Volumetric Reconstruction: Matching and Merging in DICOM Data

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Background:

Evolving protocols in Whole Body MRI (WB-MRI) present new challenges in the application of automated image processing and analysis procedures. We address two issues relating to sectionally acquired coronal WB-MRI: greyscale non-uniformity correction and accurate data merging.

The body is scanned in a number of slightly overlapping coronal sections, each containing 32 eight mm thick slices. Adjacent coronal sub-section often demonstrate a significant greyscale mismatch resulting in sharp discontinuities within homogeneous tissue regions in the body. This presents problems for automatic segmentation and classification approaches.

Similarly a simplistic reconstruction procedure can lead to inaccuracies in the relative alignment of the data from each DICOM image in the reconstructed volume, resulting in the dislocation of small structures.

Conclusion:

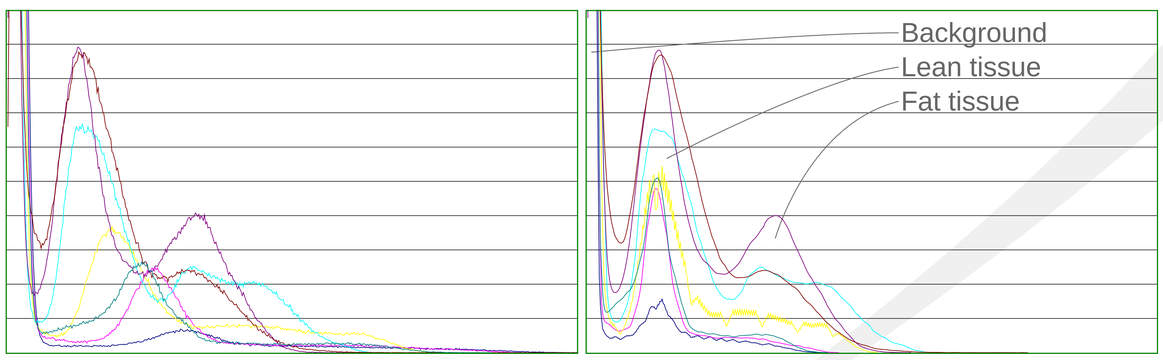
The reconstruction method described here generates matched and merged volumetric datasets well suited to the application of automatic image processing and analysis techniques.

It alleviates a number of problems which, while often unimportant in the manual assessment of the data by a radiologist, become more significant when computerised data analysis procedures are brought to bear on the problem of processing the data.

The human visual system is extremely efficient at compensating for intensity variations and physical misalignments in a scene. However, these effects can cause significant difficulties in an automated approach to image analysis, and their minimisation greatly enhances the accuracy and reliability achieved with such a system.

Histogram Matching

We perform a histogram matching procedure in order to compensate for greyscale variations between adjacent coronal sub-volumes.



(a) (b)

Fig 1. Greyscale histograms from a seven section WB-MRI dataset showing, a) uncorrected and, b) corrected intensities.

The characteristic peak representing lean tissue is identified algorithmically in each histogram and a normalisation procedure is applied in order to correct for the intensity non-uniformity across sections.

