

Digital Video Processing To Enhance ClearBoard:

A Technique and Possibilities

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ClearBoard in 1992

- ClearBoard seamlessly integrates shared workspace and interpersonal space based on the metaphor of a transparent glass board.
- Drafter-mirror architecture captures the drawings and the user with a single video camera. Distortion of the drawing surface, which occurs when capturing the surface at an angle, is offset by a counter distortion.
- *Gaze awareness* is supported.
- ClearBoard-2 supports computer drawing. Distortion was not offset, but minimized by the camera and screen arrangement because the consistency of the drawing was assured by computer drawing.



Simple but Requires Precise Optical Alignment

-> This difficulty prevents ClearBoard from becoming popular.

- Restores the shape of drawing surface digitally on PC.
- Uses simple affine transformation(1).
- Parameters can be obtained by assigning the coordinates of 4 corners of the drawing surface in captured image to those of the application window.

$$X = (ax+by+c)/(px+qy+r), Y = (dx+ey+f)/(px+qy+r) \dots (1)$$

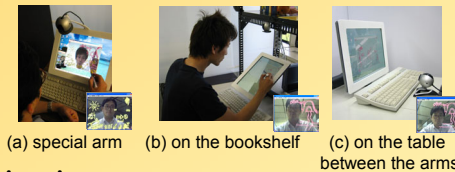
Original distorted image → **Restored image**

Digital Video Processing

Now: Digital ClearBoard

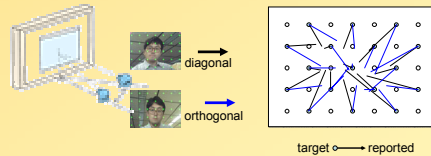
• Flexible camera arrangement is possible.

- The only restriction: the camera must capture the drawing surface.
- Digital video processing restores the shape of drawings. Camera can be set even on the diagonal.
- Easy to calibrate.
- **No need for precise optical alignment!**
- Flexibility provides many ways to avoid the lighting problem.



• Is Gaze-awareness degraded?

- To examine if the diagonal camera arrangement degrades gaze awareness, two camera settings (orthogonal and diagonal) were compared.
- Subjects reported which dot the person in the image was looking at.
- Average displacement between the target and the reported position:
 - 1.42 orthogonal
 - 1.45 diagonal
- Impacted by the sense of distance between the partner and drawings.

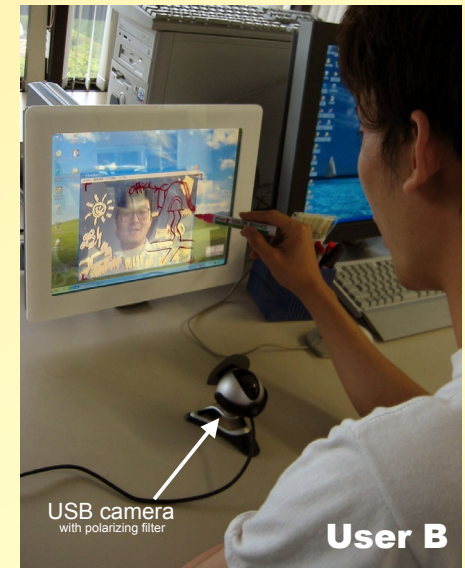
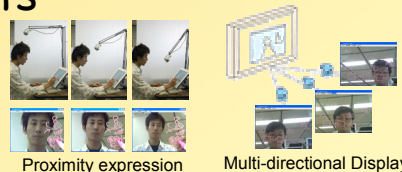


• Possibilities for enhancements

- Flexibility of arrangement provides many possibilities to enhance its functionality.

and more issues...

- size of drawing surface, computer drawing, multi-point connection



- Drawings and user's face are captured by the CCD camera.
- The image is transformed by PC, and displayed on screen.
- User A is drawing in yellow on the displayed drawing in pink by user B.