Perceptual Context Awareness through Wearable Sensors

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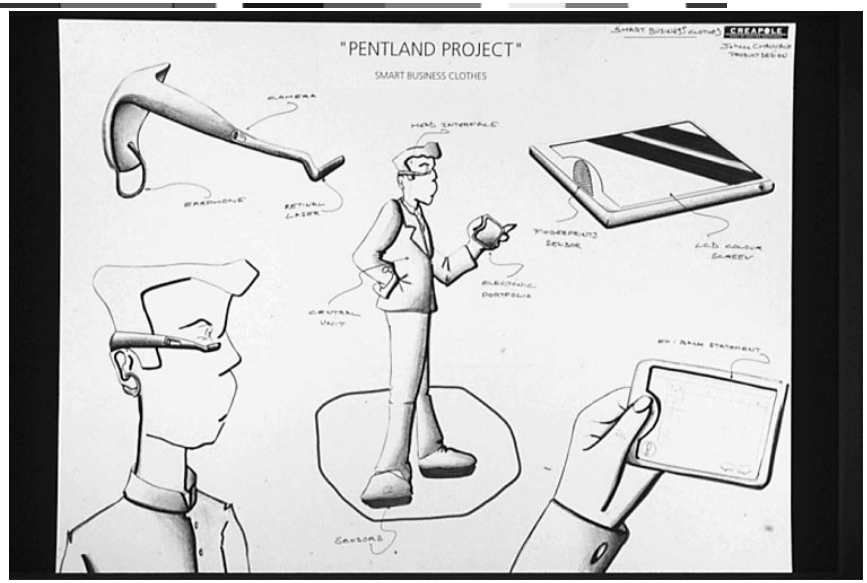
A Vision of Wearable Computing



A Vision of Wearable Computing

- Electronic Assistant - always with you
  - <u>any information anywhere, anytime</u>
  - help for your daily work
  - metaphor: a human secretary
  - a good secretary:
    - should be very supportive for work
    - we are willing to "train" a secretary
    - cost-benefit-relation has to be right: how much support we get vs. how much we have to invest (in training)

Driving Market Forces

- Professional services
  - transportation, defense, technical staff, sales, doctors, emergency
- Health
  - health monitoring, stress, heart, glucose, ...

- Entertainment & Fashion
  - the "ultimate walkman"
  - MP3, games, personal video

A Vision of Wearable Computing

- important properties of an electronic assistant:
  - form-factor: small, light, ...
  - power: 24h / 7 days a week
  - communication: should be always possible
  - interaction & control: as simple and easy as possible

Potential of Wearable Computing

- Today's Personal Computer
  - human goes to the computer
  - short term interactions
  - human-computer interactions: keyboard & mouse
  - computer knows little about the rest of the world
  - "intelligent" human-computer interaction possible ??

Potential of Wearable Computing

- Vision of Wearable Computer + Sensors
  - computer has first person perspective on surrounding world:
    - sees what the user sees (glass-mounted camera)
    - hears what the user hears (wireless microphone)
  - computer and user are always together
- Sensory Augmented Wearable Computing
  - may be basis for more "intelligent" human-computer interaction

Sensory Augmented Wearable Computing

- wearable sensors allow to determine
  - where the user is
  - what the user is doing (activity)
  - what the user is looking at
  - ...
- wearable sensors in the following
  - multiple cameras

Visual Localization of the User

- **1 camera:** [Aoki, Schiele, Pentland 99]
  - looking foward

Figure 1 A small wearable camera.

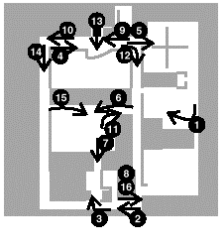


Figure 8 The floor plan and chosen trajectories.

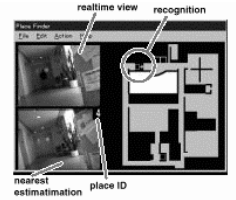


Figure 4 Screen shot of the proposed personal positioning system.

