Biomedical and Pharmacological Literature Archives

Vol 5, Issue 2, 2025

SUCCESSIVE CANCELLATION DECODER OF POLAR CODES FOR 5G COMMUNICATION

Mrs. S. JYOTHI[1], B. SRI SAI KAVYA[2], G. TEJASRI[3]

[1]Assistant Professor, Dept. of ECE, PRAGATI ENGINEERING COLLEGE

[23]UG Students, Dept. of ECE, PRAGATI ENGINEERING COLLEGE

ABSTRACT

Polar codes have emerged as a promising error correction coding scheme for the next generation communication systems, particularly in the context of 5G technology. This Project architectures for polar code decoders using stochastic computing. Prior efforts were focused on design of polar decoders via deterministic computation, while the behaviour of stochastic polar decoder, which can have potential advantages such as low complexity and strong error-resilience, was not been studied. We design implement 8-bit stochastic polar SC decoder and verify the functionality.

INTRODUCTION

The objective of this project is to design, implement, and evaluate a Successive Cancellation Decoder (SCD) for Polar Codes tailored specifically for 5G communication systems. Investigating the theoretical foundations of Polar Codes and Successive Cancellation Decoding, analysing their applicability and performance in the context of 5G networks. Designing and refining the SCD algorithm to achieve superior decoding performance, focusing on enhancing reliability, reducing latency, and adapting to the dynamic nature of 5G communication channels.

Exploring advanced optimization techniques such as parallelization, pipelining, and hardware acceleration to maximize the throughput and efficiency of the decoding process, ensuring seamless integration with high-speed 5G data transmission. Implementing the SCD decoder in software and/or hardware platforms, considering both flexibility and scalability to accommodate various deployment scenarios and hardware constraints in 5G infrastructure. Conducting comprehensive performance evaluations through simulations and potentially real-world testing, benchmarking the developed decoder against state-of-the-art techniques, and providing insights into its advantages in terms of error correction capability, energy efficiency, and scalability. Investigating the trade-offs between decoding complexity, resource utilization, and decoding performance, aiming to strike an optimal balance that meets the stringent requirements of 5G communication systems. Contributing to the advancement of error correction techniques for 5G networks, with a focus on practical implementation aspects and real-world deployment considerations, ultimately paving the way for more reliable and efficient 5G communication systems.

LITERATURE SURVEY

1."Polar Codes: A New Paradigm for Coding" by E. Arikan, published in the Proceedings of the IEEE in 2014. This paper introduces polar codes and their properties, including the successive cancellation decoding algorithm.

2."Reduced-Complexity Successive Cancellation Decoding of Polar Codes" by M. Mondelli, E. Paolini, and F. R. Kschischang, published in IEEE Transactions on Communications in 2016. This paper proposes a reduced-complexity variant of the SCD algorithm that achieves good decoding performance with lower computational complexity.

3."Adaptive Successive Cancellation Decoding of Polar Codes" by K. Niu, K. Chen, and J. Lin, published in IEEE Communications Letters in 2013. This paper proposes an adaptive version of the SCD algorithm that adjusts the decoding order based on the channel conditions.
4."Belief Propagation Decoding of Polar Codes" by I. Tal and A. Vardy, published in IEEE Transactions on Communications in 2015. This paper proposes a belief propagation (BP) decoding algorithm for polar codes that achieves good decoding performance with low computational complexity.
5."Fast Polar Decoding with a Hardware-Software Codesign" by E. Boutillon, N. Leprovost, and M. R. Bloch, published in IEEE Transactions on Very Large Scale Integration (VLSI) Systems in 2019. This paper proposes a hardware-software codesign approach for fast polar decoding that achieves high decoding throughput with low power consumption.

PROJECT METHODOLOGY

5G communication, short for the fifth generation of cellular technology, represents a transformative leap forward in wireless telecommunications compared to its predecessors. It introduces a wide array of innovations and capabilities designed to meet the growing demands of an increasingly connected world.

Both the encoding and the decoding process can in fact incur substantial speed and complexity overhead, while the performance of decoders is tightly bound to the characteristics of the polar code. Works focusing on hardware and software implementations can effectively broaden their audience by including compliance to the 5G standard. An industry standard is a document providing specifications for delivering a service agreed upon by a group of competing companies. This agreement allows different manufacturers to create products that are compatible with each other, so that standard details are often the result of a quid pro quo among companies. The outcome of the endless discussions and struggles among different agendas is a patchwork of techniques, whose mixture provides acceptable performance; for this reason, a standard usually represents the state-of-the art of a field more than its pinnacle.

