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POLAR CHANNEL CODING IN 5TH GENERATION (5G) NEW RADIO WIRELESS MOBILE COMMUNICATION

HIMANSHU SHARMA[1], SHRADDHA TRIPATHI[2], SHIVANSH SINHA[3] and NIKHIL GUPTA[4]

[1]Asst. Professor
[2,3,4]B.Tech. Students
Department of Electronics
and Communication Engineering
KIET Group of institutions
Delhi-NCR, Ghaziabad-201206, U.P., India

Abstract

In this paper, the polar channel coding technique for the 5th generation cellular network is explained. The modulation scheme used in this experiment is Quadrature Phase Shift Keying (QPSK). The error control coding is used in wireless mobile communication to compensate for noise and errors in the channel. There are many types of error control codes such as Linear Block Codes, Convolutional codes, BCH Codes, Low-Density Parity Check (LDPC) codes, Turbo codes, Polar Codes, etc. In this paper, the authors have shown the encoding and decoding process of Polar codes with different message lengths and code rates in 5G wireless mobile communication.

1. Introduction

Erdal Arikan came up with the concept of polar channel coding in 2009. Polar Codes are the first error-correcting codes (ECC) to achieve Shannon capacity. The Polar Codes provide the ultimate limit on the maximum rate at which information can be reliably sent [1]. The 5G wireless communication service has been started in many countries like the USA, China, Japan, South Korea, etc. But in India 5G mobile service is under deployment till the end of year 2021. The block diagram for channel encoding and decoding is shown in

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[1]Corresponding author; E-mail: himanshu.sharma@kiet.edu
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figure 1 and figure 2. The polar codes were introduced in 5G standard as the control channel. The polar codes are sequential nature. The polar transform is used in Polar codes. The polar codes are represented by a Generator matrix (G).

$$\text{Polar Transform Generator Matrix } (G) = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}.$$

2. Literature Survey

Arikan et al. [1] have presented channel polarisation for discrete memoryless channels. Mr. Tal et al. [2] have shown the decoding of polar codes. Niu K et al. [3] have shown decoding of CRC-aided polar codes. Niu K et al. [4] show the comparison of Turbo codes and Polar codes. Stimming A [5] shows, the decoding of polar codes. 3GPP group shows the use of channel multiplexing and polar coding simultaneously in [6].

3. Block Diagram and Operation

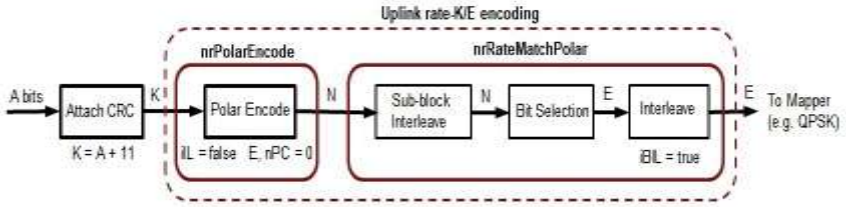

Figure 1. Block diagram of uplink rate polar encoding.

In figure 1, the input message bits are applied to the polar encoder. Then the encoded bits are sent to the 5G New Radio (NR) rate match encoder [6]. After encoding the QPSK modulation is done, and data is transmitted into the channel [7]. Similarly, on the receiver side, the encoded bits are decoded as shown in figure 2. Here, the encoded bits are applied to the channel decoder. After that, the data bits are passed from the rate match decoder [8].

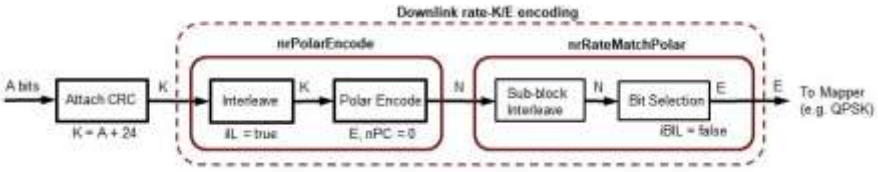

Figure 2. Block diagram of downlink rate polar encoding.

