Converting Classical BCD Adder to Quantum Circuit with User Input in Qiskit

Ahalya. R

1931003

AIM

To construct a BCD adder that consists of two 4 bit parallel adder and a combinational circuit. The input of one 4 bit adder is given as the input to combination circuit and to another 4 bit parallel adder.

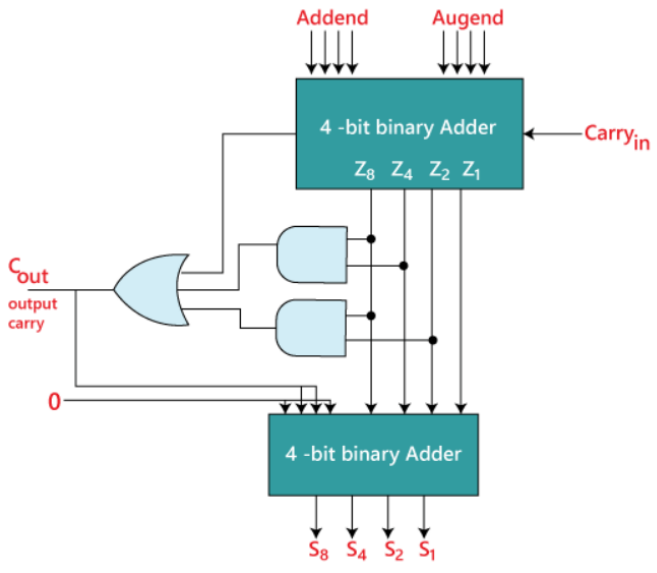
ABSTRACT

Quantum computing has the potential to provide exponentially faster computation than classical computing. By converting classical BCD circuits into quantum BCD circuits, we can take advantage of the power of quantum computing and achieve faster and more efficient computations.

SHORT DESCRIPTION

Implementation of BCD adder is done using quantum multiple gates. The input for this circuit is two 4 bits (addend and augend). It is different from existing quantum BCD adder because the inputs are given by the user in runtime. The following quantum solution is a generalized one.

CLASSICAL BCD CIRCUIT



The output consists of bits that is sum of addend and augend which is BCD values.

Binary Sum						BCD Sum						Decimal
K	Z_8	Z_4	Z_2	Z_1		C	S_8	S_4	S_2	S_1		
0	0	0	0	0	SAME CODE	0	0	0	0	0		0
0	0	0	0	1		0	0	0	0	1		1
0	0	0	1	0		0	0	0	1	0		2
.	.	.	.	.		.	.	.	.	.		.
.	.	.	.	.		.	.	.	.	.		.
.	.	.	.	.		.	.	.	.	.		.
.	.	.	.	.		.	.	.	.	.		.
0	1	0	0	0		0	1	0	0	0		8
0	1	0	0	1		0	1	0	0	1		9
10 to 19 Binary and BCD codes are not the same												
0	1	0	1	0		1	0	0	0	0		10
0	1	0	1	1		1	0	0	0	1		11
0	1	1	0	0		1	0	0	1	0		12
0	1	1	0	1		1	0	0	1	1		13
0	1	1	1	0		1	0	1	0	0		14
0	1	1	1	1		1	0	1	0	1		15
1	0	0	0	0		1	0	1	1	0		16
1	0	0	0	1		1	0	1	1	1		17
1	0	0	1	0		1	1	0	0	0		18
1	0	0	1	1		1	1	0	0	1		19

USEFULNESS

Quantum BCD adders are useful in quantum computing because they can perform BCD addition faster than classical computers. Quantum computing allows for parallelism and superposition, which can speed up calculations for certain types of problems. In particular, BCD addition is a problem that can be parallelized in quantum computing.0

