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Need for a Non-Commercial Open-Source MR Simulator

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Summary

Many members of the society would greatly benefit from a flexible and intuitive MR Bloch equation simulator with standardized interfaces. Currently no general use simulator is available which meets the needs of the MRI/MRSI community. We propose to develop a non-commercial, open-source MR simulator as a collective project within the MR community. To guarantee a supreme design, an extensive planning and design phase should precede the actual coding.

Motivation and significance

An arbitrary MR experiment can be completely simulated by application of the Bloch equations, if the physical properties of the MR scanner and the object of investigation are known. An MR simulator can be an aid for many tasks, e.g.

- Pulse sequence design: Effects could be explored which are not easily accessible analytically; examples include the slice profile and off-resonance effects in the transient phase of steady state imaging and the signal evolution in sequences with variable timing.
- Image artifacts: For example, prediction of unwanted coherences in multi echo imaging; as image contrast could be studied as well as other sources of artifacts.
- System design: With the input of the relevant system parameters, an MR simulator can aid engineers in building systems or components like coils.
- Education: An MR simulator can be an excellent educational tool: Visualization of the real time signal evolution as well as the contrast behavior of various MR sequences can aid the study of MR principles.

Current implementations

Currently there are a range of MR simulators in use. Most of them were designed with a specific goal in mind. They are not freely accessible and/or difficult to operate. Some powerful simulators do not support MRI/MRSI and are not easily extensible to allow such support.

Proposed plan

We propose to bundle the resources of the interested members of the society to build an open source, non-commercial MR simulator. The simulator should fulfill the following design criteria:

- Modular design to allow concurrent development and flexible/adaptive use
- Intuitive and consistent user interface
- Simple and stable data interfaces to allow input/output with different programs and to allow e.g. interfacing with vendor measurement instruction dumps.
- Extensible: New functionality should be easily implemented by means of above mentioned open interfaces and modular programming, e.g. use of virtual phantoms as input or use of sophisticated processing routines for generated data (parallel imaging routines etc.).
- Scalability of the simulator, which would allow quick basic simulations for educational purposes as well as Monte-Carlo simulations to study intravoxel effects in the ultimate case.

In order to make sure that the needs of all interested parties are met, we propose an extensive discussion and design phase where features are prioritized before coding is started (see Fig. 1 for a proposed road map). It has been shown that open source software projects can produce high quality software. We are very confident that the scientists of our MR community have the capabilities to build a high quality MR simulator which would benefit many of us and would certainly trigger advancements in our field.

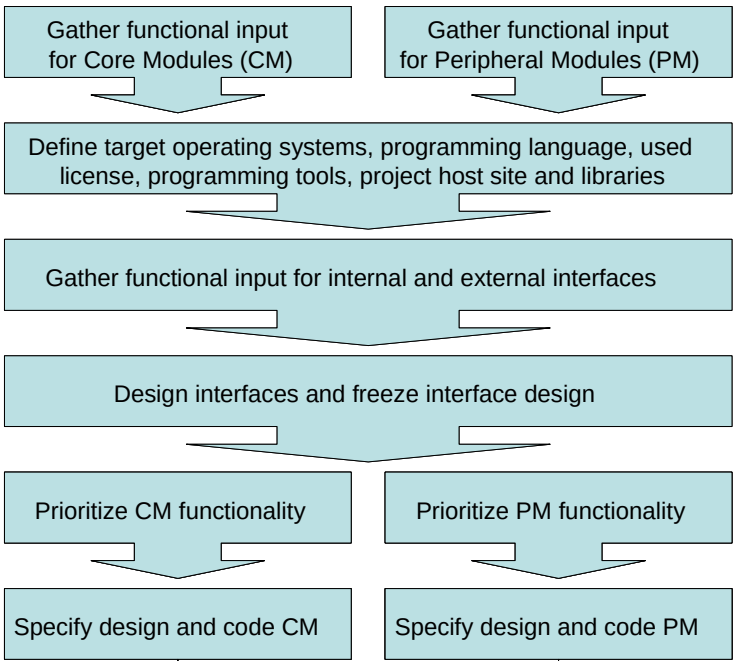

Figure 1. Proposed road map