Motion Detection as Interaction Technique for Games & Applications on Mobile Devices

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Interaction Techniques on Mobile Devices

- **Common Interaction Techniques:**
  - Keys
  - Stylus
  - Voice Recognition

Concept of the Motion Detection Technique

- **Classification in Terms of Usability:**

- Reaction time	very good	good	very bad
- Input quantity	very good	medium	bad
- Intuitivity	very bad	good	very good

Concept of the Motion Detection Technique

- Optical Markerless Inertial 2D-Tracking
- Idea: Device Motion => Motion in Camera Images

Concept of the Motion Detection Technique

- **Optical Markerless Inertial 2D-Tracking**
- **Idea: Device Motion => Motion in Camera Images**

- **Analysis of Motion in Camera Images**
- **Very intuitive User interaction**

Concept of the Motion Detection Technique

- **Classification in Terms of Usability:**

				MD
- Reaction time	very good	good	very bad	good
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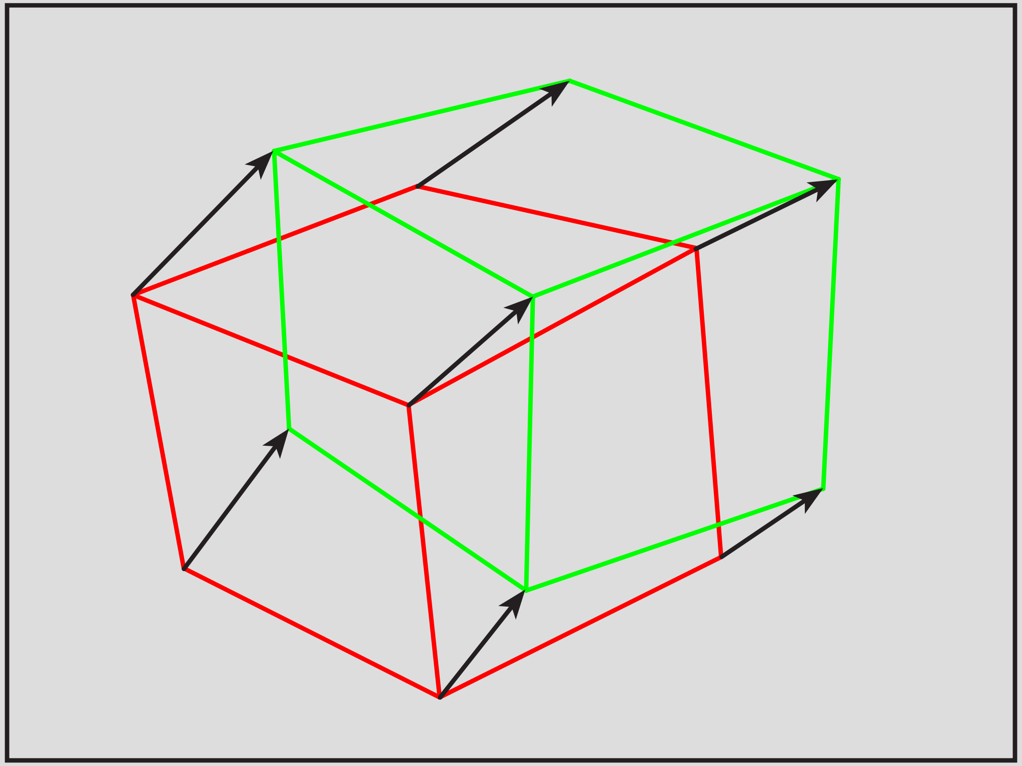
Common Tracking Algorithms

- **Algorithms capable of analysing Scene Motion**
  - Edge Detection and Tracking
  - Analysis of Scene Components
  - Block Matching
  - Analysis of Optical Flow

