*M*anual *A*nd *G*aze *I*nput *C*ascaded Pointing

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Human Computer "Communication"

- **Asymmetry** *(R.J.K. Jacob, 1990-93)*
  - **High bandwidth from computer to human**
    - *Text*
    - *Graphics*
    - *Sound*
  - **Low bandwidth from human to computer**
    - *Mouse*
    - *Keyboard*

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The CHI is the Limit
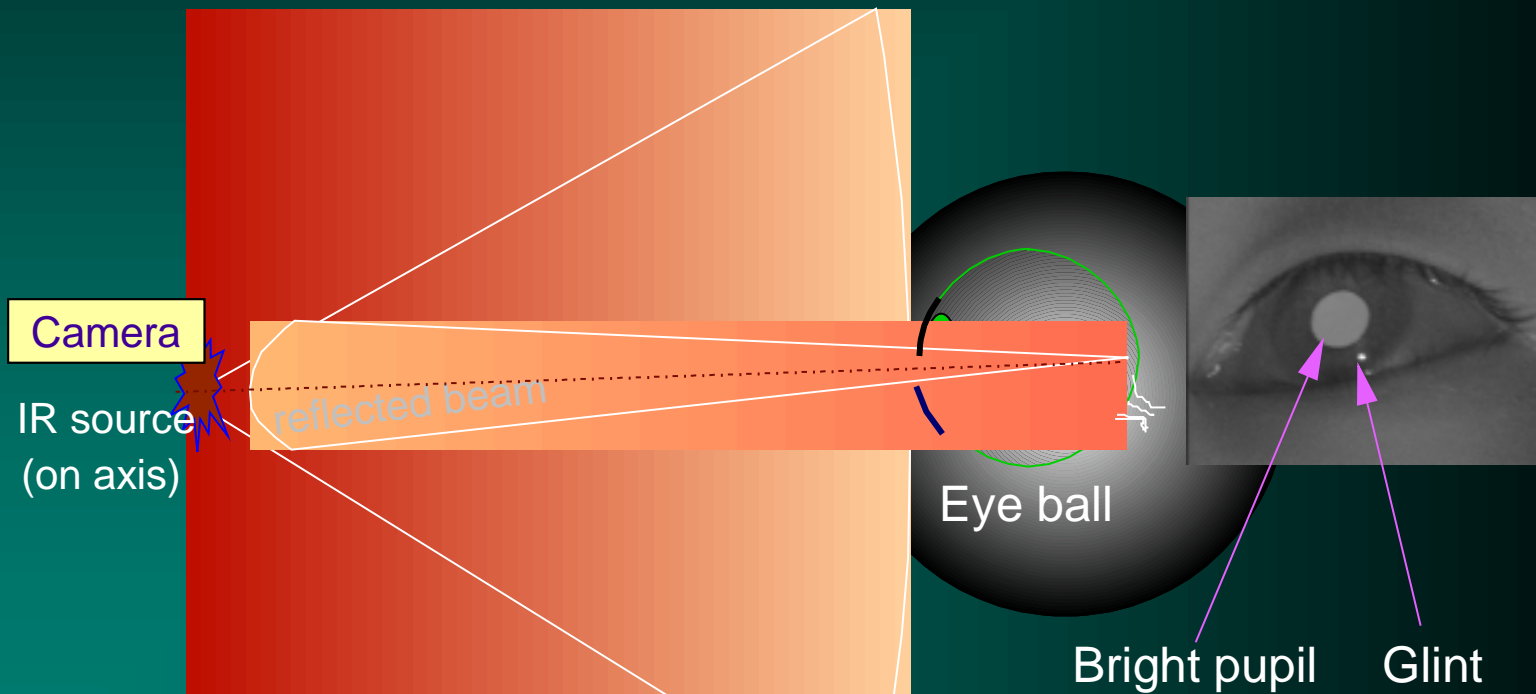
Enabling multi-modal interaction

- *Increasing computing power*
- *Speech recognition*
- *Low cost ($10) camera to appear*
- *Computer Vision / Image Processing*

