Real-Time Landscape Visualisation: Experiences in a Teaching and Learning Context

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1. Introduction

Landscape visualisation is typically seen as the use of computer-generated 3D perspective views of predominantly natural landscapes, usually striving for some appropriate level of photorealism (Appleton & Lovett, 2003). Such forms of visual communication which mimic the public's natural view of the world, and allow past or future scenario representation, are becoming increasingly common in environmental decision making. Orland *et al* (2001) described the trend towards more interactive participatory visualisation in a planning context. Dockerty *et al* (2005) provide one example of how modern VR software can create and render realistic models of future rural landscape scenarios using GIS data. It has been recognised that 3D landscape visualisation is a powerful way to enhance the awareness of environmental phenomena and has the potential to foster action and influence policy (Sheppard, 2005). It is also important to reflect on the degree to which virtual landscapes provide representations which are true to our real world experience of that landscape (Lange, 2001; Priestnall and Hampson, 2008) or which allow us to simulate real field experience within a laboratory setting (Whitelock and Jelfs, 2005). The way in which visual imagery works for different people is complex and people are influenced in different ways by the same visual presentation (Nicholson-Cole, 2005).

In a research-led teaching and learning environment there are several ways in which landscape visualisation can be approached in a GIS curriculum. Technical procedures for data capture, processing and model building can be complemented by field-based studies (Priestnall and Polmear, 2006). The use of landscape visualisation in conjunction with an environmental decision making exercise is an additional approach and forms the focus for this paper. It has been recognised that such applications require the interface to the virtual environment to be intuitive and to support basic functions which enable users to begin to utilise some of the potential of the technology without it actually getting in the way (Furness, 1998).

This paper will focus on the case study of using semi-immersive VR as part of a Masters level student exercise to determine and communicate the location and impact of wind farms in Cumbria, UK using GIS-based analysis. Being able to assess *cumulative visual impact* of multiple wind farm proposals from many viewpoints is an important issue for ongoing wind farm planning applications such as the Berrier Hill proposal to the East of Blencathra, Cumbria (Cumbria County Council, 2006).
Specific issues addressed in this paper are:

- The practicalities of setting up a semi-immersive VR environment.
- The model building workflows for both terrain and furniture.
- An exploration of the ability of the basic VR environment to support a visual impact scenario to a small to medium sized group of people.

- Reflection on this experience and feedback to make recommendations for good practice in the use of semi-immersive VR in this context, including a description of ongoing work to address issues highlighted.

2. The Teaching and Learning Context

The activities described here are a result of Nottingham's involvement in SPLINT (SPatial Literacy in Teaching), a collaborative HEFCE-funded Centre for Excellence in Teaching and Learning (CETL) led by the University of Leicester with University College London as the third partner. The Nottingham component of SPLINT is run jointly by the School of Geography and the Institute of Engineering, Surveying and Space Geodesy (IESSG) and considers how VR and mobile computing can enhance the use of digital geographic information within and beyond geography.

As part of a Masters level module 'Fundamentals of Geographical Information Science' students from the MSc in GIS and the MSc/MA in Environmental Management undertook a group project to suggest and justify the location for a fictitious wind farm within northern Cumbria. A large amount of data was made available including RADAR-derived terrain, colour aerial photography, Ordnance Survey Mastermap vector data, wind speed data and the extent of many planning designations. The students were also given the opportunity to use a semi-immersive VR theatre as part of their final presentation to enable the visual impact of their proposals to be communicated. They were asked to supply the locations and height of three wind turbines a week before the final presentations and were given instruction in the basic operation of the VR theatre.

The following sections describe the VR theatre and the processes involved in creating a suitable virtual environment.

3. The VR Environment

At the University of Nottingham a stereo VR theatre has been installed. It features two pairs of data projectors creating a 5m wide by 2.5m high image, viewable in 3D through the use of polarised glasses. A schematic representation of the lab is given in Figure 1.

The laboratory environment can also replicate the use of location based devices in the field as it simulates the output from a Bluetooth GPS unit. Location-aware applications on mobile devices can be tested within the laboratory as previously described by Priestnall and Polmear (2007).