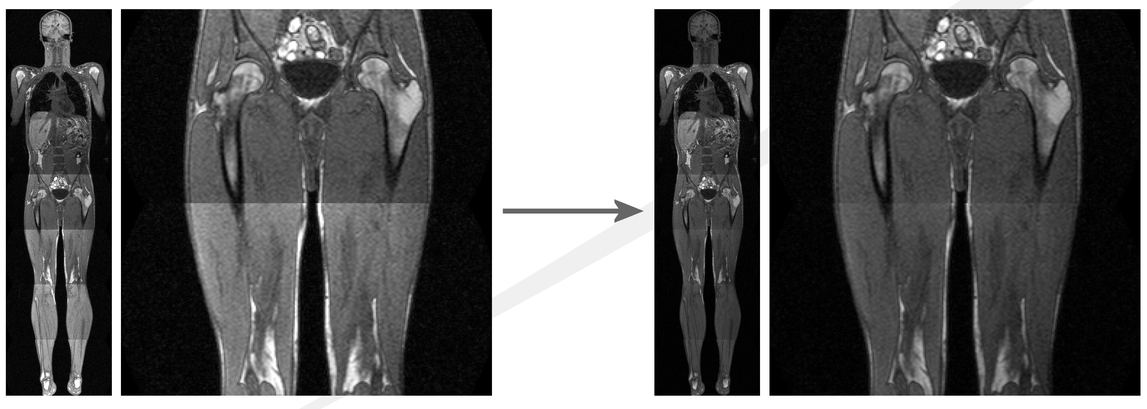


Fig2. The effect of histogram matching. Artificial boundaries are reduced allowing for more successful subsequent processing.

Coordinate System Merging

With off-coronal alignment and an overlap of several pixels between adjacent sections care is needed in order to maximise the accuracy of the volume reconstruction procedure, which will subsequently govern the reliability of global measures made on the data and the performance of volumetric processing performed.

Original off-coronal DICOM study

Reconstituted axial volume

Head first supine

X axis: Right – Left
Y axis: Anterior – Posterior
Z axis: Inferior – Superior

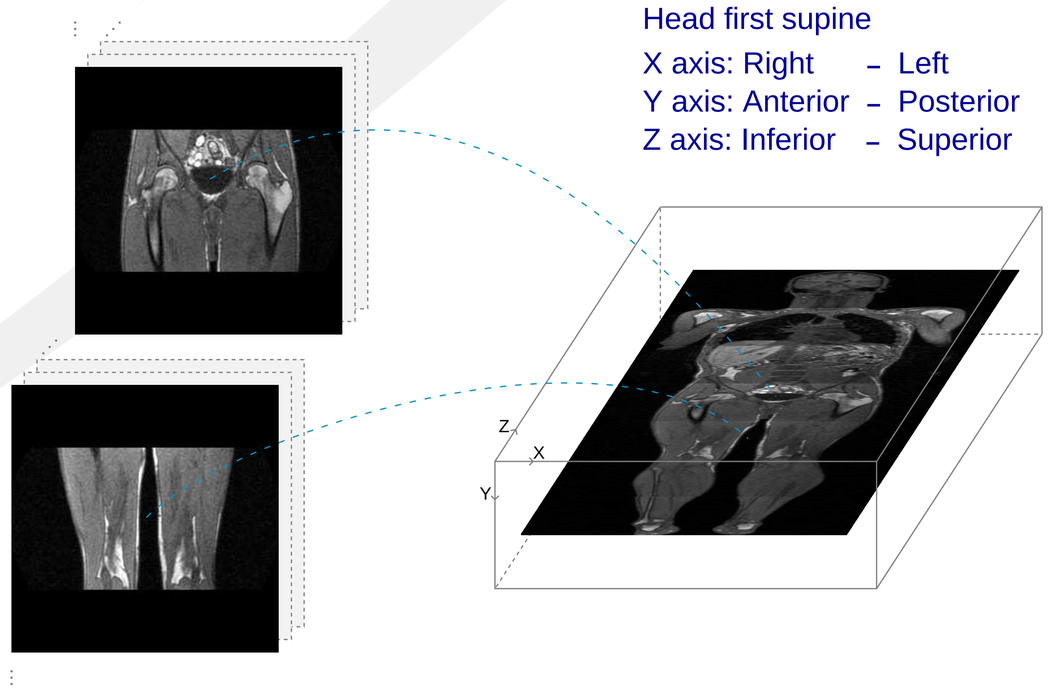


Fig 3. Data transformation achieves coordinate system merging.

Each DICOM image contains a real world origin, and two orientation vectors, one parallel to the image rows and the other parallel to it's columns. These allow a data transformation to be calculated in order to accurately reconstitute the data volume. Each image is projected into the volume using this transformation in order to build up the final data array.