Implementing a paper flier metaphor using cloth simulation

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1 Overview

In designing interfaces for large screen, digital, community bulletin boards, we have moved away from the desktop metaphor and have implemented a paper flier metaphor using a real-time cloth simulation algorithm. We use a real-time 3D approach to preserve the aesthetics of physical bulletin boards and add attractive effects like papers riffling in the wind (Figure 1).

Our dynamic effects grab the attention of passers-by who are also able to manipulate the digital fliers with natural gestures. Gestures include folding the corners to see what is underneath, adding and removing virtual pushpins, and rotating the digital fliers. Letting go of a flier causes it to swing under the force of gravity.

2 Implementation: Simulation and manipulation

The graphics simulation is a client connected to a server process. Users post new content to the digital bulletin board by sending any URL to the server. Upon receipt, the server opens a new Web browser window and asks the client to simulate a new flier. Periodically, the client requests the latest version of the flier; the server grabs the corresponding window and streams it back to the client. The client maps this bitmap as a texture onto the flier.

When users' actions occur inside a flier, we retrieve the (U,V) texture coordinate at this location and send it to the server, as in [VNC]. The server generates the same event (e.g. click) onto the corresponding window. With this technique, users can still interact with the original content.

We represent each flier by a set of particles linked by distance constraints. The physics simulator moves each particle independently using a simple but fast verlet integrator [Jakobsen 2001], taking into account gravity and wind. We don't model springs between particles. An iterative loop simply enforces distance constraints between the particles. If two particles are too close, they are moved away; if too far apart, they are moved closer. We use structural, bending and shearing constraints [Provot 95]. The number of particles is proportional to the size of the texture to display: X pixels correspond to (X*7) / 1024 + 4 particles. For example, a 512*512 texture is represented by 7*7 particles. These values provide a uniform behavior regardless of the size of the slier and are a good compromise between speed and visual realism.

In order to get paper-like objects, the loop has to be iterated at least 15 times for each flier. With less iteration, the flier resembled a stretchy piece of fabric. To speed-up each iteration, we use an approximate square root function [Jakobsen 2001]. Our OpenGL implementation in C++ simulates 20 fliers of 7*7 particles on a Pentium II with a low-end NVIDIA Vanta graphics card at interactive rates.

When a user grabs a border of a flier, the closest particles' location is tied to the finger's location on the touch-screen. The particle's mass and velocity are set to zero and its Z position is incremented a little so that users feel they have lifted the flier from the screen. This technique provides very realistic folds but also removes potential self-cloth collisions. To this end, the bending constraints are very important to help the flier flip back to a flat resting position. We also add a force pushing each particle against a virtual background.

3 User impressions and future work

We have carried out preliminary user studies. The simulation has proven attractive and appealing; people enjoyed lifting and folding fliers, and moving pushpins. Live content that allows hyperlink following proved particularly appealing.

Our implementation currently lacks a robust collision-detection algorithm. We only check for proximity between triangles; when users lift the corner of a flier, we directly modify the Z position causing some triangles pass through each other. This is being addressed using Bridson *et al.*'s solution [Bridson et al. 2002].

Figure 1. The Digital Bulletin Board runs on a touch-screen, showing folded fliers. Each flier is animated with a real-time cloth simulation. The textures are periodically refreshed over the network and remain interactive.

References

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VNC, VIRTUAL NETWORK COMPUTING ,
HTTP://WWW.UK.RESEARCH.ATT.COM/VNC/WINVNC.HTML.

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