Finding Smallest Number in a Set Quantum Circuit

P.k.Vijay
Department of CSE
Anna University

Abstract – **Finding smallest number in a set which is a simple process which can be performed in a classical computer. Then what is the reason of this paper?**

The main motive of this paper is not finding the smallest number using the iterative method i.e. using classical computer but rather using the most power computer ever built i.e. "Quantum computer". But what is the use of quantum computer for this purpose which can be performed using a normal laptop? So in order to explain this question lets create a situation that you have to find out the hospital which is at the shortest distance in one shot (emergency situation) and you are given with a classical computer and quantum computer. Let's say you selected a classical computer for this job you don't succeed because basically normal computers which actually works by iterative method i.e. going one by one. But if you selected Quantum computer you can find the solution in one shot. Where this power comes from? Basically from two concepts "superposition" and "entanglement". So this paper explains how to find the smallest number in a set using a quantum circuit.

Keywords– **Quantum Circuit ,IBM, Quantum computer.**

I. INTRODUCTION

Quantum computers works with help of qubits which is similar to the bits in the classical computer. So what makes these qubits special are they can be 0 or 1 or 0 and1 but when you take a simple bit it can take only 0 or 1. This property of 0 and 1 is called superposition. Due to the advantage of superposition it can process many states at the same time. Another concept which makes this Quantum computer to be powerful is entanglement.

Let's take two qubits and if these two qubits are entangled then with the help of one qubit we can measure other and the distance does not matter e.g. the two qubits can separated at the either side of the universe. So these two concept i.e. superposition and entanglement combine to power the Quantum computer.

Since there is no high level language for programming we have to use quantum circuits to perform experiments. Eventhough we have algorithms to solve for finding smallest number either it takes larger number of qubits to process or it will work out only for specific process. So the algorithm which proposed in this paper is more generalized i.e. it can be used for larger numbers and it is efficient in using the qubits. So let us take some example problem and understand the algorithm.
Problem 1: Find the smallest number in the set [1, 2, 0]

Before setting up our quantum circuit we have to convert each number of the set to 0's and 1's in order to input the data to the circuit. Since the range of our problem is very small we can represent each of the number as two bit number.

Fig.1. Input structure.

So the input data to the quantum circuit will be [01 , 10 , 00] . In order to construct the quantum circuit we should have better understanding of the input. Analysis made on one input is shown in the above figure.
The below flowchart should be converted into quantum circuit. We are going separate all the left and right bit. Qubits are represented as ket 1 or
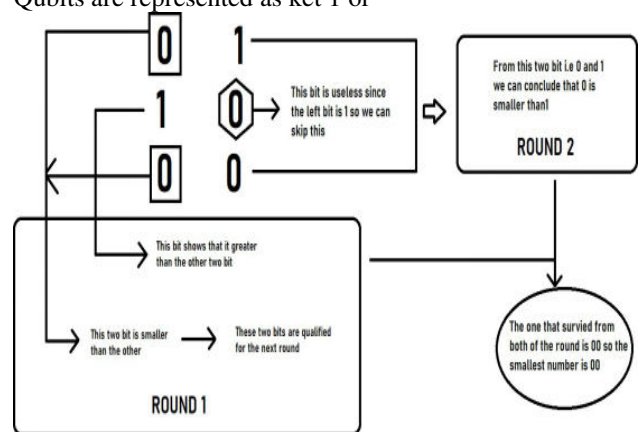

Fig.2. Flow chart.

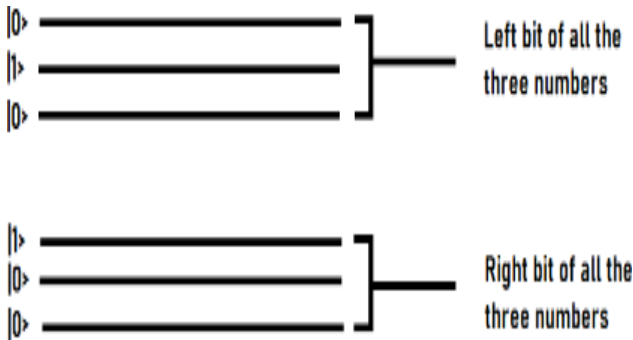ket 0. The below figure shows how we are going to send input to our quantum circuit.

Fig.3. Part 1 of the circuit.