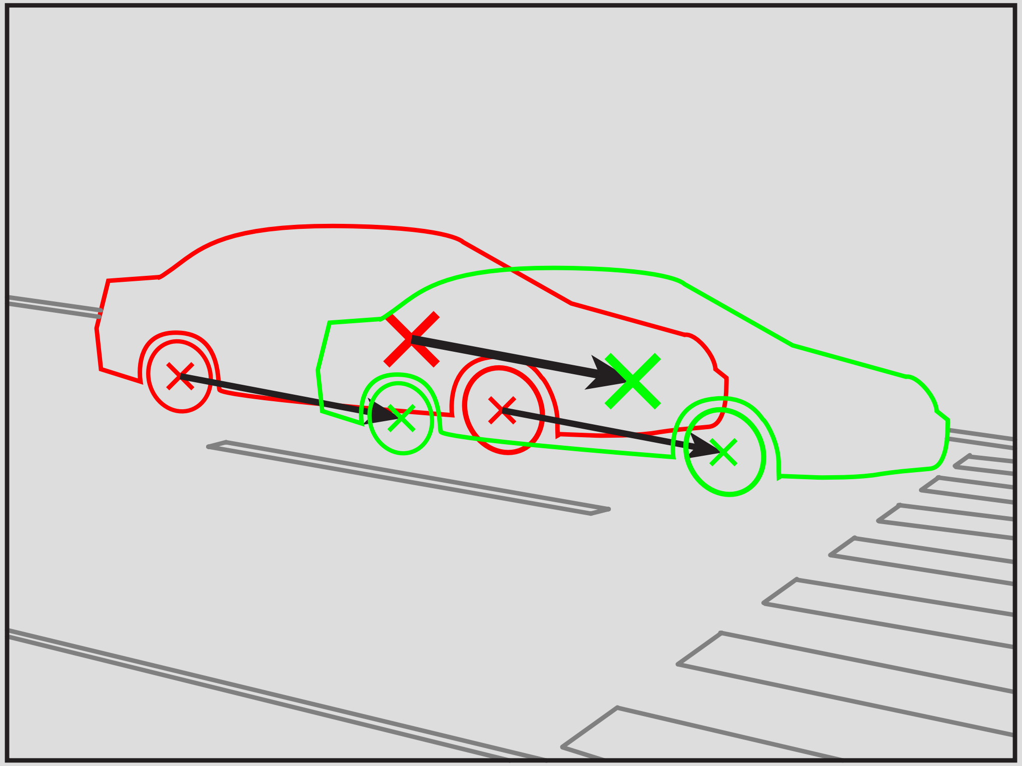
Common Tracking Algorithms

- **Edge Detection and Tracking**
  - 3D Tracking of Edges and Vertices



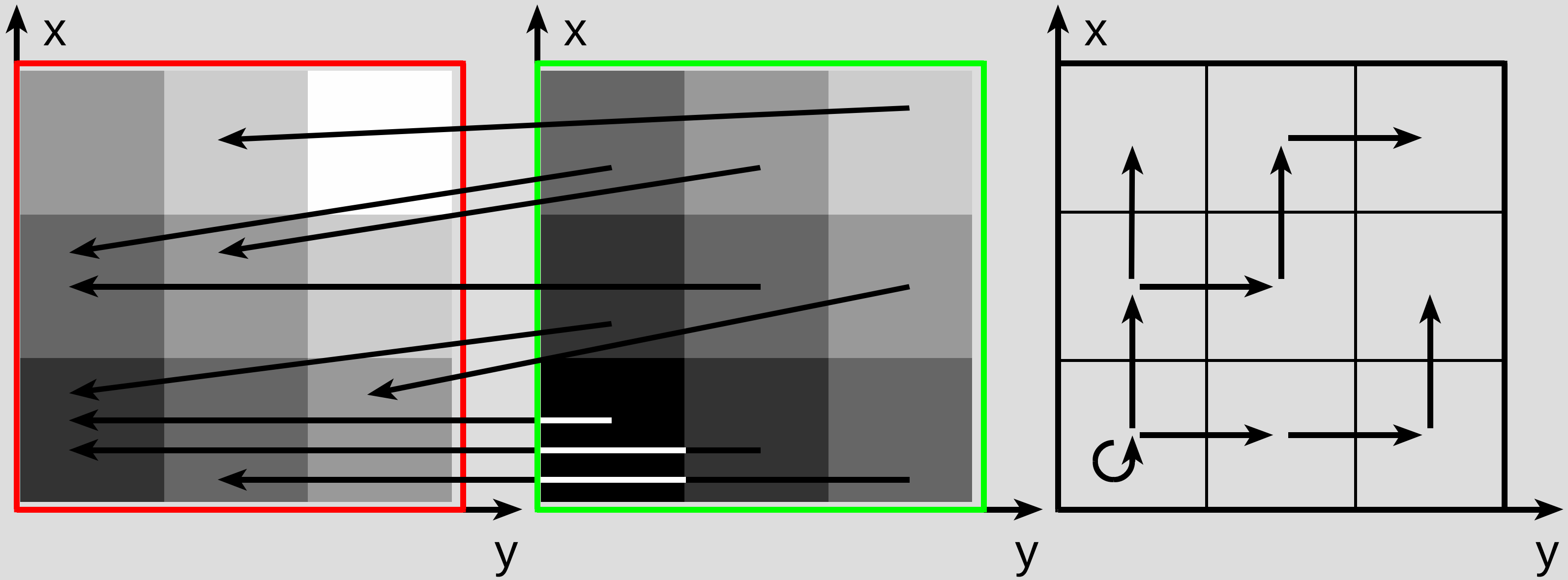
Common Tracking Algorithms

- **Analysis of Scene Components**
  - Analysis of Movement of 2D Scene Components



Common Tracking Algorithms

- **Block Matching**
  - Method from Video Compression Sector

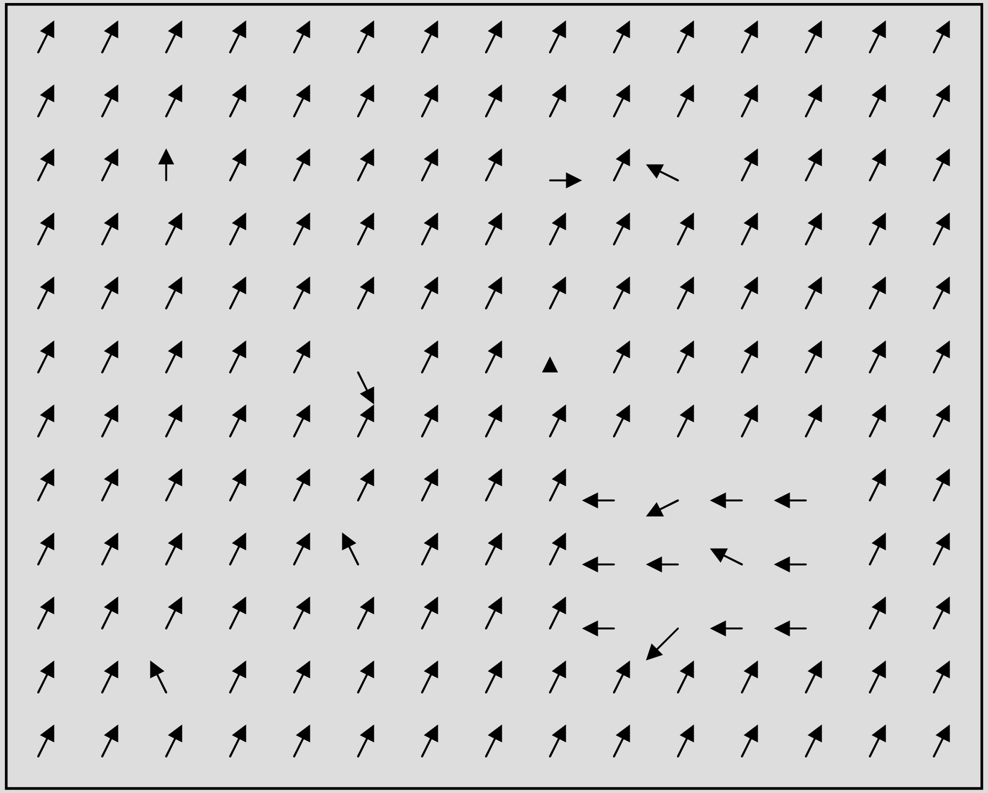


  - Interpret Block References as Motion Vectors
  - Motion Estimation =

    (sum of all v_{motion}) *block_size/nr_blocks
  - In our example: (8/9;8/9) ≈ (1;1)

Common Tracking Algorithms

- **Analysis of Optical Flow**



Common Tracking Algorithms

- **Summary:**
  - Edge Detection and Tracking
    - Computing time dependent on Scene Complexity (AR, 3D)
  - Analysis of Scene Components
    - Computing time dependent on Scene Complexity (2D)
  - Block Matching
    - Image sizes very small (Mozzies)
  - Analysis of Optical Flow
    - Fairly interactive framerates (Sweep Technology)

