A Modified-SCD for Optimize Performance Rate at Polar Code

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ABSTRACT

The first verified capacity-achieving codes were developed by Arikan called “polar codes.” It has gained significant attention due to their low encoding and decoding process complexity and optimum capacity-achievement process. In the original form of polar codes, the decoder has the inferior performance with finite ‘block-lengths’ as compared to the LDPC codes, therefore, the successive cancellation decoder (“SCD”) for the polar codes is a very important element in order to provide a capacity theorem, but it comprises complexity at a larger number of iterations that is not applicable for the point of view of lower latency application. Therefore, in this article we proposed a modified SCD that rearranges the stages but it can cause decoder performance degradation, so we applied a novel design rule of the polar codes in order to match with our MSCD model. In the result analysis section, we show the effectiveness of our proposed model that tends to have higher performance rate as compared to standard SCD.

KEYWORDS

Bit Error Rate (BER), Frame Error Rate (FER), Likelihood Ratio (LR), Low-Density Parity-Check (LDPC), Successive Cancellation Decoder (SCD)
INTRODUCTION

Several types of capacity approaching codes has been developed and used for the real-time application such as in data storage and wireless network communication in order to achieve better data-rates. Earlier, the Shannon’s proof for the noisy channel code theorem was used as random coding approach (Shannon, 1948), but the random approach causes complexity during encoding and decoding. Therefore, to achieve the high capacity of code sequence with less encoding and decoding complications has been a major goal for the researchers. The first verified capacity-achieving codes were developed by Arikan and called as “polar codes” (Arikan, 2009), it has achieved required channel capacity with the explicit construction and attracted many courtesies for that.

The most important property of polar codes is their low designing complexity of decoding \( O(A \log A) \), where \( O \) is order and \( A \) is block length, the implementation of polar codes with high block length is up to \( 2^{17} \) (Leroux, Raymond, Sarkis, & Gross, 2013). The initial classic SCD for the polar codes is very important element in order to provide capacity theorem, in addition SCD consist of some important properties like as deterministic and fixed complexity recursive architecture for better performance. In original form of polar codes, the decoder has the inferior performance at the finite ‘block-lengths’ as compared to the LDPC codes (Tal & Vardy, 2011). The channel polarization is the major breakthrough in the coding process, where the polar codes with different construction is asymptotically obtained by the symmetric binary input with the several memory-less channels and block codes. However, the application for error correction has recently shows the chances of polar codes applicability, also the phenomena of polarization in several signal processing and communications difficulty like as multiple access channels (Mahdavifar, El-Khamy, Lee, & Kang, 2016), wiretap channels (Mahdavifar & Vardy, 2011), BICM channels (Mahdavifar, El-Khamy, Lee, & Kang, 2015), broadcast channels (Goela, Abbe, & Gastpar, 2015) and data compression (Abbe, 2011). Moreover, there has been different enhanced prototype of polar codes for different type of applications such as concatenated polar codes (Mahdavifar, El-Khamy, Lee, & Kang, 2014), generalized polar codes (Korada, S.,as,og”lu, & Urbanke, 2014), universal polar codes (Hassani & Urbanke, 2014) and compound polar codes (Mahdavifar, El-Khamy, Lee, & Kang, 2013).

The encoding and decoding of polar codes have very less complexity, but less complexity at both encoder and SCD are at code length \( (N) \), in addition the memory requirements and decoding latency of decoders can be decreased to \( O(N) \) (Leroux, Raymond, Sarkis, & Gross, 2013; Sarkis, Giard, Vardy, Thibeault, & Gross, 2014; Mahdavifar, El-Khamy, Lee, & Kang, 2014). The hardware design for polar decoders with the processing element and \( O(N) \) memory is implemented in Sarkis, Giard, Vardy, Thibeault, and Gross (2014), a semi-parallel model for the SCD has been proposed in Leroux, Raymond, Sarkis, and Gross (2013), where the optimization has obtained without a drawback of significant throughput via resource sharing approach and consideration of general model of polar codes. Moderate parallel design has been
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