BurnAR: Feel the Heat

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We present the design and implementation of BurnAR, a demonstration which enables users to experience the illusion of seeing their own hands burning, which we achieve by overlaying virtual flames and smoke on their hands. This BurnAR demonstration was shown at the International Symposium on Mixed and Augmented Reality (ISMAR) 2012 in Basel and won the Best Demo Award. It comprises several components based on a closed layer architecture, where data flow is only allowed between connected elements. The lower MR Platform layer drives the MR scene (hand display) and is connected to one or more video images that are streamed to the computer graphics layer. The fire effect uses the 3D point cloud to initialize the particle system, which is overlaid onto the camera images.

Computer Graphics

- Realtime, interactive fire effect:
  - 3D voxel grid with 128x cells
  - Randomized modifiers
  - 3D Navier Stokes fluid simulation
  - Color mapping and image compositing
- Integrates Fairlight Demolition engine:
  - Award winning graphics engine
  - HLSL shader pipeline
  - Authoring tools
  - Custom computer vision connector
- Nvidia GeForce GTX-570

Visualization of 16 slices of our volumetric fire simulation at one timestep: (a) velocities, (b) densities. Velocities are mapped to RGB from low (blue) to high (red). Densities are mapped to grayscale.

Computer Vision

- Color segmented hand mask refinement:
  - Shape from silhouettes technique
  - Tukey estimation for pose weighting
- 3D hand reconstruction:
  - Rectified camera images
  - Depth reconstruction of hand outline
  - Interpolate using nearest left/right borders
  - New map results to camera image
- Scene flow
  - 2D optical flow

A dense disparity map is obtained by interpolating the border parity along the scan line.

MR-Platform

- Canon VX-2007 stereo head worn display:
  - Optical axes are aligned
  - Video see-through
  - Firewire cameras: 640x480, 30 fps
  - LCD panels: 1280x960, 60 Hz
- MR-Platform SDK:
  - Offline calibration tools
  - Marker tracking
  - Color based hand segmentation
  - Sensor fusion

Axes of cameras and displays are precisely aligned using a free-form prism.

References: