Automatic selection of anterior floating coil array based on lipid layer signal analysis

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Introduction The use of a floating anterior array (AA) coil coupled with posterior array (PA) coil offers superior SNR as well as great flexibility for abdominal scans. Typically, such coil arrays consist of equal spaced coil elements (Fig. 1) along the S/I and L/R direction as currently provided by the major vendors. In typical clinical operations, only some of the coil elements shall be activated to cover the user set FOV and avoid wrap around artifacts. However the floating nature of the coil array makes its position unknown to the system; hence hinders automatic selection of the proper coil elements. This is especially troublesome in whole body imaging. On the other hand, manual selection of the coil elements is vulnerable to errors, as the corresponding PA coil elements need to be simultaneously selected. In this work, we report an uncomplicated yet robust method of determining the locations of AA coil elements. This method may be readily integrated into standard user workflow and adds little or no additional scan time.

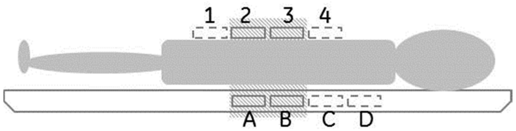

Figure 1: illustration of the coupling of anterior array (AA) and posterior array (PA) coils. For the user set FOV (shaded region), appropriate elements in both AA and PA coil shall be activated. However the system has no knowledge of AA's p position due to its floating nature.

Method Since abdominal coils are placed in close proximity to the scan subject, the signal variation from each coil element directly reflects the distance away as a result of the coil spatial sensitivity variation, and may be used for locating the coil elements within the FOV. However, the effect of coil sensitivity is modulated by the tissue's intrinsic properties and structure in in-vivo images. On the other hand, the peripheral lipid layer in a PD weighted is highly homogenous and may closely reflect the coil element's footprint as illustrated in Fig.2. The proposed scheme uses this lipid layer to determine the coil elements' positions in real time, and may be described in two parts: data acquisition and data processing.

Data acquisition: Since the main challenge is to map out the coil element's position along the S/I direction, a single slice sagittal scout at FOV center would suffice for this purpose. The data acquisition needs to be rapid and provide near PD contrast, a gradient recall spoiled sequence (SPGR) with the following parameters are used: FOV 48x48cm, matrix 256x64, TE/TR = 3/7ms, Flip angle = 4, slice thickness = 20mm. The scan time for a single slice is about 0.5s.

Data processing: The first step is to separate out the lipid signal in images from each coil element. Ideally, an image segmentation that 'peel off' the lipid layer shall be performed (Fig.2(a)), which unfortunately is computational heavy. A much simpler approach is taken here to achieve the same purpose: assuming the lipid signals are the strongest as they are closest to coil elements in a PD weighted image, along each line in A/P direction, average of the maximal intensities is used as an estimate of lipid signal strength. In this way, 2D images are transformed into 1D signal profiles and the footprints of the coil elements may be located. The key is to detect the rising and falling edges of the profile, and identify matching pairs of edges whose centers may be considered as the center of the coil elements. In practice, some coil elements may be only partially within the FOV, and the falling edges of lipid signal may also be caused by the signal drop out at edges of FOV, which may lead to incorrect estimates of the coil elements. A simple test is to compare the separation of the edges to the known physical dimensions of the coil elements, those separations that are smaller than the coil element's size shall be discarded (Fig.2).

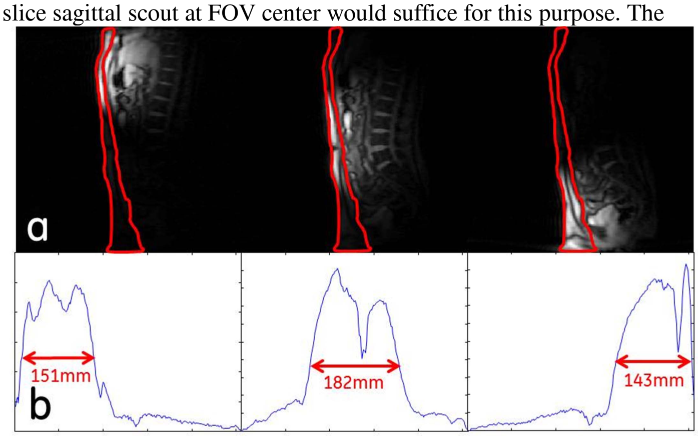

Figure 2: (a) images from elements of anterior coil array along S/I direction; (b) The lipid layer signal may be used to locate the footprint of the coil elements. The center between rising and falling edges may be considered as the center of the coil element, however should match with the size of the coil element (180 mm) to avoid signal drop out at edge of image FOV, such as coil elements 1 & 3.

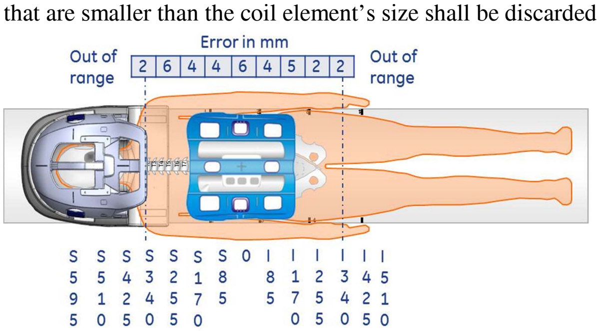

Figure 3 : diagram illustrating the experiment mimicing the process a whole body imaging using a 3x3 floating AA coil: the user set FOV shifts along S/I from head to knee covering a from S595mm to I510mm is covered. Coil array's positions were determined within the range from S340 to I340, as there is no overlap between the coil elements and the data acquisitoin FOV outside this range.

Experiment The proposed method is implemented and tested on a GE 1.5T Optix scanner equipped with a 3x3 floating coil array whose dimension is 550mm (S/I) by 510mm (L/R). Volunteer scans were performed with subjects of different builds to test the robustness against different lipid signal level. The coil was initially placed at a known position with respect to the magnet center, and the user set FOV varies with a range of S595mm to I510mm in step of 85mm to mimic the workflow of whole body imaging in which abdominal scan follows head and neck imaging (illustrated in Fig.3).

Results and Discussion The differences between the estimated coil center and the actual coil center at positions tested are shown in Fig.3 at tested locations. It is seen that the error range is well-below the threshold for auto-coil selection (half of the coil size, 90mm) hence this method provides accurate estimate of the coil's position for auto-coil selection. It is noted for cases where none of the coil elements is within the reach of the data acquisition (48cm), the position of the coil cannot be determined and are marked as out of range. From users' side, if the AA coil is too far away, it cannot provide sufficient coverage for user set FOV and hence cannot be selected; and as soon as one element of the AA coil falls into the data acquisition FOV (48 cm) the AA coil's position would be available and the appropriate coil elements may be selected.

Conclusion A practical scheme for determining the positions of floating anterior coil array for auto-coil selection is proposed. This method has been demonstrated to be rapid and robust in volunteer scan. The data acquisition nature allows it to be readily combined with standard scout scan so that no additional scan time is added.