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Virtual reality learning resources in building pathology

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Abstract

Building surveying students must be capable of analysing the condition of buildings and their components and, where this falls below an agreed standard, make recommendations for their repair. Hence university courses must provide opportunities for students to learn about the main causes of deterioration. Fieldwork exercises are essential but there are often problems locating appropriate buildings, programming visits to satisfy course timetables and complying with health and safety requirements.

Whilst virtual surveys of existing buildings are not considered to be a substitute for real-life educational visits, this paper critically examines the development of a novel building pathology educational resource. Alternative technologies for creating digital panoramas are examined, prior to the development of an interactive case study, which enables students to conduct an on-line survey of a Grade 1 listed 16th Century hunting lodge. 360 degree panoramic scenes are linked with hot spots to create an interactive virtual tour of the building.

The paper considers how virtual resources can be embedded within the curriculum, gauges tutor reaction to case study materials and identifies opportunities for the development of a suite of building pathology educational media-rich learning materials.

Keywords: defects, maintenance, multimedia, photo-realism, surveys

1. Introduction

Concern that tutors become fascinated with technology and lose sight of the key educational goal – to stimulate cognitive development – is seldom far from the minds of academics when they hear of some new e-wizardry that purports to offer solutions to assessment, learning and teaching problems. Whilst they are right to be cautious, there is no denying the advances made in educational technology and the opportunities that e-learning now has to offer. However, e-learning must not stand in isolation. Blended learning is advocated, bringing together traditional physical classes with elements of virtual education (Motterham, 2006). This case study reports on the rationale for and implementation of a virtual reality (VR) system to enhance the learning experience of building surveying and architectural technology students in the School of the Built Environment at Leeds Metropolitan University.

2. Rationale

An important component within construction-related programmes is the site visit. Students are able to experience first-hand the activity, working conditions and excitement that characterise a busy construction project. However, as Frank (2005) observes, it is surprisingly difficult to witness the actual process of construction that lead to a building's existence. In a review of the teaching approaches and learning opportunities that students consider most valuable in built environment education, she notes that some aspects of built environment education are difficult to visualise. Realising that it is not always possible or feasible to organise site visits with large groups of students, student feedback suggested that images and graphic representations are effective aids which enhance the learning experience - hence the need to create a simulated construction site environment.

Shelbourn *et al.* (2003) state that experiential learning i.e. learning by doing, is the norm for learning in building surveying, but they also acknowledge that learning by doing is a risky, time-consuming and costly task. Rising to the challenge that this creates for tutors, Shelbourn *et al.* (*ibid*) devised an interactive computer-aided learning (CAL) resource that enabled building surveyors to diagnose defects in buildings. However, evaluation of the application was inconclusive. Many students

were sceptical that a virtual survey would enable them to learn about building pathology, whereas practising surveyors thought that the tool was appropriate for inexperienced surveyors to learn.

Virtualsite, a National Teaching Fellowship project, draws upon the experiences of Shelbourn (*ibid*) and seeks to extend the concept in a variety of contexts. Moreover, the project evaluates recent developments in digital technology which enable panoramic scenes to be created efficiently and adopts software applications that offer users visual prompts to assist in navigating through virtual environments.

3. Creating Digital Panoramas

Early attempts to create 360 degree panoramas relied on stitching together a series of digital images taken at set intervals. The process was time consuming and the quality of the final scenes was dependent upon the accuracy of the stitching process. Today photo warping software can be used to generate panoramas from either a single 'do-nut' image, shot using a bespoke panoramic optic attached to a digital camera e.g. Kaidan's 360 One VR Optic (see Fig. 1), or two fisheye images (see Fig. 2).

