News

• extra office hours in lab
  – 5:15-6:15 today

• project 3 draft out
Display Technologies recap

- CRT: Cathode Ray Tubes
- LCD: Liquid Crystal Displays
- plasma display panels
- DMD/DLP: micromirror array projectors
- display walls: tiled projector array
Display Wall Discussion

• pros
  – commodity technology
  – can be seamless (theoretically)

• cons
  – geometric alignment solvable
  – colorimetric alignment difficult
  – large space footprint
Future: Plentiful Pixels?

• digital wallpaper
  – 300dpi, ubiquitous
  – cheap as paint/wallpaper

• projectors as lightbulbs, flashlights

• challenges
  – rendering
  – physical delivery of pixels to displays
    • would need lots of wires
Mobile Displays

640x480 1” colour
virtual image 2 ft away
3 oz
Mobile Displays

1. DRIVE ELECTRONICS
The drive electronics acquire and process signals from an image source, then synchronize the color mix, gray-level and placement of individual picture elements (pixels) that comprise the image. The image source may be from a computer, video camera or almost any video input.

2. LIGHT SOURCES
In a full-color display, pixels are generated by modulated light sources that vary the intensity of red, green and blue light - producing a wider range of the color palette than any other display technology. The light sources used in the VRD operate at safe, extremely low intensity levels.

3. SCANNERS
A horizontal scanner sweeps the light beam into a row of pixels, and a vertical scanner moves the light beam to the next line, where another row of pixels is painted. In a VGA display, more than 18 million pixels per second are formed, projected and arranged on the retina - with exacting precision.

4. OPTICS
Refractive and reflective optics direct the light beam into the viewer’s eye, projecting an image through the viewer’s pupil onto the retina.
Stereo Displays

- active glasses or active screen
  - autostereoscopic also possible
Laser Stripe Range Scanners

- camera records laser stripe
  - second camera records texture image

[graphics.stanford.edu/papers/volrange]
Laser Stripe Range Scanners

Cyberware

BIRIS
Laser Stripe Range Scanners

The different views for a portion of the face.
Result after the alignment of those views (each image is color coded).
Same result but with synthetic shading (no smoothing).
Laser Time-of-Flight Scanners

- Cyra
  - picosecond clock rates
Depth from Stereo
Shape Tape

- fiber-optic based bend-and-twist sensor
Haptics
3D Printers

- spread layer of powder
- print binder solution
- vacuum away loose powder

4.5 hrs printing, $100 printing cost electroplated

[Z Corp]
3D Printers

printing telephones?
etc.
Virtual Trackball
Virtual Trackball

• imagine a trackball embedded in screen
  – cs.calvin.edu/CS/352/02Graphics/lectures/primer-demo.exe

• if I click on screen, what point on trackball am I touching?
Trackball Rotation Axis

- If I move the mouse from $p_1$ to $p_2$, what rotation does that correspond to?
Virtual Trackball Rotations

- Rotation about the axis $\mathbf{n} = \mathbf{p}_1 \times \mathbf{p}_2$
- Angle of rotation: use
  $$\mathbf{p}_1 \cdot \mathbf{p}_2 = |\mathbf{p}_1| |\mathbf{p}_2| \cos \theta$$
- Fixed point: if you use the $[-1, 1]$ cube, it is the origin
Virtual Trackball

• can we use the mouse to control the 2-D rotation of a viewing volume?
• imagine a track ball
  – user moves point on ball from \((x, y, z)\) to \((a, b, c)\)
• imagine the points projected onto the ground
  – user moves point on ground from \((x, 0, z)\) to \((a, 0, c)\)
Trackball

• movement of points on track ball can be inferred from mouse drags on screen

• inverse problem
  – where on trackball does \((a, 0, c)\) hit?
  – ball is unit sphere, so \(||x, \ y, \ z|| = 1.0\)
  – \(x = a, \ z = c, \ y = \) solve for it
Trackball

- user defines two points
  - place where first clicked $X = (x, y, z)$
  - place where released $A = (a, b, c)$
- ball rotates along axis perp to line defined by these two points
  - compute cross product of lines to origin: $(X - O) \times (A - O)$
- ball rotates by amount proportional to distance between lines
  - magnitude of cross product tells us angle between lines
    - $(\text{dot product too})$
    - $|\sin \theta| = ||\text{cross product}||$
- compute rotation matrix and use it to rotate world