2020

Conputational Magnetic Resonance Imaging: New Concepts and Emerging Applications

Awojoyogbe O. Bamidele
Federal University of Technology, Minna, Niger State, Nigeria, abamidele@futminna.edu.ng

Raymond Confidence
Federal University of Technology, Minna, Niger State, Nigeria

Dada O. Michael
Federal University of Technology, Minna, Niger State, Nigeria

CONPUTATIONAL MAGNETIC RESONANCE IMAGING: NEW CONCEPTS AND EMERGING APPLICATIONS

Dada O. Michael, Raymond Confidence, Awojoyogbe O. Bamidele,

Department of Physics, Federal University of Technology, Minna, Niger State, Nigeria

Email: abamidele@futminna.edu.ng

INTRODUCTION

Interaction between science, technology and healthcare has emerged as a critical area of research. The rapid development of innovations including Internet of Things (IoT), big data analysis techniques, and miniature wearable biosensors are generating new opportunities for situation-aware mHealth and uHealth healthcare systems. Many challenges in the emerging technology can be addressed by the development of consistent, suitable, safe, flexible and real-time healthcare systems based on the Bloch NMR flow equation.

MATHEMATICAL CONCEPT

A second order non homogeneous differential equation has been derived from the fundamental Bloch NMR equations given as:

$$v^2\frac{\partial^2 M_y}{\partial x^2}+2v\frac{\partial^2 M_y}{\partial x\partial t}+\frac{\partial^2 M_y}{\partial t^2}+\left(\frac{1}{T_1}+\frac{1}{T_2}\right)v\frac{\partial M_y}{\partial x}+\left(\frac{1}{T_1}+\frac{1}{T_2}\right)\frac{\partial M_y}{\partial t}+\left(\gamma^2 B_1^{\,2}(\mathrm{x},t)+\frac{1}{T_1T_2}\right)M_y=\frac{M_o\gamma B_1(x,t)}{T_1}\ (1)$$

where γ is the gyromagnetic ratio, v is the fluid velocity, T_1 and T_2 are spin lattice and spin spin relaxation times respectively, M_o is the Nuclear Magnetic Resonance (NMR) equilibrium magnetization and M_y is the Nuclear Magnetic Resonance (NMR) transverse magnetization. At any given time t, we can obtain useful (previously hidden) information about the system, if appropriate boundary conditions are applied. The term $\frac{M_o\gamma B_1(x,t)}{T_1}$ is the forcing function. If this function is zero, a freely vibrating system results; else, the system is undergoing a forced vibration. The term $\gamma B_1(x,t)$ defines the radiofrequency identification (RFID) system.

INNOVATIONS

Analytical solutions to equation (1) in terms of NMR/MRI relaxation parameters have further enhanced the power of NMR and MRI. Specific applications are featured prominently in our recent publications [1-4]. Our theoretical concepts and analytical models were applied to open up new research fields in Cognitive Neuroscience, Biomedical Engineering, Crystallography, Petroleum Science and Engineering, Computational medicine and Quantum Mechanics. Such knowledge can initiate unforeseen technological possibilities based on much improved understanding of nature.

CONCLUSION

Our present study has explored the excellent applications of equation(1) to the field of neuroscience, with the goal of further applications to recent advances in selective recording and perturbation approaches involving large populations of neurons. This will offer unique opportunities to test and challenge current interpretations of large data sets and trigger novel theoretical developments in the following topics of particular interest: hybrid cloud quantum computing / quantum systems, Artificial Intelligence, cloud / open source technologies and data science systems.

REFERENCES

1. Dada O. Michael, Jayeoba O. Babatunde, Awojoyogbe O. Bamidele, Uno E. Uno, Awe E. Oluseyi (2017). Mathematical Development and Computational Analysis of Harmonic Phase-Magnetic Resonance Imaging (HARP-MRI) based on Bloch Nuclear Magnetic Resonance (NMR) Diffusion Model for Myocardial Motion. *Journal of Medical Systems*, 41:1-20. DOI: 10.1007/s10916-017-0816-2.
2. Awojoyogbe O. Bamidele, Dada O. Michael, Onwu O. Samuel, Ige A. Taofeeq, Akinwande I. Ninuola. Computational Diffusion Magnetic Resonance Imaging Based On Time-Dependent Bloch NMR Flow Equation and Bessel Functions. *Journal of Medical System* (2016) 40:106.
3. O.M. Dada, O.B. Awojoyogbe, A.C. Ukoha, (2015): A computational analysis for quantitative evaluation of petrol-physical properties of rock fluids based on Bloch NMR diffusion model for porous media. *Journal of Petroleum Science and Engineering* 127, 137 – 147.
4. Awojoyogbe, O. B.(2007):. A quantum mechanical model of the Bloch NMR flow equations for electron dynamics in fluids at the molecular level. *Phys, Scr.75*, 788-794.