

In-vivo current density imaging of pig torso

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Current density imaging (CDI) is an MRI technique that measures a current density vector field in a conductive object [1]. The goal of this work is to measure the current flow inside the pig torso while applying current pulses through flexible automatic external defibrillator (AED) electrodes placed on the chest. The required pulse sequence is fast and cardiac-gated to avoid motion artifacts. The sequence also requires sufficient time between existing MRI gradient pulses for the application of current pulses.

A fast 3D cardiac-gated GRE sequence was modified as shown in figure 1. Current pulses with two different polarities corresponding to two different phase cycles were applied between the encoding gradients and readout gradient. Veterinary PO₂ monitor was used to provide trigger signal for the MRI.

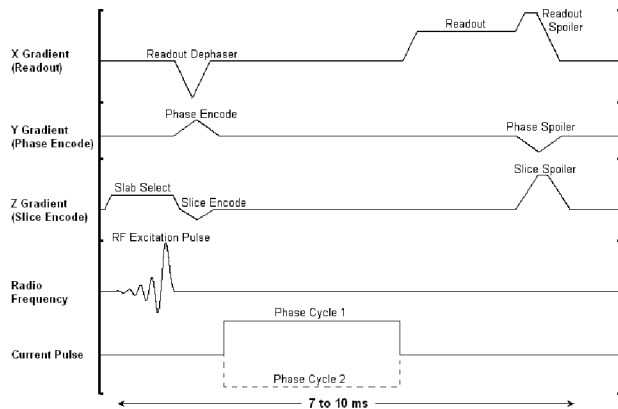


Fig. 1: Pulse sequence for Fast GRE-CDI.

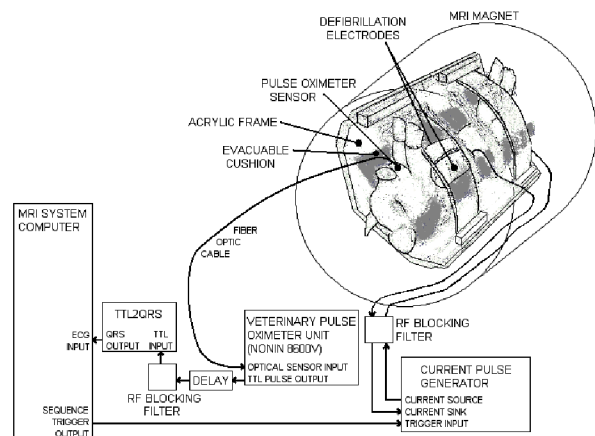


Fig. 2: Cardiac gating and current pulse synchronization circuits.

Figure 3 shows results for CDI of the heart and chest. Figure 3(a) shows the anatomical MR image where the pig's head is located to the right of the figure. Figure 3(b) gives the current density magnitude of a baseline CDI acquisition where no current was applied. Figure 3(c) gives the current density magnitude of a CDI acquisition with 40 mA current pulses applied. Comparison of figures 3(b) and 3(c) demonstrates successful measurement of current density. Analysis of the data gives an average current density of 9.0 A/m² in the blood of the left ventricle, 13.0 A/m² in the blood of the right ventricle, 7.5 A/m² in the myocardium of the left ventricle and 10.0 A/m² in the myocardium of the right ventricle.

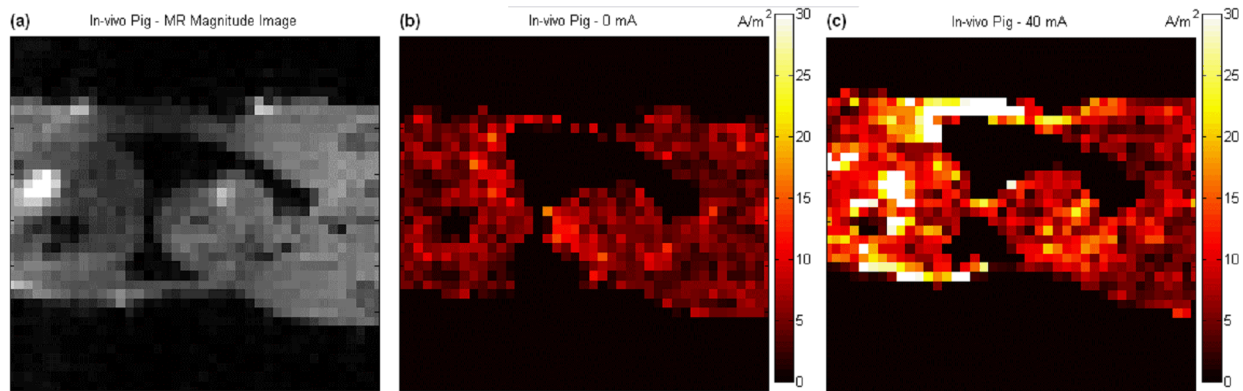


Fig. 3: (a) Anatomical MRI of heart & chest with pig's head to the right. (b) CDI baseline with no current applied. (c) CDI magnitude with 40 mA current applied.

[1] G. C. Scott, M. L. G. Joy, R. L. Armstrong, and R. M. Henkelman. *IEEE Tran. Med. Imag.*, Vol. 10, No. 3, pp. 362-374, 1991