The Interventioal Device Tracking Using Miniaturized Micro Coils

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Objective: Considerable efforts are being made to perform device tracking in MR image guided interventions using active tracking coils [1, 2]. However, the dimensions of these coils are bulky in nature thereby increasing the size of normal interventional devices (for e.g. catheter). In order to overcome this disadvantage in this work, highly miniaturised micro coils with built-in amplifier are being developed and its feasibility is demonstrated on a clinical scanner with phantom experiments.

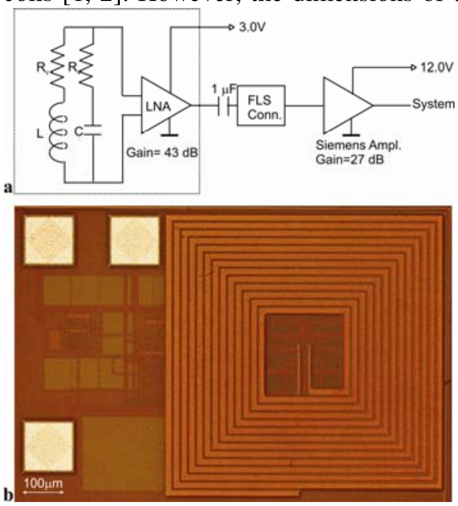

***Figure 1** a) Equivalent circuit diagram of the micro coil including connection to clinical scanner through flex coil interface. b) The enlarged photograph of the planar coil circuitry (dotted area in Fig 1a)*

Materials and Methods: The coils which have been developed are designed to operate at 63 MHz corresponding to 1.5T magnetic field strength. The equivalent circuit of the micro coil setup including connection to the clinical scanner through Flex coil interface is shown in Fig 1a. The planar micro coil L tuned to 63 MHz frequency using capacitor C, is connected to a low noise amplifier (LNA) with a gain of 43dB. The photograph of the enlarged planar coil circuitry (dotted area in Fig 1a) is shown in Fig 1b. A weakly magnetic battery (3.6 V) was used as a power supply to LNA. A glycerol nitrate capsule (T_1=135 ms; T_2=90 ms; 5mm in diameter) was used as a sample for MR measurements and was placed directly above the coil.

All the measurements were done on a Siemens Espree 1.5T scanner. The flip angle and frequency adjustments were made using the body coil. In order to demonstrate the tracking performance of the coil, the projections were obtained along X, Y and Z directions with coil acting as a receiver. The acquisition parameters were: a hard pulse (duration 0.5 ms); data points 256; FOV 300 mm; TE/TR 1.55/5.0ms. In addition, the projections were also obtained at different Z positions with an increment of 10 mm.

Results: Fig 2a, b and c shows the projections obtained along X, Y and Z directions respectively. The peak detection at the coil position can be clearly visualised. The SNR of about 10 was obtained for every projection. Fig 2d shows the graph of the difference (Z_m-Z_a) between actual position and measured position using projection technique against the actual Z-positions (Z_a). It can be seen that the difference (Z_m-Z_a) increases linearly with the increasing distance from the iso-centre, which is consistent with the non-linearity of the gradient system, hence proving the utility of the coil as a RF receiver.

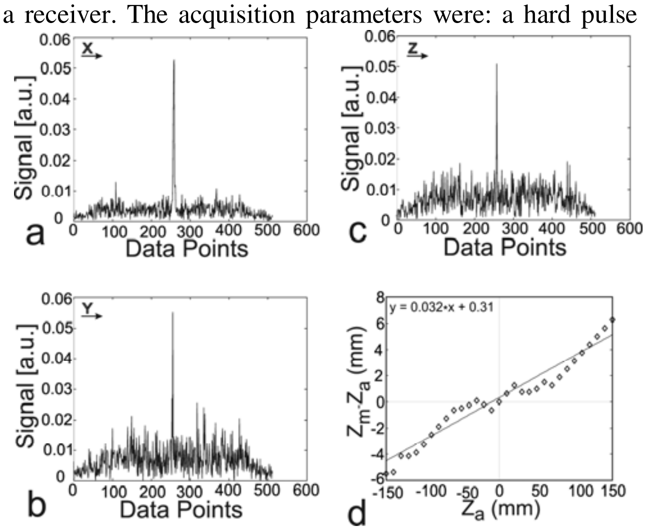

***Figure 2** a) Micro coil projections obtained along a) X b) Y and c) Z directions. d) Plot of the difference (Z_m-Z_a) between measured and actual coil position as a position along z-direction*

Conclusion: Our initial phantom results indicate that the micro coil with typical dimensions of 500µm X 500µm and built-in amplifier can be used as a RF detector on clinical scanner. Further modifications and experiments are necessary to incorporate the micro coil into an interventional device.

References: [1] Bock M et al., JMRI 19:580-589, 2004. [2] Elgort DR et al., JMRI 18:621-626, 2003.