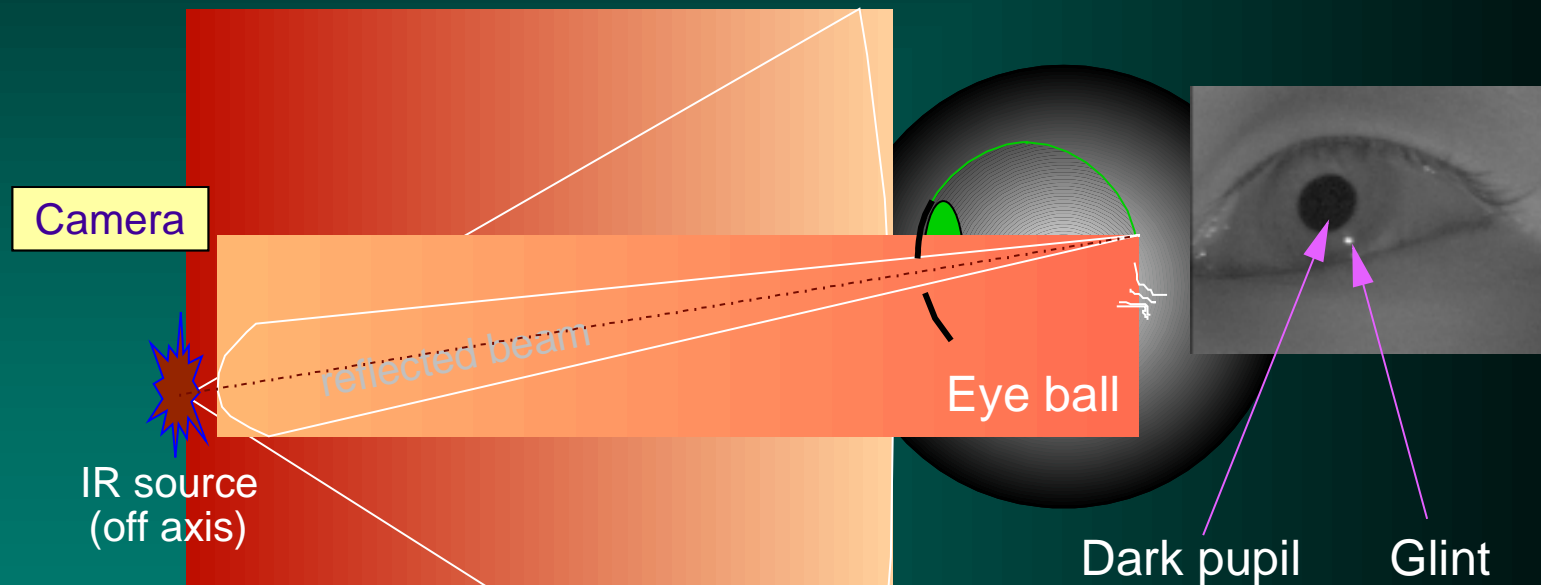- *Gaze tracking*

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IBM Almaden Eye-tracker

The Bright Pupil Effect
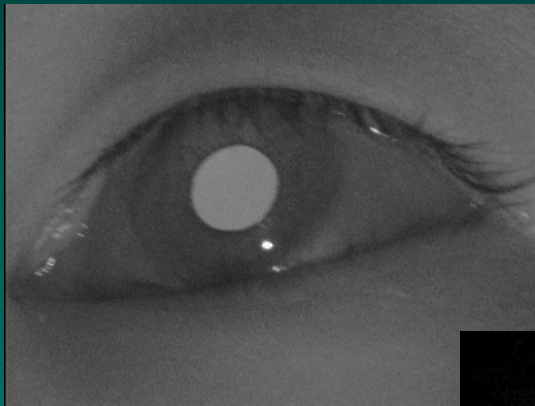
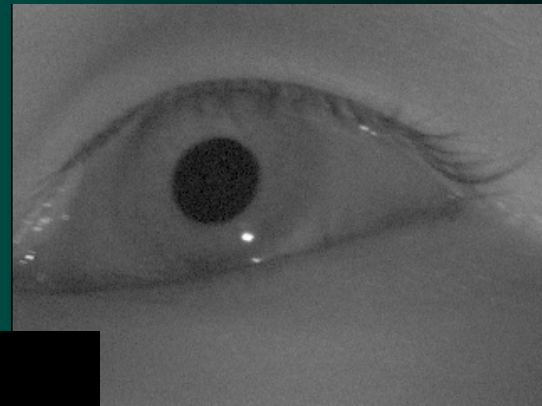- ■ *On-axis IR produces a bright pupil image*

