MAXIMUM LIKELIHOOD DECONVOLUTION OF DYNAMIC CONTRAST MRI DATA VIA WEIGHTED NONLINEAR LEAST SQUARES.

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Bolus tracking of contrast agent with MRI is a well established technique for measurement of local cerebral haemodynamic parameters flow and volume. This technique can provide useful information for assessment of treatment options related to ischemic damage following stroke. The analysis requires de-convolution of the tissue time course to reconstruct the residue function of the contrast agent.

$$C_T(t) = k\int_0^t C_I(s)R(t-s)ds$$

where C_T is the amount of contrast agent observed in the tissue region, C_I is the concentration of tracer entering through a supply artery and R is the residue function. Measurement of C_T and C_I are obtained by scanning. Reconstruction of R provides estimates of flow, volume and mean transit time. The raw MRI scan signal intensity is well approximated by a Rician distribution, i.e. the signal intensity at the t can be described as

$$S(t) = S_0\sqrt{[\nu(t)+a(t)_r]^2 + a(t)_i^{\,2}}$$

where $a(t)_r$ and $a(t)_i$ represent separate independent components of error, both following a N(0,σ) distribution. The true signal is given by

$$\nu(t) = e^{-k.TE.C_T(t)}$$

where TE is a parameter of the MR acquisition. The standard approach to estimation involves logarithmic transformation and least squares deconvolution. An iterative re-weighted non-linear least squares algorithm has been developed to a maximum likelihood reconstruction. Studies are presented to evaluate improvements achieved by maximum likelihood in estimation of the residue and the derived functional flow and blood volume parameters. The results show that over a range of realistic signal to noise values, significant improvements in estimation accuracy are achieved.