Improving Depth Perception in Medical AR
A Virtual Vision Panel to the Inside of the Patient

Christoph Bichlmeier¹, Tobias Sielhorst¹, Sandro M. Heining², Nassir Navab¹

¹Chair for Computer Aided Medical Procedures (CAMP), I-16, Technische Universität München, Boltzmannstraße 3, 85748 Garching, Germany
²Trauma Surgery Department, Klinikum Innenstadt, LMU München, Nußbaumstraße 20, 80336 München, Germany
Email: bichlmei@cs.tum.edu

Abstract. We present the in-situ visualization of medical data taken from CT or MRI scans in real-time using a video see-through head mounted display (HMD). One of the challenges to improve acceptance of augmented reality (AR) for medical purpose is to overcome the misleading depth perception. This problem is caused by a restriction of such systems. Virtual entities of the AR scene can only be presented superimposed onto real imagery. Occlusion is the most effective depth cue [1] and let e.g. a correctly positioned visualization of the spinal column appear in front of the real skin. We present a technique to handle this problem and introduce a Virtual Window superimposed onto the real skin of the patient to create the feeling of getting a view on the inside of the patient. Due to motion of the observer the frame of the window covers and uncovers fragments of the visualized bones and tissue and enables the depth cues motion parallax and occlusion, which correct the perceptive misinformation. An earlier experiment has shown the perceptive advantage of the window. Therefore seven different visualization modes of the spinal column were evaluated regarding depth perception. This paper introduces the technical realization of the window.

1 Introduction

Real-time in-situ visualization of medical data is getting increasing attention and has been a subject of intensive research and development during the last decade [2], [3], [4]. Watching a stack of radiography is time and space consuming within the firm work flow in an operating room (OR). Physicians have to associate the imagery of anatomical regions with their proper position on the patient. Medical augmented reality allows for the examination of medical imagery like radiography right on the patient. Three dimensional visualizations can be observed by moving with a head mounted display around the AR scene. Several systems [5, 2, 6] that are custom made for medical procedures tend to meet the requirements for accuracy and to integrate their display devices seamlessly into the operational work flow.
2 State of the Art and New Contribution

Depth perception has become a major issue of current research in medical AR. Virtual data is superimposed on real imagery and visual depth perception is disturbed (Fig. 1). The problem has been identified as early as 14 years ago in the first publication about medical augmented reality [7]. This group tackled the problem by rendering a "synthetic hole" ... "around ultrasound images in an attempt to avoid conflicting visual cues.” In an earlier paper Tobias Sielhorst et al. described an experiment that evaluated seven different visualization modes for the spinal column regarding depth perception [8]. This paper describes the technical realization of one of the winners of the evaluation. This is a virtual window that can be overlaid onto the skin and provides a bordered view onto the spinal column inside the patient. Due to the virtual window depth perception of the visualized medical data can be corrected.

3 Method

Medical data taken from a CT or MRI scan is presented using a stereoscopic video see-through HMD. The whole tracking system that allows for tracking the observer wearing the HMD, the patient and several surgical instruments is described at [8]. We use direct volume rendering and presegmented surface models to visualize the data.

3.1 Position the Window

Placing the window to get the desired view into the patient can be performed without touching or moving the patient. While positioning the window, the observer wearing the HMD views a frame (Fig. 2) and guides it to the area of interest by moving his or her head. When the frame is at the desired position, the window can be set by key press. The size is adjustable by mouse interaction, which can be performed by an assistant on an external monitor that shows a copy of the imagery presented by the displays of the HMD. The window adopts...