Design of Quantum Circuits for performing Arithmetic Operations (#17)

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Qiskit

Idea: To Construct Reversible Circuits

Goal:

- *To construct/design reversible quantum circuits.*
- *Implement using Qiskit.*
- *Optimize the quantum circuit in terms of cost, depth, etc.*
- *To contribute the implemented idea as a Journal Paper.*

Problems Considered

1. *Two's Complement Adder/Subtractor*
2. *BCD Adders/Subtractors*
3. *Code Convertors*

Our Contribution # 1 - Two's Complement Adder/Subtractor

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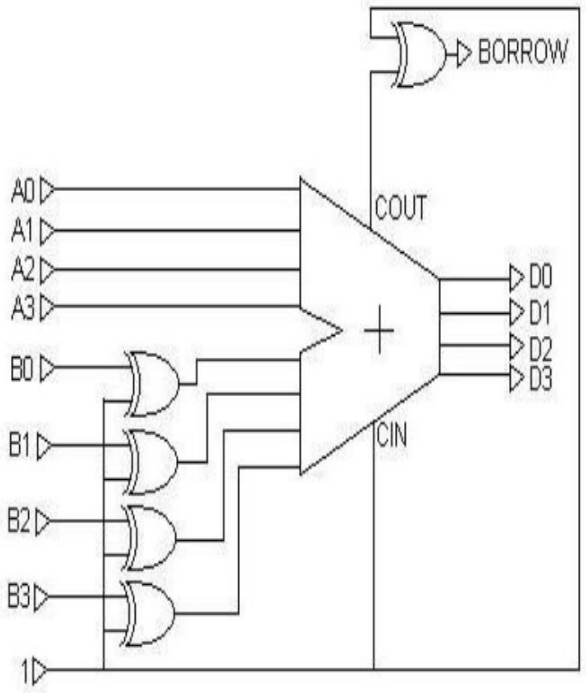
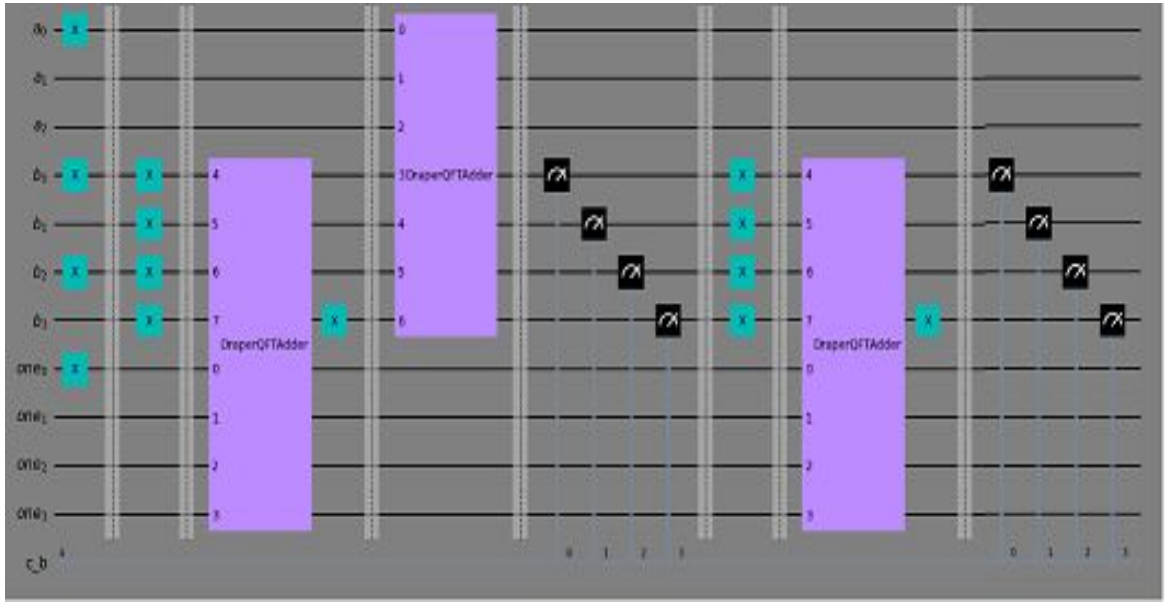
Classical Circuit



