VIRTUAL RADIOGRAPHIC ENVIRONMENTS

GEOMETRIC VALIDATION OF A VIRTUAL RADIOGRAPHY SIMULATOR

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INTRODUCTION

Virtual environments are now accepted as valuable for training in aviation, driving, deep sea diving, parachute situations, fire-fighting, air traffic control, power station control, ship manoeuvres, battlefield situations, surgery, anesthetics, and space. They have been developed for dental radiography[1] and forensic radiography.[2] This is because they embody many of the characteristics of the ideal medium; they are student centred and highly interactive.[3,4]

Virtual training is especially valuable when the task involves danger[4] (ionising radiation), takes place in an unpredictable environment (hospital), is difficult to timetable (large student numbers) and where alternatives are expensive (live x-ray rooms and CR/DR systems). Additionally, adopting a computer game format may increase student motivation.[4]

The mechanism of learning is not certain, but a number of theories have been suggested; the student may gain a simple familiarity with the x-ray room and its components, which aids subsequent learning in clinical practice. Alternatively, it could be due to particular cues 'jumping out' at a student from their practices in the virtual radiography room. The virtual radiography experience also allows students to rehearse specific sequences of actions (such as placing cassettes in the bucky and centring to them). Virtual environments are thought to help students remember things due to the mixing of 'where' and 'when'. Students learn the right thing at the right time in the right physical space, rather than reading a book or listening to a lecture or even passively watching an animation or video.[5]

In the training of spatial skills 'positive transfer' from virtual to real has been reported without exception.[6,7,8] Clear evidence of 'positive transfer' of procedural learning from virtual to real environments is also reported.[8] Possible 'negative transfer' is a significant issue with simulation. The main aim of this project was to evaluate the accuracy of the projection geometry obtained by virtual radiography.[9]

METHODS

Data from a CT examination of a tissue equivalent plastic embedded dry skull were acquired with a matrix size of 512 x 512 x 184. The pixel size of each tomographic slice was 0.46mm, the slice thickness was 1mm and the slice spacing was 1mm. This same skull phantom was then radiographed in Four projections; Fronto-Occipital 20, Lateral, Townes, and Optic Foramina.[10] Three of these projections were with the central ray perpendicular to the cassette and one with the central ray angled 30 degrees to the cassette.

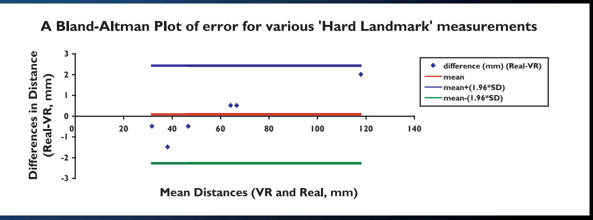
The same Four projections were accomplished in the simulation, following the same methods. Tracings were made of the resultant radiographs and various "Hard Landmarks" were marked on these. Measurements between points were specifically chosen to have the most sensitivity to rotation in each of 3 planes; axial, coronal and sagittal. The virtual radiographs were created with a matrix size of 2048 x 2048, and measurements taken from a 20" LCD monitor capable of presenting them at 1:1 scale (Hewlet Packard, Palo Alto, Calif. LP2065.)

RESULTS

Projection	Plane validated	Measurement	Real radiograph (mm)	Virtual radiograph (mm)
Fronto-Occipital 20	Coronal plane	ANS - Petrous	46.5	47.0
		Petrous - Bregma	119.0	117.0
Townes 30	Sagittal Plane	Lt. TMJ - Sella	67.0	66.5
		Sella - Rt. TMJ	64.5	64.0
Lateral	Axial Plane	Lt. Outer Canthus - Sella	37.5	39.0
		Sella - Lt. EAM	31.5	32.0

ANS = Anterior Nasal Spine, EAM = External Auditory Meatus, TMJ = Tempero-mandibular Joint

The Bland-Altman 95% limits of agreement[11] show that the measurement from the Virtual Radiograph may be 2.4mm above or 2.27mm below the measurement from the Real Radiograph. No systematic error is apparent and the mean difference is close to 0.



A qualitative comparison was conducted for the optic foramina projection:

Which is virtual and which is real? Press optic foramina to find out.

CONCLUSION

The test comprised 4 exposures covering a range of projections both through the dataset and to the cassette. The differences between the virtual and real measurements were extremely small, and within the reported error of cephalometric analysis.[12,13] The qualitative results show little observable projection differences between the two images. virtual radiography 3.1 can produce simulated x-ray images with high geometric accuracy based on perspective projections through a CT dataset. The software can continue to be used for simulation of radiographic examinations without the danger of a negative training effect. Further research is required to validate the non-geometric aspects of the simulation.

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