BurnAR: Feel the Heat

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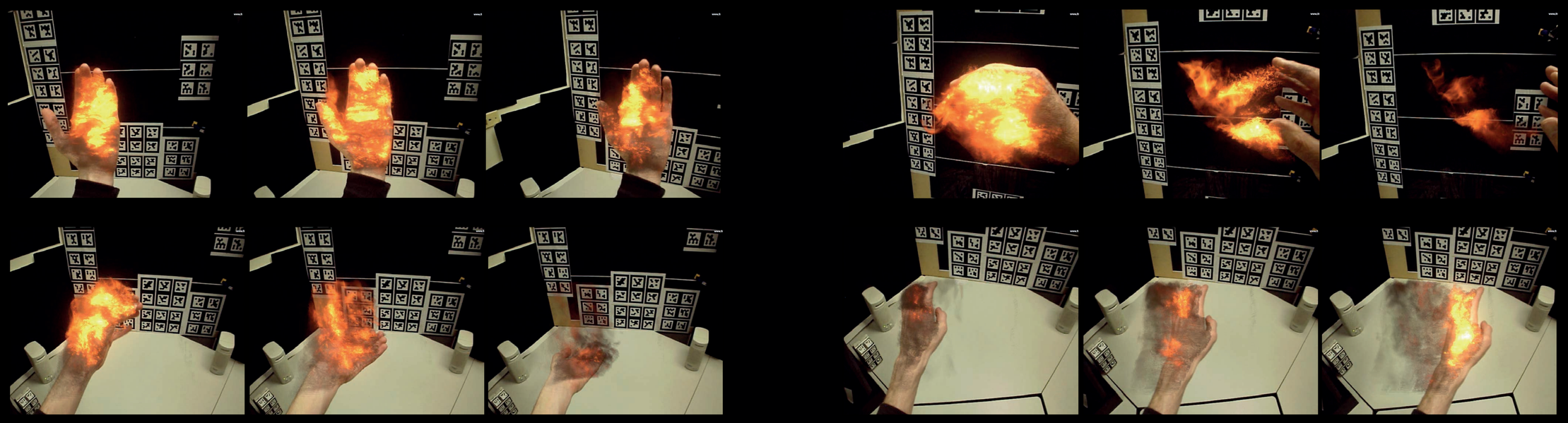
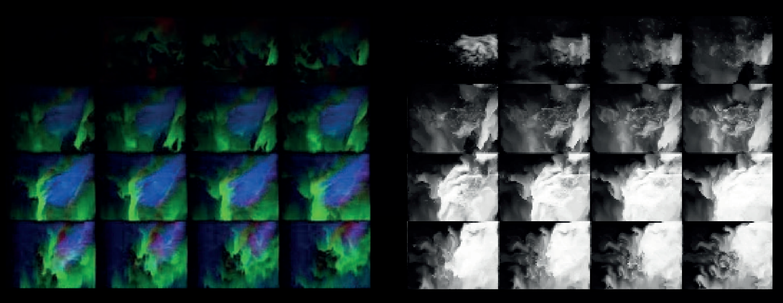


We present the design and implementation of BurnAR, a demonstration which enables users to experience the illusion of seeing their own hands burning, which we achieve by overlaying virtual flames and smoke on their hands. This BurnAR demonstration was shown at the International Symposium of Mixed and 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 adjacent layers. The bottom MR Platform layer drives the stereo head-worn display, streaming a pair of video images, and camera poses to the computer vision layer. In the computer vision layer, the video images and hands, segmented by color, are processed to reconstruct a dense estimation of the hand surface. The resulting 3D point cloud, 3D scene flow, and a pair of video images 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 with128^3 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

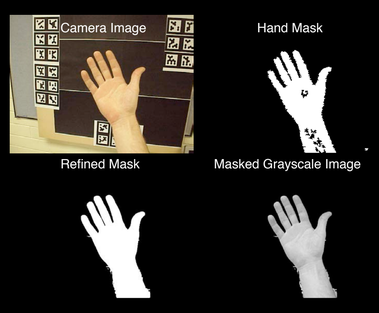


a) b)

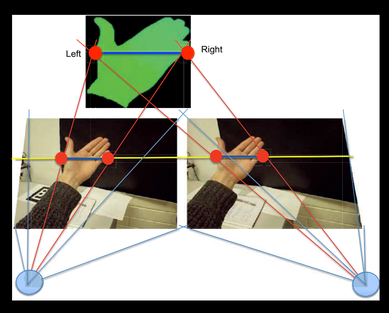
Visualization of 16 slices of our volumetric fire simulation at one timestep: (a) velocities, (b) densities. Velocities are mapped to RGB from low (blue) to high (red). Densities are mapped to greyscale.

Computer Vision

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



Raw hand masks from MR-Platform are refined with a robust filtering method.

