Chapter 13
Investigations on the Swiftness of a Quantum and a Classical Processor

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ABSTRACT

The cutting-edge technologies cloud computing and IoT are taking an upper hand in every domain. A huge and wide variety of data is being handled and processed by clouds. The cloud federation technique further adds up to this. In the coming years, quantum computers will replace the conventional computers. Pulling out particular data from the gigantic data set processed by clouds in a conventional computer would take a considerable amount of time. In the chapter, Grover's algorithm, a search algorithm, is implemented on traditional computers on IBM quantum simulator and also on QUIRK quantum simulator. Three qubit data is considered in the proposed scheme. The objective of this chapter is to compare the execution time taken to run the Grover's algorithm on IBM and Quirk quantum simulators and on classical computers. The work carried out proves that quantum computer execution speed is high compared to the classical counterpart. This could be effectively used in the future in searching for specific data from a mammoth data set using quantum simulators.

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INTRODUCTION

The widely used recent technologies include Cloud Computing (Naved et al., 2022)(Gupta et al., 2022), Internet of Things (Dhingra et al., 2021), Quantum Computing (Seegerer et al., 2021),..etc. The scalability, automation, speed and cost efficient features of them have enabled many organizations, corporate's, government sectors and companies to implement them in handling the data, processing the data, maintaining their databases and in achieving their intended goals. The Clouds (Kannadasan et al., 2018)used by organizations and corporate's these days, generally are dumped with huge and a wide variety of data.

The most significant usage of any database is information storage and recovery. With the Cloud's handling huge amount of data (Li et al., 2022), locating a particular item in a given database is generally time consuming. The faster the required data is determined, further processing of the same is carried out without any delay.

The work carried out confirms that the quantum processor finds out the required item very much faster than the conventional processors in searching a particular item from the given database. Grover's algorithm is executed on a quantum processor and also on a traditional processor. The processing time taken to perform the execution in both the processors are also recorded and compared.

Any classical computer generally takes (N/2) iterations to locate a specific data or at the worse would require (N-1) iterations for a given data base. Identifying an item O(N) with N being the size of the database can be executed using brute force search technique. However, 'binary search' is a search algorithm which requires sorting of the data. The unsorted database cannot be searched with the binary search technique. The significant drawback of binary searching is filtering and then searching. The most difficult moment finding an object using this method is O(log N). In real time scenario however, sorting the data all the time is not possible. Hence, an efficient system is required to hunt for the precise data from the given record without sorting. This would also be appreciable if it could take less time than the conventional computing. Accomplishing this task, is a challenging job.

Implementation of Grover's algorithm using a quantum computer is the answer to this. Quantum computer makes use of quantum computing concepts which have been influenced by quantum mechanics. Quantum computing (Abd El-Aziz et al., 2022b; Golestan et al., 2023) is an emerging technology where the speed of its computing is very high. The days are not far away when quantum computers will replace the conventional computers.

A Quantum computer (S et al., 2022) is a one which uses the principle of quantum mechanics to do the computation (*IBM - India | IBM*, n.d.; *IBM Quantum Computing | Tools*, n.d.). It is Feynman, the American physicist who introduced the concept of quantum mechanics. A quantum computer (S et al., 2022) takes ($\sqrt{N}$) iterations to find the required data from a given length of database 'N=2^n', where 'n' is the number of bits used. Quantum computing is an interesting area of research which finds its applications in the areas of cyber security, artificial intelligence, computational chemistry, machine learning, drug design, logistics and scheduling, data management, financial services etc. Quantum computing makes use of quantum mechanical effects such as superposition, entanglement and quantum tunneling to perform a computation more effectively. Quantum computation provides the possibility to significantly decrease both runtime (Wack et al., 2021) and power usage compared with traditional digital computation. However, the quantum programming differs substantially from traditional computer programming. Classical or Conventional computing makes use of laws of mathematics while Quantum computing makes use of the laws of physics. All the significant quantum algorithms found to date execute functions exponentially quicker than their classical peers. A classical computer makes use of bits to perform computation while