Section: **E-Learning und Simulation**

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Abstract-Title:
VIRTUAL REALITY SIMULATOR FOR THE TRAINING OF LUMBAR PUNCTURES
VIRTUAL REALITY SIMULATOR FÜR DAS TRAINING VON LUMBALPUNKTIONEN

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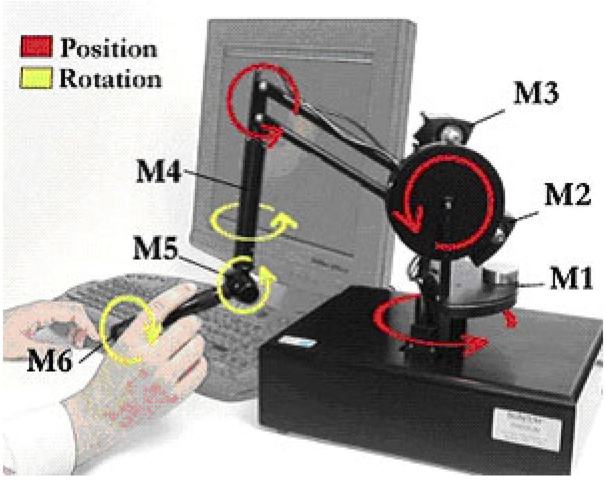
Abstract-Text:
Purpose:Lumbar punctures are performed for diagnosis and therapy. The puncture is done by inserting a needle into the body to inject medicaments or to extract liquor. The training is usually done guided by experienced supervisors directly in contact with the patient. The use of training dolls or cadavers is unusual. The relevance of virtual reality based simulators is increasing because with the use of simulators experience can be gained cheaply without risking the patient's health. Thus, a lumbar puncture simulator has been developed to support the training. Method:The simulator is split into a haptic and a visual component. The haptic component renders the forces that affect the needle during the insertion. We use a force feedback device with six degrees of freedom for the haptic I/O. This device enables haptic feedback in three directions in space and in three rotation axes of the endeffector (Fig. 1). The forces are calculated in real time depending on needle position, needle rotation, insertion angle and local tissue properties. The haptic device is then used to return the rendered forces to the user. Different force components are considered: Resisting force, surface friction and viscosity of medical structures are simulated based on a haptic volume rendering approach [1]. The rotation and transversal motion of the needle inside the body is restricted using the insertion angle and position at the moment of insertion. Furthermore the friction that resists the needle insertion is computed based on the penetration depth.The visual component is build up of 2D and 3D visualizations of the virtual body. The 3D scene shows a virtual representation of the needle and the surfaces of relevant medical structures like skin, bone, fat and muscles. The whole scene can be rotated, panned and zoomed using the mouse (Fig. 2). A stereo view facilitates the impression of depth. Three 2D views show orthogonal slices (sagittal, coronal and axial) of the image data (Fig. 3). The slice positions are defined by the current position of the needle tip. The alignment of the needle is shown by a projection into each orthogonal view. In a first step the input data for the lumbar puncture simulator has been generated based on the visible human male data set. We used the CT data and the segmentation (label data) of skin, bone, muscles and fat. Surface models have been generated based on the label data to enable the 3D visualization. Parameters for haptic and visual component and the definition of the input data are provided to the framework using an XML file. Results:Several users with varying medical experience tested the simulation of lumbar puncture. The users were able to identify different tissues like muscles, fat, skin and bone by means of viscosity, resisting force and friction. Viscosity turned out to be essential for a realistic haptic feedback. The synchronization of force feedback and miscellaneous visualization techniques provided a realistic impression of the anatomy though the usage of a haptic device is very unusual for most users. I turns out

that the simulator developed is able to support and improve the lumbar puncture training using virtual reality techniques. Conclusion:Virtual reality enables the development of new approaches for visualization and evaluation of the insertion procedure during the training. The training method offers a new way to understand anatomical contexts and to gain experiences in using a puncture needle. Our future work will be the enhancement of the existing simulator and the design of other puncture simulators. The next steps will be the simulation using patient data, the realistic simulation of soft tissue deformation and bending of needles to enable the simulation of soft tissue punctures like liver or lung puncture.References:[1] Lundin K, Ynnerman A, Gudmundson B. Proxy-Based Haptic Feedback From Volumetric Density Data. In: Proceedings of the Eurohaptics Conference 2002, Edinburgh, United Kingdom: 104-5

Bild 1/JPG



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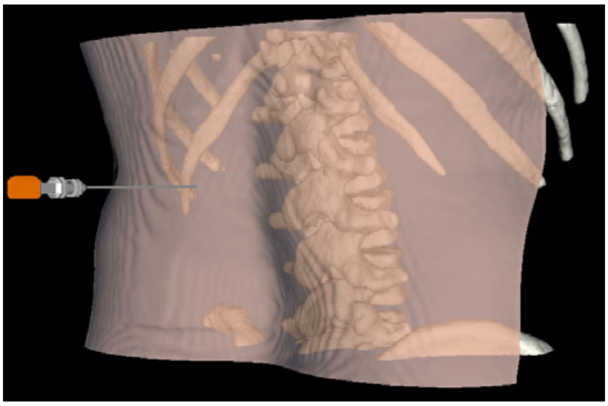

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