Remote Tuning and Matching an 8-Channel Transceive Array at 7T

C. Snyder[1], C. Rogers[2], L. DelaBarre[1], M. Robson[2], and J. Vaughan[1]
[1]University of Minnesota, Minneapolis, MN, United States, [2]Oxford University, Oxford, Oxfordshire, United Kingdom

Introduction:

The ability to tune and match multi-channel transmit or transceive arrays is necessary for increased transmit efficiency, reduced coil coupling and optimal receive sensitivity. However, tuning and matching large array is not feasible for clinical studies. Here we show the ability to remotely tune and match (and monitor) transmit arrays from the console this can also be automated by monitoring the forward and reflected power on the transmit line near the individual coils.

Methods:

Variable Capacitor. The remotely tunable variable capacitor is shown in figure 1. Here a piezoelectric actuator, b, (SQ-100, New Scale Technologies, Victor, NY) is mechanically grounded to a cylindrical capacitor, fig 1g. As the actuators titanium shaft, fig 1c, moves forwards and backwards, it changes the position of the capacitors center cylinder, fig 1h, in the variable capacitor. A compression spring, fig 1e, provides a return force for the piezoelectric actuator and is isolated from the center cylinder by a Teflon sheath. Two NO micro switches figs 1a and 1f, are used to set the rear and forward home positions for the capacitor. These remotely tunable capacitors have proven successful in previous studies. (1)

8-Channel Array: An 8-channel TEM transcieve array, fig 2a, was designed to fit in a Siemens 7T (ω_o=297.14MHz), 90cm bore magnet (Mangex Scientific, UK) equipped with Siemens console and head gradients. The array has 30 cm outer diameter with a 25.4 cm inner diameter/head cavity. The individual TEM elements were 15 cm in length and the center conductor was separated from the ground plate via a 2.5 cm air dielectric. Sixteen remotely driven variable capacitors (8 tuning and 8 matching capacitors) were installed in this array.

Drive Controller: Figure 3 shows the feedback control of the tuning and matching of the 8-channel array. A single driver (MC-1100, New Scale Technologies, Victor, NY) outputs two 200V 42KHz sine waves to drive a single piezoelectric actuator. The front and back micro switches provide feed back control to a micro controller. The microcontroller communicates to the driver (speed and direction) via RS 485 serial port.

The 8-channel array can either be connected to a network analyzer and a user can manually tune and match each coil. This process may also be automated by programming the microcontroller to reduce the standing wave ratio on the transmit line.

Results:

Gradient echo images (TR/TE=75/5ms; res=0.4 x 0.4 x 5.0 mm; NEX=2) of the axial slice are shown in figure 2. The presence the remotely driven variable capacitors and control logic in the array does not induce gross B_0 inhomogeneities, eddie currents or gradient spikes; nor does increase either structured or non-structured noise.

Conclusion:

Here we have shown the ability to remote tune and match a transceive array from the console. By monitoring the forward and reflected power from the RF amplifier it is feasible to automate the process.

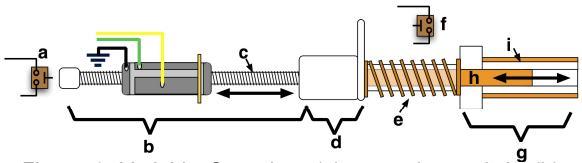

Figure 1: Variable Capacitor. (a) rear micro-switch; (b) piezoelectric actuator; (c) threaded titanium shaft; (d) nylon standoff with stop washer; (e) compression spring; (f) forward micro-switch; (g) variable cylindrical capacitor (cut-away view); (h) center cylinder; and (i) outer cylinder.

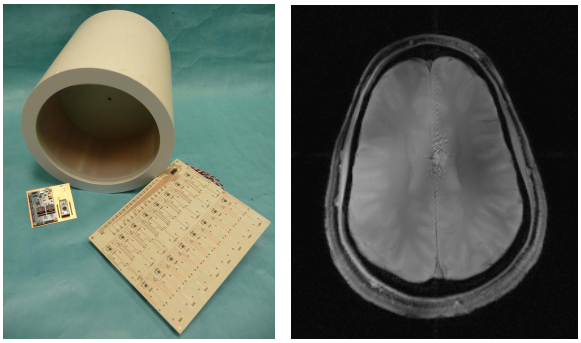

Figure 2: (a) Eight-element TEM array with piezoelectric driver and demultiplexer boards. (b) Axial slices of gradient echo images (TR/TE=75/5mx, res=0.4 x 0.4 x 5.0mm) acquire from the remotely tunable array.

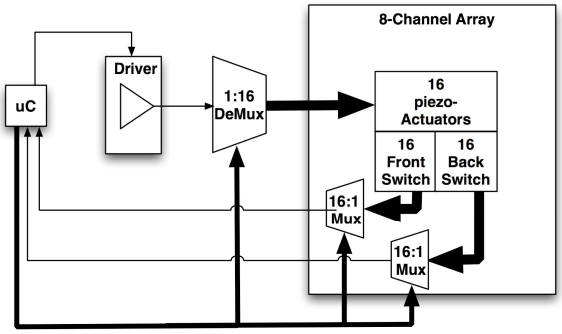

Figure 3: Feedback and control loops required to tune and match the 8-channel array.

References: ISMRM 2010, p 1523

Acknowledgements: NIH-NIBIB-EB000895, NIH-NIBIB-EB006835, NIH-NIBIB-EB007327, NIH-NCRR-P41-RR08079, Keck foundation