IJCSEInternational Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.8, Issue.5, May 2020 E-ISSN: 2347-2693

Quantum Computing:A possibility to find COVID-19 antidote

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DOI: https://doi.org/10.26438/ijcse/v8i5.3742 | Available online at: www.ijcseonline.org

Received: 10/May/2020, Accepted: 18/May/2020, Published: 31/May/2020

***Abstract*—** Today, the whole world is suffering from pandemic of Covid-19 diseases. Corona virus disease 2019 (COVID-19) is an illness caused by a novel coronavirus now called as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; formerly called 2019-nCoV), which was first identified amid an outbreak of respiratory illness cases in Wuhan City, Hubei Province, China. Today, every country in the world is trying to find the antidote of COVID-19. Meanwhile, a hope to find the medicine of Covid-19, can be seen through Quantum Computing. For the readers who are not familiar with quantum computation, a brief introduction to it is provided. Classical computers that are used today can encode information only in binary format that take the values of 1 or 0. This restricts the ability of classical computers. On the opposite hand, Quantum computing is a region of computing that deals with developing engineering supported the principles of scientific theory, that explains the behavior of energy and material at the atomic and subatomic levels. Quantum computing uses quantum bits or qubits. it's the distinctive ability of subatomic participles that enables them to exist in additional than one states i.e. one and zero at an equivalent time. These supercomputers area unit supported by Superposition and entanglement, 2 vital options of physics. Quantum computing relies on the principles of scientific theory and uses the quantum-mechanical phenomena like superposition and entanglement to perform computations.

***Keywords*—**Quantum computing, COVID-19, Quantum Computers, Superposition, Entanglement, Qubits

I. INTRODUCTION

Classical computers that are used today can encode information only in binary format that take the values of 1 or 0. This restricts the ability of classical computers. On the opposite hand, Quantum computing is a region of computing that deals with developing engineering supported the principles of scientific theory, that explains the behavior of energy and material at the atomic and subatomic levels. Quantum computing uses quantum bits or qubits. it's the distinctive ability of subatomic participles that enables them to exist in additional than one states i.e. one and zero at an equivalent time. These supercomputers area unit supported by Superposition and entanglement, 2 vital options of physics. Quantum computing relies on the principles of scientific theory and uses the quantum-mechanical phenomena like superposition and web to perform computations. Computers that perform quantum computation area unit referred to as quantum computers. Quantum computers area unit presupposed to be able to solve bound procedure issues, like number resolution (which underlies RSA encryption), considerably a lot of quicker than classical computers. The study of quantum computing could be a subfield of quantum informatics. Quantum computing is a new and more potential technique in Computer world. Today, the whole world is suffering from pandemic of Covid-19. Corona virus disease 2019 (COVID-19) is an illness caused by a novel coronavirus now called as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; formerly called 2019-nCoV), which was first identified amid an outbreak of respiratory illness cases in Wuhan City, Hubei Province, China. Today, every country in the world is trying to find the antidote of COVID-19.[7] Meanwhile, a hope to find the medicine of Covid-19, can be seen through Quantum Computing. High-performance computing such as supercomputers and AI can help to accelerate this process by screening billions of chemical compounds quickly to find relevant drug compounds. This process will explore through quantum machine learning to find out new capabilities in drug discovery by producing complex compounds faster. Rest of the paper is organized as follows, Section I contains the introduction of how Quantum Computing can be seen as a possibility to drug-discovery of COVID-19 , Section II contain the related work of Quantum Computing over drug-discovery of COVID-19 , Section III contain the methodology by describing the techniques used to discover the drug , Section IV contains the Result of the research and Discussion about the possible outcomes, section V concludes research work with future directions.

Aim and Objectives

The purpose of this study is to –

1. Give brief analysis and specialty of quantum computing.
2. Finding the significance of quantum computing for drug-discovery of COVID-19 pandemic.
3. Give a light on Moore's law for computing power increase ratio.

