A Study of Quantum Computing and Quantum Diamond Microscope Techniques to Advance Neuroimaging

[1,2]***Venkateshwarla. Rama Raju***, *CMR College of Engineering & Technology, Kandlakoya, Medchal Road, Hyderabad, Telangana, T.S. 501 401, India.*
[3]***Srinivas Konda***, [4]***Kavitha Rani Balmuri,*** *CMR Technical Campus, Kandlakoya, Medchal Road, Hyderabad, Telangana, T.S. 501 401, India*

Abstract— With the increasing power of ultra supercomputing, the power of quantum computing (QC) in healthcare sectors swiftly advancing neuroimaging, pinpointing sole cells, molecules or clusters of molecules instead of the intact-tissues, hence lets neuroscientists to observe less-significant transforms in the tissue. The growth of QC in neuroimaging has the potential-to-progress modern-medical-management(MMM/M³) for a myriad-of-multitude neurological disorders specifically cancer and Parkinson`s disease. To elucidate the quantum computing and quantum microscope diamond techniques efficacy in healthcare modern management for advancing neuroimaging. The following methods are examined in this study. Computed-axial-tomography(CAT) Magnetic resonance imaging(MRI,7T) by the injection of radioactive-substance, and positron emission tomography(PET) with the injection of radio-active-tracer(RAT) and/or radio-pharma-ceuticals(RPC). Quantum computing(QC) MR-fingerprinting(QC-MRF), QC with neuroimaging fingerprinting for pinpointing at sole-molecules or clusters-of-molecules as a substitute of the intact-tissues. Quantum-microscope with MRI for observing cuprous-ions(Cu^{+2}) molecules. CAT showed the information on shape and size-of-tissue. PET disclosed how brain organs are functioning, can point the tumor by verifying metabolic movement of body tissues. MRI(7Tesla) viewed the entire tissues and considered high resolution. Quantum computing with neuroimaging glanced at sole-molecules or clusters-of-molecules rather than the intact-tissues. The QC is contributing the likelihood-opportunity of considering yet surplus we are capable-to-perceive by this process. Quantum computing of neuroimage fingerprinting-technique can be produced in as little as $\frac{1}{6}$ one sixth of the time, at present attains over and above 25% extra defined, hence letting neuroscientists to observe less-significant transforms in the tissue. ***Significance***: Quantum computing for neuroimaging has the prospective to progress modern-medical-management (MMM/M³) for complex-neurological disorders, such as, heterogenous cancer/breast-cancer, neurodegenerative Parkinson`s disease, and seizure epilepsy. Optimistically, to a great extent faster than they presently are able to, which occasionally achieves in few days.

Keywords— Computed Axial Tomography (CAT), Magnetic Resonance Fingerprinting (MRF), Magnetic Resonance Imaging (MRI), Positron-Emission-Tomography (PET), Quantum Computing(QC), Modern-Medical-Management(MMM/M³).

Key message: Quantum computing (QC) for neuroimaging has the potential-to-progress modern-medical-management for complex-neurological-disorders. QC pinpointing sole-molecules or clusters-of-molecules rather than the intact-tissues, hence lets neuroscientists to examine less significant-transforms in the tissue.

1. Introduction

With the increasing power of ultra supercomputing, the power of quantum computing in healthcare sectors swiftly advancing neuroimaging cells, pinpointing sole molecules or clusters of molecules instead of the intact tissues, hence lets neuroscientists to observe less-significant transforms in the tissue. [1], [2] The growth-of-quantum computing in neuroimaging has the potential-to-progress modern-medical-management (MMM/M³) for a myriad-of-multitude neurological disorders specifically heterogenous cancer, advance neurodegenerative idiopathic Parkinson`s disease, and seizure epilepsy. [3]. Quantum computing (QC) is a new age, new era in the region of area that is envisaged and predicted to transform and revolutionize the whole thing in the real world universally and to wonder the cosmos restlessly for yearns. Insightful changes will transpire in all industry as the applications of QC are achieved. Medical science specifically medicine is one of the first sectors assigned to turn into one of the untimely implementers of the technology. The increased power of quantum-computations shall be employed in multitude-of-myriad (MoM) areas, as of rapidly swifting up research and design and development of new therapeutic drugs, for creating radiotherapy advancing further and precisely advancing prognostics. One space in healthcare that has already been looking at how quantum computing can help them overcome their challenges is that of medical imaging, particularly for modern medical management (MMM/M³) and tracking of cancer treatment. Hitherto, medical imaging has become a backbone to neuroscience and had develop into mandatory for inferring every neurological disorders health hazards especially human brain`s heterogenous and neurodegenerative multi-system diseases such as Cancer, Parkinson`s diseases, Alzheimer`s, epileptic seizures, etc particularly for modern medical management (MMM/M³) and tracing of current treatment. Quantum computing is a new era and it is expected and envisaged to transform the whole thing, insightful renovations will take place in every industry as the applications of quantum computing are apprehended and recognized or comprehended. Medical science especially medicine is one of the first sectors tagged to befall and befit one of the early implementers of the technology. The superior power of ultra super-computations will be

