Nonrigid registration notes:

Previous work:
1. ratio of variance minimisation by Zuo et al: divide each voxel in the transformed image by the corresponding voxel in the reference image. If the images are aligned, a homogenous image is obtained, otherwise it is heterogenous. The algorithm iteratively maximises the homogeneity (i.e. minimises the variance of the ratio between images across all voxels). Limitation: assumes rigid motion

2. Optical flow type algorithm: pyramidal approach, minimises SSD error. The algorithm computes a motion vector u(x,y,z) for each voxel which represents the displacement from the reference image of that voxel. The set of all vectors U is iteratively refined using a Gauss-Netwon method. Assumes intensities in pre and post-enhanced images remain constant.

3. thin-spline formulation of Bookstein seems to deal with non-rigid motion and non-uniform changes in intensity, but the computational time rises with the number of control points, which limits its use.

Future work:

1. Julia Schnaebel and Daniel Rueckert: A generic framework for non-rigid registration based on non-uniform multi-level free-form deformations.
   1. Control points are split into active and passive components
   2. new applications:
      1. pre- and post-operative brain MRI (MP-RAGE)
      2. liver MRI registration between inhale and exhale positions
      3. inter-modality registration for pre-operative MR brain scan to post-operative CT scan
      4. inter-subject registration of brain MRI

2. In the meantime, newer methods have superseded Rueckert's algorithm for contrast-enhanced MR (see Andrew Melbourne, Registration of dynamic contrast-enhanced MRI using a progressive principal component registration). This uses Principal Component analysis

FFD:
The FFD model is based on cubic B-splines. The B-splines are used instead of Bernstein polynomials because they have local control. This means that a control point only influences its local, surrounding area, which makes the use of large lattices computationally tractable.