Simulation of Fruit Decay

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ABSTRACT

The purpose of our project is to create a program that can take an input mesh of a tomato and accurately simulate the effects of natural decay based on certain user specifications. We decided to choose a tomato as our food of choice due to its relative simplicity of form and its fascinating decay behavior.

Although much work has been done in the past in relation to food, most of this work has focused on created aesthetically pleasing or appetizing food. Very little research has been done on the simulation of food decay.

This project will be delivered in the form of a Maya plug-in, with the user able to input a polygon mesh and specifications such as color.

Project Blog: http://fooddecay.blogspot.com

1. INTRODUCTION

1.1 Significance of Problem or Production/Development Need

Food is a common background element in most films animated features. Although not usually the highlight of a scene, these background elements have the capacity to add a high level of detail and realism. In most animated films today, produce and other foodstuffs are generally in a state of ripe health, which is not indicative of real-world scenarios, where food is often in some state of decay, especially in dirtier or older environments. Our project would automate the process of food decay (specifically, tomatoes) and allow set designers to incorporate these more realistic background elements to their scenes, especially scenes in a trash, kitchen, or restaurant setting.

1.2 Technology

Autodesk Maya, C++, OpenGL. We would like to create this project as a plug-in for Maya.

1.3 Design Goals

1.3.1 Target Audience

The target audience of this project would be set designers and other members of a filmmaking team who would like to generate food items in a realistic state of partial or complete decay.

1.3.2 User Goals and Objectives

The goal of the user would be to input a pre-made mesh of a tomato and, based on their individual needs, specify a degree of decay for the tomato. The program will simulate this decay.

1.3.3 Project Features and Functionality

The project will be in the form of a Maya plugin. The plugin will have a simple and intuitive user interface which will allow the user to input a mesh (preferably that of a tomato, but any mesh should be accepted, given that it is not highly complex). The user will also be able to specify a beginning color (green for an unripe tomato, red for ripe, etc). Finally, the user will specify the degree of decay to which they would like their tomato to have progressed. Based on these initial specifications, our plugin will generate characteristics of decay such as wrinkling and reduction, mold growth, and color changes, and apply this to the given mesh.

2. RELATED WORK

While extensive research has been done in the rendering of fresh and cooked food by Pixar for their feature film *Ratatouille*, not much has been done specifically in the area of extreme food decay. However, existing research on various topics could be combined to create the effect we desire. Work in reaction-diffusion for generating naturally-occurring surface textures could be applied in making spots and irregularities on the skin. [1] and [2] have developed methods for both generating textures with nonlinear partial differential equations, and binding it seamlessly to polygon meshes. In addition, fur or hair effects could be applied to mold growth in the areas indicated by reaction-diffusion.

There are a few approaches we could take to render the transformation of a plump, round tomato to a dry, crumpled mass. Numerous methods of creating wrinkle deformations in cloth and skin have been developed, and could be applied softly to the tomato skin in its early stages

of decay (for example, Dreamworks' wrinkle system in [4]). Another possible approach employs a voxel space automata of growth processes ([5]) that takes into account sunlight direction and the surrounding environment – for example, an ivy plant would tend to grow against a nearby wall. Perhaps we could develop an inverse version of this that takes into account gravity, mold weight, and the internal structure of the tomato. This would allow for the model's shape to evolve in extreme ways.

The pre-decay tomato is also important in emphasizing the extremity of the decay; several lighting and rendering techniques from Pixar can be applied to give the initial model a quality of "freshness" (and in turn, lessen the intensity of the effects as it nears "rottenness"). [3] highlights the importance of softness, reflection, and saturation in making food look convincing, and describes how diffuse softening combined with scatter illumination (techniques similar to those used in rendering skin) can capture the pleasant translucency of a tomato's surface.

3. PROJECT PROPOSAL

3.1 Anticipated Approach

We have not yet worked out the specific details of the approach we plan to use, but we do have a rough idea of what sort of strategies we would like to implement. We will simulate the tomato as a two-part entity containing an external skin and an internal volume. We have yet to decide which volumetric approach to take, but we plan to model the skin as a type of mass-spring based cloth. The cloth will be initially stretched out by the volume inside, but as the volume decreases over time, the cloth will wrinkle and crumple together, simulating the effect of fluid loss in a rotting tomato. We can use a randomly generated fractal pattern to plot out areas of mold growth, and expand these areas as decay progresses. Color changes should be fairly straightforward; depending on the initial color of the tomato, we can transform it over time into black, brown, or yellow.

3.2 Target Platforms

3.2.1. Hardware

PC, Mac

3.1.2. Software

Microsoft Visual Studio (C++), Python, Autodesk Maya, Adobe Photoshop

3.3 Evaluation Criteria

The project, when completed, should present a realistic and aesthetically pleasing simulation of tomato decay. It should be faster and easier than the manual creation of decaying food, and produce results that are more accurate. Its results should also be consistent in quality regardless of input mesh or parameters.

4. RESEARCH TIMELINE

Project Milestone Report (Alpha Version)

- Iron out implementation details
- Initial tomato model completed (skin + internal volume)
- Wrinkling and collapsing of tomato body
- Mold generation
- Color changes
- Aesthetically pleasing render

Project Final Deliverables

- Maya plug-in with intuitive user interface
- Realistic decay algorithm incorporating body collapse and dehydration, mold growth, and color change

Project Future Tasks

- Allow user to input such variables as temperature, exposure to sunlight, and humidity and modify decay to reflect these attributes
- Simulate decay for other types of food

5. Method

6. RESULTS

7. CONCLUSIONS and FUTURE WORK

References

[1] *Reaction-Diffusion Textures*, Andrew Witkin and Michael Kass.

[2] *Generating Textures on Arbitrary Surfaces Using Reaction-Diffusion, Greg Turk.* Computer Graphics, Volume 25, Number 4, July 1991

[3] *Anyone Can Cook – Inside Ratatouille's Kitchen*. Jun Han Cho, Athena Xenakis, Stefan Gronsky, Apurva Shah. August 5, 2007

[4] *An art-directed wrinkle system for CG character clothing and skin*

Lawrence D. Cutlera, , , Reid Gershbeina, , Xiaohuan Corina Wanga, ,

Cassidy Curtisa, , Erwan Maigreta, , Luca Prassoa, and Peter Farsonb,

[5] ***Voxel space automata: modeling with stochastic growth processes in voxel space*** **. Ned Greene.Computer Graphics, Volume 23, Number 3, July 1989.**


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Initial tomato model (Skin + internal structure)
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