Significance of Study

This report will guide the researchers, scientists and drug analysts to focus on quantum computing technique to screen out the billions of chemical compounds at once that separate conventional computers from quantum computers. Based on the information, people will be able to determine whether to convert their existing pipeline of drug-discovery of COVID-19 or any other pandemic diseases to quantum systems or not. The system administrators will attain more control and efficiency on their information and chemical compounds screening to find out drug components. It will assist the government entities and scientists to handle this COVID-19 pandemic.

II. RELATED WORK

As the COVID-19 virus which is a newly arrived virus, is a big challenge to the world. Finding out its antidote is highest priority of every country. So its previous researches are not very much obvious because this COVID-19 is Zootic in nature, which is different from all the previous forms of Corona virus (such as SARs and MERs). It can be easily transferred one person to another person through any type of contacts. So its research is very recently started by many countries. It is very necessary to find out its drugs as soon as possible because of the number and speed of infection is bring spread around the world. Our primary focus is how Quantum computing can be used to discover the COVID-19 treatment. As quantum computing has computational power exponentially higher than the conventional computers we are using. So quantum computers can screen out the larger number of chemical compounds at once to find the COVID-19 drug sooner.

Quantum machine learning, an newly growing field that merges the concept of machine learning and quantum physics, is that the focuses on the analysis to get an achievable treatments for COVID-19. As per Penn State researchers led by Swaroop Ghosh, Joseph R. and Janice M. Monkowski of EE and applied science and Engineering. The researchers believe that this methodology can be quicker and a lot of economical than the present strategies used for drug discovery. There are very few and recent researches are being carried out by the various researchers across the world.

III. METHODOLOGY

Quantum computers do its calculations based on the probability of an object's state prior it is measured - instead of just 1's or 0's - which means that they have the potential to process exponentially more data as compared to that of classical computers. A quantum computer looks like this, taking n input qubits, the register V, and producing n output qubits, the register W:

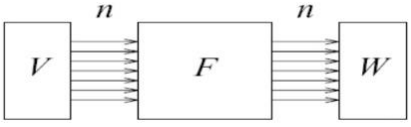

Figure 1. Basic structure of quantum computing

Classical computer carries out logical operations using the definite/fixed position of a physical state. These are usually binary, meaning its operations are based on one of two positions. A single state - such as ON or OFF, up or down, 1 or 0 - is called a bit [1]. Ian quantum computing, operations instead use the quantum state of an object to produce which is called as a qubit. These states are the undefined properties of an object before they have been detected, such as the spinning of an electron or the polarization of a photon.[2]

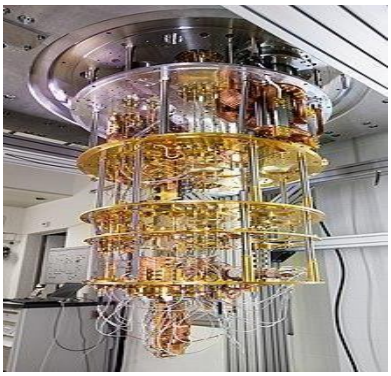

Figure 2: Quantum computer based on superconducting qubits developed by IBM Research in Zürich, Switzerland. The qubits in the device shown will be cooled to under 1 kelvin using a dilution refrigerator.

Rather than having a clear position, unmeasured/undefined quantum states occur in a mixed 'superposition', just like a coin spinning in the air before it lands in your hand. These superposition (multiple states) can be entangled (connected) with those of other objects, meaning their final outcomes will be mathematically related even if we don't know yet what they are[3]. Qubits have some quirky quantum properties that mean a connected group of them can provide way more processing power than the same number of binary bits. One of those properties is known as superposition and another is called entanglement.[5]

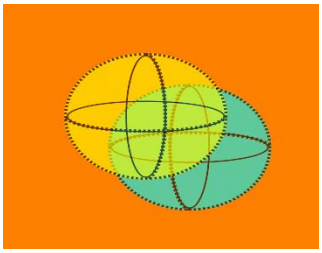

Figure 3: Quantum Qubits representation

The basic properties of quantum computing are as follows :

•**Superposition**-Superposition is the ability of a quantum system to exist in multiple states simultaneously. The go-to example of superposition is the flipping of a coin, which consistently can land as a head or tail--a very binary concept. However, when the coin is in middle of the air, it is both head and tail and until it lands, heads and tails exist simultaneously. Similarly, before measurement, the electron exists in quantum superposition. To keep qubits into superposition, researchers manipulate them using precision lasers or microwave beams. The final result of a

calculation emerges only once the qubits are measured, which immediately causes their quantum state to "collapse" to either 1 or 0 [3].