Figure.1 Basic Blocks of Total Communication

SIMULATION & SYNTHESIS RESULTS

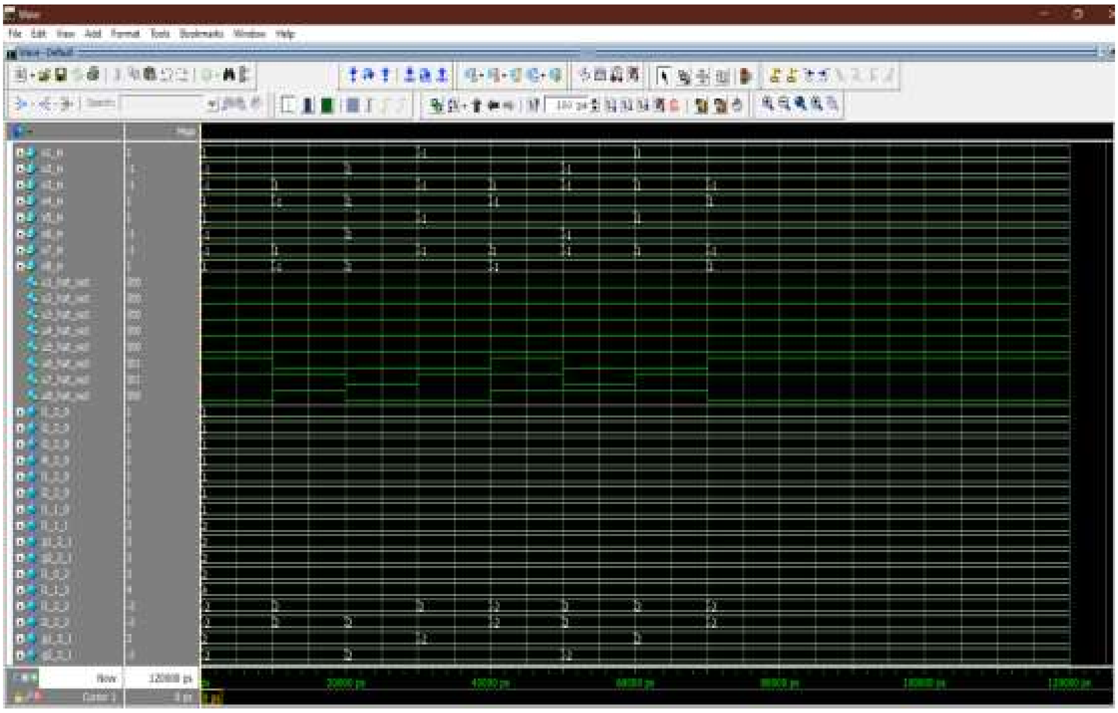


Figure.2 Stimulation result

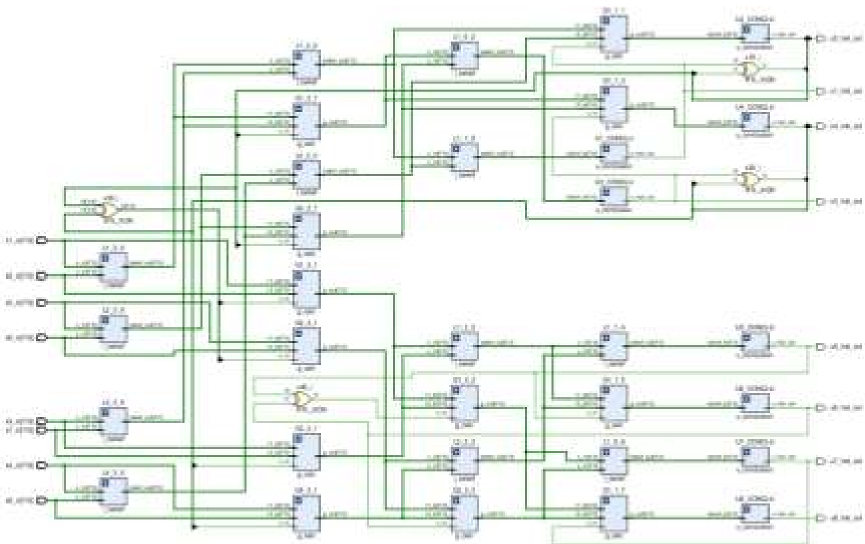


Figure.3 SC Polar Decoder Schematic

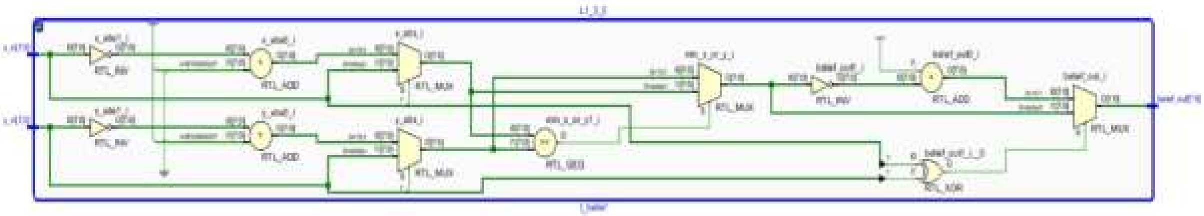
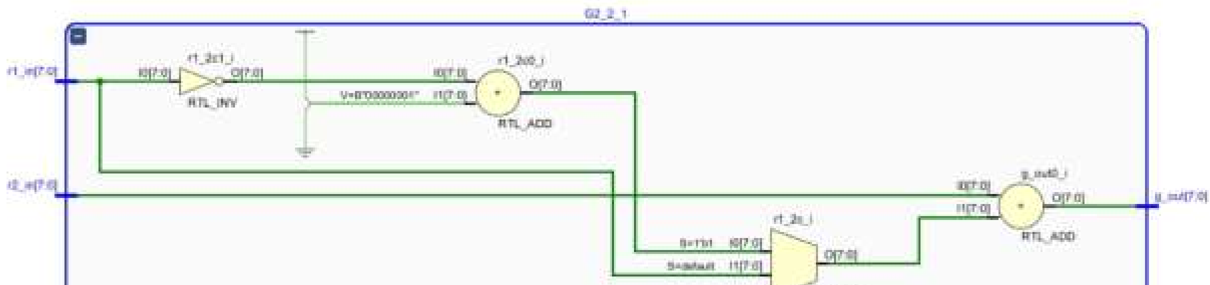


Figure.4   Schematic Decoder Polar L-Cell



F igure.5 Schematic Decoder Polar G-cell

Area Report

Site Type	Used	Fixed	Available	Util%
Slice LUTs*	424	0	303600	0.14
LUT as Logic	424	0	303600	0.14
LUT as Memory	0	0	130800	0.00
Slice Registers	0	0	607200	0.00
Register as Flip Flop	0	0	607200	0.00
Register as Latch	0	0	607200	0.00
F7 Muxes	0	0	151800	0.00
F8 Muxes	0	0	75900	0.00

Ref Name	Used	Functional Category
LUT6	195	LUT
LUT3	108	LUT
LUT4	88	LUT
LUT5	79	LUT
IBUF	64	IO
CARRY4	38	CarryLogic
LUT2	27	LUT
OBUF	8	IO
LUT1	3	LUT

ADVANTAGES

- Excellent error-correction performance.
- Low latency.
- Scalability
- Efficient use of resources
- Standardization

APPLICATIONS

1.5G wireless communication: The primary application of polar codes is in 5G wireless communication, where they are used to encode the data transmitted over the airwaves. Polar codes are particularly useful in 5G NR because of their ability to provide reliable communication in harsh environments, such as those with high interference and noise.

2.Internet of Things (IoT): Polar codes can also be used for communication in IoT devices, which are expected to play a significant role in the 5G ecosystem. IoT devices typically have limited power and processing capabilities, making them ideal candidates for low-latency and efficient error-correction techniques like polar codes.

3.Autonomous vehicles: The use of polar codes in autonomous vehicles is another potential application. These vehicles rely heavily on communication networks to transmit data, such as sensor data and mapping information, in real-time. Polar codes can ensure that this data is transmitted reliably and with low latency, which is critical for safe and effective operation of autonomous vehicles.

4.Edge computing: The use of polar codes in edge computing can help ensure reliable communication between edge devices and the cloud. This is particularly important in 5G NR, where edge computing is expected to play a significant role in enabling low-latency applications, such as virtual and augmented reality.

CONLCUSION

