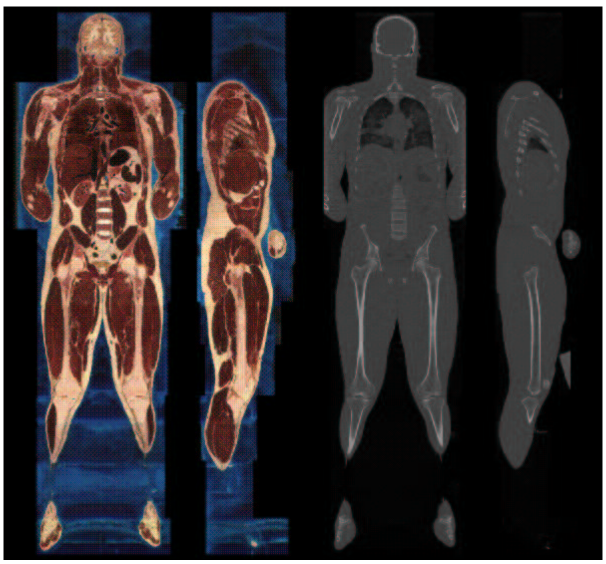
Preprocessing of the Visible Man Dataset for the Generation of Macroscopic Anatomical Models

F. B. Sachse, C. Werner, M. Müller, K. Meyer-Waarden

Insitute of Biomedical Engineering, University of Karlsruhe, Germany

INTRODUCTION

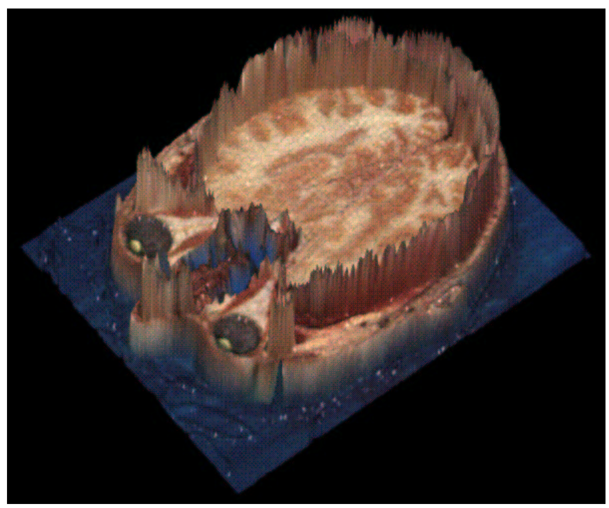
Models of the anatomy of the human body are of increasing importance for scientists, engineers and physicians. The applications of these models vary widely from medical education and diagnostics to simulation of physical fields.



Picture 1: Frontal and lateral section of preprocessed volume dataset based on thin-section photos and CT scans

To create anatomical models generally information extracted from medical images is used and advanced strategies of image processing are employed. Commonly tissue distributions are determined indirectly using some form of tissue classification scheme based on computer tomography and magnetic resonance tomography (MRT) data.

Anatomical models also form a base for the Meet Man Project (Models for Simulation of Electromagnetic, Elastomechanic and Thermal Behaviour of Man). The purpose of this project is the creation of models to simulate the physical behaviour of man [6][7]. Continuing our work of creating macroscopic anatomical models from MRT datasets, we studied the possibilities and opportunities offered by the Visible Human Project [1]. In this paper we describe the preprocessing of the Visible Man dataset to obtain a volume dataset in voxel representation of thin-section photos and computertomographic scans. This volume dataset forms the base of further processing like segmentation and classification.



Picture 2: Thin-section photo combined with CT image as height information

METHODS AND RESULTS

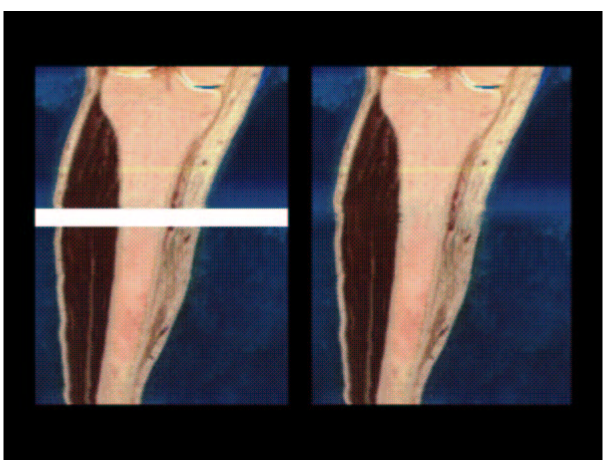
The thin-section photos and computertomographic scans (frozen) from the Visible Man dataset are chosen as base for the creation of macroscopic anatomical models. These images have a sufficient high spatial resolution and are - in conjunction - suitable for tissue classification.

The creation of models starts with geometric transformations to combine images of different regions of the body and to match images of the different sources. In this essential preprocessing step the inter- and intra-image translations, scalings and rotations are detected and adjusted to obtain a correct volume representation (Tab. 1).