effusively utilized in multitude of areas, from speeding up research and design of new drugs, to making radiotherapy more accurate and improving diagnosis. While MRI is considered to be high resolution, quantum computing is offering the possibility of seeing even more than we can see with this method. This study elucidates the quantum computing efficiency in healthcare sectors modern medical administration (MMA) to improve the neuroimaging neural cells and in allied areas. In this study, we elucidate the quantum computing efficiency and quantum microscopic method which is a diamond-based imaging system employs magnetic resonance of electrons plans MRI for the detection of molecules and charged atoms for observing chemical-compounds and substances feedback response and reaction in real-time, and diamond microscope efficacy [4] in healthcare sectors for modern medical management to advance the cell-imaging - neuroimaging cells.

2. METHODS

The following methods are examined in this study. Computed axial tomography (CAT) imaging employs unique Rontgen X-ray paraphernalia, and in few subjects a distinctive substance to generate numerous image-objects of the within the body. An expert neuroradiologist inspects and construe or deduces and draw the inferences of these images through a computer machine. Overall, CT-imaging can impart luminous radiant anatomical—structural information. Magnetic resonance imaging (MRI, with 7T) by the injection of radioactive-substance, and positron emission tomography (PET) with the injection of radioactive-tracer or radiopharmaceuticals, quantum computing MR-fingerprinting (MRF) method looking at sole molecules or clusters of molecules as a substitute of the intact tissues, hence letting neuroscientists to observe less-significant transforms in the tissue. Positron emission tomography (PET), a kind of nuclear medicine imaging uses tiny amounts of radioactive—substances referred to as radiotracers or radio—pharmaceuticals, plus a unique camcorder video Polaroid camera and a computer-machine with the interfaces operating system to estimate organ and tissue functions. By means of detecting variations at the cellular level, PET possibly will discover the untimely inception of disease prior to supplementary imaging tests can. Nowadays, by fusioning the CAT and PET, i.e., pooling jointly, and mutually can accomplish most of the PET scans. Furthermore, the methods jointly can track down anomalous metabolic activity and can yield additionally perfect diagnoses than discretely.Process: X-ray testing creates a reflection called image by means of transmitting X-rays in the course of the body. Nuclear imaging medicine use a radioactive substance termed as a radio-pharma-ceutical (RPC) or radio-tracer(RT). This substance is instilled into the bloodstream, consumed or ingested like gab. The substance gathers in the area of the body during testing (while in testing condition), somewhere it gives or rotten, not much of power in the manner of gamma γ-rays *(*γ-radiation or γ-ray), is a penetrating electromagnetic radiation coming from the radioactive decay of atomic nuclei, comprises the direct-wavelength (λ) electro-magnetic (EM) waves and so imparts the highest photon energy.. Special cameras detect the power and, using a smart computer, it creates pictures so as to offer information on the anatomical-structure and function of tissues or organs of brain. In contrast, PET scans uses RT injections. This PET centers on the processes within the body, for instance, pace of metabolism or stages or intensities of dissimilar extra chemical—substance activities but not like supplementary imaging signal modalities. Locations of superior intensity, termed as hot—spots, point out wherever large amounts of the radiotracer have stored and wherever there is a sophisticated chemical-substance/compound or metabolic action or movement-activity. A lesser amount of severe deep areas, or cold—spots point to a less significant deliberation of radiotracer and not as much of action or movement-activity.2.1. Advancing neuroimaging cellsResearch engineers at Microsoft teamed up with scientists to test a prototype—model that has been designed to work on quantum computers with the objective of progressing the medical cell imaging by advancing both the swiftness pace—tempo and eminence or excellent quality. The method is defined as magnetic resonance fingerprinting (MRF), analogous to magnetic resonance imaging. Like MRI magnetic fields and radio waves are used to generate images, but the difference is, with the help of quantum computing it can look at single molecules or groups of molecules instead of the single tissues. Further, with MRI, the image object will only generate light or dark, and a radiologist then 'translates' these. The benefit with MRF is that the image generated is already able to differentiate between tissue type, giving a more accurate construal interpretation of what`s occurring inside the body. Investigations revealed that Quantum computing can support this more fine grained analysis due to its ability to process and analyze data analogously (concurrently inparallel), making it significantly more powerful than conventional computers. It does this through replacing the transistors which we find in long-established computers with qubits, which can store data as 0s and 1s, rather than the traditional binary method of 0s or 1s. [5], [6], [7], [8], [9]With the power to process data concurrently, the quantum computer has a far greater capacity for information transfer and manipulation, this key quality allows it to not only make processes at higher pace, but also allows it to receive more data, which in this case results in a higher characterization image. It is not the earliest algorithm to have been designed in application of the quantum computers that will be available to us in the near future. Algorithms have also been created to find better ways to manage in other areas of applications such as the electrical grid, improve delivery routes in urban areas, and manage risks and returns in investment portfolios.

