BirdcageBuilder Mobile: New Functionality and Portability for a Standard MR Engineering Tool

Giuseppe Carluccio[1], Chih-Liang Chin[2], and Christopher Michael Collins[1]

[1]*Bernard and Irene Schwartz Center for Biomedical Imaging, New York University School of Medicine, New York, New York, United States,* [2]*Merck Sharp & Dohme, Singapore, Singapore*

Target audience: anyone interested in designing birdcage coils or RF coils in general.

Introduction: Birdcage coils [1] are the most commonly-used volume coils in MRI for their ability to provide homogeneous circularly polarized fields inside their volume with a quadrature channel excitation. Birdcage coils are resonant circuits that operate at specific frequencies and are tuned by choosing the proper capacitor values. Over 15 years ago [1-3] a simple method to compute the mutual inductances in a birdcage coil, and the determine the capacitors needed to make the coil able to resonate at a specific frequency formed the basis of a software package, BirdcageBuilder [4], which determines the approximate value of the capacitors to use for a given coil geometry: length and number of legs (or rungs), cross-sectional shape of legs and end-rings, radii of coil and shield. The software has become one of the tools most used by RF coil designers. In this work we extend the functionality and portability of the software [4] by designing a version which can 1) run on common mobile devices for easy access anywhere coils are constructed, and 2) provide all resonant frequencies of the coil as designed.

Methods: The first screen (Fig. 1) allows the user to input the data that best describe the geometry of the desired coil. After the "Calculate" button is pressed, the software operates in the following way:

Step 1: the self and mutual inductances of the legs and of the end-rings are computed using the geometrical properties [2, 3].

Step 2: the capacitors that make the coil resonate at the frequency selected by the user are computed using the equations in [2].

Step 3: the capacitors computed in Step 2 are used to compute all the possible resonant frequencies [5]. The resonant frequencies correspond to the values of ω which nullify the determinant of the appropriate matrix, as related to the self and mutual inductances of all conductive segments in the coil [5].

Results: The following results are reported in a second screen (Fig. 2): the values of the mutual inductance of the legs and of the end-rings, the value of the capacitors to be used to make the circuit resonate, and on the top row all the resonating frequencies in a drop-down menu. Capacitor values are identical to those predicted by the existing desktop version of BirdcageBuilder. Selecting one of the resonating frequencies also updates the values of the mutual inductances. At the time of abstract submission, the software is available for Android operating systems. In the future it will be ported to other common mobile operating systems, including iOS. The tool will be available online for download soon. Meanwhile, inquiries can be sent to giuseppe.carluccio@nyumc.org

References:

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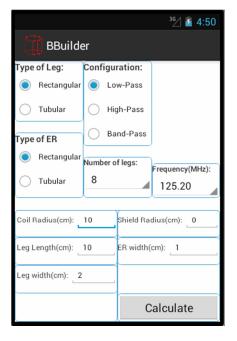5. J Jin, "Electromagnetic Analysis and Design in Magnetic Resonance Imaging", CRC Press LLC, 1999.
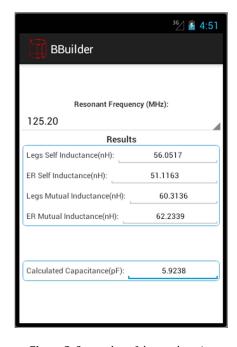
Figure 1 Screenshot of the geometry input screen.

Figure 2: Screenshot of the results print screen.