=>

Development of an

Efficient Optical Markerless Inertial 2D-Tracking

Algorithm

Motion Detection Algorithm

- **Starting Basis:**
  - We have two Successive Images captured by the Camera:

Motion Detection Algorithm

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  - We have two Successive Images captured by the Camera:


- **Wanted:**
  - The relative Motion Vector of the image contents

Motion Detection Algorithm

- **Idea**
  - Correlate the images using every possible 2D Shift

Motion Detection Algorithm

- **Idea**
  - Correlate the images using every possible 2D Shift
  - Algorithm too complex by Orders of Magnitude
    - Computing Time dependent on 4th power of image size
    - Reduce amount of Information to Correlate

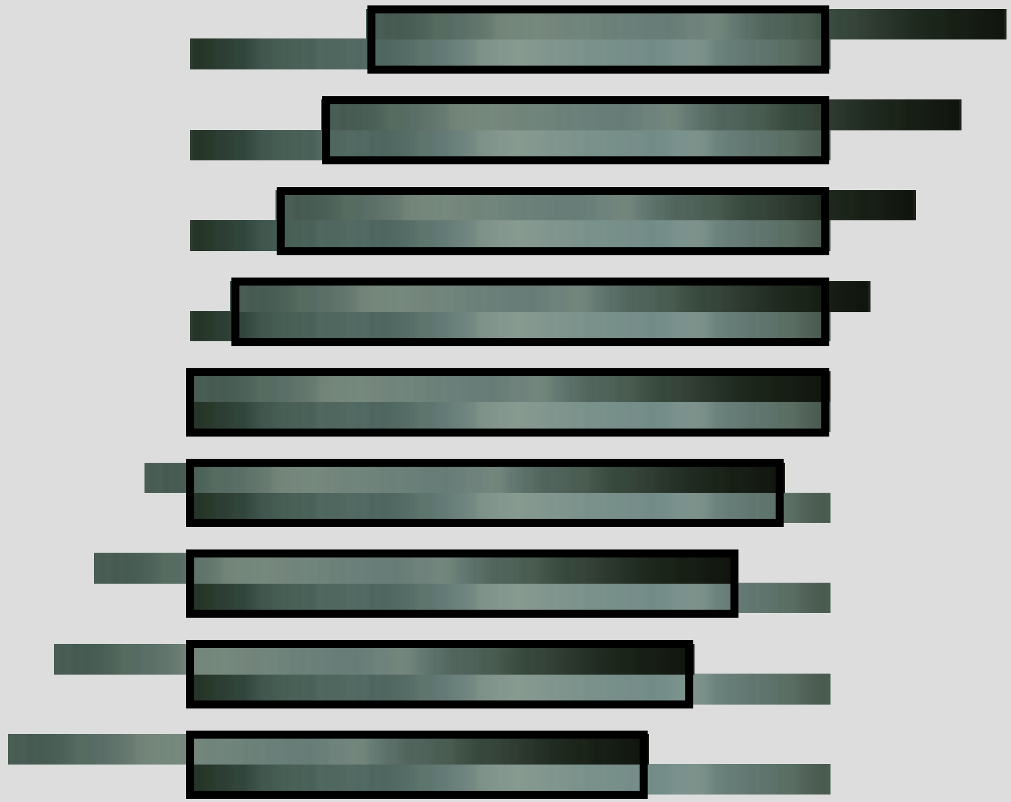
Motion Detection Algorithm

- **Concept**
  - Project the Image onto its X- and Y-Axis

Motion Detection Algorithm