2.2. Quantum microscopic plans magnetic resonance imaging for moleculesQuantum microscopic (QM) is another method which is a diamond-based imaging system employs magnetic resonance of electrons to detect—discover charged atoms and observe at chemical-

compounds and substances feedback response and reaction in real-time. [10]. This method uses a sensor built from diamonds could allow researchers to study such nano-pico-scale mysteries as how DNA folds in a cell, why drugs work or how bacteria metabolize alloys—metals. Crucially, the technique is able to image entity ions in a resolution and disclose biochemical feedback responses and reactions as they transpire — devoid of inquisitive in the procedure.

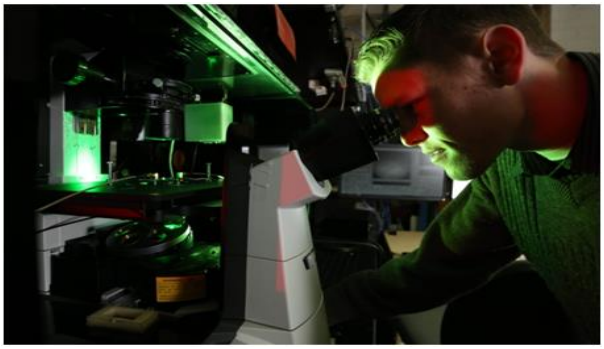

Fig 1. A picturesque of quantum microscope plans for MRI molecules

This innovative quantum microscopic process or quantum MRI [Fig. 1] is a noninvasive process which divulges and exposes the molecular anatomical-structures inside the human body without harming them which functions like hospital imaging systems such as MRI machines but contrasting MRI which gives the only the clarity of the image with boasting temporal resolution (7T and 10T at present). Quantum MRI images at the quantum intensity by electron spins and the idea is to accomplish and achieve the identical for chemical-substance or compound reactions with those connecting alloy or metal ions. Current magnetic resonance techniques can only reveal structures determining 10μ ten micron (microns diameter) or a bit extra, and the solitary way to discover alloy or metal ions within a cell is to adjoin imprudent hasty chemicals-compounds or ice up the cell such that the object tissue can be captured during powerful microscopes — procedures so as to exterminate the cell or to destroy the cell. In hospital environments, MRI machine functions by placing the subject inside the magnetic field, so as to notch or shuffle the protons and atoms within the body with the magnet of MRI. The then MRI transmits radio waves through the respective human-body region of interest/or area by the user being captured or imaged that rap or tap the protons elsewhere. Whilst these radio-waves are switched or toggled inedible, the protons then really and emanate the electromagnetic EM pulses by a scrupulous frequency. But the frequency emanated by the human-body's tissues contests to that of sensors during MRI, subsequently the two frequencies will vibrate like guitar sequence of threads refrained and adjusted to the identical message. The machine uses this reverberation to rebuild and restructure and scan the body image.

