Anatomic realism comes to diagnostic imaging

K. H. Höhne, M. Bomans, B. Pflesser, A. Pommert, M. Riemer, Th. Schiemann, U. Tiede

Institute of Mathematics and Computer Science in Medicine
University of Hamburg, Martinistraße 52, D-20246 Hamburg

1. Introduction

For over decades after the discovery of the X-rays by Wilhelm Konrad Röntgen medical imaging techniques did not change: X-rays were cast through the patient and the shadows caused by the anatomical structures were recorded on photographic film. Beside the fact that the shadows of different objects are overlaid, the low contrast for soft tissue requires highly trained and experienced radiologists to interprete these images. With the advent of modern computers, imaging techniques could be developed that deliver cross-sectional images, such as Computer Tomography and Magnetic Resonance Imaging as shown in figure 1. They do not have the problem of overlays, but they still show only a limited two-dimensional aspect of the anatomy which is really three-dimensional in nature.

In principle there is no reason to image the human body just this way, it is more or less a consequence of the technical development. If we were asked nowadays to design an imaging system without the knowledge about X-ray projection and cross-sectional techniques, we would certainly aim at a technique that shows the human body as we know it from our experience or the anatomy textbook.

Using methods of image processing and computer graphics, we are now well on the way to making clinical imaging as realistic as anatomy textbooks. In addition, we also see many new applications which we could not think of before. This article reviews applications presently under investigation and their perspectives for the future.

2. Method

A variety of methods of 3D visualization have been described by several authors in the past decade [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]. We describe here just their general principle, while details can be found in the respective literature. Basically all methods start with a spatial sequence of tomograms which include the organ to be imaged. This sequence of images (represented as image matrices of up to 512x512 picture elements) can be considered as an image volume. One of the main problems of 3D visualization comes from the fact, that unlike in 2D imaging, objects in the volume may obscure each other. Thus for the display of the real anatomy the outlines of the objects have to be identified in order to be visualized or removed [11, 12, 13, 14, 15, 16]. Once we know the outlines through a segmentation step they can be rendered. This is done by simulating a light source illuminating the object from a certain direction and then computing the reflected light that a viewer would see from his viewpoint. For this purpose the surface inclination has to be computed rather accurately, which is again not trivial for tomographic