

Stochastic Simulation of Trees with Environmental Sensitivity

K.D.S. Jinasena and D.U.J. Sonnadara

Department of Physics, University of Colombo, Sri Lanka



Figure 1: Tree growth with different environment configurations



Figure 2: Tree growth with different η values



Figure 3: 3D trees with different environment configurations

1 Introduction

Modeling visually realistic trees is a challenging problem in computer graphics due to the complex variation of tree forms and interactions with the surrounding environment [Palubicki *et. al.*, 2009; Pirk *et. al.*, 2012].

In this work, we present a new stochastic algorithm to generate tree growth which dynamically interact with the environment. Our algorithm is based on the hypothesis that the growth probability of branches depend on the resource availability of surrounding environment. A popular dielectric breakdown model was adopted to simulate the influence due to the surrounding environment [Niemeyer *et. al.*, 1984].

2 Method

We have used the geometric branching model of Honda [1971] for generating the tree structures. The sensitivity to the environment was modeled using the Dielectric Breakdown Model (DBM) [Niemeyer *et. al.*, 1984]. In DBM, electrical discharge grows stepwise from a negative potential ($\varphi=0$) to a positive potential ($\varphi=1$) where the growth will proceed by searching for new lattice points which can be attached to the existing pattern. Similarly, in our model, branches grow towards positive potential where buds formed in each parent node were considered as possible growth candidates.

Initial potential distribution was calculated by placing attracters ($\varphi=1$) and solving the Laplace equation numerically. Growth of the tree was initiated by forming the main trunk and attaching two buds into the trunk as initial growth candidates. Step by step, the algorithm searches through the potential candidates and picks one bud to grow into a branch. The probability (P_i) of selecting a bud randomly for the next growth position can be given as;

$$P_i = \frac{\varphi_i^\eta}{\sum_{i=1}^N \varphi_i^\eta}$$

where the exponent η can be varied to change growth patterns.

3 Results and Future Work

We have simulated the response of a tree to the light based on the hypothesis that branches will have higher tendencies to grow towards light. Figure 1 demonstrates the results obtained from 2D version of our algorithm for different potential configurations.

We have noticed that exponent η plays a major role in deciding the ‘dense’ nature of the tree. Figure 2 shows the results obtained for different η values.

Figure 3 illustrates 3D trees generated by our model with different environmental configurations. This model opens a new approach to simulating tree growth where one can study the environmental sensitivity of trees through a highly dynamic approach. Future work includes the variation of branching angles, branch lengths with the availability of resources and interactive development of tree with obstacles and tree communities.

References

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