The panorama shown in Figure 3 used a Kaidan Optic to capture the image. Photowarp software transformed the 'do-nut' image into a panoramic strip and icons, created in Adobe Photoshop, were inserted. Finally, the scene was converted into a QuickTime VR (QTVR) movie, using VRWorx software, to allow users to navigate around the movie and explore other scenes via a series of hotspots. Unfortunately the resolution of the original image – a reflection from the optic's mirrored surface - was insufficient to allow users to make full use of the zoom functionality available in QTVR. To compensate, hotspots were provided enabling students to see close-ups of building defects on the exterior of the building. However, this was perceived by tutors to be a major limitation – not only were students were being directed to specific defects but the hotspots themselves detracted from the photorealism of the virtual environment. Moreover, the field of view was restricted as a full spherical panorama could not be created from the mirror image.



FIGURE 1: Kaidan 360 One VR Optic



FIGURE 2: Fisheye converter



FIGURE 3: QuickTime VR panorama

IPIX is also acknowledged as being one of the sector's leading providers of digital panoramic virtual reality photography software (VRP, 2005), produces excellent results and would have lent itself to this type of application. However IPIX is normally preferred for large volume work. An annual license fee to use the software inflates the costs for low-end users and precluded its use on this project.

In order to overcome the twin problems of low image resolution and restricted fields of view, spherical panoramas were created by stitching together two high quality fisheye images of opposing i.e. 180 degree, views (see Fig. 4) and imported into Panoweaver (version 4.00) software.



FIGURE 4: Fisheye image of the building interior

A Nikon Coolpix 8400 8MB digital camera with Nikon FCE9 183 degree fisheye convertor, positioned on an Agnos M rotator head screwed to a regular tripod pan head, were trialled – the rotator enabling an accurate through 180 degrees. Software settings allow adjustment of the centre X, Y co-ordinates and the radius size to ensure a good stitch before the image is published as a .jpg file (see Fig. 5).

4. Navigation

Rebelsky *et al.* (1999) state that most movies have relatively low viewer interactivity and there is need, in an educational context, to enhance the interactive quality by creating different story-lines, characters or camera angles. However, tension exists between too little and too much freedom when navigating through learning material (Benyon *et al.*, 1997). Too much freedom, they suggest, results in students becoming bewildered or lost. Hence, users must remain in control if they are to explore new virtual environments with confidence. The concept of learner control regularly appears in the literature (Wild and Quinn, 1998; Stoney and Wild, 1998) both in the context of the user interface and the instructional design. Attention to navigation and feedback in computer-aided learning applications, Wild and Quinn (*ibid*) argue, will reap educational rewards as learners develop deep approaches to the tasks being presented.

Shelbourn (*ibid*) suggests that many building surveying students may not have been exposed to VR and that this may make them sceptical of such applications. Hence the concepts of navigation and control are of particular importance.



FIGURE 5: 360 degree scene created from 2 fisheye images

Tourweaver software was found to possess many features that lent itself to the proposed building pathology application, namely an interactive map with compass effect and customised walkthrough (EasyPano, 2006). Students can navigate via a floor plan, a series of hotspots embedded within the virtual tour or thumbnails. Not only did the compass highlight the direction in which the user was travelling but it also showed the field of view – as the user zoomed in to see a particular construction defect, so the field of view narrowed. Moreover, the application could accommodate several floor plans, presented either within one skin or on a number of different screens.

Drawing on images of a 16th Century hunting lodge restoration, which involved lime pointing, dry rot eradication, wall stabilisation, stained glass repairs and specialist joinery, a virtual tour of the building was compiled. Each fisheye image was processed in Tourweaver and a simple design, chosen from a variety of pre-designed skin styles (which define the viewer size, format of the map and thumbnails) was used to create the tour. Panoramas, together with complementary icons created the visual cue in each of the 3D scenes. The field of view, the opening view in each scene, and the minimum and maximum zoom capabilities were adjusted in Tourweaver. Plans of the lower ground, upper ground, first and second floors were presented on screen and text, to complement each room, appeared within the viewer skin (see Fig.6).

