Introduction

Segmentation of Grey/White/CSF from MR images depends on contrast to noise ratios (CNR) among these tissues and the CSF. The CNRs are determined by the acquisition method and imaging parameters. These factors can be optimized for improved image segmentation [1,2]. In many MR studies, multiple images of the same slice locations are acquired, each with different weightings based on TI/T2/proton density (PD) or other tissue properties. These images can be combined to further increase image CNR hence improving subsequent image segmentation. In this study, we apply the principle component analysis (PCA) method to determine weighting coefficients used for combining these images.

Method

A set of five spoiled gradient echo images (SPGR) were used as the test data set. These images were acquired with a GE 1.5T Sigma Horizon LX system (Milwaukee, WI) using a regular quadrature head coil. The echo time used was 5.6 ms. Repetition times varied from 90, 150, 250, 400 to 600 ms. Fig. 1 shows two of these images (TR’s of 250 ms and 400 ms). For illustrative purposes, Fig. 2 gives a distribution of pixel values of images in Fig. 1. Distribution centers of grey and white matters were estimated from histograms of these images and are plotted in Fig. 2. With respect to the origin, these distribution centers are not co-linear because of grey and white matters’ difference in T1 values.

Treating images as parameters and pixels as observations in the same way as in Fig. 2, but including all 5 available images, the feature space is 5 dimensional. The PCA method was applied to the 5 dimensional data set. The first principle component generated by the PCA is an eigenvector along which the standard deviation of data distribution is maximum. In other words, projections of observations along the eigenvector gives a combined image (eigenimage) on which the standard deviation of pixel value (therefore, image contrast) is maximum.

Result and Discussion

Fig. 3 compares an original SPGR image with the eigenimage. Fig. 4 plots histograms of the original SPGR image and the eigenimage shown in Fig. 3. If we assume noise in the original 5 images is Gaussian, noise in the eigenimage is the same as the original images because the eigenvector (the first principle component) is normalized. However, as demonstrated by Fig. 4, contrast between gray and white matters has been increased in the eigenimage. Furthermore, by using the PCA method, this increase is greater than obtainable by any other linear combination of original images.

References