An Attempt to Develop Color Magnetic Resonance Imaging (MRI) by using Visible Human Data

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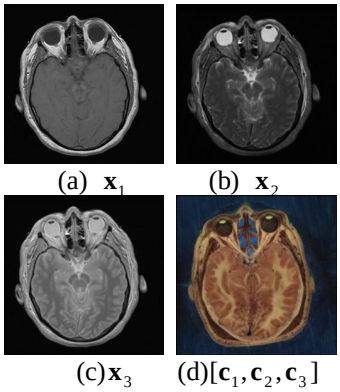
Introduction

This basic research seeks to develop a color MRI system by using Visible Human Data (VHD). The MRI volume datasets obtained under different scanning conditions are transformed to components by independent component analysis (ICA), which enhances physical characteristics of the tissue. The mapping functions for generating color values from independent components are obtained using the radial basis function (RBF) network by training the network with sample data chosen from the visible female data set. We will show two examples of generating full-color volume data from MRI data sets only.

Method

The positions, orientations and scales of three MRI datasets (T1-weighted, T2-weighted and Proton density weighted MRI) and the full color cross-section images of the Visible Female Data (VFD) are aligned using a rigid-body registration technique [1] as shown in Figure 1.

We applied independent component analysis (ICA) [2] for registered MRI data sets, $\mathbf{x}_1, \mathbf{x}_2$ and $\mathbf{x}_3$, to obtain statistically independent components, $\mathbf{s}_1$, $\mathbf{s}_2$ and $\mathbf{s}_3$ (Figure 2). This operation transforms the three MRI components into components that characterize the physical features of tissues such as fat and free water as



(a) $\mathbf{x}_1$ (b) $\mathbf{x}_2$ (c) $\mathbf{x}_3$ (d) $[\mathbf{c}_1, \mathbf{c}_2, \mathbf{c}_3]$

Figure 1 Slices of registered volume data of VFD. (a): T1-weighted MRI (b): T2-weighted MRI (c): Proton density weighted MRI (d): Full-color images.

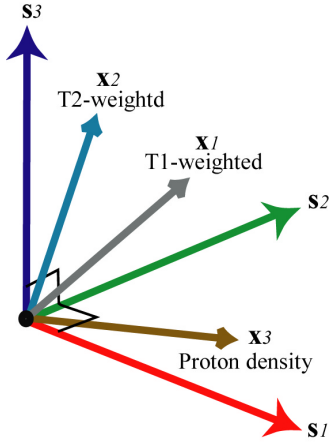
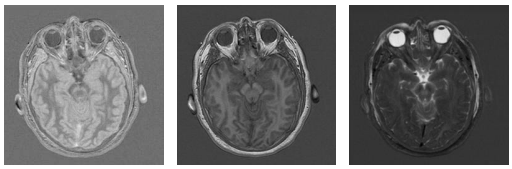


Figure 2 The concept of ICA of the multichannel MRI.



(a)$\mathbf{s}_1$ (b)$\mathbf{s}_2$ (c)$\mathbf{s}_3$

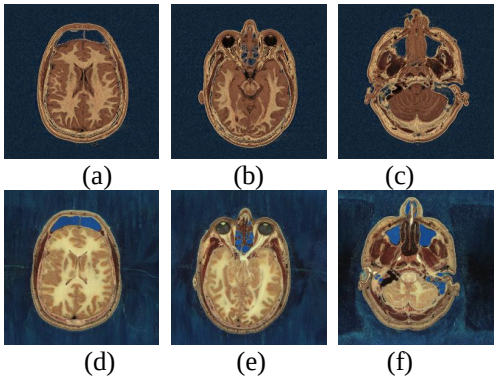
Figure 3 Independent components (ICs) of the multichannel MRI of VFD.

Figure 3 [3]. We then generate a mapping function that produces correspondences between these independent components and the color components of the full-color cross-section data. We used a radial basis function (RBF) network [4], a kind of neural network, to generate the mapping function. The training samples for the network were selected using the k-mean clustering method [5].

Once we obtained this kind of mapping function, we could generate anyone's full-color data using an MRI machine. Consequently, this enables development of the color MRI system.

