Simulation of Autumn Leaves

1 Introduction

Visual simulation of autumn leaves and their weathering sequences requires both the convincing geometry shapes and the reasonable materials for the leaves. This problem can be solved from two major aspects, the geometric modeling and the material synthesis. With realistic rendering of autumn leaves, our system can generate convincing results as is shown in Fig. 1.

2 Double Layered Model

The deformation of a leaf is the aggregation of the deformation of all the cells on the leaf. Mesophyll cells and vascular bundle cells have distinctly different degree of rigidity for shrinkage. In order to simulate the deformation of an autumn leaf realistically we need the realistic venation distribution of the leaf. We modify Runion’s technique [Runions et al. 2005] by increasing the growing speed of the strongest vein or the primary vein on the top growing point. Then, according to the venation, a double layered model (DLM), a physically-based mechanism, is proposed to simulate the deformation of autumn leaves. In DLM, the upper layer stands for the cells in mesophyll which have remarkable shrinking ratio, meanwhile the lower layer stands for the cells in venation which are more rigid to resist the shrinking force, as shown in Fig. 2. The two layers are also inter-connected to hold the mechanical stability. By setting up the mass-spring system in two interconnecting layers, different kinetic manners of mesophyll and veins can be simulated respectively. Meanwhile the double layers affect each other and determine together the deformed shape of leaves.

3 Material Model

Differing from Wang et al. [Wang et al. 2006], we find that only a single leaf is insufficient to represent all the aging appearances of the leaves. Hence our system extends the construction of appearance manifold to the input by multiple leaves, which is called complete aging space. We can thus interpret the relative degrees of aging on all the sample points from the multiple leaves. As shown in Fig. 3, the complete aging space is created by the front sides of several sample leaves at different aging status. Since the sample points in the aging space typically form a dense distribution, the k-means clustering method can be applied to separate the sample points. And then we can create an aging curve by using a Bézier curve according to the means of the clusters. After that, aging degrees of all the sample points can be easily determined by projecting them onto this curve. By replacing the appearance values of the sample with degree values, we obtain an aging degree map, which displays spatial variations in aging degree over the leaf sample. With the aging degree map, our method synthesizes detailed appearance onto leaf model according to a given distribution of aging degrees over the surface.

References
