Multi-Touch- and Multi-User-Interfaces

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Tracking

- What is it?
- What can be tracked?
- How does it work?
- [...] 
- Track fingers!
What does “tracking” mean?

- It means to track an object (follow its movement)
  - Spatial and temporal
  - “Movement”: moving objects / moving viewer
- Unambiguous allocation of identified objects
- Sensors are needed to capture the data
How does it work?

- Object must be identified clearly
  - Mobile phone (IMEI)
  - Aircraft
  - Bird in the sky (in a flight of birds?)

- Temporal & spatial tracking
  - \( \text{ObjPos}_T(i) \to \text{ObjPos}_T(i+1) \to \text{ObjPos}_T(i+2) \to [...] \)
  - Change in position per time-unit can very short, depending on the speed of the tracked object and the frequency of the sensor \( \to \) local search
Tracking Features

- Mark
- Geometry (lines, points, ...)

Marker Tracking  Punktbasiertes Tracking  Linienbasiertes Tracking
Optical Flow

- Retrieval of features from frame to frame by incorporating a local search algorithm
Motion Capture

- Motion Capture → Tracking/capturing of movement
  - Body movements
  - Facial expressions
Motion Capture

- Passive system (optical)

http://www.cacs.louisiana.edu/labs/ecrg/vicon/index.html
Motion Capture

- Active system (optical)

http://www.mixamo.com/
Motion Capture

- Active system (non-optical)
  - “XSens”
    - Gyroscope
    - Acceleration sensor
    - Magnetometer
Motion Capture

- Movies
Motion Capture

- Videogames
Motion Capture

- Product design

http://www.carmk.net/thread-113244-1-2.html
Eye Tracking
Eye Tracking

• Analysis
  • Progress of attention
  • Where does somebody look at, and where don't they?

• Application Fields
  • Market research
  • Cognitive analysis (image and movement analysis)
  • Medical Areas (Example: Usage as a human-computer interface for handicapped people)
Eye Tracking

- Market research

http://www.kinau-mediaforschung.de/eyetracking.htm
Augmented Reality

- This technology combines the real and the virtual world
Augmented Reality

- MINI Cooper advertisement
Augmented Reality

- Lego advertisement
Wii Remote

- Optical tracking + acceleration sensors
Environmental tracking

- Automatical environmental spatial awareness for autonomous car-systems
  - Objects in direct vicinity to the car will be tracked
  - Avoid collisions → for example: brake assistant
Laser Mosquito Killer

Mosquito Shootdown Sequence
Intellectual Ventures
Blob Tracking

- Tracking of the “finger blobs”
- No feature extraction needed!
  - The image contains only “finger blobs” (you made sure of that in the first practical assignment)
- What are the possible “conditions”?
  - A new finger has been detected → assign ID, save position
  - A previously detected finger changed it's position → update position of corresponding touch-ID
  - An active finger disappeared → remove the object from your data structure
- How?
• Using the result of the image processing (contours in the binary image with “finger blobs”), we can calculate the positions of the fingers with different methods:

1) Geometric mean of all contour points of a finger-blob

2) Center of a precalculated ellipse
   - The function *fitEllipse()* returns a *RotatedRect* object, which already contains a *.center* member-variable
Blob Tracking (2)

<table>
<thead>
<tr>
<th>Distance</th>
<th>New_1</th>
<th>New_2</th>
<th>New_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old_1</td>
<td>3</td>
<td>3.6</td>
<td>2</td>
</tr>
<tr>
<td>Old_2</td>
<td>1.41</td>
<td>2.82</td>
<td>4.1</td>
</tr>
</tbody>
</table>
Blob Tracking

- Nearest neighbour algorithm
- Distance calculation between two points (2D)
- Framerate of the camera is important (threshold: max distance which a “touch” is allowed to travel per frame)
- IDs must be unique! (no doubles)
- Chose a fitting datastructure to store the “touches”
- Minimum needed data: ID, x/y-position
- Optional data: path, age, size, ...
- Don't forget to delete inactive “touches”!
Blob Tracking (Demo)
Questions?