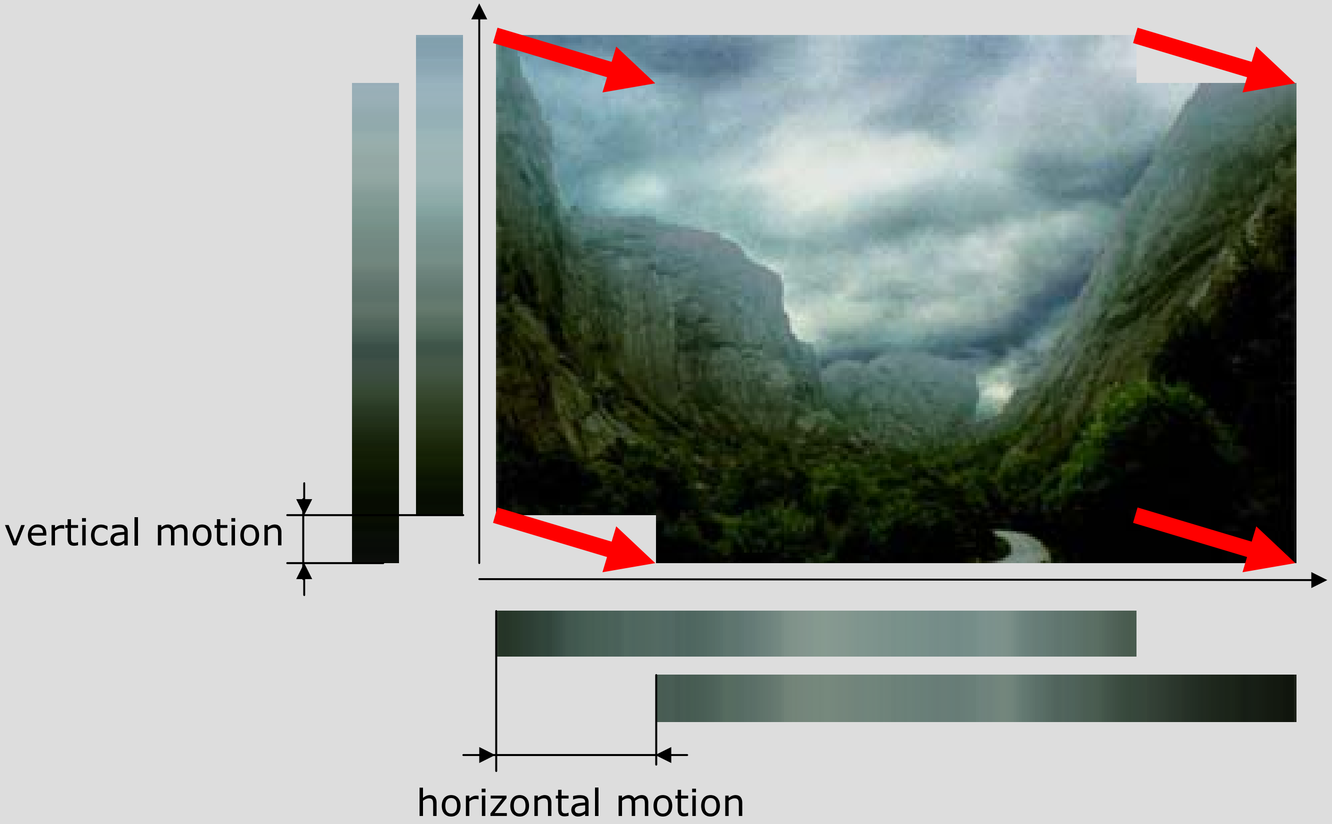
- **Concept**
  - Project the Image onto its X- and Y-Axis
  - Calculate Color MSE for Overlaps of every 1D-Shift

Shift	MSE	Shifted Projection Buffers
-4	2	
-3	3	
-2	6	
-1	10	
0	21	
+1	23	
+2	35	
+3	63	
+4	101	



Motion Detection Algorithm

- **Concept**
  - Project the Image onto its X- and Y-Axis
  - Calculate Color MSE for Overlaps of every 1D-Shift
  - Best Matching Shift is the Actual Motion



Motion Detection Algorithm

- **Concept**
  - Project the Image onto its X- and Y-Axis
  - Calculate Color MSE for Overlaps of every 1D-Shift
  - Best Matching Shift is the Actual Motion
  - Computing time
    - $n*size^4 => o*size^2+2*p*size^2$

Motion Detection Algorithm

- **Advantages**
  - Fast MotionDetection Algorithm
  - Capable of running on a Mobile Device
  - works with Greyscale Images (YUV)
  - Relatively Resistent to
    - Rotation
    - Scaling