Result

We have generated full-color data from three MRI data sets of the Visible Male Data (VMD) by using the mapping function generated from VFD. The MRI data sets for VMD were obtained under the same scanning conditions as for VFD, components similar to those of Figure 3 are



(a) (b) (c)

(d) (e) (f)

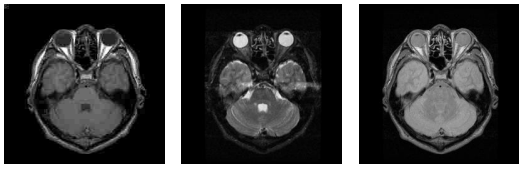
Figure 4 The results of generating color volume data from the multichannel MRI data set of VMD.

generated using ICA. However, the scale uncertainty of ICA makes it necessary to perform calibration [4]. Figure 4 (upper row) shows the resultant full-color cross-sections of VMD. By comparing them to the actual cross-sections (lower row), we can confirm that this color generation method works well.

Next, we tried to generate full-color cross-section of a living body. We obtained three MRI datasets, i.e., T1-weighted, T2-weighted and proton-density-weighted MRI, of a normal volunteer by using a spin echo sequence on a 1.5 T MRI scanner. (Figure 5) The parameters were matrix 256×256, $5mm$ thick, *and 25* slices. The combination of TR and TE for each data set is shown in Table 1. Figure 6 shows the resultant full-color cross-sections from this data.

Conclusions

We have reported our first attempt to develop a color MRI system using VHD. Although there are some problems, we could obtain full-color cross section images from MRI data sets alone. We are planning to apply this technique to the pathology analysis in the near future.



(a) $\mathbf{x}_1'$ (b) $\mathbf{x}_2'$ (c) $\mathbf{x}_3'$

Figure 5 The normal volunteer's data sets

Table 1 TR-TE combinations (*ms*).

Data	$\mathbf{x}_1$	$\mathbf{x}_2$	$\mathbf{x}_3$
TR	600	6000	6000
TE	17	102	17

Acknowledgements

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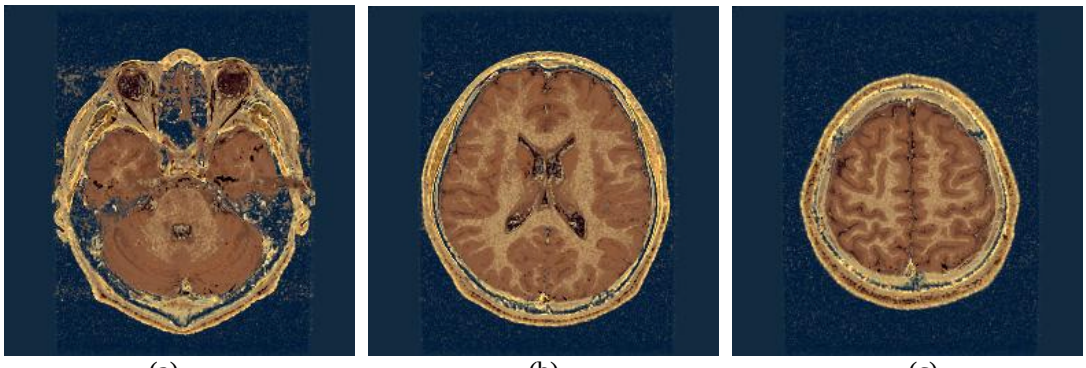
References

1. Maes, F., Collingnon, A., Vendermeulen, D., Marchal, G. and Suetens, P., Multimodality Image Registration by Maximization of Mutual Information, *IEEE trans. Medical Imaging*, 1997, vol. 16, No, 2. pp.187-198.
2. Lee, Te-Won, *Independent Component Analysis*, Kluwer Academic Publishers, 1998.
3. Muraki, S. and Nakai, T., Independent Component Analysis of multi-channel MRI Data, *Proc. ISMRM 2000*, 2000, vol. 1, pp.582.
4. Bishop, C. M., *Neural Networks for Pattern Recognition*, Clarendon press, 1995.
5. Muraki, S., Nakai, T. and Kita, Y., Basic Research for Coloring Multichannel MRI Data, ETL Technical Report TR-2000-11, 2000



(a) (b) (c)

Figure 6 The results of generating color volume data from the MRI data sets of the normal volunteer.