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Progress in the development of a video-based wind farm simulation technique

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Progress in the development of a video-based wind farm simulation technique

SYNOPSIS The progress in the development of a video-based wind farm simulation technique is reviewed. While improvements have bben achieved in the quality of the composite picture created by combining computer generated animation sequences of wind turbines with background scenes of the wind farm site, extending the technique to include camera movements has proved troublesome.

1 INTRODUCTION

Two years ago at BWEA12, a technique for simulating the visual appearance of a wind farm was first demonstrated (1). The technique of 'videomontage' involves combining computer generated animation sequences of wind turbines with video-based live action scenes of a wind farm site. In this way, the appearance of a proposed wind farm can be created. The composite images created by this method accurately portrays all the landscape features of the site, while enabling simulations to be generated from a variety of viewpoints. Importantly, the rotation of the rotor could be shown using this technique, thereby adding a degree of realism unattainable using any other visualisation technique. Despite the novelty of the method and the crudeness of the first images shown, considerable interest was shown in this approach to wind farm visualisation. Since then, however, progress in developing the technique has had limited success. This paper reviews the results of a wind farm simulation project funded by ETSU on behalf of the Department of Energy and carried out by Ambit Computer Graphics.

2 TECHNICAL BACKGROUND

The videomontage technique involves combining computer generated animation sequences of wind turbines with 'live' video film of a wind farm site. The live scenes are filmed using broadcast quality video equipment to ensure good quality images are recorded. Generally, the camera remains stationary. However, the realism of the simulation would be enhanced by camera movements, e.g. pan and zoom, and by including movements in the scene, e.g. vehicles passing through the foreground, but these are technically demanding.

The wind turbines are modelled using the PictureMaker computer system. PictureMaker is a computer graphics system specifically designed for video productions and allows live video images to be combined with computer generated images. Individual background scenes can be 'grabbed' from video film using a frame-grabber. The wind turbine models are accurately represented in three-dimensions and can be fully colour rendered to create photo-realistic images. The models can also be viewed from any position in the work space, but viewpoints are chosen to correspond to the camera locations from which the on-site sequences have been recorded. Rotor movement can be simulated by animating the wind turbine model.

There are several options available for combining the live video images with the computer generated animations. The choice of montage technique depends upon the complexity of the scene being created and the quality of the final image demanded.

Finally, it should be noted that video film consists of a sequence of discrete images. Twenty-five images, i.e. frames, are required fro one second of real-time animation. To create a animation sequence, each image must be rendered by the computer system and the image 'dumped' to video tape on a frame-by-frame basis. A typical cycle time for these operations is 3 minutes. Thus a 20 second animation sequence, i.e. 500 frames, may take over twenty four hours to generate and record to video tape. An alternative approach involves creating a series of rendered images that are stored as image files on the hard disk. To simulate the rotor movement of the WEG MS-3 wind turbine, 16 such images need to be created. These files can be repeatedly recalled in sequence and the images recorded to video tape. A typical cycle time for this operation is 30 seconds. Thus, significant time savings can be made using this approach, though the wind turbine will only be seen operating at constant rotor speed.

3 WIND FARM SIMULATION PROJECT

The wind farm simulation project was undertaken by Ambit Computer Graphics on behalf of ETSU in two phases. In Phase One, the proposed wind farm at Capel Cynon was the subject of an initial study of the videomontage technique. In Phase Two, Capel Cynon and the proposed wind farm at Kirkby Moor were the subjects of further experiments with the technique. The aims of the wind farm simulation project were as follows:

(a)To improve the quality and realism of the composite images.

(b)To move the camera during the simulation sequence.

Throughout the project, it has been the method of combining the live scenes with the computer generated animation that has required the most experimentation. The computer modelling and on-site filming techniques remained essentially unchanged.

In the following sections, the key actions of the project are summarised.

3.1 Phase One: Methodology

*Camera pan recorded on-site.

*Wind turbines rendered against a black background and images stored in image files.

*Animation sequences created by cycling through the image files.

*Pan animation sequence created on a frame-by-frame basis.

*Animation sequences combined with live sequences during off-line edit.

3.3 Phase One: Results

*Movement evident in foreground of scene.

*Correct perspective scaling of wind turbines achieved.

*Rotors move at constant speed.

*Wind turbines appear to have a dark outline.

*Hidden tower bases still visible.

*Wind turbines appear very bright and show little or no contrast of colour across their surface.

*Transparency effects evident.

*Pan sequence shows loss of synchronisation between camera movement and animated pan.

3.3 Phase One: Refinement required

*Eliminate of transparenct effect.

*Eliminate dark outlines.

*Improve quality of rendered image.

*Mask features to be hidden.

*Vary rotor speed, e.g. start-up sequence.

*Synchronise camera pan with animated pan.

3.4 Phase Two: Methodology

*Camera pan and zoom recorded on-site.

*Wind turbines rendered against a single, frame-grabbed background scene. Masks used to obscure hidden detail. Final composite image stored in image file.

*Animation sequence created on a frame-by-frame basis. Requires the complementary background scene to be frame-grabbed from live video film and composite image created in each cycle.

*Composite images dumped to video tape directly from computer.

3.5 Phase Two: Results

*Static foreground.

*Rotors move at constant speed.

*Hidden detail obscured.

*Wind turbines appear integrated into landscape.

*No transparency.

*No dark outlines.

*Poor choice of wind turbine colour.

*Render error, i.e. blade passes through nacelle.

*Frame-by-frame pan creation not achievable with available equipment.

*Zoom sequence is not continuous but incremental.

3.6 Phase Two: Refinements required

*Improve wind turbine colour choice.

*Vary rotor speed.

*Synchronise camera pan with animated pan.

*Restore movement to foreground.

3.7 Conclusions

The wind farm simulation project was of limited success in achieving its aims. The resulting video films show an improvement in the quality of the composite images for static camera positions. However, since the background scene is static, the only movement in the scene is that of the wind turbines. As the Phase One results show, foreground movement provides a much better sense of realism and takes the attention away from the wind turbines to some degree.

The simulation of continuous pan and zoom movements has not been achieved. The frame-by-frame creation of a composite image requires a new background scene for every frame generated. The original background scene has to be on the same video recorder to which the results are dumped. The synchronisation of the video recorder in both play and record modes with the computer proved too demanding and insidious feedback prevented the animation sequence being completed.

4 COMMERCIAL ISSUES

Although initial interest in this approach to wind farm visualisation was good, the expense of producing site specific simulations was too much for most parties. Also, since the wind farm simulation project was disappointing, inasmuch that expectations were not realized, it might be considered that the videomontage technique is not suitable for wind farm applications. However, the wind farm simulations of Capel Cynon and Kirkby Moor have been shown at two wind farm public enquiries, and selected scenes shown on local and national television. The public enquiry inspectors have given encouraging repsonses to the technique, recognising the experimental nature of the technique, and videomontage sequences have been shown on television in preference any other visualisation technique. This use of the videomontage simulations has encouraged Ambit Computer Graphics to continue its development of the technique, although it is not possible to report on their current progress here.

5 CONCLUSIONS

Whilst there remains many technical challenges to produce cost-effective wind farm simulations that will provide realistic simulations of a wind farm, it is considered that consultative and promotional uses of the simulation vindicates its use for wind farm applications.

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