Quantum Circuit

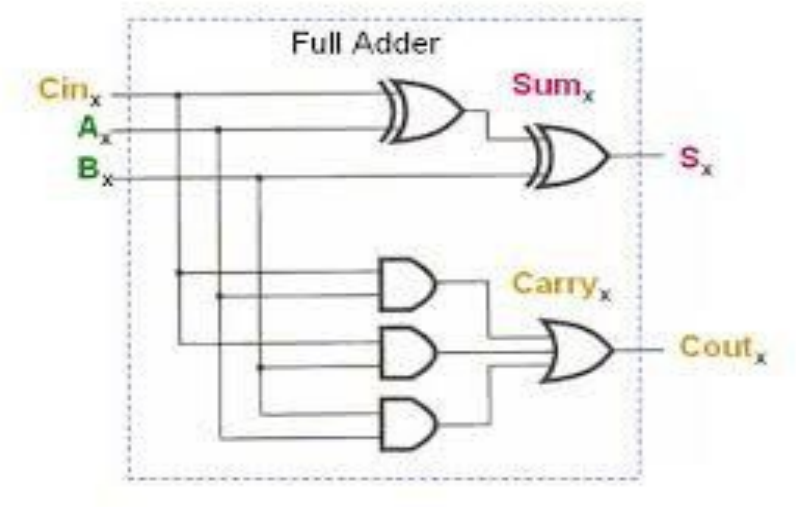


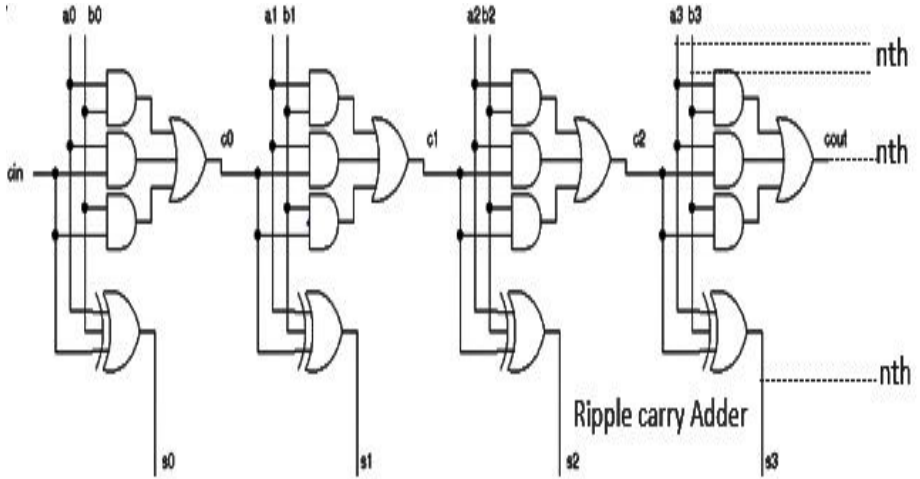
- from qiskit.circuit.library import DraperQFTAdder