Then after defining our input we should define our quantum gates to calculate the smallest number. The gates should be such that it should allow only smallest qubit to next level.
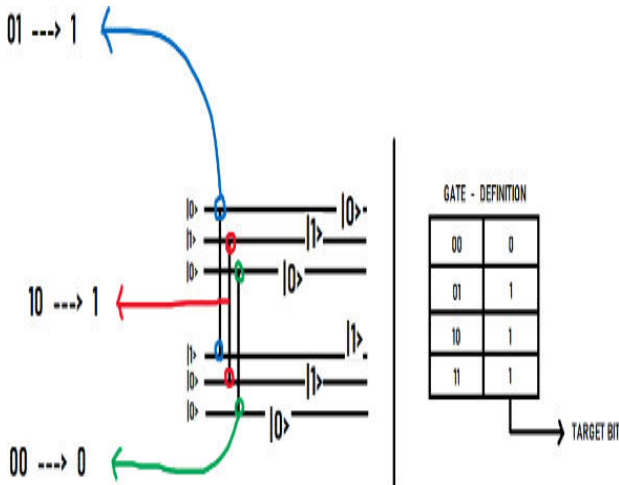

Fig.4. Part 2 of the circuit.

For storing the result another two qubits are required. So total number of qubits which is used in this process is 8. For processing the input 6 qubits and for storing the result two qubits are required.

NUMBER OF QUBITS REQUIRED = (NO. OF ROW * NO. OF COLUMN) + NO. OF COLUMN

Let's take this circuit and apply the above formula to get number of qubits.

NUMBER OF QUBITS REQUIRED = (3 * 2) + 2 = 8

The last step for completing the circuit is to apply the AND gate (with the help of quantum gates).

So the answer that came of the circuit is ket 0 and ket 0 i.e. according to the circuit the smallest number in the set of three numbers is 00. The decoded version of 00 is 0 which is correct. The main point is we done it all in one step or shot. When we give this problem to the normal computer it would take atleast 6 steps to complete i.e. it will go through the 6 bits 01 , 10 , 00 iteratively and then only it will give the answer. Since we are using the property of entanglement (gate which we are using helps us to create entanglement). Finally defining the general circuit for finding the smallest number in a set.

The last step for completing the circuit is to apply the AND gate (with the help of quantum gates).
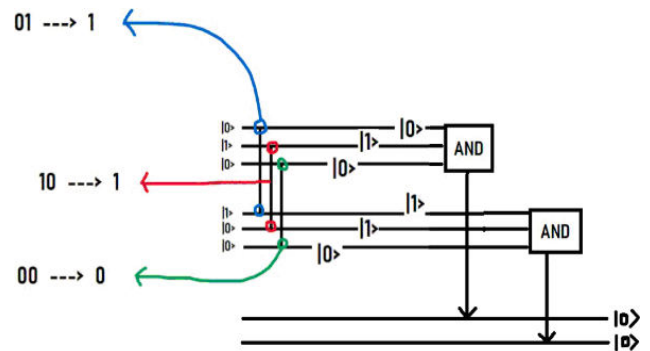

Fig.5. Part 3 of the circuit.

So the answer that came of the circuit is ket 0 and ket 0 i.e. according to the circuit the smallest number in the set of three numbers is 00. The decoded version of 00 is 0 which is correct. The main point is we done it all in one step or shot. When we give this problem to the normal computer it would take atleast 6 steps to complete i.e. it will go through the 6 bits 01 , 10 , 00 iteratively and then only it will give the answer. Since we are using the property of entanglement (gate which we are using helps us to create entanglement). Finally defining the general circuit for finding the smallest number in a set.
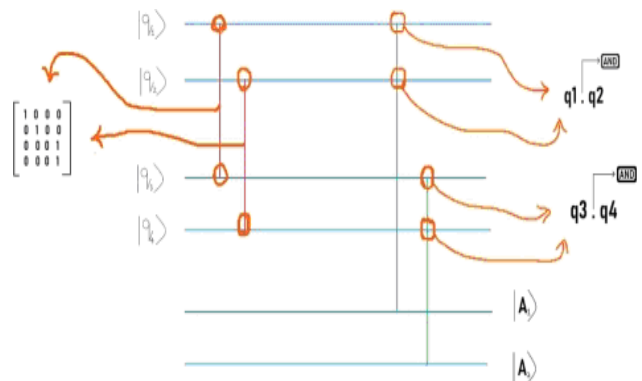

Fig.6. Part 3 of the circuit.

REFERENCES

[1]. IBM Quantum Experience

[2]. Building your Quantum circuit in python - https://towardsdatascience.com/building-your- own-quantum-circuits-in-python-e9031b548fa7 (author - Rishabh Anand)

[3]. Quantum computing using Qiskit - https://qiskit.org/textbook