In polar communication, particularly through the implementation of polar codes, stands as a pivotal advancement in the realm of digital communication. Offering a potent combination of capacity-achieving performance, low complexity encoding and decoding, and adaptability to various communication scenarios, polar codes have emerged as a cornerstone technology in modern communication systems. Their significance is further underscored by their adoption as a fundamental component of 5G wireless communication standards, where reliability, efficiency, and flexibility are paramount. As the demand for high-speed, low-latency, and massive connectivity continues to escalate in the era of 5G and beyond, polar communication remains poised to play a crucial role in meeting these evolving requirements. With on-going research and development, polar communication holds the potential to unlock new frontiers in wireless communication, empowering innovations across industries and driving the realization of a more connected and technologically advanced world.

REFERENCES

1.IEEE Xplore Digital Library

IEEE Xplore is a comprehensive resource for technical literature, including papers related to polar codes and 5G communication. You can search for specific keywords like "successive cancellation decoder," "polar codes," and "5G" to find relevant papers.

2. Google Scholar

Google Scholar is another valuable tool to search for academic articles. Use specific keywords related to your topic and explore the latest research papers and conference proceedings.

3. Research Journals:

Look for articles in journals that focus on communication theory, information theory, and signal processing. Journals like the IEEE Transactions on Communications, IEEE Transactions on Information Theory, and others often publish papers on polar codes and decoding algorithms.

4. Conferences

Check proceedings from conferences such as the IEEE International Conference on Communications (ICC) and the IEEE Global Communications Conference (GLOBECOM). These conferences often feature the latest research in communication technologies.

5. University Research Databases:

Explore the research databases of universities and research institutions. Many researchers publish their work on institutional websites.

6. Books and Tutorials:

Books on channel coding, information theory, and 5G communication may also cover successive cancellation decoding of polar codes. Look for relevant books authored by experts in the field.