Interactive Spatially Aware Visualization of Medical Images

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1. Purpose

The technological advances and the widespread of the image acquisition equipments have made possible the creation of tools to assist in surgery planning, realistic surgery simulation for training, creation of custom patient models for diagnosis and so on [5]. While medical images are fundamental in the diagnosis procedure, the process of analyzing such images slice-by-slice is still tedious and inefficient. The alternative use of dedicated and expensive workstations for volume visualization is non-intuitive and requires focused training. A system allowing the doctor to visualize the inner structures of a patient's body, using a mobile display (tablet PC) as a see-through device [2] with semi-transparence and opacity, is desirable.

The purpose of this work is to develop such a system where the exploration of internal anatomy occurs directly on the surface of the real body as if the doctor had "X-ray vision" (see Figure 1). We hypothesize that this would make visualization and exploration of the inner anatomy a more intuitive and natural procedure when compared to traditional visualization methods.

2. Methods

In this work we develop a strategy based on augmented reality [4] for interactive visualization of the volume generated from CT and MRI. Such strategy includes the development of an optimized volume visualization [1] system compatible with commodity hardware, where a doctor's actions, for example, would be similar to those they would perform while examining a real patient. Our volume visualization approach is based on a texture mapping technique [3] and is produced from CT. Augmented reality, then, associates such volume to a fiducial marker which is tracked by a webcam through computer vision to define a dynamic pose for the virtual camera.

The system allows for the analysis of inner body structures by pointing the mobile display directly upon the body. It could also be used in anatomy classes or with anatomy 3D books, allowing the students or trainees to form more easily a mental model associating actual emplacements of organs in relation to the external body.

3. Results

The system has been conceived to be used with a tablet PC, this class of laptops which allow rotating the screen and closing the lid with the display turned upwards. They allow interaction directly on the screen with one or more fingers or a stylus, without mouse or keyboard.

Using the system, a participant can hold the tablet vertically while moving in the environment. Thus, the device becomes a window to the virtual world. When an object of interest, e.g. a patient, is focused, their internal structures are rendered according to the angle and position of the participant. Figure 1 shows an example with a mannequin. The video of the real world (patient's body) and the volume (patient's scanned images) are fused in

3D and rendered on the display according to the position and angle of the user/doctor handling the device. Tests show that the proposed system has the ability to run efficiently in generic mobile hardware, despite the complexity of the data.

4. Conclusions

The system proposed allows for a novel paradigm of interactive study of the human anatomy which is compatible with current commodity hardware and built up with low cost software components. It could be used, in the future, to teach anatomy and pathology in different levels, from the primary school up to postgraduate. Another application is in the doctor's office, helping them to show to patients and relatives, in an intuitive and visual way, where the pathologies are. In addition, studies should be done to discover if the system could effectively be applied in image analysis with the purpose of disease determination.

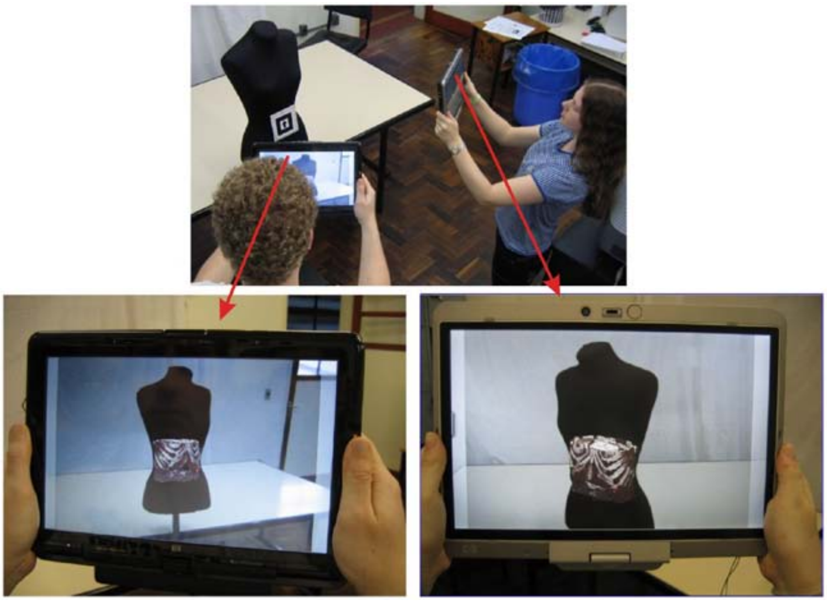

Figure 1 – Simulation of a use case for the system using a tablet PC display. Different viewing angles are allowed according to the user position.

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