Camera

IR source
(on axis)

reflected beam

Eye ball

Bright pupil   Glint

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How - The Dark Pupil Effect

- *The off-axis IR produces a dark pupil image*

Camera

reflected beam

Eye ball

IR source
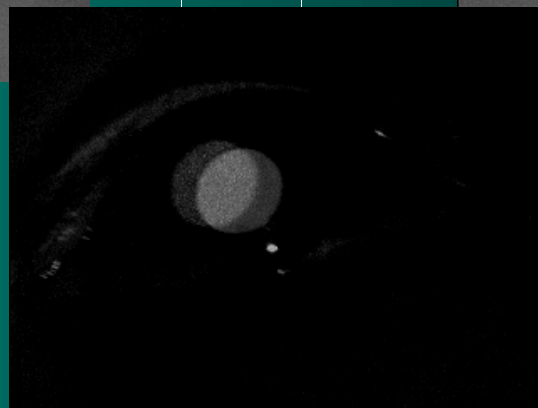(off axis)

Dark pupil   Glint

Dual light source gaze tracking
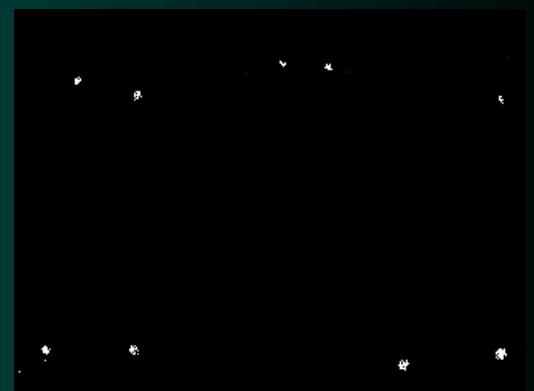
Pupil Detection

Gaze for Pointing?

- **A classic topic:**
  - *"What you look at is what you get!"*
    - **J.L. Levine 1981**
    - **C. Ware and Mikaelain 1987**
    - **R.J.K Jacob 1990**

- **Why gaze pointing?**
  - *Hand unavailable*
  - *Eye faster than other organs*
    - *Look first, manipulation follow*
  - *Fatigue / injury in hand pointing*

Difficulties with Gaze Pointing

- **Eye tracking not precise**
  - *Measurement error*
  - *Eye movement - saccades and fixations (1 degree - twice scrollbar width)*
- **Only large targets work (0.5 in)**

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Difficulties with Gaze Pointing

■ *How to do buttons (click)?*

- *Blink - often subconscious*
- *Dwell time - continuous fixation for set period (e.g. 200 ms)*
  - *False selections ("Midas touch")*
  - *Misses*
- *What about double or right click?*

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Difficulties with Gaze Pointing

- **Unnatural model:**
  - *eye - perception organ, driven by mind and world*
  - *hand - manipulation (motor) organ*
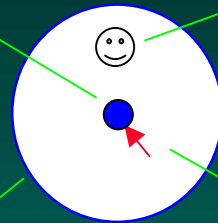 - *gaze pointing - loading perceptual channel with motor tasks*

- **Dead end ????**

Utilize Eye Gaze Implicitly?