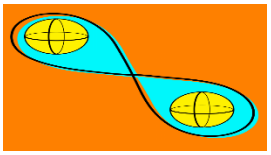

Figure 4: Qubit superposition

Experimentally the phenomenon of quantum superposition can be demonstrated using given experiment. Here a light source emits a along a
path towards a half-silvered mirror. This mirror splits the light, reflecting half vertically toward detector A and transmitting half toward detector B. a photon however represents a single quantized energy state (E=hν) and hence cannot be split, so it is detected with equal probability at either A or B. this is verified by observation that if the detector A registers the signal then B does not and vice-versa.[4]

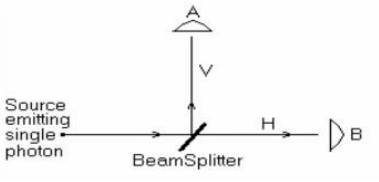

Figure 5. Beam splitting of light

• **Entanglement** -Researchers can generate pairs of qubits that are "entangled," which means that two members of a pair exist in a single quantum state. If we change the state of one of the qubits will instantaneously change the state of the other one in a predictable way. This can happen even if they are separated by very long distances. Entanglement as a quantum property is concerning taking objects along and connecting them by for good entangling them along. once a further qubit is supplementary to a quantum pc, a 50-qubit quantum machine will examine 2 to the facility of fifty states at the same time. the rise in power additionally to the trap of qubits permits quantum computers to resolve issues expeditiously, finding the solutions quicker, with several fewer calculations.[2]

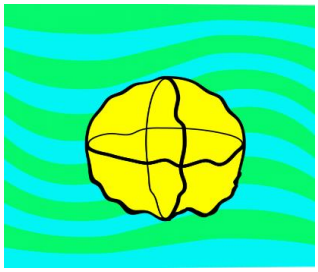

Figure 6. Qubit entanglement

•Interference can be used to control quantum states and amplifying the signals that are leading toward the right answers and cancelling signals that are leading towards the wrong answers.[4]

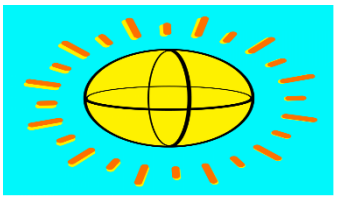

Figure 7. Qubit Interference

How quantum computing can unlock COVID-19 drug discovery

Quantum machine learning, an newly growing field that merges the concept of machine learning and quantum physics, is that the focuses on the analysis to get an achievable treatments for COVID-19. The researchers believe that this methodology can be quicker and a lot of economical than the present strategies used for drug discovery. Seed funding from the Penn State Huck Institutes of the Life Sciences, as part of their rapid-response seed funding for research across the University to address COVID-19, is supporting this work. Researchers has analyzed that using the existing drug-discovery pipeline, it can take almost 5-10 years from preliminary idea to final market approval, and also cost billions of dollars. It is also analyzed that any new drug discovery that can cure a disease is like finding a needle in a haystack.

Law stated that microprocessor's transistors number tends to be doubled after 1.5 years. According to this law if it continues in the same pattern till 2020 then conventional computers will run with RAM of 160 GB and its CPU speed at 40 GHZ. By using moor's law analogue, quantum bits' number might double in 1.5 years. On the contrary, if one qubit is added, then the speed is doubled. Therefore, increasing the speed of the quantum computing as well [CITATION Chi04 \l 1033].

