



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS**

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**SHORT ABSTRACT**

The introduction of 5G technology has significantly enhanced the Internet of Things (IoT), improving performance and reliability in applications such as smart cities and industrial automation. A key enabler of these advancements is the adoption of Low-Density Parity-Check (LDPC) codes, which offer superior error correction and high throughput efficiency. To meet the growing demand for adaptable coding rates in diverse environments, the 5G New Radio (NR) specifications include multiple LDPC coding rates and block lengths, ensuring compatibility across various devices and network configurations. An FPGA-based fixed-point decoder was developed to support these code rates, demonstrating high throughput, low latency, and optimized resource utilization across stable and dynamic settings, such as smart factories and remote sensing. However, the complexity of supporting various Base Graph Matrices (BGMs) in the 5G NR specifications presents challenges for traditional FPGA-based fixed-point LDPC decoders. To address this, a flexible FPGA-based stochastic decoder was proposed. This decoder simplifies inter-node routing by converting channel probability values into stochastic bit sequences, reducing hardware complexity and interconnects. The stochastic decoder offers a scalable, efficient, and energy-efficient solution for managing a broad range of code rates, making it a viable alternative to traditional decoders. Furthermore, this research explores the integration of deep learning with stochastic decoding to enhance the performance of 5G LDPC decoding. The proposed Stochastic Decoding-Convolutional Neural Network (SD-CNN) architecture improves the robustness of 5G communication, particularly in IoT applications affected by colored noise. This combined approach ensures more reliable and efficient communication across a variety of real-world scenarios, further advancing 5G's potential in IoT and industrial automation.