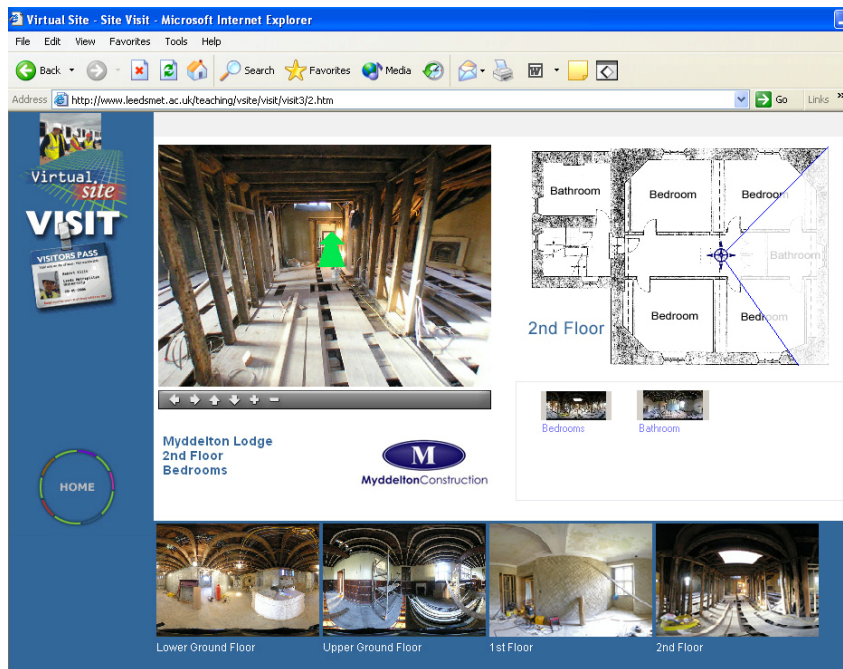


FIGURE 6: Virtual tour of building interior (created in Tourweaver)

Early reaction to the resource has been positive from tutors and students, although the application has currently only been used in a formal classroom setting (see Fig. 7). One tutor stated:

These visuals will make a step change to my presentations. Whilst I can see how students will be able to benefit from using these resources at a PC, they also give me the flexibility in a lecture to react to the students – they ask me about traditional lime mortar and I can point straight to it.

5. Discussion

Frank (*ibid*) identifies five factors that comprise good learning experiences: hands-on practice-relevant education; seeing things with your own eyes; teacher enthusiasm and experience; team working; and tactile emotional experiences.

Prima facie VR applications, such as those described offer students new ways of learning about building pathology. But they must not be seen as attempts to replace the site visit. Whilst students generally welcome innovations of this nature, it



FIGURE 7: Virtual tours embedded within PowerPoint presentations

is understandable that they might initially be sceptical or indeed cynical about the motivations for developing such materials. Maximum benefit, it is suggested, will be gained by using VR materials in a holistic teaching and learning approach which values existing approaches. Aspen and Helm (2004) argue that this mix or blend of approaches can be of considerable benefit to students, leading to effective engagement in a range of situations.

Kirkley and Kirkley (2005) suggest that old technologies are unlikely to go away. They see them being incorporated with the newer technologies into the overall learning environment and suggest that the challenge will be to bring together teams with multiple roles and tasks. The experience gained from this project, however, suggests that tutors are keen to embrace new technologies, are excited by the potential applications they offer and welcome the opportunity to work together to create new learning resources.

6. Future Development

Whilst this paper has reported on the creation of virtual internal and external site surveys, on-going work is being conducted to create external object movies, which



FIGURE 8: Rendering CAD model in SketchUp

will enhance further the delivery of the building pathology curriculum. In the example shown in Figure 8, a CAD model imported into SketchUp is being rendered with photographic textures. Exported graphics of the model, rotated at pre-defined intervals will then provide the media necessary to create a QuickTime VR object movie of existing properties.

Alternative methods of producing these movies are also being explored – principally by creating 3D virtual models in SketchUp directly from photographic images. The rationale being that increased use of visuals and graphics can only serve to enhance the student learning experience, provided that they are introduced into the curriculum in an appropriate and sensitive manner.

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