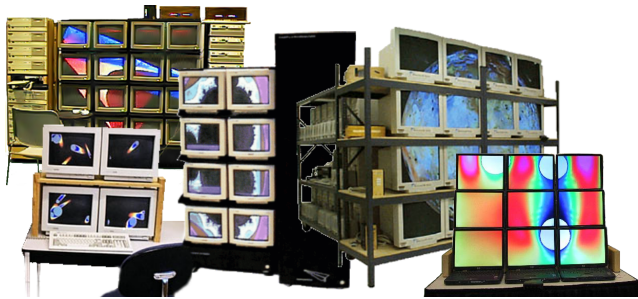
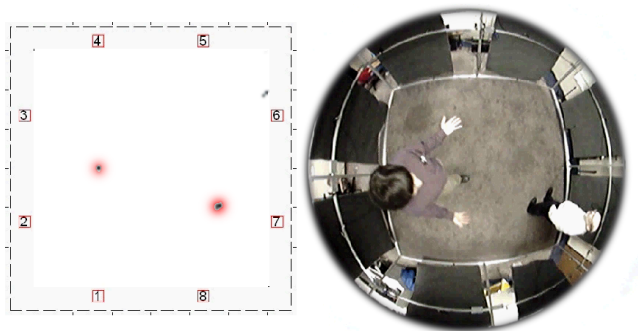


# See & Hear, Show & Tell

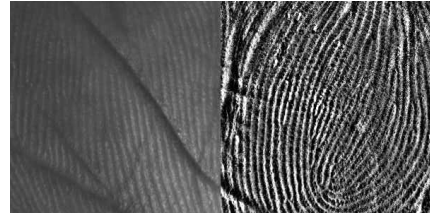
In February 1994, we built the world's first LINUX PC cluster supercomputer in order to test a new communications concept: the AGGREGATE FUNCTION NETWORK (AFN). This hardware provides a wide range of "global state" operations with just a few microseconds total latency, and also can synchronize nodes to within a fraction of a microsecond... but how could we demonstrate this? Video, and moreso audio, walls depend on tight coordination, so we created software for them... but it was hard to find sufficiently impressive images, so we also began working on techniques improving digital image quality. This paper briefly summarizes some of the sensing & display research that for us began as cluster-supercomputing spin-offs. Much of this research is done in close collaboration with members of the UNIVERSITY OF KENTUCKY'S CENTER FOR VISUALIZATION & VIRTUAL ENVIRONMENTS (CVVE).



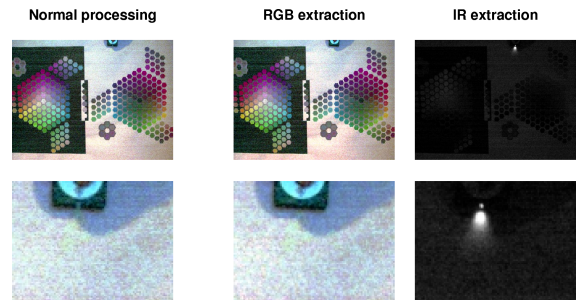
**Video Walls.** Our first LINUX cluster video walls were built using 386/486 systems with dumb video cards, but by 1996 we had a cluster able to perform non-trivial computations while maintaining a 6,400 × 4,800 pixel video wall. Some of our older computational video walls are shown above. VWLIB, freely available at [Aggregate.Org](http://Aggregate.Org), implements a simple but very powerful virtual frame buffer model. For example, at SC99, we were able to use a reference MPEG decoder to play videos on a wall simply by using VWLIB's image file mapping. Multiple dynamically repartitionable walls are supported and generalized subpixel rendering enhances resolution of single-panel LCDs.



**Audio Walls.** Our first LINUX cluster audio wall was demonstrated at SC94 – playing multi-voice music. Over the past few years, we have focussed on audio input and sound source location. The above figure shows *simultaneous* tracking of two sound sources (people) using 8 microphones.



**3D Capture.** CVVE has significant expertise in structured light 3D capture. Combining that with our work in high-quality digital imaging, we have been working on full-handprint flash 3D capture for DHS. The above image is a small crop from such a handprint; the left side is a conventional optical image, the right side is a 2D rendering of the 3D ridge details captured.



**Computational Photography.** We are getting more out of *unmodified* commodity digital cameras: extraction of multispectral data from a single raw capture, in-camera depthmap capture using CHDK (Canon Hack Development Kit), methods to use *bokeh* (the out-of-focus portion of an image) to determine scene and camera (forensic) properties.

**Senscape.Org.** A SENScape is an integrated presentation of multidimensional sensory data allowing a human to understand and use properties of the environment that might otherwise have been beyond human perception. Our target applications range from AVA (the grid-like AMBIENT VIRTUAL ASSISTANT integrating hundreds of cameras, microphones, other sensors, projectors, and speakers) to FIREScape (a helmet-mounted multi-sensor device to help firefighters navigate burning buildings).

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