A Haptically Enabled Dental Simulator

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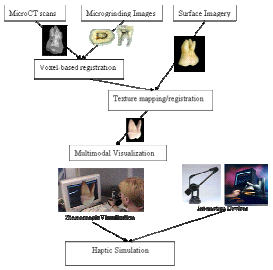
Traditionally training in dentistry has used a combination of group classroom lecture with laboratory exercises. With the huge growth of computer technology, and particularly computer simulation technology as teaching tools, it is increasingly clear that this traditional method is costly and time consuming. [1,2,9,10,12] Assessing skills acquisition is difficult; furthermore, simulation of procedures is inexact resulting in some students reaching clinical practice without adequate skills.

There is currently a movement in medical/dental education to change the curriculum to include the principals of adult learning where students can adjust their learning experience to their own time frame and learning style. [16] Multimedia lectures over the web are starting to replace conventional lectures. Procedural simulation using virtual reality is beginning to be utilized. Computer based virtual reality simulation allows for unlimited on-demand access to 'deliberate practice" sessions and provides immediate feedback on the level of skill acquisition achieved. [1,9] Competency, even against a national standard, can be easily judged. Unlike human specimens or plastic models, a computer model, once developed, can be used an infinite number of times. Studies indicate that this approach can increase the efficiency of skills acquisition, retention, and has "carry over" to clinical performance [1,2,8,10,11,16].

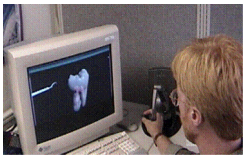
In recent years training in clinical dentistry has been significantly impacted by the rapid growth of simulation technology. The introduction of computer generated Virtual Reality, together with haptic devices, have the potential to further improve clinical training across a broad range of skills acquisition. Given that a restorative dental procedure is a planned intervention in a complex 3-D space, the advent of VR would allow the student, and clinician alike, to practice skills acquisition in a virtual 3D world.

The aim of this project is to put a computer-based simulation system to work. We have developed a tooth treatment planning system that integrates information derived from different imaging techniques and accommodates the intrinsic three-dimensionality of the resulting data set. The planning environment presents a stereo 3D computer-generated reconstruction of the imaging data in a 3D space and allows the operator to interact directly in 3D in a natural, direct and easy manner. The system allows for a believable simulation of a wide variety of tooth preparations that clinicians could encounter.

By combining tooth-specific micro-CT scans, microgrindings, and high-resolution photographic images, data is registered and displayed as a single 3D object. The result is a photo realistic, 3-D voxel model of a tooth. The system allows for real-time manipulation of the multimodal 3D data. Additionally, the system provides a number of dental instruments for tooth preparation and shaping. The 3D image is moveable in all axis of rotation but can be fixed in a desired position when needed.



A sensor resembling a dental hand piece appears as a computer generated virtual hand piece on the computer screen. It can be used to perform tooth preparation procedures. The position of the virtual instrument in the user's hand is calibrated in such a way that the user perceives it to be in the same orientation and spatial position. Through the use of haptic force-feedback it is possible to simulate the sensation of actual tooth preparations.



Intel Pentium System

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