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ScienceDirect

IERI Procedia 10 (2014) 144 – 152

Procedia IERI

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2014 International Conference on Future Information Engineering

# A Comprehensive but not Complicated Survey on Quantum Computing

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**Abstract**

This paper discusses the basic components that are required to build a quantum computing environment. Quantum computers have a distinctive advantage over classical computers due to its ability to solve problems with large number of computations faster. To utilize these capabilities to its best, we should ensure that the computers are on par with the quantum computing requirements to float a working environment. The whole thrust on this is to ensure that the quantum computing environment is chained by the laws of quantum mechanics. The issue becomes more complicated when it is to be executed on a classical platform. This paper surveys the basics of Quantum Computing and the existing Quantum Computing simulators. Further, it also points out the basic rules to ensure a proper translation of each capabilities from a classical system to a quantum system and vice versa.


Selection and peer review under responsibility of Information Engineering Research Institute

*Keywords*:Quantum computer; qubit; superposition; entanglement; parallelism; Bloch sphere;

## 1. Introduction

Quantum computers have their principles based on quantum physics. Unlike today's computers, Quantum computers have to go a long way before we start using them on a day to day basis. Quantum computers is the next generation of computers that are expected to overcome some of these limitations. They are said to reduce the number of computations to complete a process. Meanwhile the time needed for these computations are said to take longer. Even with such complexities they are said to overcome certain difficulties that we face with the classical computers.


Selection and peer review under responsibility of Information Engineering Research Institute
doi:10.1016/j.ieri.2014.09.069

But today they exist on paper or as experiments at high end laboratories that are part of various premier global institutions, companies and research groups. Though there are a few emulators and simulators that are available to people who do not have access to such facilities. These emulators and simulators have their limitations. Section 2 describes the basics of quantum computing and the various underlying theories. Section 3 is on Quantum gates which form the basis for the hardware that Quantum computers work upon. Section 4 discusses a few programming languages and libraries that are used to simulate a quantum computing environment. Quantum algorithms that enable Quantum computers to produce the same result with lesser computations is discussed in section 5. Advances in this area are elaborated in Section 6. At last we conclude the paper in section 7.

## 2. Basics of quantum computers

The differences between Quantum computers and its contemporaries arise from its hardware compositions. With proper understanding and better implementation of a quantum computer we can use it to solve various problems that we face in a classical computer.

### *2.1. Qubit*

The elementary component of a Quantum computer is a qubit [16]. Qubits are found in a Quantum computer as photons or nucleuses of certain elements. The minute particles that form the fundamental part of a qubit in the form of a quantum particles make a qubit. They influence various physical properties that a qubit exhibit [16]. These properties are called superposition, entanglement, parallelism. In a Quantum computer a qubit is directed into two distinctive spin directions a spin up for 0 and spin down for 1 [16]. This distinction is necessary to ensure that data is demarcated properly when superposition and entanglement comes into play on the same qubit.

At normal room temperature these photons are in a really unstable state [11]. As they are bouncing around from a lower energy state to a higher energy state and vice versa. Tough at a substantially low room temperature they are at a stable spin down state. If the spin has to be altered into a spin up or down position external energy is need to do this alteration [11].

$$|0\rangle = 0 \qquad |1\rangle = 1$$

This form of notation is called the Dirac notation [16].

Fig. 1.

The first spin state represents |1> and the second represents |0> [16].

### *2.2. Superposition*

The most important ability of a Quantum computer is that it can superimpose various bit with different values into a single qubit this property is called superposition [16]. The distinctive superposition property is exhibited when both the sates co-exist in a single qubit. Here the qubit is considered to be depicting a |0> state as well as a |1> state individually they are called the basis state [2]. Their coexistence is governed by a factor called the probabilistic amplitude [2]. This probabilistic amplitude is important to determine a value for the