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Department of Electronics and Communication Engineering

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

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A Study of Deutsch Jozsa Algorithm on Computational Basis

Priyanka Sharma
Department of Electronics & Communication
SKIT M & G Jaipur
Jaipur, India
priyankas@skit.ac.in

Rukhsar Zafar
Department of Electronics & Communication
SKIT M & G Jaipur
Jaipur, India
rzafar@skit.ac.in

***Abstract*— Quantum Computing is one of the most recent technology in the computer science domain. Its root is tied to underlying concepts of quantum mechanics. Classical computing approach is quite different from quantum computing approach. Various program constructs are available for programming the quantum computers. Different circuits are designed for applying quantum mechanics concepts on some applications. In this paper, we have illustrated few quantum circuits that work on qubits and give output in inclination with the quantum concepts. Here, we have analyzed a quantum algorithm which possess an important property of being constantly balanced called a global property. This property is given by an n-bit function f : {0, 1} n → {0, 1} which is promised to be constant or balanced, and we wish to determine which is the case. Here, constant means f(x) is the same for all x ∈ {0, 1}, and balanced means is f(x) = 0 for precisely half the x ∈ {0, 1} n and f(x) = 1 for the remaining inputs. In this paper, we have carried out the complete analysis of this quantum algorithm that is applicable to single qubit. We presented a complete implementation of this algorithm using quantum computing circuit.**

Keywords—quantum computing, programming, quantum circuits, quantum mechanics, quantum gates

I. Introduction

In recent researches in the field of quantum computations and information sciences [1], many simulation responses proved that quantum computations are far efficient than the classical ones [2]. Quantum Cryptography is another revolution in the domain of encryption and information security & optimization [3-4].Using Shor's algorithm, prime factorization and discrete logarithmic algorithms have been implemented on quantum computer [5]. In the field of image processing and maritime application, quantum computational algorithms have proved to be very efficient in their performance and output [6-11]. IBM quantum computing unit is constantly working in quantum field and proving its researches in the world. [12].

In this paper, we have discussed about the first quantum algorithm known as Deutsch Algorithm. When we compared this algorithm with classical algorithm then it proved to be more efficient. It demonstrated the quantum parallelism and settlement of quantum interference. To understand the working of this algorithm, let us consider that we have a black box called Oracle and an unknown function has to be implemented on it. There is no information about this function but the task of this Deutsch Algorithm is to check that this function is constant or balanced. It is useful in demonstrating the quantum parallelism, the situation when all the computations are can be performed concurrently[13]. In this paper, we have observed the capability of the algorithm in describing its power in determining the global property of specific function by performing only one evaluation of that particular function[14-15].

Deutsch Jozsa algorithm is helpful in demonstrating that we can allow quantum amplitudes to take both the positive as well as negative values instead of considering only the non-negative values by classical probabilities.

II. Functional Analysis of Algorithm

Figure 1 provides a schematic diagram of grid-integrated photovoltaic system. In this algorithm, we are checking that an unknown function is constant or balanced.

To perform this check, let us consider the unknown function behaviour. It can be approximated by the following idea that

$$f:\{0,1\} \rightarrow \{0,1\}$$

There are four possible formations of functions can be represented as :

Such formation of function is called as constant function.

f_0:	$0 \rightarrow 0$	$1 \rightarrow 0$
	f(0)	0
	f(1)	0

f_1:	$0 \rightarrow 1$	$1 \rightarrow 1$
	f(0)	1
	f(1)	1

Such formation of function is called as balanced function.

f_1:	$0 \rightarrow 0$	$1 \rightarrow 1$
	f(0)	0
	f(1)	1

f_1:	$0 \rightarrow 1$	$1 \rightarrow 0$
	f(0)	1
	f(1)	0

The problem is to determine whether the function f is

- Constant : $f(0) \oplus f(1) = 0$; $f(0)=f(1)$;
  Output of algorithm = 0
- Balanced : $f(0) \oplus f(1) = 1$; $f(0) \neq f(1)$;
  Output of algorithm = 1

Let our function consists of two qubits. If output of algorithm is zero by measuring the first qubit, then it is a constant function otherwise it is a balanced function. Quantum logic gates are basically unitary operators and can be illustrated by unitary matrices on standard or computational basis. For representing the qubits, we use dirac notations which are braket notations. In this algorithm, we will use two quantum logic gates: Hadamard gate and CNOT gate.

Hadamard gate is Hermitian as well as unitary. Hermitian referes to those which has a restricted set of unitary operations having self-inverse property. Unitary refers to those that can be specified by unitary matrix.