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Visualising Energy Efficiency Landscape

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***Abstract*—**This paper discusses the landscape design that could increase energy efficiency in a house. By planting trees in a house compound, the tree shades prevent direct sunlight from heating up the building, and it enables cooling off the surrounding air. The requirement for air-conditioning could be minimized and the air quality could be improved. During the life time of a tree, the saving cost from the mentioned benefits could be up to US $ 200 for each tree. The project intends to visually describe the landscape design in a house compound that could enhance energy efficiency and consequently lead to energy saving. The house compound model was developed in three dimensions by using AutoCAD 2005, the animation was programmed by using LightWave 3D softwares i.e. Modeler and Layout to display the tree shadings in the wall. The visualization was executed on a VRML Pad platform and implemented on a web environment.

***Keywords*—**Tree planting, tree shading, energy efficiency, visualization.

I. Introduction

A systematic tree plantation in a house compound is an interesting activity. It does not only enhance the visual effect of the building but also effectively decrease the surrounding temperature. As an example, a model was developed in Logan, Utah which shows 98% decrease in cooling cost by shading the whole building with plants. The landscape structure design is usually presented in a manual two-dimensional form. Therefore, it is a bit difficult to imagine how they could lead to efficient energy usage in a house. A visualization of landscape design in a house compound might be able to describe how the tree shadows could prevent the direct sunlight.

The purpose of this paper is to describe energy efficiency landscape design by using visualization. The paper begins with an overview of energy efficiency landscape with particular attention on planting trees for the purpose of providing shade, which reduce cooling costs. This is followed by the design and methodology of visualization development. The model and visualization of effect of tree shadows are then presented.

II. Energy Efficiency Landscape

According to Throne-Holst et al. [1] energy efficiency and energy saving are important agenda in many countries around the world. There were many actions taken towards the issue, for example people in building industry try to exploit the solar source to be used for supporting the air-conditioning of buildings [2].

Planting trees, shrubs, vines, grasses, and hedges is another way to lower energy bills. In fact, landscaping could be a best long-term investment for reducing heating and cooling costs, while also bringing other improvements to the community [3]. Landscape refers to any activities that modify any visual features on a piece of land including life element as flora and fauna, natural element such as the soil structure, and abstract element such as weather and lighting.

Akbari et al. [4] discusses benefits from planting trees in urban area. The tree shades prevent direct sunlight from heating up a building. With the availability of gardens in the metropolitan area, it enables cooling off the air. By planting trees, the requirement for air-conditioning could be minimized and the air quality could be improved. During the life time of a tree, the saving cost from the mentioned benefits could be up to US $ 200 for each tree.

According to the United States National Renewable Energy Laboratory [5], carefully positioned trees can save up to 25% of a household's energy consumption for heating and cooling. Computer models devised by the U.S. Department of Energy predict that the proper placement of only three trees will save an average household between $100 and $250 in energy costs annually. The coolness of parks and wooded areas could be noticed compared to the temperature of nearby city streets. Shading and evapotranspiration (the process by which a plant actively moves and releases water vapor) from trees can reduce surrounding air temperatures as much as 9° F (5°C). Because cool air settles near the ground, air temperatures directly under trees can be as much as 25°F (14°C) cooler than air temperatures above nearby blacktop.

In general, there are three classifications of landscape trees:

1. Small – less than 7.5 meter
2. Medium-7.5 meter to 12.2 meter
3. Big - more than 12.2 meter

Small trees are most suitable to be planted in the house compound to prevent morning, afternoon and evening direct sunlight to the house. Medium trees give extra shades to the building and house compound. They also prevent direct sunlight to the house and develop shades on the wall. Generally, medium trees should be planted from three to four meters from the house. A big tree is not suitable for housing areas.

There are various tree shapes that could give maximum shading to the house. Oval and round shape trees could give effective shading if planted in big quantities. Pyramidal is the least effective shading. Fig. 1 presents the potential shade of

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various tree types according the canopy shape and density of the created shades.

