Stochastic computing using superconductive random number generators

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Abstract

Stochastic computing (SC) is a type of probabilistic computation that represents a numerical value as the probability of a '1' in a binary sequence. A major advantage of SC is its ability to perform complex logical operations with a remarkably small number of logic gates. For this reason, SC is attracting significant attention in fields like AI and machine learning, where approximate calculations are often sufficient and highly effective. However, SC does have certain disadvantages. These include the long computation time required for operations that demand high precision, and the need for high-quality random number sequences to ensure correct functioning.

In this presentation, we will introduce our research on SC hardware that addresses these challenges. Our approach utilizes single flux quantum (SFQ) circuits in conjunction with superconducting random number generators (SRNGs), which can generate a true random number sequence at a generation rate of beyond 30 Gbps [1,2]. We believe that SRNGs are an ideal solution for SC hardware implementation because they possess several key characteristics: a compact area, low power consumption, and very high operating speeds. Furthermore, the use of SRNGs is also highly effective for the scalable expansion of SC circuits. We will present a comprehensive overview of our work, including design and measurement results of several SC arithmetic circuits [3], the scalable interconnects of SC circuits using SRNGs [4], and the interfaces between the conventional binary computation system and our SFQ-based SC circuits.

References

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