

Automatic Motion Detection in T2* Abdomen MRI Maps: a Multi-Metric Proof of Concept Study

Gabriela Belsley¹, Elizabeth M. Tunnicliffe¹, Damian J. Tyler¹, Matthew D. Robson^{1,2}

¹Oxford Centre for Clinical Magnetic Resonance Research, Division of Cardiovascular Medicine, Radcliffe Department of Medicine, University of Oxford, UK; ²Perspectum Diagnostics, Oxford, UK

T2* maps are excellent indicators of iron presence in the liver, providing a convenient means to correct the bias iron introduces in T1 maps acquired with the ShMOLLI sequence¹. However, the multi-echo GRE sequence used to construct the T2* maps is highly susceptible to motion (Figure 1). Consequently, image quality is reduced and may result in erroneous T1 maps.

We developed four different binary classification algorithms to detect and quantify motion in the multi-echo acquisitions. The first algorithm is based on principal component analysis and the 'Haar' discrete wavelet transform whereas the second employs the reverse biorthogonal continuous wavelet transform shifted along the phase encoding direction with an adaptive scale. The third method exploits T2* map values outside of the abdomen and the fourth method (Figure 2) learns to identify motion features through a convolutional neural network².

The algorithms were tested using a dataset of 537 images and the performance evaluated through receiver operating and precision recall curves. The fourth method resulted in the highest area under the curve of 0.84 (Figure 3) and accuracy of 72%, with a false positive rate of 56% and a precision of 71% at a threshold producing 90% sensitivity. Clear differences between motion and non-motion cases are visible as ridge-like patterns, associated with ghost artefacts, present in the processed images.

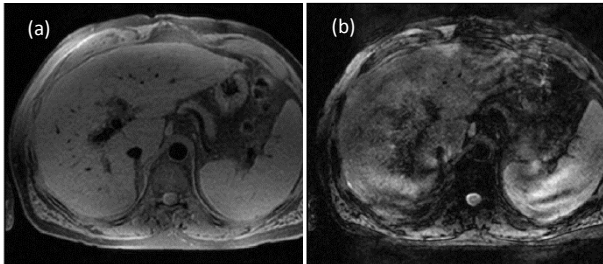


Figure 1. Echo 1 (a) and echo 5 (b) of a motion case.

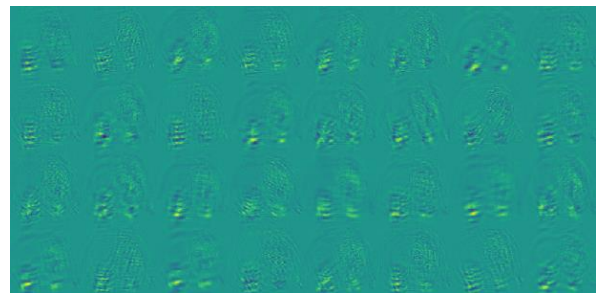


Figure 2. Feature map output of the CNN first convolution layer applied to a motion case.

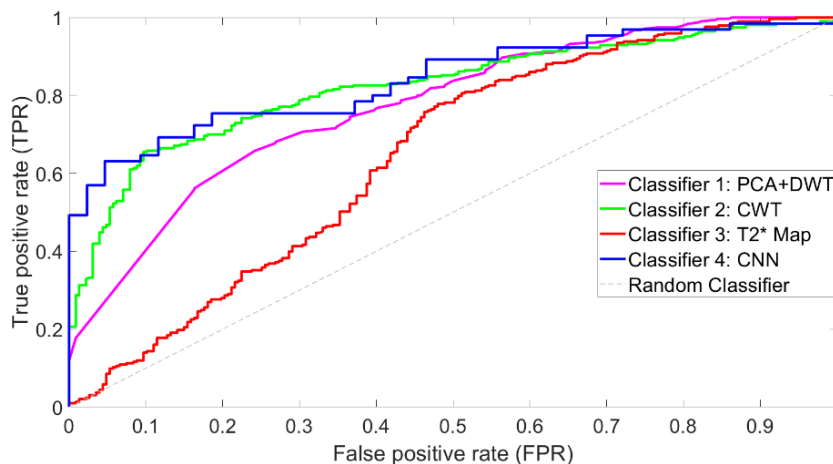


Figure 3. ROCs of the four classifiers developed. The CNN classifier (blue line) achieved the highest AUC of 0.84 and the lowest FPR of 0.56 at 90% sensitivity.

References:

1. Tunnicliffe et al., Magn Reson Med, 45: 450-462 (2017)
2. Küstner et al., Magn Reson Mater Phy, 31: 243-256 (2017)