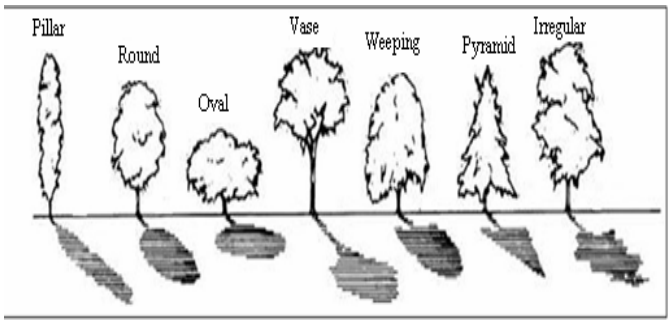

Fig. 1 Canopy shape and shade density

III. Methodology

To visualize the landscape design, first various objects were developed in three dimensions by using AutoCAD 2005. The objects include the house structure, trees with various shapes, and garden accessories such as bench. The animation of the tree shading effect was programmed by using LightWave 3D softwares i.e. Modeler and Layout. Both softwares enable the real function of the effect of landscape trees to be displayed. The complete visualization was executed on a VRML Pad platform and implemented on a web environment.

IV. Energy Efficiency Landscape Model and Visualization

The use of landscape to minimize weather influence is not a new concept, but it attracts many as it emphasise the energy efficiency issue. A designed landscape allows for significant changes in the use of required energy in a comfortable family home. One of the approaches towards energy efficiency landscape is via shading trees. To visualize the effect of tree shades, tree models with various shapes were developed. An example of weeping shape tree model is displayed in Fig. 2.

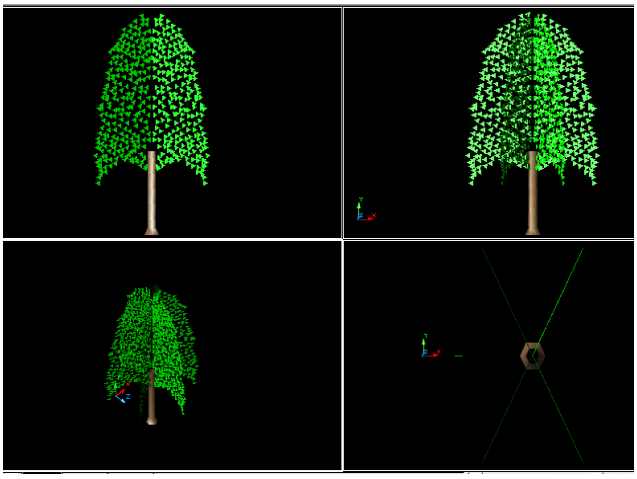

Fig. 2 Weeping shape tree model from right, front, isometric, and top views

Fig. 3 represents the combination of objects in the suitable position following the landscape design principles for energy efficiency. It combines the house, weeping shape trees with various sizes, and garden bench that was created separately using AutoCAD. A hemisphere effect was created as a preparation for the visualization process later. Fig. 4 displays the isometric view of the landscape model together with the hemisphere effect.

Fig. 3 Landscape model from integrated objects

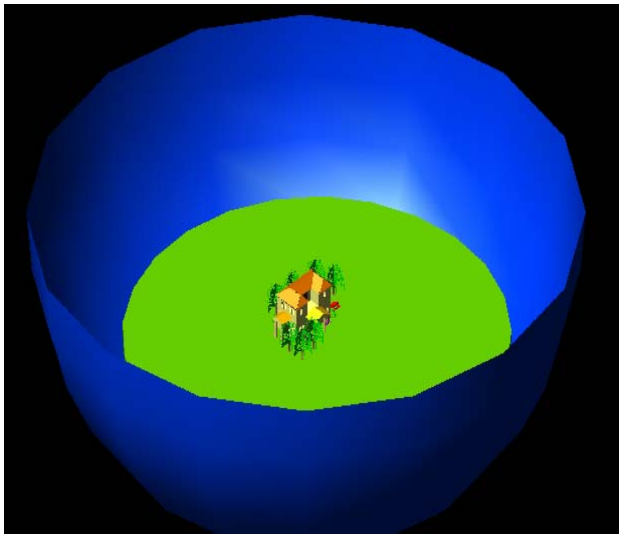

Fig. 4 Isometric view of hemisphere and landscape model

The designed model generated by AutoCAD 2000 were exported to another format i.e. .3DS. Two main softwares in LightWave 3D were used i.e. Modeler and Layout to generate the visualization of the landscape design. Figs. 5 and 6 show the interface of Modeler and Layout, respectively. Modeler was used to improve the surface of created objects to a more realistic and attractive result. Whereas, Layout was used to develop the visualization of landscape design in a video

format by manipulating the available camera, light, and render frame functions.