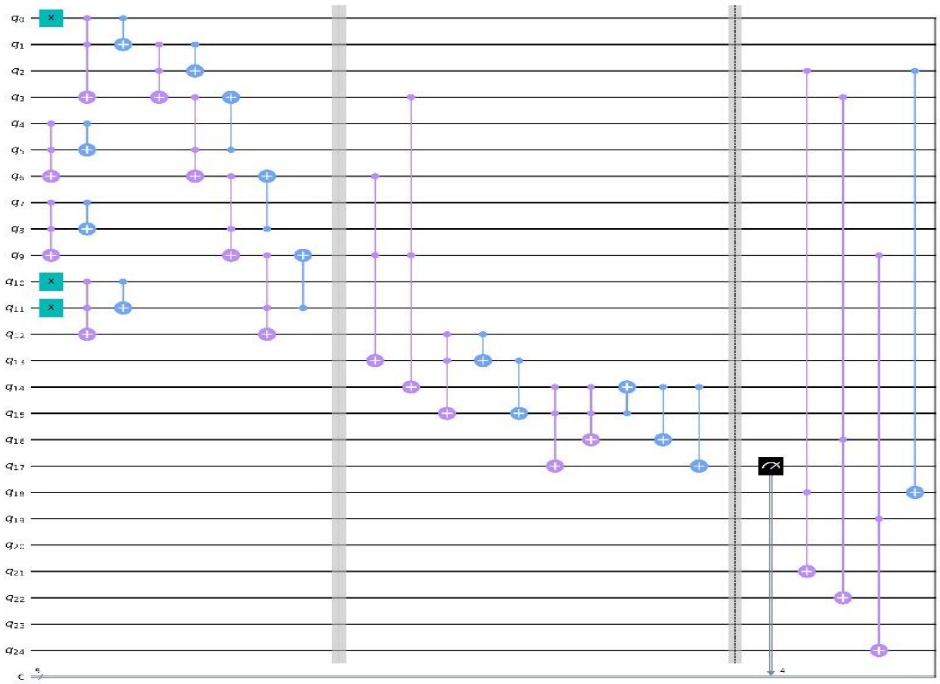
However, it's important to note that quantum BCD adders are not a general-purpose tool for all types of arithmetic operations. They are specifically designed for BCD addition, and other types of operations would require different quantum circuits.

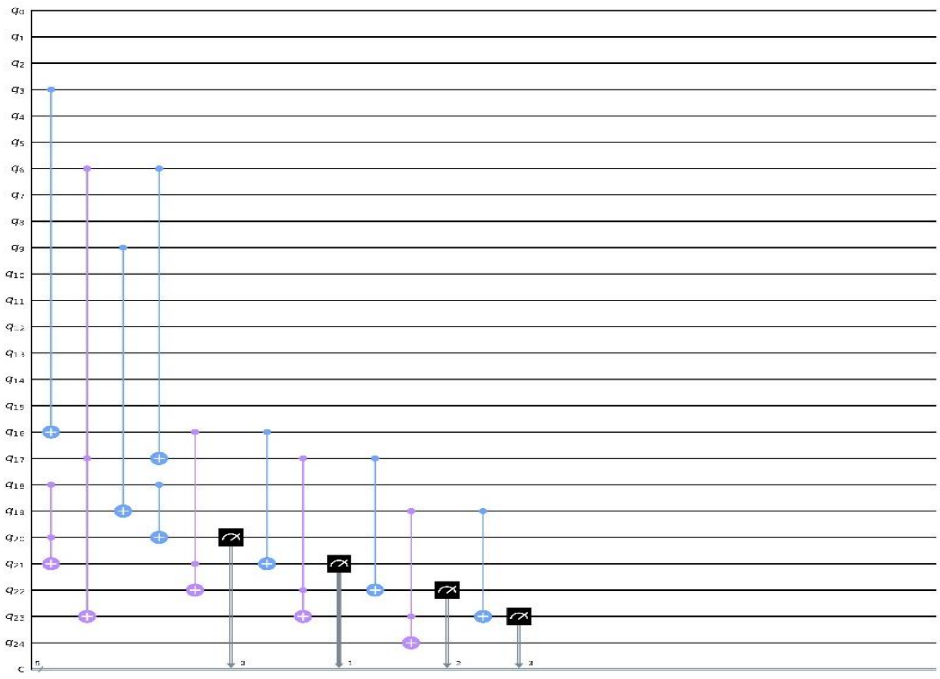
QC CONCEPTS

- Quantum Registers: The code defines a quantum register using the QuantumRegister() function to hold the qubits used in the circuit.
- Quantum Circuit: The code uses QuantumCircuit() function to define the quantum circuit that holds the quantum register and the quantum gates used in the circuit.

- Quantum Gates: The code uses various quantum gates like CX (CNOT), CCX (Toffoli), and X gates to manipulate qubits based on the input classical bits.
- Measurement: The code uses the measure() function to measure the qubits and obtain the output of the circuit.
- QASM Simulator: The code uses Aer.get_backend() function to obtain the QASM simulator backend for running the quantum circuit and obtaining the result.

CIRCUIT DIAGRAM





SAMPLE INPUT AND OUTPUT

INPUT

Enter a input : 1001

Enter a input : 1000

Output : 10111 (BCD 17)

INPUT

Enter a input : 0111

Enter a input : 0101

Output : 10010 (BCD 17)

THINGS LEARNED

- To get an input from user and apply gates according to the input before going to BCD adder.
- To reduce the depth of circuit.
- On further improvements the user input can be in decimal number and converting that decimal into binary bits which will be then given to BCD adder for calculation.

REFERENCES

- **https://www.javatpoint.com/decimal-or-bcd-adder-in-digital-electronics**
- **http://ijariie.com/AdminUploadPdf/IMPLEMENTATION_AND_DESIGN_OF_BCD_ADDER_USING_QUBIT_GATES_FOR_QUANTUM_APPLICATIONS_ijariie10841.pdf**