Visual Localization of the User

- **2 cameras:** [Starner, Schiele, Pentland 98]
  - one looking forward, one looking downward
  - feature extraction from three differnt regions

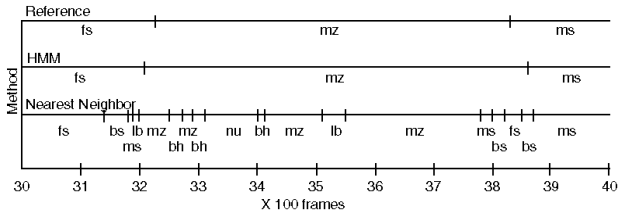
Figure 1 A small wearable camera.

Visual Localization of the User

- **2 cameras:** [Starner, Schiele, Pentland 98]
  - each room is modeled with a Hidden Markov Model
  - modelisation of room topology (statistical grammar)
  - results:

Table 1: Patrol area recognition accuracy

method	*training set*	*test set*
2-state HMM	51.72%	21.82%
3-state HMM	68.97%	81.82%
4-state HMM	65.52%	76.36%
5-state HMM	79.31%	40.00%
Nearest Neighbor	-400%	-485.18%

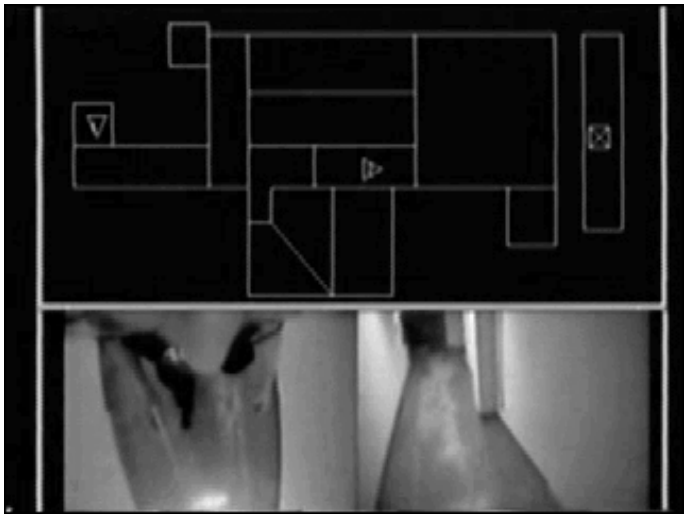


Visual Recognition of User Activity

- **Recognition of American Sign Language**
  - [Starner et al. PAMI 98]

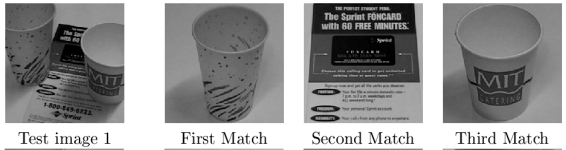
Visual Recognition of User Activity

[Starner, Schiele, Pentland 98]



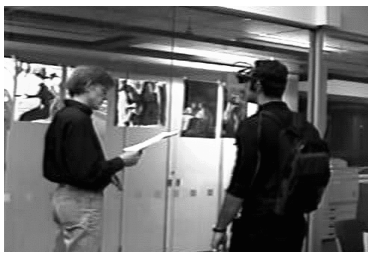
Robust Recognition of Objects

- Robust Recognition of 100+ Objects
  - [Schiele, Crowley 1996-2000]
  - statistical approach for recognition
  - local characteristics such as Gaussian derivatives
  - Bayesian approach: recognition of multiple objects in cluttered scenes



Recognition of Objects in the Visual Field of View of the User

- Remembrance Agent
  - Recording of Audio-Visual Environment of the User (Video Clips)
  - Association of the video clip with a physical object (snapshot of the object)
  - Playback of the video-clip, whenever the object is recognized by the system
- Scenario: museum's guide



Recognition of Objects in the Visual Field of View of the User

- public presentations:
  - Nicograph 98, Siggraph 99, Orbit 2000, ...
- several hundred users
  - real-time recognition (10Hz)

Museum's Guide

- use of recognition results
  - system recognizes "what is the user looking at"
  - system knows how long is the user looking at an object
    - indicates user's interest
    - deliver more information on specific paintings (i.e. access of museum's database)
    - user profile: suggestions based on other user's interest
    - idea of "user community": find visitors with similar interest - complementary interests
    - ...
    - (museum: evaluate effectiveness of museum's organization)

The END

Thank you

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