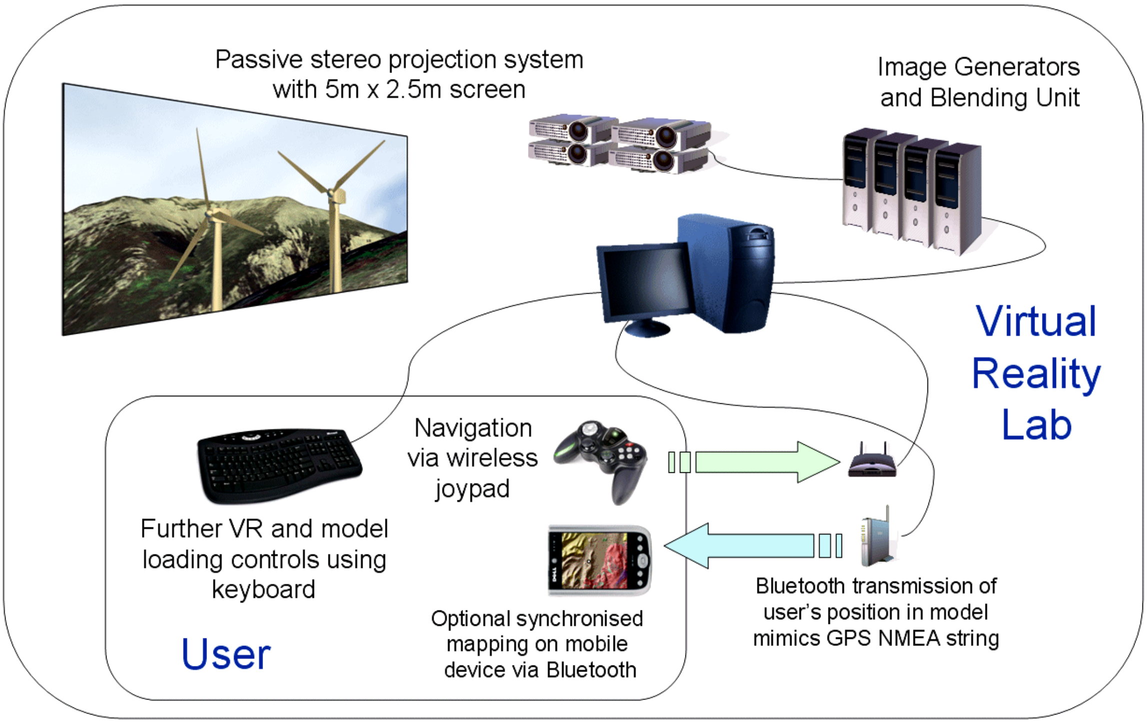

Figure 1. A Schematic Diagram of the VR Laboratory Environment.

4. Model Building

The process of the development of a model for use in the VR theatre was far from straightforward. This section will highlight the difficulties involved in the authors' method for VR world creation, using the wind-farm project as an example.

The main constraint on world development was the complexity of the software environment. The laboratory was built for use with Multigen-Paradigm's Vega Prime used in conjunction with the terrain optimisation package Blueberry (by Bionatics). These packages rely upon very specific model formats and skilled performance tuning to keep the quality high and the processing light.

The model was build up using a terrain model, overlaid with both generalised vegetation and landscape features and a collection of specific models such as buildings which added integrity and realism to the world. Firstly a georeferenced digital terrain model was tiled by Blueberry to allow rendering of a highly detailed terrain close to the viewer, and fade that down to a much less detailed terrain in the distance. Secondly a set of georeferenced aerial photographs were similarly tiled. Preprocessing of the tiles to reduce their size whilst maintaining their georeferencing was necessary to reduce processing time from days to hours.

Features such as woodland, hedge lines, power cables, and waterways were then added. A Blueberry 'plug-in' called RealNat was used to create vegetation models with suitable variable levels of detail for use in the Blueberry environment. These general features were imported to Blueberry at points, along vectors, or within areas. The level of detail settings for each model and vector were adjusted manually to optimise performance in the Blueberry Run-Time Environment.

The final part of the modelling process was to create specific models, which may be key features in a landscape, such as a fieldwork centre, to give students a known reference point in the world, or objects such as the turbines in this wind farm example. These models can be created from a variety of sources and through a variety of routes. Those currently used by SPLINT are summarised in Figure 2.