Quantum Computers Vs Conventional Computers: A Study on the Larger Scale 14 Figure 4 - Moore's Law Benefits of Quantum Computers in comparison with Classical Computers. It is possible to perform reversible arbitrary classical computing through quantum computers on all numbers at the same time that is not a possibility in case of binary computers.

Quantum computers also have the tendency to develop interface between a lot of different numbers. By doing this sort of computation, results are interfered in order to obtain one answer where quantum computers can perform in much better way and are much more powerful as compared with the same – sized conventional computers. Myriad law stated that microprocessor's transistors number tends to be doubled after 1.5 years. According to this law if it continues in the same pattern till 2020 then conventional computers will run with RAM of 160 GB and its CPU speed at 40 GHZ. By using moor's law analogue, quantum bits' number might double in 1.5 years. On the contrary, if one qubit is added, then the speed is doubled. Therefore, increasing the speed of the quantum computing as well [CITATION Chi04 \l 1033].

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Quantum Computers Vs Conventional Computers: A Study on the Larger Scale Quantum Computers Vs Conventional Computers: A Study on the Larger Scale 13 numbers, reversible arbitrary computation can be performed with the help of quantum computer.

Therefore, to perform computation on various numbers simultaneously and interfering those results can attain a single answer that makes quantum computing to be extremely powerful as compared with conventional one. 500

2 states can be attained with only 500 qubits of quantum computing. Furthermore, every state is further equal to 500 0s and 1s. As a result, observing systems can collapse to one answer correspondent to one quantum state. This computer is equal

150

to 10 processors of conventional computers [CITATION Dat08 \l 1033].

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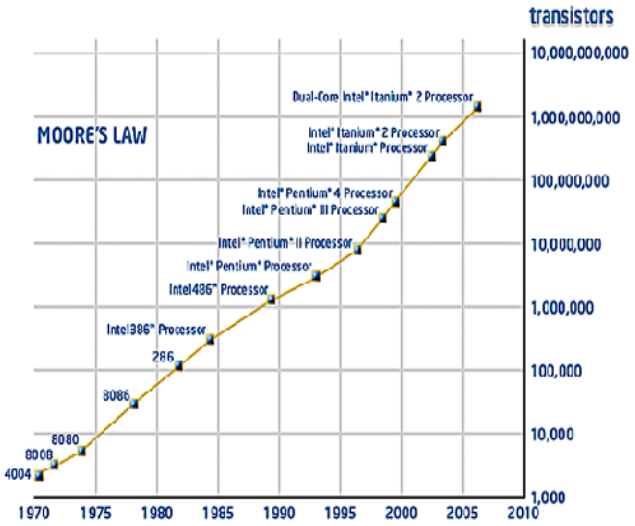

Figure 8. Moore's law to show increasing no. of transistors

It is possible to perform reversible arbitrary classical computing through quantum computers on all numbers at the same time that is not a possibility in case of binary computers. Quantum computers also have the tendency to develop interface between a lot of different numbers. By doing this sort of computation, results are interfered in order to obtain one answer where quantum computers can perform in much better way and are much more powerful as compared with the same – sized conventional computers. Therefore, we are looking with hope towards quantum computing rather than traditional computing.

IV. RESULTS AND DISCUSSION

This research is all about finding the role of quantum computing in unlocking the possible drug that can be used for treatment of COVID-19 diseases that is incurable pandemic for this whole world. Quantum computing has exponentially more computational power that that of the traditional computers have. Quantum computers definitely can discover out the antidotes for this disease. Though there are little limitations with quantum computers but researchers finding out various algorithms to sort out the difficulties ahead. The only need is to apply this concept practically. Today the world is in very much need for finding out the medicine that can cure this disease. The world is suffering from a very bad nightmare which is sure to be overcome one day but the only need is to find out the solution as soon as possible. Through this paper has only focus seek out the possibility of drug-discovery for COVID-19 with the help of Quantum Computers which can process and screen out the billions of chemical compounds at tremendous speed. To point out that thinking about and working on Quantum Computers for this purpose can be proved as boon during this COVIDian era. We should focus on this aspect also. Some research labs such as Penn state University are working on it. There is a hope for positive result using quantum computing in drug-

discovery that would be time feasible as well as cost feasible.