Motion Detection Algorithm

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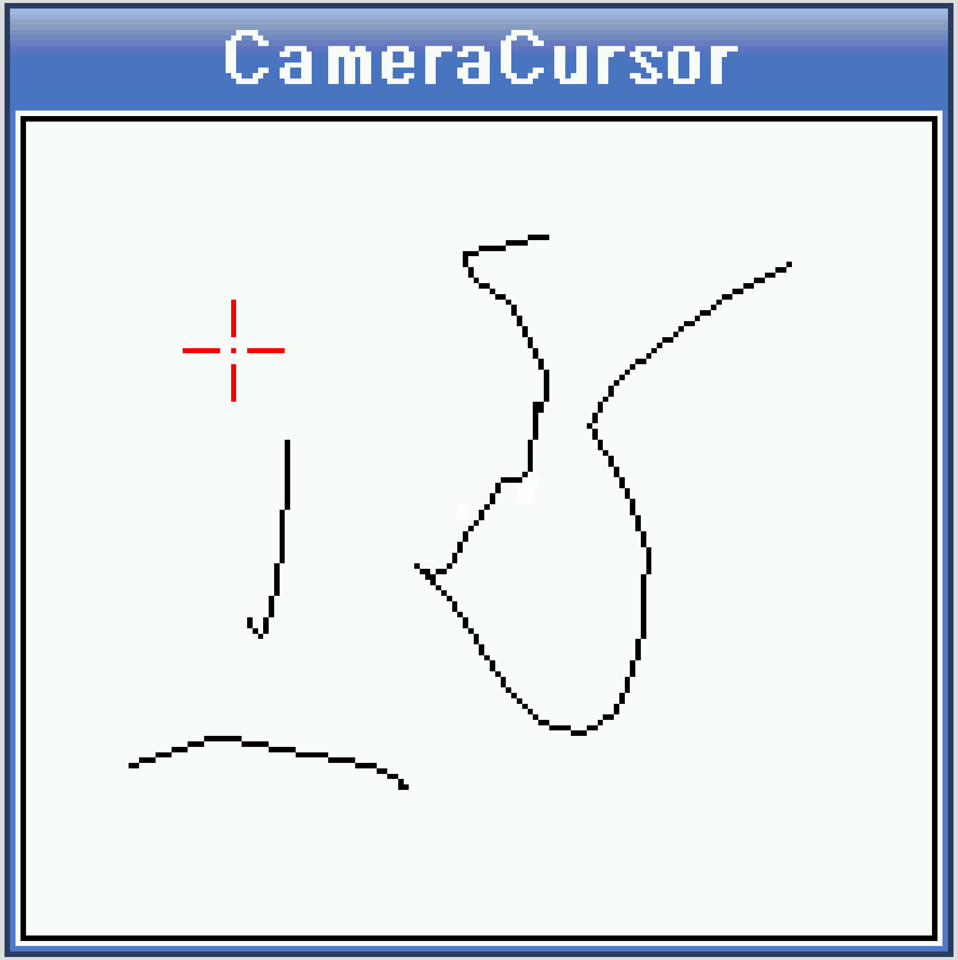
- **Disadvantage**
  - The algorithm estimates the Motion inexact when pointing the camera at:
    - repetitive patterns
    - images with a low dynamic range, e.g.
      - dark spots
      - white walls

Demonstrators

- **Demonstrators for the Concept of MotionDetection as Interaction Technique on Mobile Devices**
  - CameraCursor
  - TestApplication
  - TheBiggerPicture
  - LabyrinthGame
  - MapNavigator