- *Combining hand and eye movement*
- *Reposition (warp) cursor by gaze*
- *Hand remains to be the control device (fine movement and selection)*
- *Defy Fitts' law?*

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MAGIC Pointing

Gaze position reported by eye tracker

True target can be anywhere within the circle with 95% probability

The cursor is warped to eye tracking position, on or nearby the true target

Eye tracking boundary with 95% confidence

Previous cursor position far from target (e.g., 200 pixels)

- *Manual And Gaze Input Cascaded Pointing*
- *Manual Acquisition with Gaze Initiated Cursor*

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When to warp?

- **Every large saccade**
  - pre-intent, "liberal", proactive
  - possible distraction
- When input device actuated
  - post-intent, "conservative"
 - new form of hand-eye coordination

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Potential Benefits of MAGIC pointing

- *Reduce manual stress and fatigue*
- *Manual precision*
- *More natural interaction model*
  - *hand eye division and coordination*
- *Faster speed*
  - *smaller manual control magnitude*

- *True?*

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Pilot experiment

- ***Difficult: every thing has to go "right"***
- ***Imperfect tracking system***
  - *delay: 66 ms or more*
  - *error: 1 degree or more*
- ***Iterative design - evaluation***

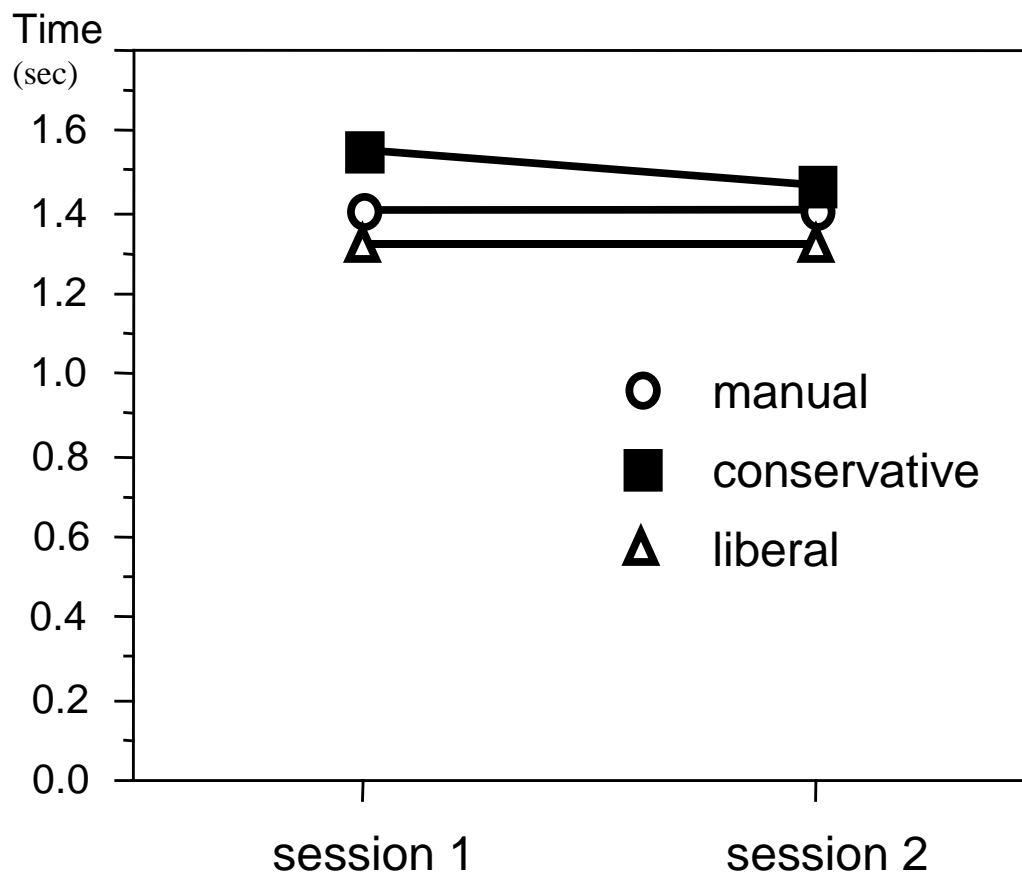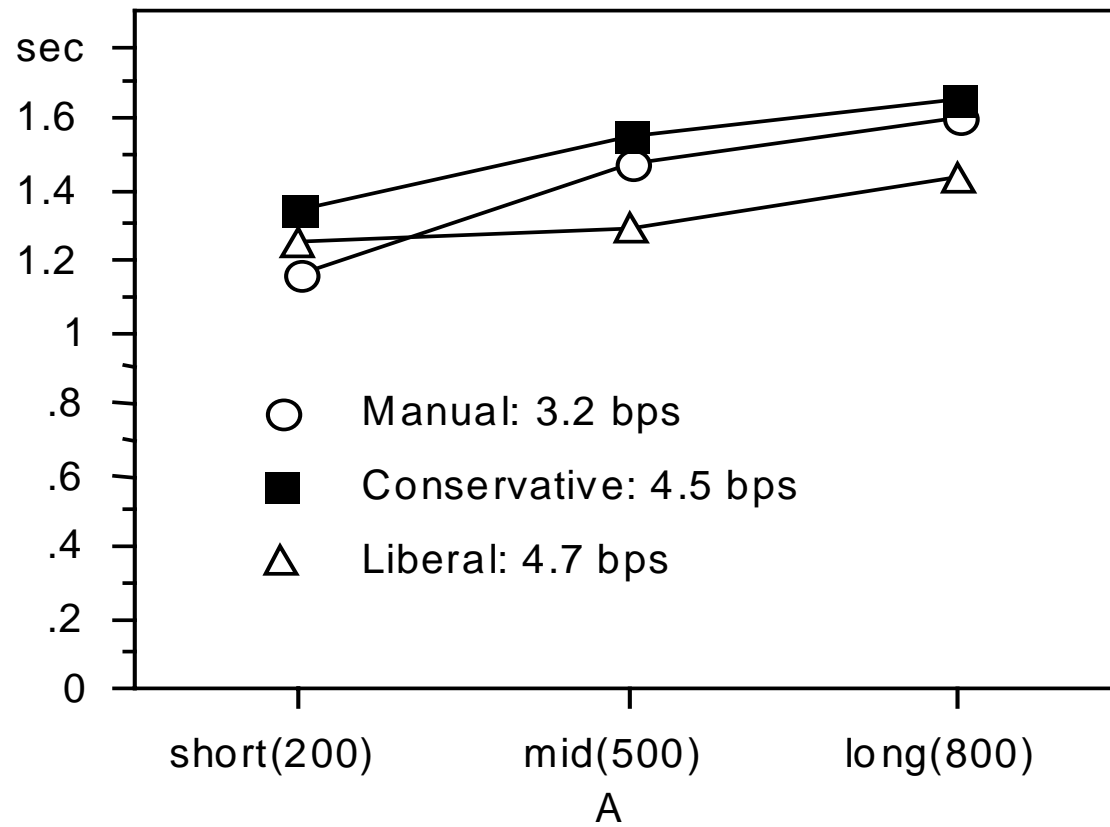CHI 99
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Task
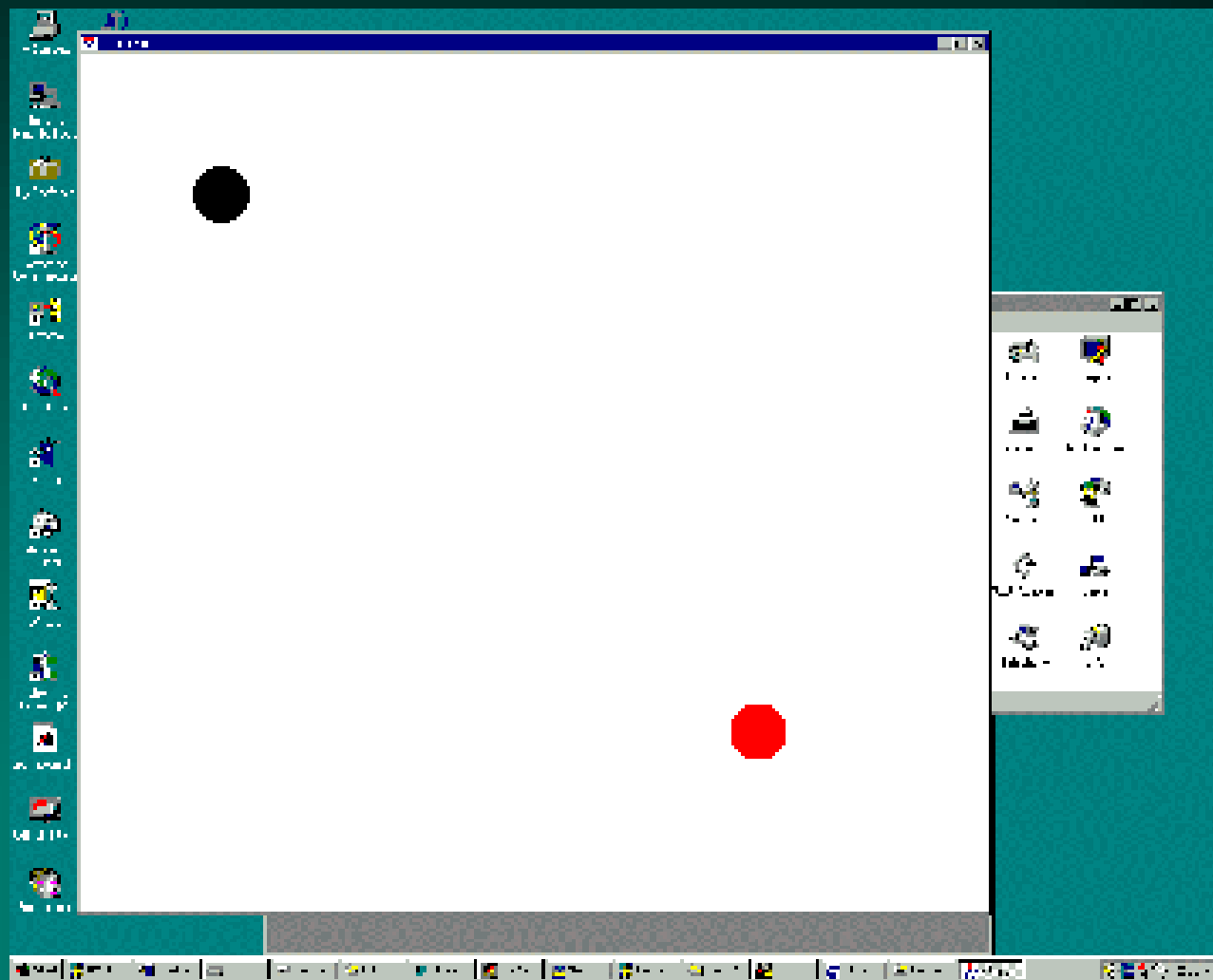
Experimental Design

