Review Article

Benefits of Quantum Computing in Predictive Healthcare System

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Abstract - Quantum computing offers various ways of thinking, corporate strategies, different IT architectures, and a high set of skills. The technology has some significant suggestions for security. Security is the essential aspect for healthcare, and the sector experiences data privacy responsibilities and challenges. Healthcare is benefits from quantum computing and its applications. This tool is helpful in predicting a person's healthcare. The study evaluates the importance of using quantum computers in healthcare and how they can be used for predicting healthcare in the future.

Keywords - quantum computing, healthcare, data privacy, security, prediction.

I. INTRODUCTION

In the last two decades, the advancement in computer processing is increased in improvement in the area of medicine and biomedical research as well. In personalized healthcare, based on pharmacokinetics, genomics, and individual physiology would have large amounts of data and need to process it clinical use format in order to evaluate in urgency. Quantum computing is the best analytical tool for achieving efficiency in a timely basis with a good accuracy rate [1]. Quantum bit or qubit is considered as the single bit obtained at the same time with a result of a sequence of '1' and a '0'. This tool is applied to all industries like automotive, IT, healthcare, and medical, and so on. In healthcare, quantum computers are related to classical computers have significant advantages in which classical computing cannot deliver. There are some potential quantum use cases that are given to the healthcare industry to undergo an ongoing transformation, such as precision medicine, diagnose patients efficiently and accurately, and so on. This study reviews the significance of using quantum computers in predicting a person's future health.

II. APPLICATIONS OF QUANTUM COMPUTERS IN MEDICINE

A. Radiotherapy

This is a widely-used therapeutic approach in the treatment of cancer. High radiation beams have eradicated the penetration of cancerous cells or control the growth of its multiplication in the human organs. On operating the radiation plan, there is less or minimize the chance of damaging the healthy body tissues surrounding the particular damage, and it has to be achieved at a high rate of complication in line with the problem of thousand variables [2]. However, it is noted that to attain such optimal radiation determination probably requires multiple simulations until to reach the optimal level of the procedure. With the help of quantum computers, each simulation is considered to be highly monitored between one or more simulations in point of its horizon level and can be operated as a much broader prospect. However, it is easy to attain the faster rate of optimal level in order to consider by running multiple simulations at the same time.

B. Drug research

To discover or design a drug, the molecular comparison is to be developed in its early phase, which has to be considered a significant process in the research of the drug. At present, some companies developed to compute several hundreds of millions of molecular comparisons done on classical computers. However, such computation is certainly limited to the size of designed molecules, which has to be computed on the actual level of classical computers [2]. With the advent of quantum computers, it will be demonstrated more readily and compare the molecules which are available in large size also, which is widely used in today's field of advancement in pharmaceutical companies to cure the wide range of diseases as well. Moreover, quantum computers are saving the cost of billions of dollars as well as much time limit for the development period to introduce a drug into the market.

C. Drug interactions

The technique used in the quantum computing model was developed to design much complex interactions of molecules in an atomic level. It is very helpful and significant for drug discovery and medical research in particular. At the near future, the development of the model will lead attain greater success in order to encode the

20,000+ proteins in the human genome and also understand easier in simulation process of such molecular interactions with the obtained model of new drugs as well as existing ones in the research process [3].

III. QUANTUM COMPUTING IN DIAGNOSTICS

A. *Artificial Intelligence*

It is a model trend to aid the diagnostic reports of patients by applying or checking machine learning nowadays. It has to be achieved by the "pattern recognition" method. In the level of checking algorithms, the main aim is to obtain leverage comparison for identifying a diagnosis with the basis of large datasets of patient information, which has to be found some signals in such noise pollution [4]. But, the quantum computing method is readily accessible, more accurate, and effective to process this type of order when compared to classical computing. This method helps the doctors for comparing relevant and much and much more patient information data simultaneously in order to discover the best patterns model with the advanced permutations to describe it. This process will be looking forward to fundamental in artificial intelligence in the comparatively less significant model.