Our Contribution # 2 BCD Adders

Qiskit

Classical Circuits

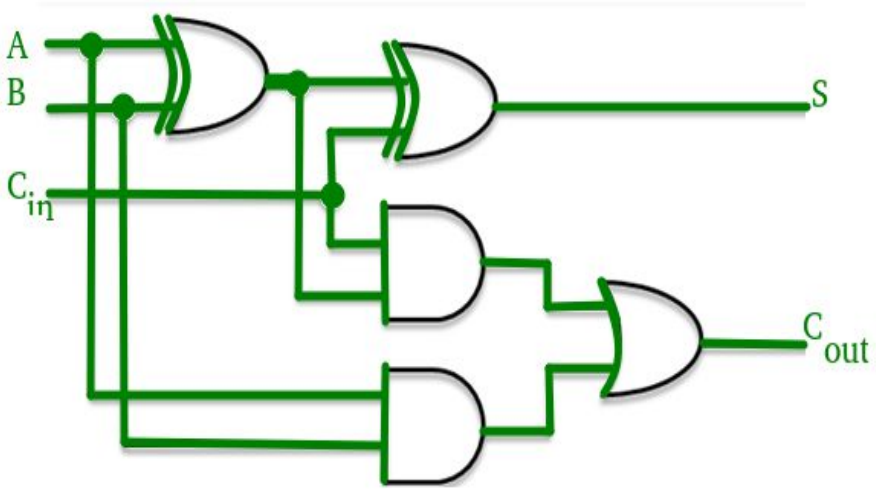




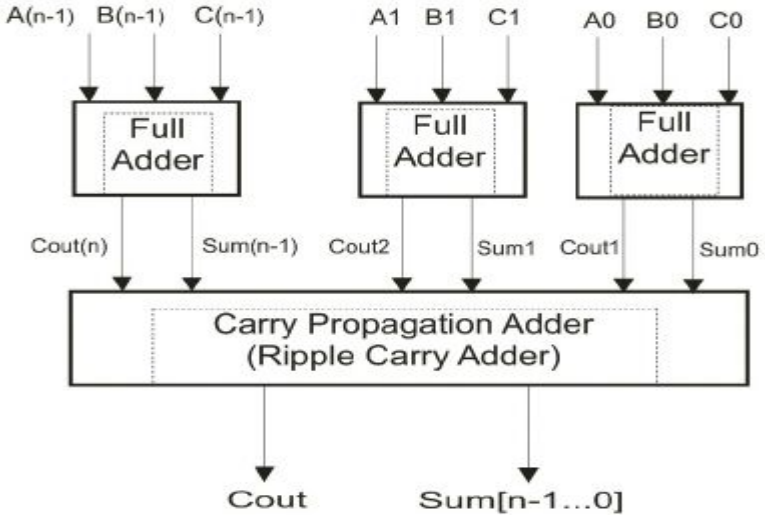
N-bit Ripple-Carry Adder

Our Contribution # 2 BCD Adders

Qiskit

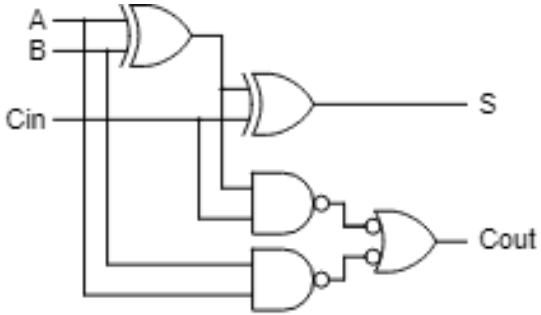


Carry Lookahead adder

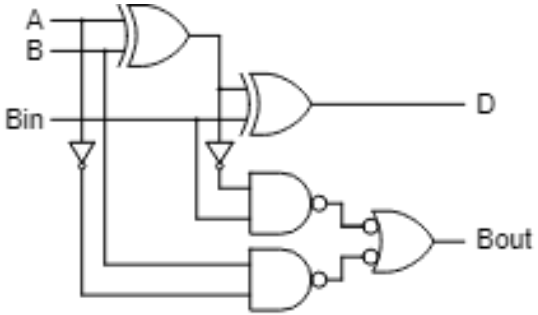


Carry save adder

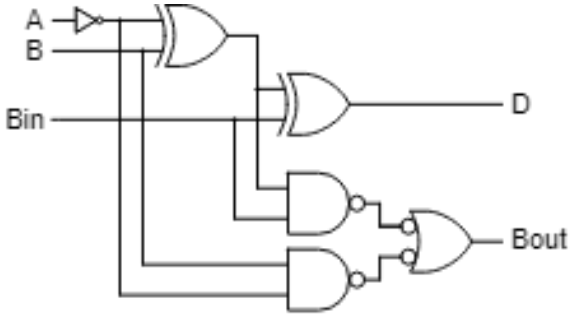
Our Contribution # 2 BCD Subtractor



Full Adder



Full Subtractor



Full Adder
configured for subtract

Ripple Borrow Subtractor

Our Contribution #2 BCD Adders/Subtractors

Qiskit

Quantum Circuits - The quantum counterparts to classical circuits for arithmetic operations

In the current scenario, the development of quantum circuits for BCD (Binary-Coded Decimal) addition and subtraction is an active area of research within the field of quantum computing. Researchers are exploring various approaches to design efficient and scalable quantum circuits that can perform arithmetic operations on BCD numbers.