If we take this as an assumption we can make rough forecasts for qubit capacities in the coming years and show when a quantum computer can be used to solve certain meaningful problems. The resulting graph is shown below:

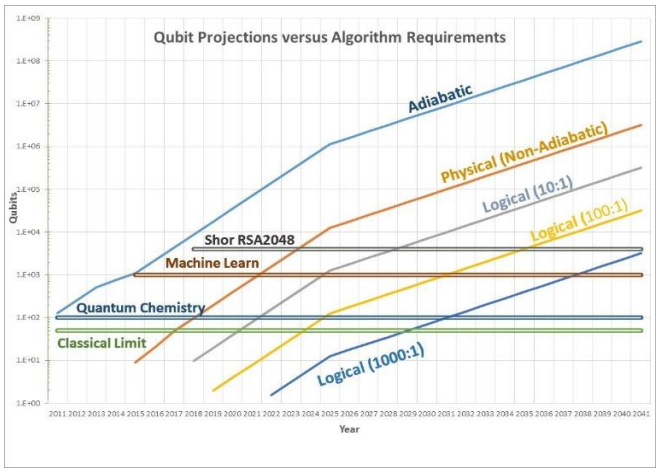

Figure 9. Quantum computing vs classical computing in year 2020

This graph was shown in a website quantumcomutingreport.com. We can analyzed that only High-performance computing such as Artificial Intelligence and Super-computers can help to speed-up this process of drug-discovery by analyzing out billions of chemical compounds quickly to find relevant drug compounds. This approach works once enough chemical compounds area unit offered within the pipeline, however sadly this could be not true for COVID-19 yet because of insufficient chemical compounds available. This project will be done by exploring out quantum machine learning to discover new capabilities in drug discovery by generating advanced compounds quickly.

Quantum computation promises the ability to compute solutions to problems that, for all practical purposes, are insoluble by classical computers. However, the quantum promise is still a long way from achieving practical realization. The some properties of quantum mechanics that enable quantum computers superior performance also make the design of quantum algorithms and the construction of functional hardware extremely difficult. We need to imply some solutions to improve the quality of qubit technology by increasing the coherence time of qubits and the speed of quantum operations. We also need to correct the state of the qubit for quantum error correction

V. CONCLUSION AND FUTURE SCOPE

The main conclusions of the study is that we can use the fastest computational power of quantum computing for the welfare and protections of life on earth from COVID-19 diseases. The only need is to implementation of Quantum computing in order to screening out billions of chemical compounds very fast which is impossible for binary computers and it will take almost 5 to 10 years by conventional pipeline of drug discovery to find the drug and it will cost in billion of dollars too. Therefore we must go for such high performance computational techniques such as quantum computing that can lead us to better and faster pipeline for drug-discovery during any emergency or any pandemic across the world.

There is a great future scope for quantum computing and its implications for medical field, agriculture, weather forecasting, and many other insolvable problems such NP - hard and NP-complete problems where conventional computers have failed to give results. Theoretical developments alone will be no good without a matching technology. Nowadays, the race for miniaturization of electronic circuits in not too far away from the quantum reality of nature. To devise new types of instruments, we must change our view-points from scientific to technological-quantum effects which are not for only observation; we should learn how to control them for practical use. The future is not foreseen yet, but it is definitely promising.

ACKNOWLEDGMENT

This paper and the research behind it would not have been possible without the exceptional support of my supervisor. His enthusiasm, knowledge and exacting attention to detail have been an inspiration and kept my work on track from my first encounter with term quantum computing and coming into this COVIDIAN era to the final draft of this paper. Also I would like to thank Gopal Krishna Sir who constantly sent me CSI communication journals on quantum computing and other latest technologies.

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