A Free and Open-Source Web Application for Pulse Sequence Development and Simulation

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Abstract

INTRODUCTION: Both pulse sequence design and acquisition simulation are essential disciplines in MRI research. In previous work [1], we introduced a graphical pulse sequence editor and a web version of the KomaMRI [2] simulator. The former, while useful, lacked flexibility for defining global parameters and included a 3D slice visualization tool not well suited for web environments. Regarding the latter, it allowed remote simulations but was not integrated with the sequence editor. This work therefore presents a complete and improved platform that integrates both components, enabling the design and simulation of advanced MRI sequences in a web-based environment free of local installations.

METHODS: A full-stack development has been carried out, addressing both the front-end and the back-end, as well as the communication mechanisms between them. Specifically, the front-end includes an improved version of the previously developed sequence editor, a 3D slice visualization tool, and two additional panels: one for visualizing the temporal sequence diagram and the other for displaying simulation results. This implementation combines the Qt framework with web technologies such as HTML, JavaScript, VTK.js, and WebAssembly. The back-end, developed in Julia, includes an HTTP server with a REST API, the KomaMRI simulator, and additional modules which include the database and front-end compiled files.

RESULTS & DISCUSSION: The tests conducted with the developed tool highlight its usefulness, interactivity, and smoothness, also demonstrating its ability to design and simulate arbitrarily complex pulse sequences without the need for local installations. Figure 1 displays the application layout, integrated within the Web browser.
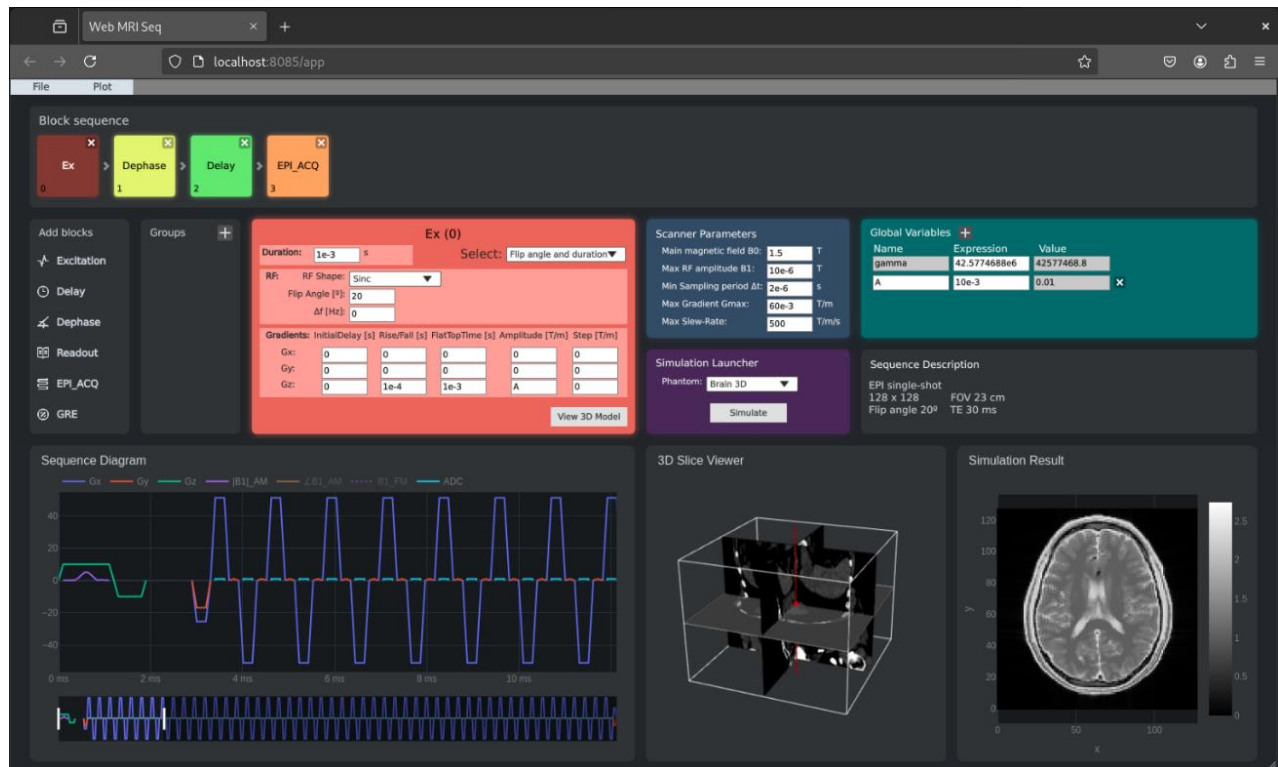
Figure 1 – Final layout of the web application. Upper panels handle sequence design and simulation launch in KomaMRI, while lower panels display the sequence diagram and simulation results.

References

1. P. Villacorta-Aylagas, I. Fernández-Arias, C. Castillo-Passi, P. Irarrázaval, F. Simmross-Wattenberg, M. Rodríguez-Cayetano, and C. Alberola-López, "A Web Version of KomaMRI. Sequence Editor and Remote Execution", in ISMRM Iberian Chapter Annual Meeting 2023, Valladolid, Spain.

2. C. Castillo-Passi, R. Coronado, G. Varela-Mattatal, C. Alberola-López, R. Botnar, and P. Irarrázaval, "KomaMRI.jl: An open-source framework for general MRI simulations with GPU acceleration", Magnetic Resonance in Medicine, vol. 90, no. 1, pp. 329-342, 2023.