One of the primary challenges in developing quantum circuits for BCD addition and subtraction is handling the unique properties of BCD representation, where each decimal digit is encoded using four binary bits. Quantum circuits need to ensure that the carry and borrow operations are correctly implemented, taking into account the constraints of BCD arithmetic.

Our Contribution # 3 - Code Converter (BCD to Excess-3 code)

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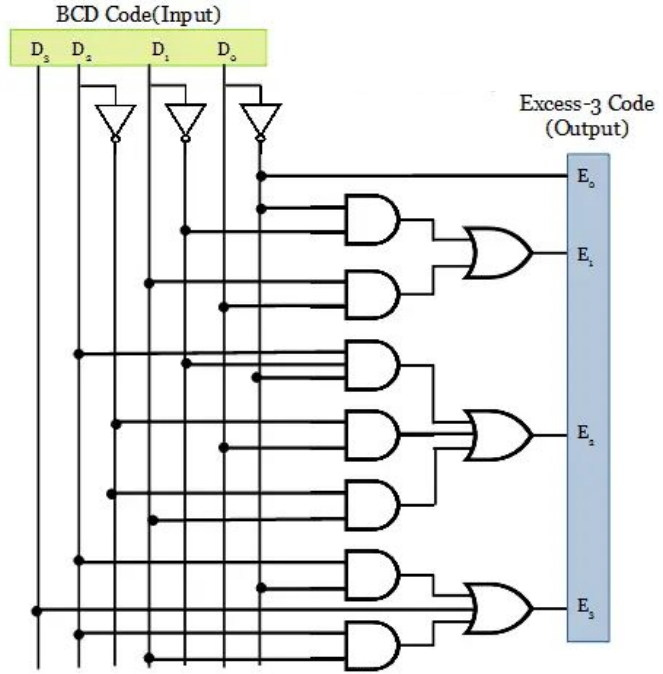
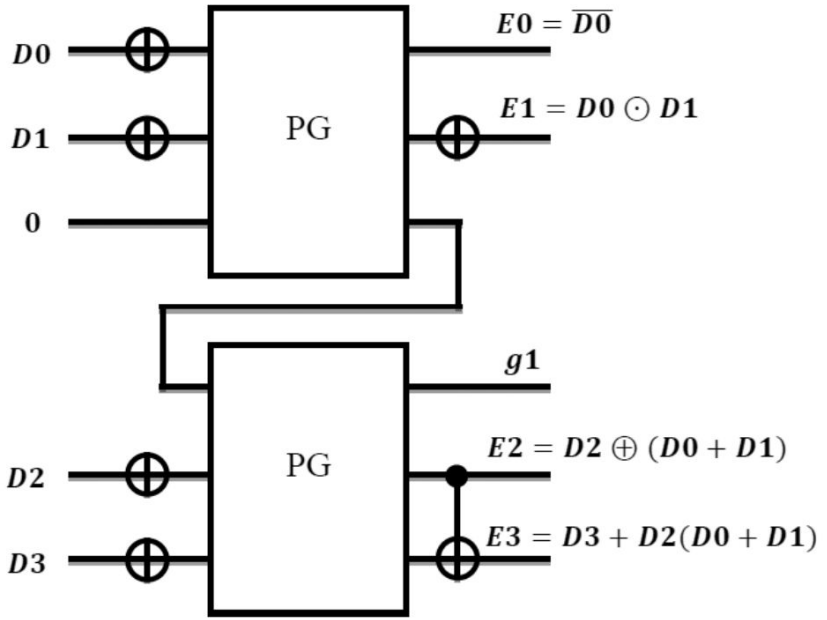
Classical Circuit



Quantum Circuit



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Future Work

Qiskit

1

Designing reversible circuits for the identified logical circuits

2

Implementation of the reversible circuits using Qiskit

3

Optimize the quantum circuit

4

Publishing the results and contributing towards the Qiskit environment