Simpson [11] intended to exploit this procedure to identify alloy-metal ions in the cells. Several alloy-metal ions can be hazardous and they can be destructive to cells, while new ones are indispensable for biochemical responses and reactions, for instance those implicated in metabolism. Here the no-win situation is that the imaging sensor has to be concerning the matching dimension as the point being captured, that is presently unattainable while tiresome to glance at a sole molecule. To design the quantum imaging microscope which resembles MRI, the scientists employed two micron lozenge equilateral diamonds that contained molecule-sized defects in their almond shaped crystal structure. These defects are susceptible to transforms in magnetic fields which can be refrained or adjusted to vibrate amid the turn of the ion molecule which is identified. While the crystal defects i.e., diamond defects are clarified through the emerald laser-sensor, the crystal fluoresces ruby, and the intensity of that fluorescence rely on the potency and path of a (applied) functional magnetic field. Simpson exploited a crystal diamond which had a range of defects or errors inside precise spots under its facade and positioned it at the last part of the microscope beside a preview. The then researchers adjusted the flaws to a frequency that reverberated by the gyrate of an ionized form of cuprous which is losing 2 electrons, i.e., structurally represented with Cu^{2+}. By emotive the crystals probe to the exterior of a trial comprising cuprous ions, the reverberation among the 2 inspired fluorescence in the crystal defects. Then they have implemented a piece of computer software module to observe the flush flaking the crystal defects and to rebuild and capture the image of the trial, disclosing the exact spot of every ion of cuprous.
Subsequently, the scientists tormented the trial by an acidic that includes an electron to 2 cuprous ions, spinning it into Cu^{+}. As they included the acidic, they captured the trial and observed the 2 cuprous roll trials (patterns) vanished. The sample then recurred more than the path of an hour as the trial was oxidized to 2 cuprous ions on spotlight to oxygen. Soon or later, such technique might let scientists to observe biochemical responses and reactions as they arise within (cubicle) ion cells.

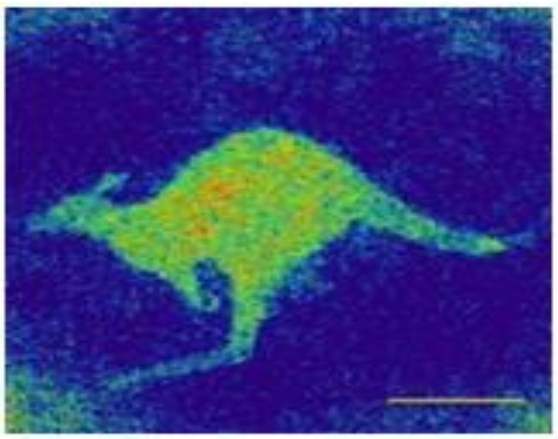

Fig 2 Encompassing the pixels of kangaroo using quantum MRI microscope

As an example, the kangaroo pictures [Fig 2] encompass the pixels was computed generated using a quantum MRI microscope to identify 2 cuprous ions into the result scheduled a experiment pattern model, by the region and locations of disparity dissimilarities illuminating an image and the size of the degree , i.e., the scale—bar taken was 10μ ten-microns. Because the method is non-invasive, it could theoretically be used to capture the center of existing ion-cells — incredible. However, the major impediment and hindrance is that the crystal search desires chosen bodily slam to the trial to generate a waveform or signal. But, the technique is standstill and can be functional for perceptive and thoughtful medical management mechanism and exploring phr (i.e., albumens, albuminoids, glutamines, glutenin`s, proteins, etc) initiate on the ion permeability of cell membranes. Moreover, the scientists are irritating en route for acclimatizing the system such that it might be and can be able to discover dissimilar amalgaming or fusioned alloys which includes flatten—irons. FriedemannReinhard, a physicist at the Technical University of Munich in Germany, praises the work. "The innovations here bring it a lot closer to the application," he says. His group is also working with diamond microscopy, creating a system that could image molecules in 3D. He adds that although the new technique still needs improvements, such as the ability to find copper ions in low-concentration solutions, it is "definitely a great step ahead".

3. RESULTS

With the increasing power of ultra supercomputing, the power of quantum computing (QC) in healthcare sectors swiftly advancing neuroimaging, pinpointing sole cells, molecules or clusters of molecules instead of the intact-tissues, hence lets neuroscientists to observe less-significant transforms in the tissue. The growth of QC in neuroimaging has the potential-to-progress modern-medical-management(MMM/M³) for a myriad-of-multitude neurological disorders specifically cancer and Parkinson`s disease. To elucidate the quantum computing and quantum microscope diamond techniques efficacy in healthcare modern management for advancing neuroimaging. The following methods are examined in this study. Computed-axial-tomography(CAT) Magnetic resonance imaging(MRI,7T) by the injection of radioactive-substance, and positron emission tomography(PET) with the injection of radio-active-tracer(RAT) and/or radio-pharma-ceuticals(RPC). Quantum computing(QC) MR-fingerprinting(QC-MRF), QC with neuroimaging fingerprinting for pinpointing at sole-molecules or clusters-of-molecules as a substitute of the intact-tissues. Quantum-microscope with MRI for observing cuprous-ions(Cu^{+2}) molecules. CAT showed the information on shape and size-of-tissue. PET disclosed how brain organs are functioning, can point the tumor by verifying metabolic movement of body tissues. MRI(7Tesla) viewed the entire tissues and considered high resolution. Quantum computing with neuroimaging glanced at sole-molecules or clusters-of-molecules rather than the intact-tissues. The QC is contributing the likelihood-opportunity of considering yet surplus we are capable-to-perceive by this process.