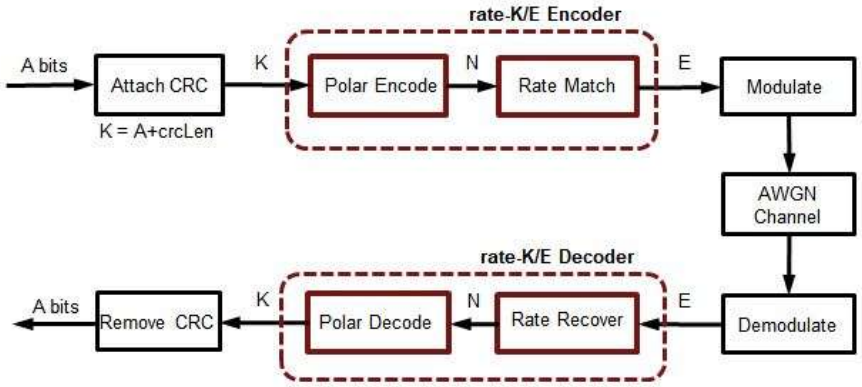

Figure 3. Block diagram of Transmitter, Receiver and Channel.

Figure 3 shows the block diagram of transmitter, receiver and channel. Here, the output from the encoder is fed to the modulator and then transmitted onto the channel [9,10]. The demodulator demodulates and sends data to the decoder [11]. Table 1 shows simulation parameters for the experimental setup [12].

Table 1. Simulation parameters.

Parameter Name	Value
Message Length(k)	54 bit
Code Rate matched output Length	124 bit
Bit Error Rate (Eb/N0)	0.8
Length	8
Number of Frames	10
Link Direction	Uplink / Downlink

Modulation technique	QPSK
Bits Per Symbol	2
Simulation Software	MATLAB 2021

4. Simulation Results

The simulation is performed using the 5G toolbox in the MATLAB 2021 software.

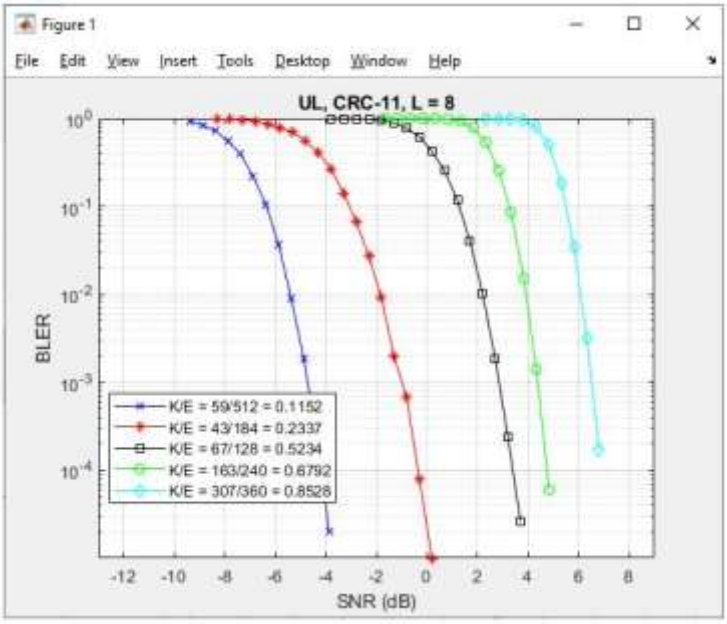

Figure 4. Uplink BER w.r.t. SNR (dB).

Figure 4 shows the uplink block error rate w.r.t. SNR (dB) for various code rates.

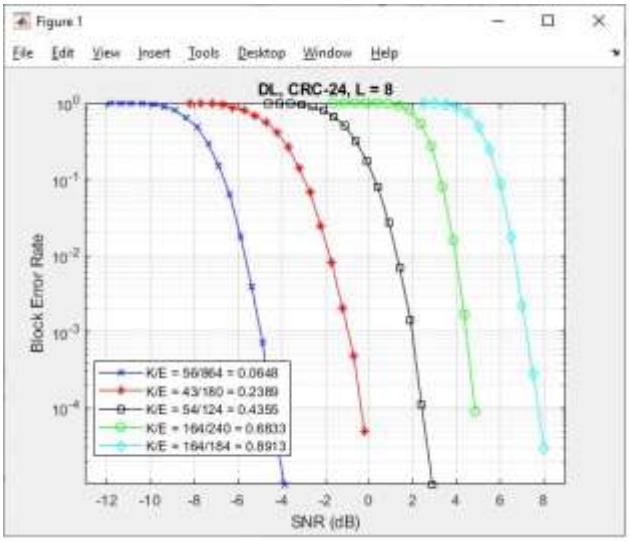

Figure 5. Downlink BER w.r.t. SNR (dB).

Figure 5 shows the downlink block error rate w.r.t. SNR (dB) for various code rates.

5. Conclusion

In this paper, the authors have shown the encoding and decoding process of Polar codes with different message lengths and code rates in 5G wireless mobile communication. The Polar Channel codes can be used in 5G wireless communication for digital twin technology to control the robots also.

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