	CT	Photo	Photo/CT
Scaling	•	•	•
Translation	•	•	•
Rotation	-	-	•

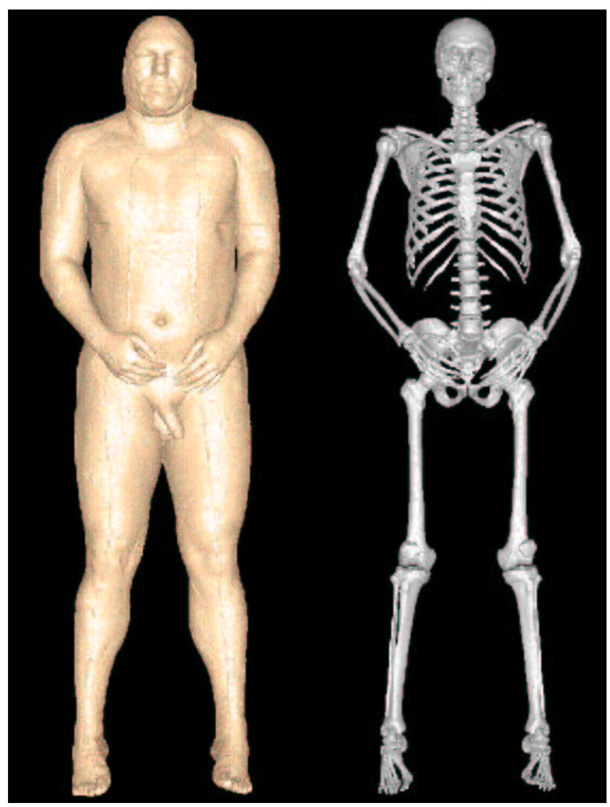
Tab. 1: Detection and normalization of image transformations in the Visible Man Dataset.

To achieve a proper volume representation of the CT scans, scaling differences and translations have to be detected and adjusted. The scalings are determined by evaluating the file headers of the scans, which are in General Electric Genesis medical image format. The correction is performed by resampling with bicubic spline interpolation [5]. The translations are detected by calculating the displacement of the first moment [4] between two successive images and are adapted by resampling (Picture 2).
To obtain a correct volume representation of the thin section photos, scaling differences and translations are detected and normalized. The scaling of the photos is constant. Translation between two successive photos is detected by 2D correlation of significant parts. The computing of the correlation was accelerated using a 2D Fast-Fourier-Transformation algorithm [3]. The correction is performed by resampling the image.



Picture 3: Interpolation of unworkable thin-section photos performed by image warping

To match the photos with the CT scans, scaling differences, translations and rotations between the two image sets are detected visually and normalized by resampling with bicubic spline interpolation.
Another preprocessing step is the detection and correction of differences in the color reproduction of the photos. The detection is performed using their colorpalette. The correction is done by transformations of the RGB values.
A further step of preprocessing is the restoration of unuseable images. These images are either partly damaged or simply not available. The techniques used to restore the unusable images. are morphing and warping algorithms [2]. To warp the contents of an image a global transformation is needed which defines a displacement of all picture elements. Such a transformation can be determined using the information of the displacement of few anchor points. Thereby the influence of one single anchor point on its neighborhood is described by a radial basis function. A sequence of images can be interpolated by moving a set of anchor points along different smooth paths through the defective volume.



Picture 4: Frontal representation of segmented preprocessed volume dataset based on thin section photos and CT scans

In the course of warping, morphing can be applied by interpolating color intensities between the color values of adjacent useable images (Picture 3).
After processing these steps the data of the thin-section photos and CT scans are converted to a volume dataset in voxel representation (Picture 1, 4).

ACKNOWLEDGMENTS

This research has been supported by the Deutsche Telekom AG.

REFERENCES

[1] ACKERMAN, M. I. Viewpoint: The Visible Human Project. *Journal Biocommunication 18*, 2 (1991), 14.

[2] ARAD, N. UND REISFELD, D. Image Warping Using Few Anchor Points and Radial Functions. *Computer Graphics Forum 14*, 1 (1995), 35-46.

[3] BRIGHAM, E. O. *FFT, Schnelle Fourier Transformation*, 3. Auflage. Oldenbourg, 1987.

[4] GONZALEZ, R. C. UND WOODS, R. E. *Digital Image Processing.* Addison-Wesley, Reading; Menlo Park; New York, 1992.

[5] LOCHER, F *Numerische Mathematik für Informatiker.* Springer, Berlin; Heidelberg; New York, 1995.

[6] SACHSE, F., MUELLER, M., MEYER-WAARDEN, K. *Macroscopic Models of the Electric Tissue Impedance in Human - Requirements, Creation and Application.* IX International Conference On Electrical Bio-Impedance, Heidelberg, 1995.

[7] SACHSE, F., MUELLER, M., MEYER-WAARDEN, K. *Erstellung von gewebeklassifizierten Modellen des menschlichen Koerpers zur numerischen Feldberechnung basierend auf bildgebenden Verfahren der Medizin.* 29. Jahrestagung der Dt. Gesellschaft f. Biomed. Technik, 1995.