B. *Disease Screening*

The bio-barcode assay is a technical method used to detect disease-specific "biomarkers" that are present in our blood by using gold nanoparticles that could be visible under MRI technology. These nanoparticles do have the unique feature of quantum properties, which could allow them to connect with disease-fighting cells. It is completely safe to use in human beings [5]. This approach is more flexible, more accurate, and also cheaper than their conventional alternatives. Mikhail Lukin, Harvard's physics professor who is also working on nanoscale particles of diamond manipulation for executing similar processes. He is dedicating completely to achieve success on the work of diamond particles, which is used to obtain clear images of human cells from the inside the body and also detect particular diseases in order to not exposing radiation to the patients. It hopes that he already finds to manage this active method in the detection of neural activity.

C. *Imaging*

By allowing ultra-precise measurements in the MRI machine with the use of quantum sensors. Therefore, quantum-based MRI has been used to investigate groups or single molecules instead of evaluating the entire body and also provide an accurate picture under the examination for the clinicians. Then, other types of quantum-based techniques would also in use in the modern world for development methodology in order to treat several diseases as earlier [6]. For instance, the gold nanoparticles are designed to program only in the effect of tumor cells in order to precise, clear images as well as the destruction of tumor cells with advanced laser treatment without harm any healthy tissues in the human body.

D. *Healthcare Data*

People need their health data to be more secure and protect for obvious reasons. Hence, it is more important to take the necessary steps to prevent the data from the ways of hacking it. ID Quantique is a technical company programming in high-security systems which is using the strange quirks of advanced quantum technology phenomena in order to protect the patient's healthcare information in an ultra-secure fashion as well [7]. In trend, quantum entanglement is used as one of the considerable practical applications of the activity to date, and also quantum cryptography strictly resist to assist the data being viewed by any other unknown person other than the one who is the intended recipient in the organization. Based on the principles of quantum mechanics, the innovations are constructed for further advent in holding up potential effects on health care basis on every level for the treatment and diagnosis of transmission as well as data storage.

E. *Genomic Medicine*

Laser microscopy is a technique that has been framed on the principles of quantum mechanics 8. Quantum computers are useful to derive readable and quick DNA sequencing as well as helps to solve various Big Data problems arrived in health care. This enabled access opens up the chance of getting secured and personalized medicine eventually based on each individuals' genetic makeup as a unique one [8].

F. *Protein Folding*

Proteins are considered to be the basic bodybuilder of life. The wrong folding in the protein blocks of DNA leads to the malfunction of the genetic metabolism. The chemical composition of the protein is basically a well-known factor, but the physical structure of the protein is not well understood as an easy matter. The formation of protein folding can be obtained in a detailed structure of knowledge is the only way to lead the further development shown in the studies of new medicines and therapies as well [9]. Hence, the quantum computer is relatively helpful in the theory part of the analysis in line with obtaining a large number of probable folds of protein structures to test simultaneously and identify the prompted one among them. All paragraphs must be indented. All paragraphs must be justified, i.e., both left-justified and right-justified.

IV. QUANTUM COMPUTERS IN MACHINE LEARNING AND BIG DATA

Quantum mechanics is an advanced technology of science which is dealt with computing capabilities

astounding to offer development in the health sector. Thus, we need to monitor the advancement and technology of quantum principles for their applications and advantages for healthcare closely. Machine learning and big data research are considered to be advent for real-world functions with the utilization of quantum computers. There is a spectrum of machine learning which operates from the predictive algorithm driven by data decisions versus human decisions as well. In statistical model adopted variable definition over the human decisions along with their inter-relationships. In the case of machine learning, computer programs are derived with few assumptions as well as algorithms for evaluating millions of data elements as well as the important directions of interactions and effect [10]. The more effort of obtaining raw data are mostly obtained by an algorithm, and there is less need of human input required yet it fits more comfortable with the machine learning process. Machine learning is clearly demonstrated in real-time clinical practice, which depends on developing databases that contain updated medical record information and also links to another format of data sources. To overcome this complexity in the machine learning programs tend to require quantum computational power for resulting best outcome in a real-time experience. With the power of quantum computers and adequate data information on the predictive models, the clinical technician can adopt the suitable match of therapy to each patient which are based on the current emerging models and update it as well to predict the response of treatment in case of accounting lot of people's characteristic features such as gender, age, race, comorbidities, genetic makeup and co-medications for better contribution result [11].

