Flip Angle modulatioN Scheme (FANS) to achieve an arbitrary signal modulation in SPGR

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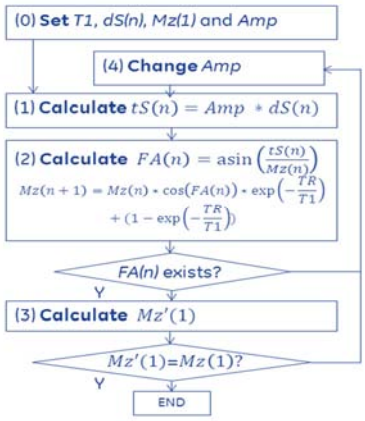
Introduction Spoiled gradient-recalled echo (SPGR) is widely used for T1 contrast applications. In order to achieve a better contrast, Mz preparations such as IR prep, Chemical Sat and Spatial Sat, are often applied. In practice Mz preparations are not implemented in each TR to maintain a short scan time. Instead a new steady state is built which leads to Mz variation among different TRs. If a fixed flip angle (FA) scheme is used, the resulting signals are modulated among different TRs that may lead to image artifacts. On the other hand, a variable FA scheme may be used to mitigate this signal modulation[1]. However, the challenge remains to find an appropriate variable flip angle scheme given a desired signal modulation. Here we propose a novel algorithm, Flip Angle modulatioN Scheme (FANS), to find such an optimal FA scheme to achieve an arbitrary signal modulation.

Method The steps in the FANS method are outlined in Fig.1. With the knowledge of T1 of the imaging object, the FA may be designed to achieve a desired signal modulation *dS(n)*.

As an example, assuming a IR preparation with TI=450ms is played once every 128 TRs (TR=8ms) in SPGR and a fixed FA = 12deg is used, the signal variation of White Matter (WM, T1=656ms in 1.5T) may be obtained by solving the Bloch Equation (dotted line of Fig.2.(a)). It is seen that the signal increases in consecutive TRs and leads to edge enhancement if center of K Space is acquired at front as usually done. On the other hand, a more desirable modulation is shown as solid line in Fig. 2(a), which makes the high signal to be at front and filled into the center of K Space. In this way, a better CNR will be achieved. The corresponding FA scheme is designed by FANS is shown in Fig.2.(b) as solid line.



- *T1*: T1 of target material
- *N*: total TR after Mz preparation
- *Amp*: temporary amplitude of signal
- *dS(n)*: desired signal modulation for each TR
- *tS(n)*: target signal amplitude for each TR
- *FA(n)*: Flip angle for each TR
- *Mz(1)*: target Mz of first TR before RF pulse
- *Mz'(1)*: calculated Mz of first TR before RF pulse

Figure 1: Block diagram of the procedure to implement FANS algorithm. By setting different Mz(1) and dS(n), the signal for each TR is changed, which can be used to tune image quality.

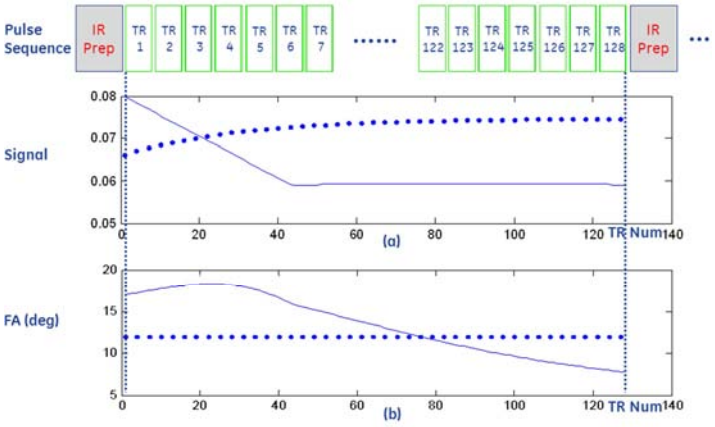


Figure 2: In an IR prepared SPGR, a fixed FA scheme (dotted line in b) will lead to an increasing signal in consecutive TRs. The FANS-designed variable FA scheme (solid line in b) leads to a signal modulation that is high at beginning and then drops (solid line in a), which achieves better CNR in practice.

Results The proposed FANS is implemented with the BRAVO of GE 1.5T scanner, which is a 3D IR prepared SPGR. Volunteer scans were performed using either fixed FA or a variable FA scheme devised by the FANS method. In the latter case, the FA modulation as shown in solid line of Fig.2.(b) is used to increase CNR. Consent form was obtained prior to volunteers scan. It is seen in Fig.3 that using the FANS scheme, the CNR between white/grey matters is considerably increased.

Discussion & Conclusion FANS is a practical approach to find an optimal Flip angle scheme for a desired signal modulation, which may be flexibly exploited to improve the diagnostic value of the images. The current implementation is limited to SPGR under the assumption that that Mz preparation does not break the SPGR condition.

Reference 1. Y. Iwadate, #1462 Proc. ISMRM, 2011, Toronto

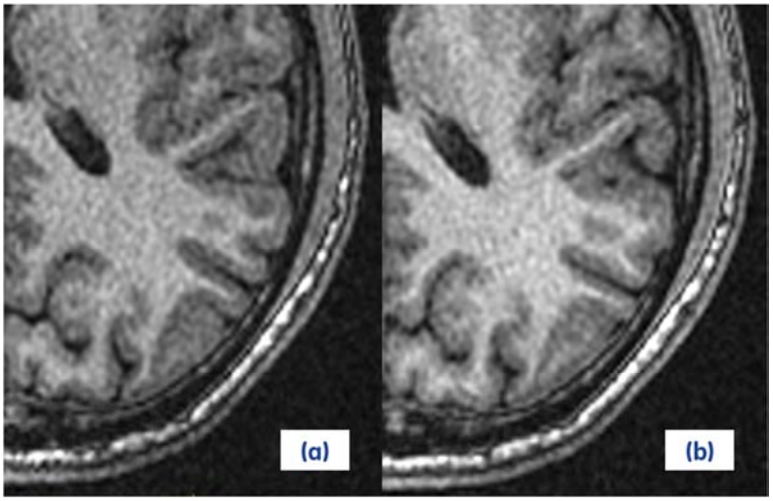


Figure 3. T1 contrast image with (a) fixed FA scheme and (b) FANS FA scheme shown in solid line in Fig.2.(b). The CNR in (b) is obviously higher than (a) .