A 3D model created from 2D MRI brain axial and sagittal slices

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Medical images are widely used in diagnosis and in the evaluation of therapeutic procedures of a human patient. The most commonly used modalities are Magnetic Resonance (MR) image, computed tomography (CT), ultrasound and X-ray projection radiography. In this work, we are interested in the use of MR images for the detection of Multiple Sclerosis (MS) lesions. MS is a disease of the central nervous system characterized by the gradual destruction of myelin (demyelination) and transection of neuron axons in patches throughout the brain and the spinal cord.

Magnetic resonance image is a medical image modality that can provide a combination of high resolution, excellent soft tissue contrast and a high signal-to-noise ratio. Additional information can be provided by the acquisition of multi-channel MR images with varying contrast characteristics, for distinguishing between different structures. Regarding to contrast, sequences of images are defined as T1, T2, Flair and PD-weighted, depending on the time constants involved in relaxation processes that establish equilibrium following radio frequency excitation. In clinical practice, considering demyelination diseases such as MS, Flair and T2-weighted sequences are particularly interesting to evaluate the brain, as the lesion appears brightly in these series.

Our work is focused on the creation a 3D brain model for posterior detection of MS lesions. The available image database was acquired from a magnetic resonance system and the data is presented in a DICOM (Digital Imaging and Communications in Medicine) format (Cordonnier E. & Mildenberger P., 2004). DICOM files provide information together into a data set. The information included in them, called metadata, describes characteristics such as size, dimensions and bit depth of the image data. Characteristics of the data, such as the modality used to create it, the equipment settings and information about the study, are also defined in the DICOM specification.

In order to extract all the important information from each slice we have used the Matlab Image Processing toolbox (The Mathworks, 2003), that includes support for working with image data in DICOM format. The *dicominfo* and *dicomread* functions can process almost all the metadata fields, returning a structure where every field is a specific piece of DICOM data. The image attributes that define the transmitted pixel array of each slice, which corresponds to a two dimensional image plane are specified in Table 1. Image position and image orientation were specified relative to a the patient based coordinate system. All specifications about DICOM format is available at < http://medical.nema.org/dicom >.

Table 1. Image plane attributes

Attibute Name	Attribute Description
Pixel Spacing	Physical distance in the patient between the center of each pixel, in mm.
Image Orientation (Patient)	The direction cosines of the first row and column with respect to the patient.
Image Position (Patient)	The x, y and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the image, in mm.
Slice Thickness	Nominal slice thickness, in mm.
Slice Location	Relative position of exposure expressed in mm

Let $S_{v,w}=\{s_1,\ldots,s_m\}$ be a set of m slices with view v and contrast w. View v and contrast w can be anyone defined in V={axial, sagittal,coronal} and W={T1, T2, Flair}. Our image database has 9 image sets S, and it was selected 2 of them, $S_{axial,Flair}$ and $S_{sagittal,Flair}$ in order to creat the 3D model. It was verified if in each set S, the m slices are correctly registered (Zitová & Flusser, 2003), then was created 2 volumes, the axial and the sagittal ones each of them with voxel size 1.0x1.0x1.0mm. This voxel transformation required the application of a scaling geometric transformation (Herman & Udupa, 2000, Hern & Baker, 1996) in both set of images. To create only one volume merging all the information, the axial volume was fixed and the sagittal one was rotated about the x and z axis. In Figure 1 it was presented the effect of rotating it about z-axis 90 degree and x-axis –90 degree. To merge sagittal and axial volumes is needed to apply a translation matrix to one of them, yielding the volume represents in the last graphic of Figure 1. It was employed the nearest neighbourhood interpolation method (Lehmann et al, 1999) for the visualization.

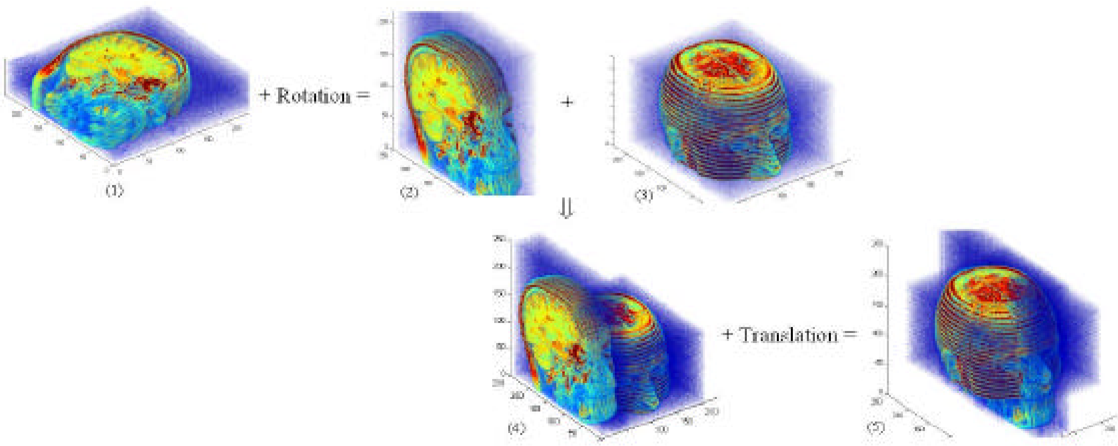

Figure 1. Fusion of sagittal and axial brain volumes applying geometric transformations: (1) sagittal volume; (2) sagittal volume rotated; (3) axial volume; (4) sagittal+axial; (5) sagittal+axial translated.

The main idea of this approach is to create a volume by integrating information coming from a series of axial slices and a series of sagittal ones. In this way, we shall obtain a 3D model that is more precise than those that can be built using a single series. The next step of this work will then consist in segmenting the brain volume in order to detect MS lesions. We believe that in this way we shall obtain a better accuracy on the segmented lesion.

REFERENCES

Cordonnier E., Mildenberger P. (2004). *Dicom. Digital imaging and communications in medicine.* (online). http://medical.nema.org/dicom

Hearn D., Baker M. P. (1996), *Computer graphics: C version* . Prentice-Hall Inc., USA.

Herman, G.T. and Udupa, J. K. (2000), *3D Imaging in Medicine*. CRC Press, New York.

Lehmann T.M., Gönner C., Spitzer K. (1999). *Survey: Interpolation methods in medical image processing*. IEEE Transactions on Medical Imaging, 18(11):1049-1075.

The Mathworks. (2003). http://mathworks.org

Zitová B., Flusser J. (2003). *Image registration methods: a survey*. Image and Vision Computing, 21(11):977-1000.