

SSY186 - Diagnostic Imaging, CT-MR Part 2

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Task 1

In this exercise a simple brain segmentation and performance evaluation was carried out. Instead of real images of the brain, simulated MR images were obtained from the BrainWeb project. After modifying the segment.m file according to the instructions we answered the proposed questions:

1. A T1 weighted image measures the differences in the T1 relaxation times of tissues, recorded by the longitudinal magnetization. While the T2 weighted image measures the T2 relaxations, recorded by the transverse magnetization. The PD weighted image measures the hydrogen proton density.
2. The noise in the simulated images has Rayleigh statistics in the background and Rician statistics in the signal regions. But our images had 0% noise.
3. Intensity non-uniformity is an MRI artifact that degrades the image quality of the MRI scan. It consists of anatomically irrelevant intensity variations throughout the image ¹.
4. From equation 1 quality of the segmentation can be evaluated.

$$QS = \frac{2|X \cap Y|}{|X| + |Y|} \quad (1)$$

Where X is the set of voxels that are assigned by our segmentation and Y is the set of voxels that the ground truth contains for a certain structure. The range of the QS values is [0,1], where 1 is perfect segmentation and 0 a complete mismatch. A confusion matrix as indicated in figure 1 refers to the possible algorithm choices. The diagonal is when the algorithm predicts a true value and it is in fact true, while the bottom diagonal is when the algorithm predicts false and it is in fact false. The other true entries represent errors. This way of classifying gives way to more specific types of measurements like specificity, sensitivity, etc.

		prediction outcome		
		<i>p</i>	<i>n</i>	total
actual value	<i>p'</i>	True Positive	False Negative	<i>P'</i>
	<i>n'</i>	False Positive	True Negative	<i>N'</i>
total		<i>P</i>	<i>N</i>	

Figure 1: Confusion matrix

¹<http://www.sciencedirect.com/science/article/pii/S1361841505000976>

5. Yes, by adding the data from PD we have improved the results of the segmentation from $QS = 0.9792$, to $QS = 0.98$.

The Jaccard-index is defined by a similar equation according to:

$$J(A, B) = \frac{|A \cap B|}{|A| + |B| - |A \cap B|} \quad (2)$$

The Jaccard-index was implemented by this equation and placed into the `diceIndex.m`.

Task 2

In this task there were no deliverables although the aim was to study Algebraic Reconstruction Techniques (ART) which are alternative reconstruction methods for traditional backprojection methods.

For the **optional** exercise the standard ART-Kaczmarz algorithm had to be applied to an image of a square. The result can be seen in figure 3.

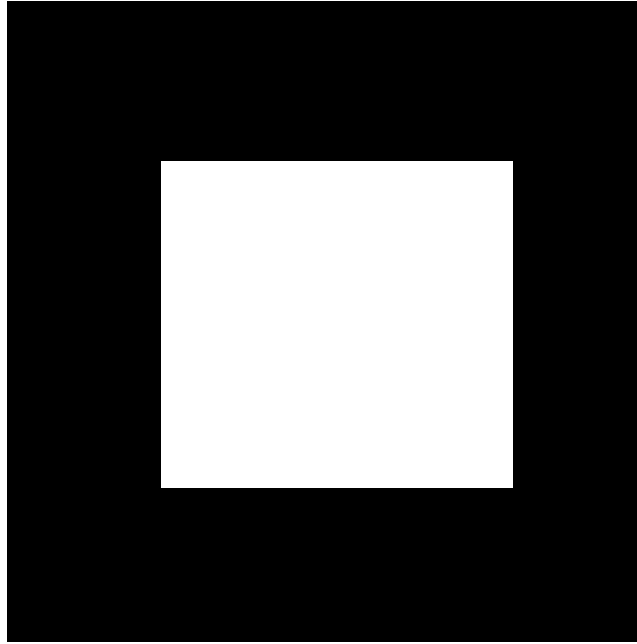


Figure 2: The original phantom

Kaczmarz reconstruction

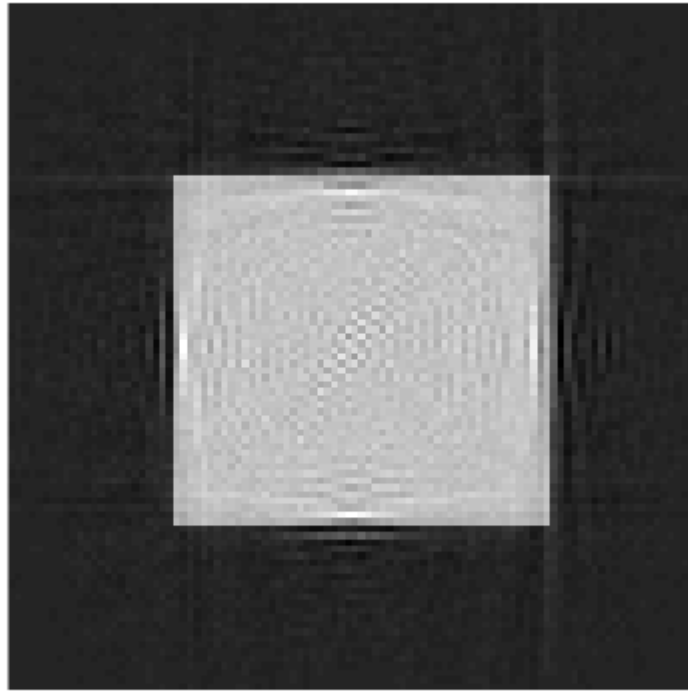


Figure 3: Reconstructed image