# Interactive MRCP with Adaptive Averaging

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**Introduction:** We have developed an interactive version of a driven-equilibrium single shot fast spin echo (SSFSE) sequence integrated into a proprietary interactive imaging system (i/Drive Pro Plus, GE Medical Systems, Milwaukee WI) [1]. The system provides interactive control of slice thickness, TE, TR, field of view, fat suppression, scan plane prescription and respiratory triggering. The technique has been used for thick slab 2D MR cholangiopancreatography (MRCP), where a heavily T2 weighted acquisition is used to image the biliary and pancreatic ducts. Our implementation provides a capability for short TR rapid localisation and then immediate switching to thick slab projection imaging for MRCP. A limitation of current 2D MRCP techniques is the trade-off between SNR and spatial resolution for detecting subtle strictures and duct irregularities, e.g. early sclerosing cholangitis. Interactive imaging in the same location provides an opportunity for simple additive averaging to improve SNR on small field of view studies. However, motion of the bile ducts will result in impaired image quality. Previous authors [2-4] have utilised interactive imaging systems together with adaptive averaging (AA) to improve the image quality of coronary MRA studies. In this work we investigate the feasibility of using adaptive averaging in interactive MRCP (with and without the use of respiratory triggering) to improve SNR at reduced FOVs and thereby image quality.

**Method:** An IDL program was developed to analyse MRCP images, either retrospectively or during interactive scanning. The technique involves the computation of a correlation image, formed from the correlation coefficient [2] of each pixel when correlated with a user-defined kernel region typically the main duct confluence (Figure 1), chosen from an initial (reference) image. Since the coefficient is greatest where the kernel exactly matches with the region surrounding the pixel of interest, a peak is formed in the correlation images at the positions where the structure in the kernel appears. The use of prewhitening [2] when calculating the correlation coefficient ensures these peaks are sharp. The autocorrelation image formed from the kernel and the reference image is compared with the correlation images from the other frames in the series. Images may be discarded if the peak is found to be too diffuse, indicating a poor match with the reference image or if the peak has moved so far that we no longer consider the assumption of rigid body deformation to be valid. The positions of the peaks in the correlation images are used to calculate the required translation for each individual image to place the structure appearing in the kernel at the same position as in the reference image. These shifted images are then summed to create the adaptively averaged image.

**Results:** Fig. 1 shows a typical result from the AA of 8 non-respiratory triggered images from a healthy volunteer. A marked improvement in image quality can be seen in the AA image. Typically there is a 20% (with triggering) or 10% (without triggering) increase in SNR in the common bile duct when compared with standard averaging. In a preliminary analysis of 8 consecutive images, the shifts applied to the individual images to make the maxima in the correlation images coincide were small (at most one pixel) in the horizontal direction, but respiratory motion produced greater translational movement in the vertical direction. The mean vertical shift was 5 pixels for non-respiratory-triggered acquisition (TR=4s), and 2 pixels for respiratory-triggered acquisitions (TR=2 x respiratory intervals). The maximum shifts were 11 and 5 pixels respectively. In most cases, the peaks were well defined, and the decision to accept or discard images was based on setting a limit to the allowed area of the correlation peak at half its maximum intensity.

**Conclusions:** i/Drive SSFSE with adaptive averaging shows potential as a robust method for interactive MRCP, and produces a marked improvement in image quality compared with straightforward averaging. The increased SNR can be used to improve spatial resolution and show small branch ducts not visible in a standard MRCP image. For normal subjects, discarding images or using respiratory triggering was unnecessary but this may be required when using patient data.

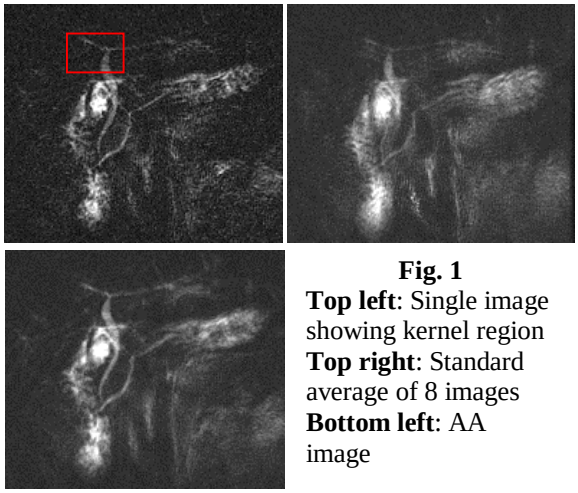

**Fig. 1**
**Top left**: Single image showing kernel region
**Top right**: Standard average of 8 images
**Bottom left**: AA image

**References:**

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