

Dynamics Based p-bits for Invertible Logic

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Invertible logic, a promising paradigm for unconventional computing, enables bidirectional logic operations, offering the potential for complex problem-solving. This work proposes a novel architecture for invertible logic using networks of coupled nonlinear dynamical systems as probabilistic bits (“p-bits”). We explore two approaches: (1) Noise-driven p-bits, where noisy nonlinear systems perform logic operations in forward mode with fixed inputs and explore valid input combinations in reverse mode with clamped outputs. Optimal robustness is observed within a specific noise range, akin to stochastic resonance. (2) Deterministic p-bits, using coupled chaotic systems. Attractor geometries and transitions represent logic operations, enabling parallel implementation of NOR/NAND, OR/AND, and their inverses. Both approaches leverage system dynamics to mirror logic in both directions. Proof-of-principle electronic circuit experiments validate the concepts, demonstrating robustness and potential for diverse physical realizations. These dynamics-based p-bits offer a robust and parallel approach to invertible logic.