- **Two target size - 20 vs. 60 pixels**
- **Three distances - 200, 500, 800 pixels**
- **Three pointing direction**
  - *horizontal, vertical, diagonal*
- **Three pointing techniques**
  - *two magic*
  - *one manual*
- **12 subjects**

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Trial completion time

Time
(sec)

	manual
○	
■	conservative
△	liberal

1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0

session 1   session 2

Fitts' law?

Other observations

- *$20 prize claimed with magic technique*
- *User's subjective experience*
  - *rated both magic techniques higher than manual (1.5 and 3.5 on -5 to +5 scale)*
  - *The "liberal" technique was "easier"*
  - *Disappointed with pure manual - subjective ease of operation (work done at will)*

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What can we conclude?

- **■ *Reduced fatigue (less manual work)***
- **■ *More precise than traditional gaze pointing (small target)***
- **■ *More practical than traditional***
- **■ *Speed advantage to be improved:***
  - *tracking system limitations*
  - *magic method limitations*
  - *experimental limitations*

There is more ......
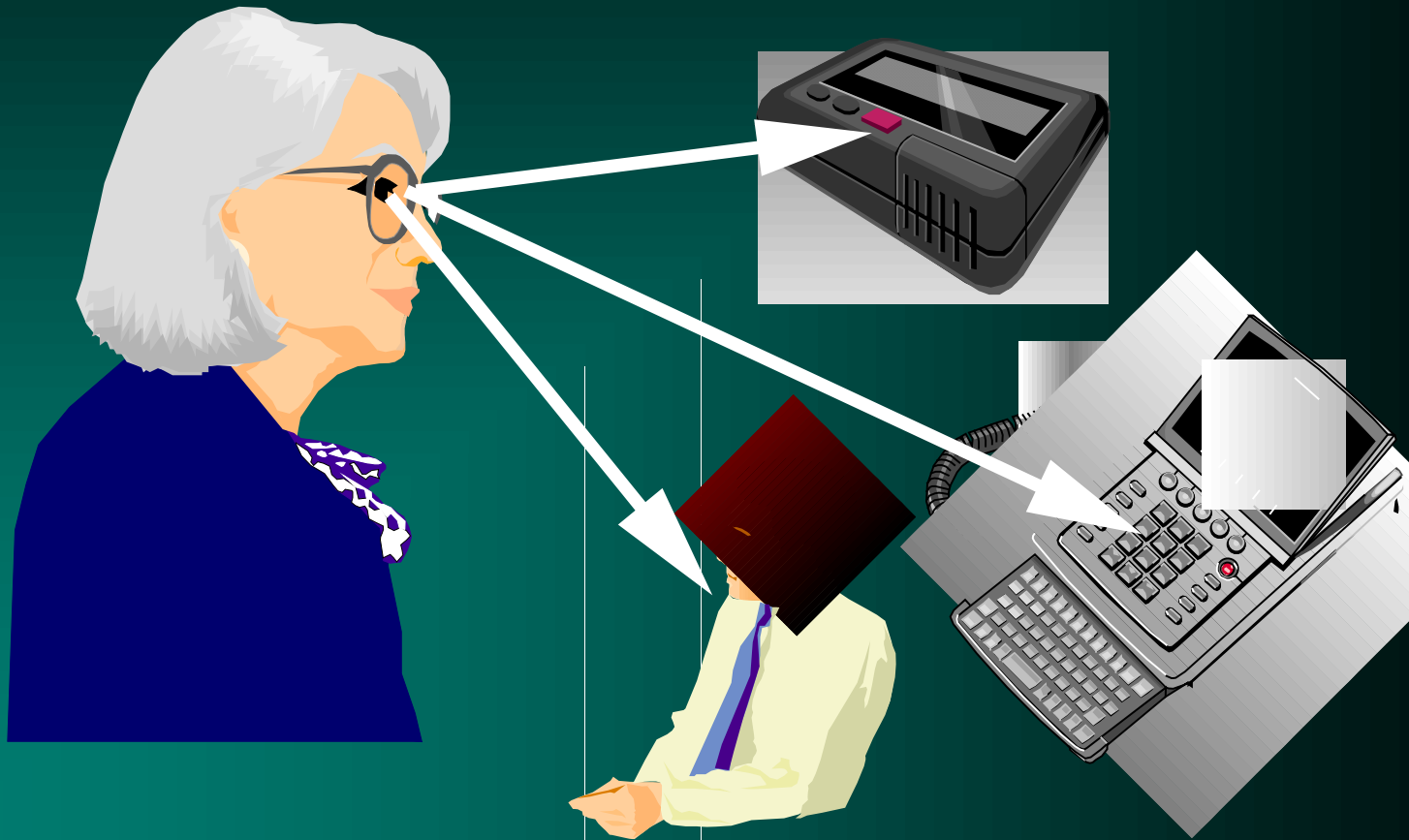
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What if computer can "see"

- *More efficient and effective HCI?*
- *Can computer know user "intention"?*
- *What if the computer can see the user's gaze?*