficiency with a reduced BER. Therefore, it offers superior performance in comparison to turbo and convolution codes. LDPC demonstrated superior performance compared to other modulation levels and rates in the simulated outcomes. Secondly, code compilation and adjustments for LDPC, turbo, and convolution were necessary to achieve this. Two equivalent equations were also found for the scenarios described in the study. The equations demonstrate the relationship between LDPC, turbo, and convolution by displaying a variety of values. In this work, the main contribution is that it simulates different types of coding using MATLAB code. The target is to get a full idea of how well each encoding method works and how well it can be used in 5G networks. In future work, the results will be used as guides for reliable coding and classification, especially since they are different from the rates in the 3GPP tables. In recent years, LDPC has become more useful because it works well on high-speed networks. This makes it a good candidate for the fifth generation. In the future, the same methods of LDPC QAM modulation of 512, 1024, or 2048 bits will be used to look at the error rates of coded OFDM in 5G networks. They can be compared with polar codes and different types of noise distributions.

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