The operation of the first quantum computers done in 2000, Parsons (2015) demonstrated the application of quantum computing devices would involve generating new advancements of the era in medical images. It results in that quantum MRI machine assists in providing exceptional precise imaging, which allows visualization of each individual molecules in the clear-cut picture. Quantum computing methods can be implemented to interpret the result of diagnostic images with the help of using artificial intelligence as well. The clear image will be improvised in detail and exponential to the point, but the clinician can tend to interpret better results when compared to obtain efficient machine learning with the adoption of quantum techniques can interpret the abnormal findings obtained with better precision rather than the human eye errors.

In cancer therapy, the quantum computing method is likely to contribute more to therapeutic use. The application of quantum computers is mainly dealt with the thousands of mixed variables obtained in order to develop a radiation plan which particularly targets the cancerous cells without any dangerous damage to the healthy cells as well [12]. It would be used to allow comparison on all possible approaches as well as allows very rapid and effective

precise radiation plan while in the treatment process. The final interpretation would be an ideal and accurate radiation dose, which has been pointed out right target cell with the effect of well-reduced side effects in the procedure.

Artificial intelligence and machine learning are evidently used in the traditional computational requirement, which is basically used to interpret the surgical aid procedures, CT scans, and Big data analysis in order to develop predictive models of disease treatment. Carson et al. (2017) obtained machine learning for processing approximately 10,000 retinal images to make an algorithm for detecting diabetic retinopathy with high specificity and sensitivity. The researcher predicted that it is an experimental design that has no evidence of proper clinical use. Carson and colleagues programmed a new computational power of quantum computers that would help to run an algorithm in order to help the physicians in real-time accuracy of detecting the retinopathy at an earlier stage of diagnosis.

When reading images on the machine learning process, it is easy to eliminate most diagnostic errors. Caron et al. (2017) explained how to overcome all sources of diagnostic errors in the medical imaging process with the use of artificial intelligence. Computers can minimize or eradicate the complete source of human errors like over-reliance on context, hanging over on initial impression, drawing rapid conclusions over the previous case, and also failed to evaluate other options of the answer before concluding the patient history.

A. Clinical practice
Nowadays, there is an overwhelming response of records available in the volume of materials and speed in new discoveries of medical researches. The guidelines are provided by best attempts driven in the research mostly based on the evidence-based medicine and helps to create new evidence in imaging [13]. With the continuous support of a combination of big data and quantum computing technology is ready to provide access to current evidence as well as generating continued use of electronic data in the delivery of care. The personalized medicine realized to draw a great analysis work on mega-data, which is involved in measuring process of imaging, wearable technology, patient records, genomics, screening measures, environmental measures, and more altogether.

Quantum computing clearly mentioned that there is no added value for any medicine without the presence of parallel raise in evidence-based meaningful data clinically obtained from various sources. In the healthcare system, quantum computers realized their challenges to obtain some decades of data along with the billions of clinical encounters are analyzed and recommends for a specialized medication for each patient who presents their onset of illness such as cancer, depression, diabetes, or any condition, and these are considerably evaluated and

overcome it even the data can be merging with other multiple sources like patient's existing data networks, wearable health devices or bio-banks, etc. [14].

In the future, there is a question to ask virtual physicians are in demand or not. Most patients expect more than a pill when they are in seek and particularly when they are under treatment, which creates greater risk in surgery, as well as patient adherence to very strict requirement of effective treatment, requires complex regimens. However, quantum computing would not replace the big balance between the doctor-patient relationship, trust, and transparency while taking any decision sharing. Even though there is well-versed success obtained from the computers, it will not replace the position of physician care to offer social support, empathy, encouragement words, providing handshake, a smile, a hug, or a pat on the back when serious illness found in the patient's care. We cannot underestimate the social contract of patients bond with the physicians as well as the support of nurses, doctors, or any staff who involved to play a great role in the healing process of patient care. Based on the programming algorithms, traditional computer or advanced quantum laptop computer are not able to demonstrate any feelings to the patient care, and it will never provide the experience with surgeon's promise or create any impact through the procedure or reinforce the effect of encouragement by the primary care provider and advice to walk just another 5 minutes for health requirement [15].