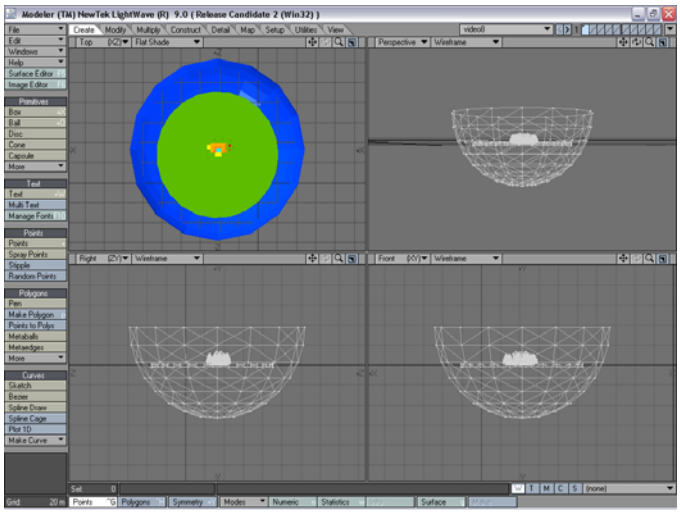

Fig. 5 Interface of Modeler to improve the landscape model results

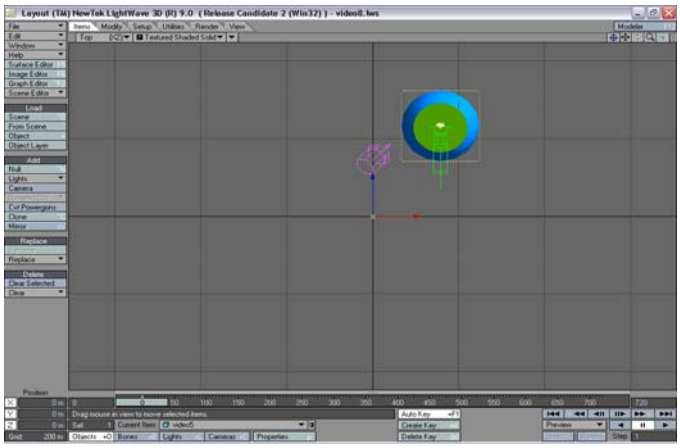

Fig. 6 Interface of Layout to animate the landscape effect

The visualization intends to display how the shades from planted trees could prevent direct sunlight from heating up the building. With the support from various functions in Layout, the visualization enables for the display of sunlight from early in the morning to the late evening and how the shades were developed during this time. Fig. 7 shows the visualization of landscape design. Figs. 8 and 9 display the generated visualization of shade effect of two different tree shapes, weeping and oval respectively.

Fig. 7 Visualization of landscape design

V. Concluding Remarks

The landscape design visualization is an approach to virtually describe an important approach towards energy efficiency. The real process could be visualized in an efficient manner. For example, the house compound and landscape models are replications of the available and typical house compound and landscape. The visualization technique allows for learning process of important process in energy efficiency. Other methods towards energy efficiency could be virtually described in this platform.

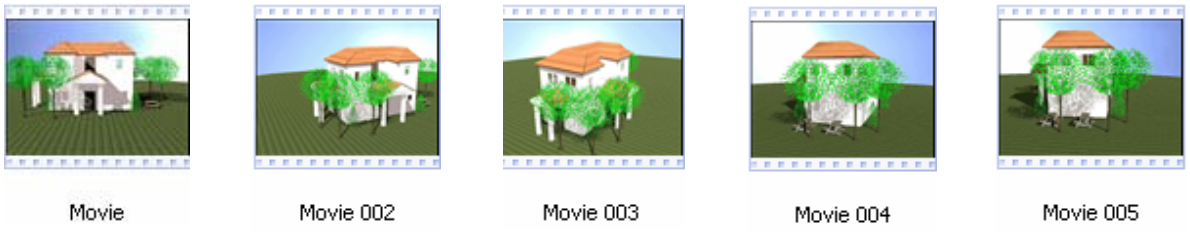

Fig. 8 Visualization of round shape shade effect in the morning, afternoon and evening

Fig. 9 Visualization of oval shape shade effect

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