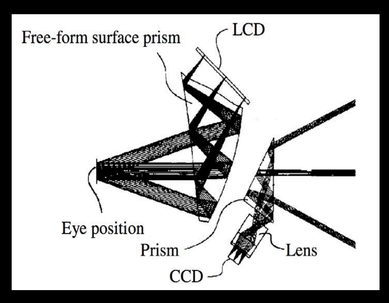


A dense disparity map is obtained by interpolating the border parity along the scan line.

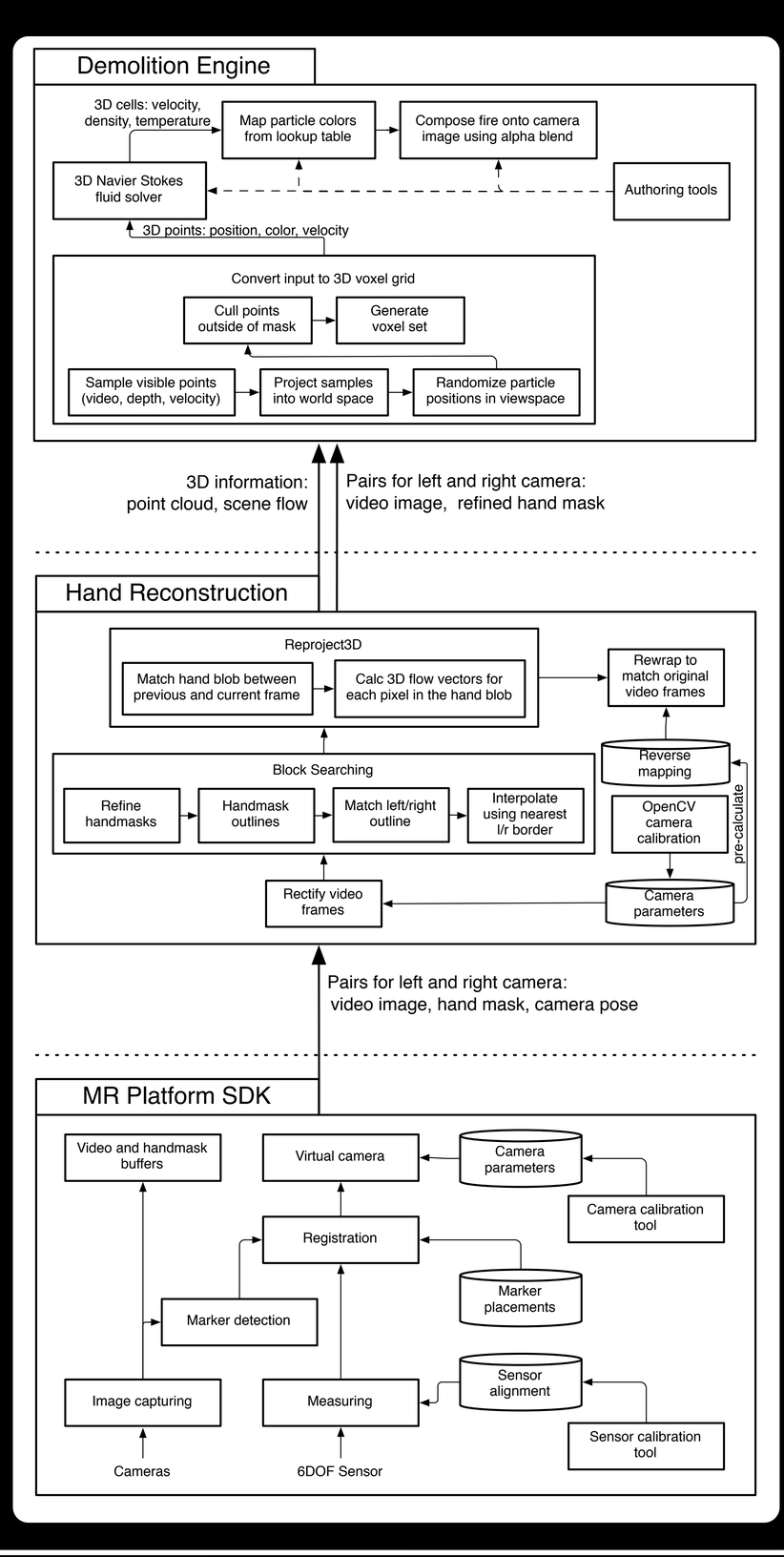
MR-Platform

- Canon VH-2007 stereo head worn display:
  - Optical axes are aligned
  - Video see-through
  - Firewire cameras: 640x480, 30 fps
  - LCD panels: 1280x900, 60 Hz
- MR-Platform SDK:
  - Offline calibration tools
  - Marker tracking
  - Color based hand segmentation
  - Sensor fusion

Canon COASTAR-type head worn display VH-2007 with wide field of view (60 degrees horizontal).



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



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