B. Quantum computers in CT scans

Quantum's ability is constructed to compute at a different level of scale in order to allow clinicians to assist the incorporation of several cross-functional data, which tend to sets with the model of a patient risk factor as well. For example, in an analysis of the effect of pollution with the evidence of environmental databases obtained from the patient's health history. In another way, quantum computers create an added advantage to its ability to develop imagery at a level of scale. It helps to analyze clear print images obtained in the CT scans and is necessarily required for processing power when compared to the traditional data sets. Clinicians could have easy access to review the CT scans in order to identify certain anomalies or changes in the computation. The supercomputer does have possible promising capabilities, but it has found enormous danger significantly raise in view of security concerns and DigiCert [15]. According to the global industries, over 71% of the majority of organizations viewed quantum computers as a security threat and DigiCert. However, it is a totally new technology whose security issues are not in widespread use. But, it has been rapidly popularized in the next upcoming three years, which would be a big threat to the world healthcare system.

C. Precision medicine

Likewise, we can get through precision medicine based on such anomalies of the patient. According to the clinical trial practice, participants were encouraged to use the quantum computing method for analysis with surplus reference points and to ensure evaluation of a better fit between the patient and protocol. There are enhanced data processing abilities in acquiring quantum computation that really helps to identify quick and targeted chemotherapy protocols with a high customization process. After the post-treatment, there could be able to understand and analyze where and why a protocol become succeeded and failed accurately, which provides valuable insight for the researchers and clinicians.

D. Diagnostic approach

The early diagnostic approach tends to be accurate, quick, and efficient, with better outcomes generated with less cost-effective treatment. For instance, when there is colon cancer is diagnosed at early 8, the survival rates increased by a factor of 9, and also treatment costs will be decreased by a factor of 4. With the wide range of health conditions, the present diagnostics are complex and costly. After diagnosis, the estimated rate of suggestion marked over wrong up to 5 to 20% of cases [16]. Over the last century, the usage of medical imaging techniques like MRI, CT scan, and X-ray are crucial diagnostic tools for each practitioner at that time. Both the diagnosis methods and computer-aided detection are developed rapidly in the analysis of medical images. These images are mostly impacted with the poor resolution, noise as well as low replicable effect considered as disadvantages. Hence, these challenges should overcome by adhere safety protocols to follow by healthcare. Image matching and edge deduction are called processing steps, which have been used in view of medical images with the quantum computing method. Such steps are improved with the enhancement of image-aided diagnostics. Furthermore, the usage of single-cell methods in the modern diagnostic approach as well. Flow cytometry and single-cell sequencing data are considered advanced analytical methods, which are used for combining datasets with different techniques. The classification of cells is fully based on biochemical and physical characteristics, and it is more challenge for the identification process. Thus, the high dimensional values are obtained from the abstract space in live predictor variables. Classification of cells is considered to be very important to note or distinguish normal cells and cancerous cells. Quantum enhanced machine learning techniques readily related the quantum support vector machine for such classification and also involved in boosting single-cell diagnostic methods.

Moreover, biomarkers are to be discovered as well as characterized for analysis of complex "-omics" information of datasets likely proteomics, transcriptomics, genomics, and

metabolomics. These could be achieved by a large feature space in order to interact with certain features related to correlations, interdependencies, and pattern making, which are very challenging in the way of finding in traditional computational methods. More advanced models are required for further extends in biomarker insights on an individual basis. Thus, quantum computing would help to discover such biomarkers in order to analyze for each individual specifics. The care providers tend to make eliminate repetitive invasive diagnostic techniques through the quantum computing method [17]. It helps the patient assistance, and also health plan providers and insurers are also attained good benefit from the reduced level of treatment cost which the onset has been discovered as soon earlier. It is also determining the elaborate diagnostic procedure to undergo in a timely manner with the possible meta-analyses of the patient state. It helps perhaps cut costs and provided more data-driven procedures, which are obtained from the health plans and government providers and also the individual ones. Quantum-advanced machine learning techniques are allowed to provide more accurate, earlier, and increased granular risk predictions for future purposes.

V. CHALLENGES

In the adoption of technology, there could be complete lagging occurred in the healthcare division when compared to the other industrial sector. Thus, the hardness of artificial intelligence and trailing advancement is already used in the private sector, but the industry is involved at the beginning stage. There is the very slow embracement of quantum computing in the modern field, which resulted from the innovation of healthcare fall behind in compared to the other industries.

Privacy policy and ethics of quantum computing are considered as other major concerns to the healthcare industry. It has shown clear potential insights for individuals in order to monitor the risk factor of the healthcare future. Most approaches of quantum computers are widely receptive to the patients about the information once they understand risks, which would migrate easily in the way of preventative medicine. The prognosis of the future indicates grim outlooks of health conditions, which helps to raise ethical situations consecutively.

Based on the current healthcare technologies, there is a series of questions circulating with regards to the future prognosis, which could be predicted or not might cause the impact of the patient's current mental status. The information obtained from the computing could be able to use by health insurers or employers in order to make negative employment decisions, or is coverage another question? Thus quantum power amplifies the successful and thoughtful approach to make predictive medicine.

The security system in quantum computing: The supercomputer does have possible promising capabilities,

but it has found enormous danger significantly raise in view of security concerns and DigiCert. According to the global industries, over 71% of the majority of organizations viewed quantum computers as a security threat and DigiCert [18]. However, it is a totally new technology which their security. Issues are not in widespread use. But, it has been rapidly popularized in the next upcoming three years, which would be a big threat to the world healthcare system.

Due to the advancement of processing technology, a quantum computer can completely eradicate the present encryption practices, and also resulting the personal healthcare history would be vulnerable. Thankfully, the US government and many institutions took necessary action to evaluate research based on "quantum-proof" encryption, and this could be obtained promising results initially [20].

In a quantum world, it is necessary to take action by the healthcare providers who could promptly implement quantum-resistant encryption; patients and providers does have relaxed peace of mind. With the help of next-generation security forces, the personal data could be better protected, but also healthcare organizations would take necessary action to protect from malicious activity and use limited data breaches even before. Quantum's technology also adapts to process the cybersecurity departments in order to analyze the potential threat and large amounts of access activity in advance [19].

Finally, quantum computing can obtain life-saving medical applications for rapid processes in healthcare development. Such applications are utilized in the way of a mindful and measured approach as well. In the meantime, the healthcare industry realized to take the opportunity for grasping eventual true quantum capabilities as well as challenges obtained not as before to consider as mainstream.

Google's also achieved quantum computing supremacy from the contest of several rival tech giants like IBM, who leads a quiet ways off in order to use and assess real-world applications [18]. The healthcare industry will tend to build a new principles for obtaining the advantage of quantum in its applications, and it has to be ready to operate with an accountable cost structure. If good financial support for healthcare must be driving these capabilities high enough to achieve or target the cost burdens low, and also the privacy of data in healthcare would be compromised even it introduces several potential risk securities. Quantum-advanced machine learning techniques are allowed to provide more accurate, earlier, and increased granular risk predictions for future purposes.

VI. CONCLUSION

Quantum computing also provides data homogenization strategy and fundamental algorithmic search in different analyses. Milicevic also demonstrated quantum computers

are readily accelerated DNA sequencing techniques for enabling effective treatment of cancer with personalized medicine. Quantum algorithms allow for processing a multitude of sources of healthcare data, which could be curating and collective in nature and also considered as a challengeable one. Clinicians could review CT scans periodically to obtain or access specific changes and anomalies become quickly with the help of advanced availability of computing technology. Likewise, precision medicine is accelerated quite commonly. Therefore, targeted chemotherapy protocols are encountered rapidly with the attainment of the customized report from quantum computing's enhanced data processing abilities. The massive processing power, as well as artificial intelligence of quantum computing, could readily change the landscape for the evidence of all AI-based healthcare applications, which proved the clarity rate is more accurate than any other traditional methodology as well.

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