Quantum Molecular Imaging Device (QMID)

(Biomedical department, Faculty of Engineering, Cairo University)

Keywords: *Decoherence, Electromagnetic, Quantum Computing, Superposition.*

Introduction: - To better understand the complexities of diseases, scientists must investigate molecular dynamics and interactions to uncover the hidden mechanisms driving disease progression and treatment response. Quantum computing is promising in field of molecular imaging, enabling direct interaction with molecules at the quantum level. However, quantum decoherence is major challenge for realizing this potential and by overcoming it unlocking transformative possibilities in medicine.

Broken Principle: - According to the principle of *Superposition*; a bit can be in a state $|0\rangle$, a state $|1\rangle$, or any quantum superposition of these states, mathematically represented as $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$; where α and β are complex numbers. This feature improves the computing power by enabling them to process enormous amounts of data the same time. However, *Decoherence* occurs when quantum systems interact with their environment, causing superpositions to collapse into classical states instead of quantum states, leading to loss of information. This makes maintaining quantum information extremely difficult.

How it should work: A specialized emitter generates a coherent, high-frequency electromagnetic field (e.g., perfect X-rays) as shown in figure (1). This field is designed to:

- *Maintain quantum coherence:* It doesn't disturb the quantum state of the system it interacts with.

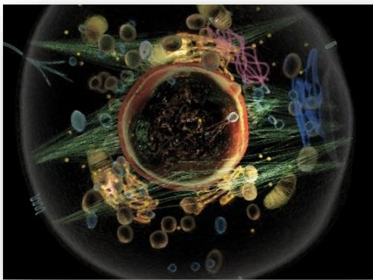
- *Penetrate biological tissues*: Allows for deep scanning without scattering or losing coherence.

- *Interact with quantum states of molecules:* Enables direct observation of molecular quantum behaviour without collapsing the superpositions.

Fig(1): Visualization of the device design

Applications: -

i. Early detection of diseases like cancer at a cellular level. Real-time monitoring during surgeries
ii. Study of living systems in their natural state, revolutionizing research in genetics and molecular biology as shown in figure (2).
iii. Simulating Large Systems: Complex biomolecules (e.g., proteins, enzymes, DNA) and large-scale chemical systems (e.g., drug interactions) could be simulated in full quantum detail
iv. High resolution Imaging of small trabecular and cortical bone structures and other soft tissues including visceral and fat.



Fig(2): Molecular Imaging of live cell

Conclusions: - To conclude, Quantum Molecular Imaging Device will revolutionize early disease detection, the Study of living systems and genetics based on a coherent, high-frequency electromagnetic field enables quantum-level precision in medical imaging.

References: -

[1] A. Deshmukh, “The Role of Quantum Decoherence in Quantum Computing Systems,” *Journal of Quantum Science and Technology*, vol. 1, no. 2, pp. 37–43, Jul. 2024, doi: 10.36676/jqst.v1.i2.14.

[2] S. L. Avri, “Introduction-How can quantum computing shape the future of Medicine ?,” Jul. 2024, doi: 10.13140/RG.2.2.21665.62567.

[3] A. Hashemi, S. Dutta, B. Georgeot, D. Kouamé, and H. Sabet, “Quantum inspired approach for denoising with application to medical imaging.” Jul. 18, 2024. doi: 10.21203/rs.3.rs-4600863/v1.