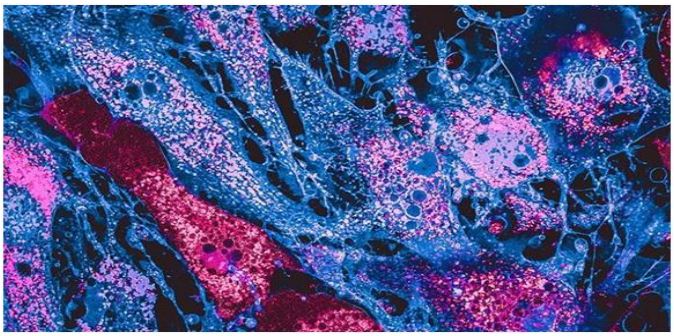

Fig 3. Quantum computing with single and group of molecules

CAT given information on the shape and size-of-tissue.PET disclosed how brain organs are functioning, can point the tumor by verifying metabolic movement of body tissues. MRI (7Tesla) viewed the entire tissues and considered high resolution. Quantum computing with neuroimaging looked at single molecules and also groups of molecules instead of the entire tissues [Fig. 3]. Quantum computing is offering the possibility of seeing even more than we can see with this method.

4. CONCLUSION

Quantum computing of neuroimage fingerprinting-technique can be produced in as little as $\frac{1}{6}$ one sixth of the time, at present attains over and above 25% extra defined, hence letting neuroscientists to observe less-significant transforms in the tissue.Quantum computing (QC) for neuroimaging has the potential-to-progress modern-medical-management for complex-neurological-disorders. QC pinpointing sole-molecules or clusters-of-molecules rather than the intact-tissues, hence lets neuroscientists to examine less significant-transforms in the tissue.The significance of the work and its importance to the biomedical engineering: Although this research study deals with the quantum computing applications to the magnetic resonance neuromagingapplications to the motor sensory nervous system it deals withapplication of neuro electrophysiological evaluation of Parkinson disease, cancer and particularly breast cancer. With this study, we can improve the currently available MRI techniques for evaluating single or group of molecules instead of the tissue only. Quantum computing of neuroimage fingerprinting technique can be produced in as little as $\frac{1}{6}$ one sixth of the time, at present attains over and above being 25% extra defined, letting neuroscientists to observe less-significant transforms in the tissue.

5. ACKNOWLEDGMENT

The author wish to thank MrGopal Reddy, Secretary and Correspondent, CMRCET, CMRGI, Hyderabad.

REFERENCES

[1] Chetan P, Daniel JOS, Collins J, Jozefowicz R, Stavisky SD, Jonathan CK, et.al. Inferring single-trial neural population dynamics using sequential auto-encoders. Nature Methods 2018;15:805-815.

[2] Sarah M. Using Quantum Computing to Enhance Cell Imaging. Nature 2019;1:1-4.

[3] Rama Raju V, Rukmini KM, Rupam B. Effect of Microelectrode Recording in Accurate Targeting STN with High Frequency DBS in Parkinson Disease. Taylor & Francis IETE Journal of Research. 2019;65:1-14.

[4] Stephen JP, and Sergei VK.Microscopy: Hasten high resolution. Nature 2014:515:27:487-

[5] Davide C. Quantum computers ready to leap out of the lab: The race is on to machines turn scientific curiosities into working. Nature 2017;541:9-10.

[6] Elizabeth G. Quantum physicists think big. Springer Nature computing, Infocus news, Macmillan Publishers Limited 2017;1:1-1.

[7] Elizabeth G. Quantum physics: Flawed to perfection: Ultra-pure synthetic diamonds offer advances in fields from quantum computing to cancer diagnostics. Nature 2014;505:472-272.

[8] Gibney E. Quantum physics: flawed to perfection. Nature - Nature in London 2014; 505:7484:472-4.

[9] Robert H. Business Bets on a Quantum Leap. Quantum computing could help companies address problems as huge as supply chains and climate change. Nature 2019;1:1-2.

[10] Sara R. Quantum microscope offers MRI for molecules, Nature 2017;543:7644:162.

[11] Simpson D A. Preprint at https://arxiv.org/abs/1702.04418. 2017.