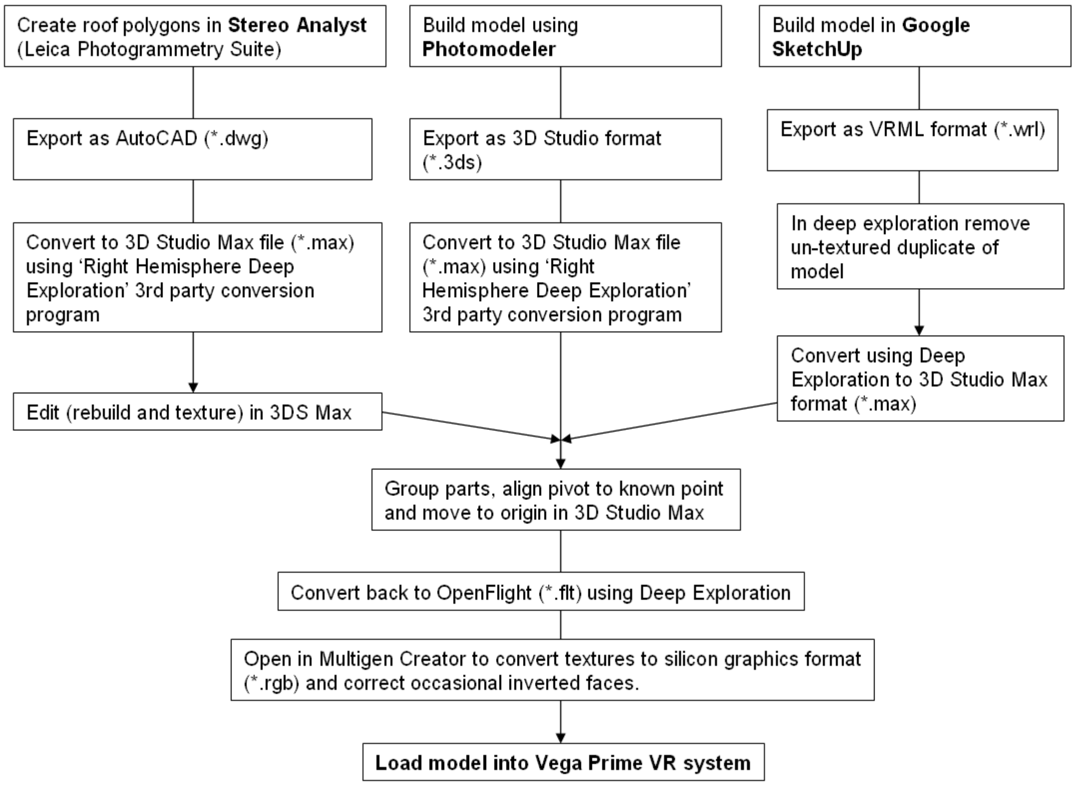

Figure 2. SPLINT's Workflows to get viable OpenFlight models from several modelling packages

5. Real-Time Visualisation in a Lecture-Room Environment

From the student perspective the emphasis of this work was not on creation of the virtual environment, but on using the semi-immersive VR theatre to supplement a presentation justifying their choice of wind farm location. The functionality available in the system was as follows:

- Representation of the region of interest as a virtual model as described in section 4.
- Production of stereo perspective views of the virtual model allowing up to 35 viewers.
- Real-time navigation via a wireless joypad (shown in Figure 3) as used with modern games consoles with two speeds of movement switchable via the joypad.
- Alternation between terrain-following and free flight movement.
- Jumping to a set of start positions (pre-defined by the students) via the keyboard
- Toggling wind turbine models on and off via the keyboard

Figure 3. Controlling the virtual environment with the joypad

The groups presented a justification for their site selection via a PowerPoint presentation to the side of the VR screen and could utilise the functionality of the VR theatre as described above in any way they wanted, as part of the presentation and in response to questions.

All groups demonstrated the location of their wind farm in free flight mode although largely focussing on the local environment and one group showed the relative proximity of major power lines to their site. Questions from the audience asking for the observer position to be relocated, for example, "Can you see the wind farm from Keswick?" were more difficult to deal with. In fact issues relating to intervisibility in the broader landscape context would seem fundamental to exploiting the benefits of a real-time VR environment, but were not well served by the default system configuration. A focus group involving the thirteen students undertaking the module was held a few days after the presentations to discuss system usability issues and to focus ongoing development work.

6. Discussion and Recommendations

Establishing a VR theatre represents a major investment of time, effort and financial expense and the creation of virtual models to support real-time landscape visualisation using such technology is non trivial. The relative virtues of large screen, stereo, real-time VR environments of this type need to be investigated: however some basic usability issues need to be addressed first. The aim of this paper has been to reflect on the practicalities of developing a VR environment which can allow landscape visualisation to play a tangible role in a student presentation context without requiring undue time and effort on the students' part.

Some issues that arose relating to the hardware, software and data required to facilitate the real-time landscape visualisation were:

- Hardware configurations should be assessed very carefully in relation to the software packages required.
- The extent of data coverages should be checked carefully to ensure an adequate landscape representation is available for both the immediate geographical area of interest but also all areas visible from that area.

In terms of the usability of the VR environment a focus group proved useful in prioritising development in order to allow some of the theoretical virtues of such environments to be realised:

- A compass or location map would allow easier orientation within the virtual model. Ad hoc changes in observer position require a high degree of spatial awareness within the virtual model.
- The ability to switch between alternative terrain drapes, such as an intervisibility map or Ordnance Survey map, was considered important.
- Of lesser importance was the ability to snap to pre-defined paths, for example a significant footpath in the case of a popular walking area such as upland Cumbria.

The priorities for ongoing development work are to develop a context map for use in conjunction with the VR display and to allow alternative map drapes to be easily defined and used by the students. The development of the context map can exploit the Bluetooth positional output from the model to allow a mapping application to be displayed a separate large monitor. A bespoke application is being written for this purpose, to provide clear display of the user's position, orientation and field of view.

7 Conclusions

This paper has reflected on the experience of using the standard interaction functionality of a semi-immersive VR theatre in the context of presentations made to medium sized audiences (10-35). The nature and magnitude of the development work necessary to build the required virtual models has been described and in consultation with students a set of development priorities have been established, including a context map remotely synchronised with the VR display.

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Biographies

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