Using On-board Microprocessors to Control a Wireless MR Receiver Array

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Introduction: In recent years, particular attention has been devoted to the development of wireless receiving technology.[1,2,3] Wireless receiving will potentially alleviate many of the engineering costs and complexities associated with the design of receiver arrays with a large number of elements. As wireless systems become developed commercially, elegant solutions will be necessary to control the entire system. Channel identification, channel spacing, and power settings are among many of the parameters that may be necessary when controlling a wireless array. We propose to use on-board microprocessors to control these operational aspects. In this abstract, we present a single AM wireless channel controlled by microprocessor that shows no serious degradation to image quality.

Methods: *Array Design:* A single wireless receive-only channel based on analog AM frequency multiplexing was designed and constructed. The MR receiver element was tuned and matched to 63.6MHz with an approximate $Q_{loaded}/Q_{unloaded}$ = 4.1. The receive element was attached to a transmitter module, which contained a PLL (Analog Devices - ADF4111) and VCO (Maxim IC – MAX2623) to generate a unique carrier signal. To control these devices, a microprocessor (Microchip-PIC12F635) was used, which in this case, controlled the frequency of the wireless carrier signal. External components connected to the microprocessor defined a specific RC time constant which determined a predefined carrier frequency. The wireless signal was transmitted received using a simple stub antenna and received on a wide-band path antenna.
MR Studies: The wireless channel was placed in a 1.5T Espree MRI (Siemens, Germany). A simple GRE sequence (TE/TR/FA = 15ms/150ms/25^{o}) was used to evaluate the system's performance. Images were collected wirelessly at a transmission distance of 30cm. Then, cables were placed immediately after the low noise preamplifiers and the same imaging experiment was performed. To evaluate their respective performances, the signal-to-noise ratios (SNR) for both wireless and wired acquisitions were compared. The SNR for each imaging experiment was estimated using ROIs collected from each of the images.

Results: Figure 1a shows an image collected with the wireless system controlled by the microprocessor. Figure 1b shows the same image collected by directly collecting the signal from the preamplifier. The same ROIs from each image region show that the SNR from the wireless image is 63.85 +/- 5.3 while the SNR from the wired case is 72.5 +/- 5.3.

Discussion: These results demonstrate that a microprocessor can be used on-coil without losing stability of the wireless system. While the SNR in the wireless case is less than the wired case, the difference is not significant. We are exploring means to improving the performance of this wireless module. Recall that if the signal quality of the MR signal is amplified sufficiently to overcome the losses from wireless transmission, the same SNR can be theoretically obtained. While this work only presents AM wireless technology, microprocessors can also be applied to other, possibly more complicated, wireless transmission technologies. This work has introduced a novel way to controlling wireless MRI technology, and future work will focus on using this technology in a multi-channel wireless array.

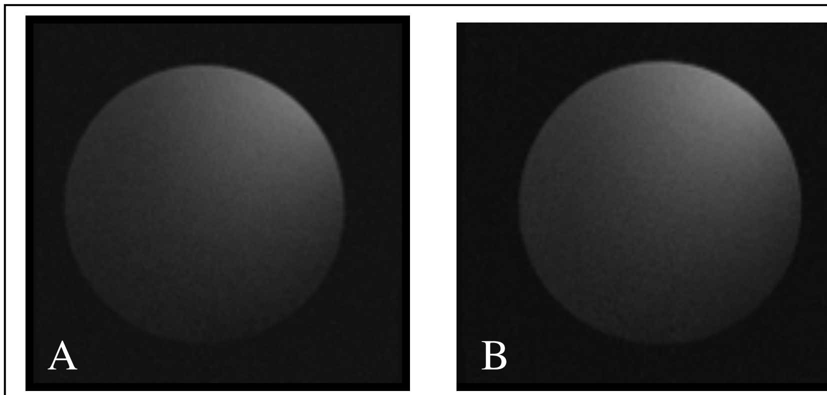

Figure 1. a.) Selected image collected from a wireless receiver controlled by a microprocessor. b.) The same selected image directly connected the reciever coil's preamplifier. The image quality between the two images are nearly the same.

References

[1] Scott et al., Proc ISMRM 2005: #330
[2] Wei et al., Proc ISMRM 2008: #682
[3] Shen et al., Proc ISMRM 2008: #683

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