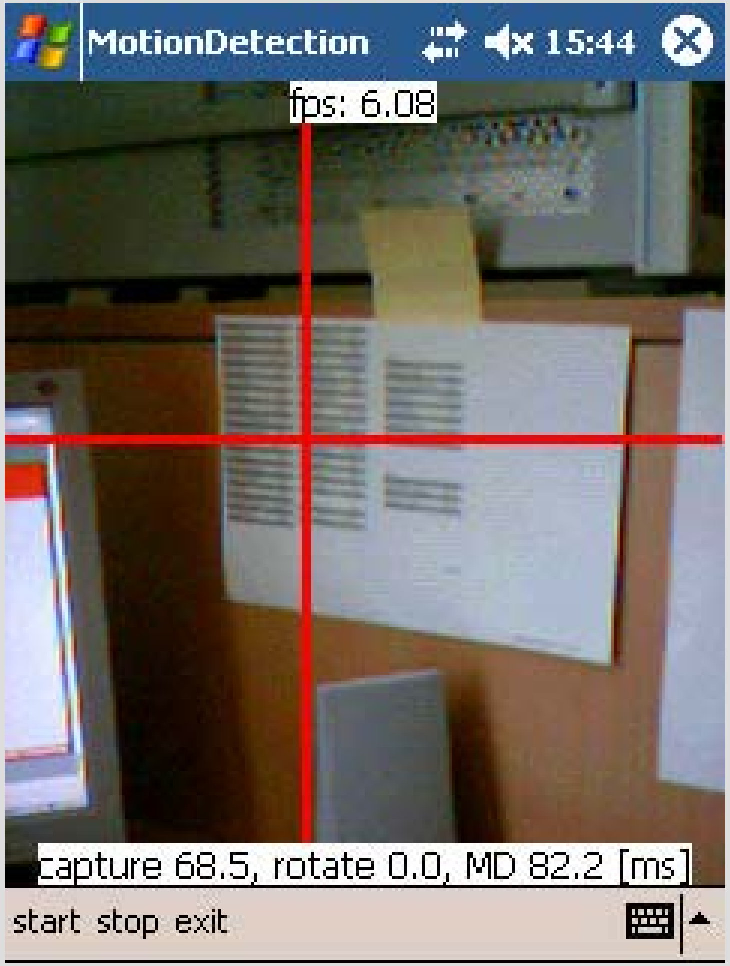
Demonstrators – CameraCursor

- **Test of Cursor Concept**
- **Motion Information moves Cursor**
- **Lines can be drawn**



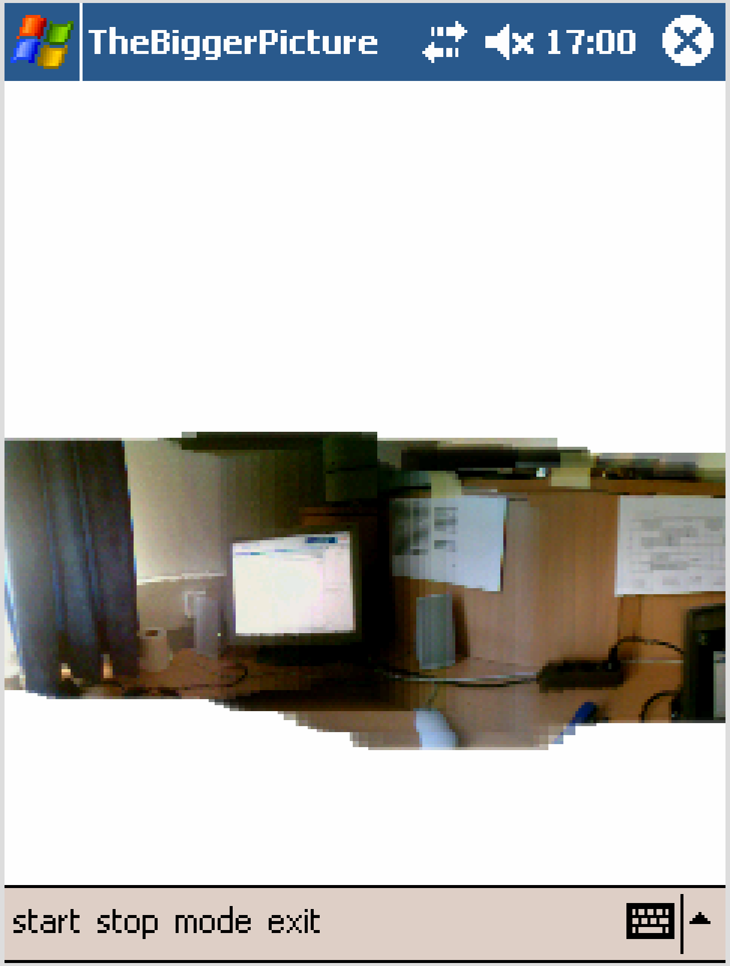
Demonstrators – TestApplication

- **Test & Debug of MotionDetection**
- **Motion Information is visualized by a red cross**
- **The cross always points at the same spot**



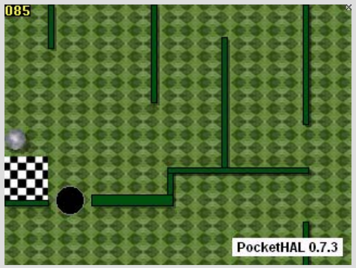
Demonstrators – The Bigger Picture

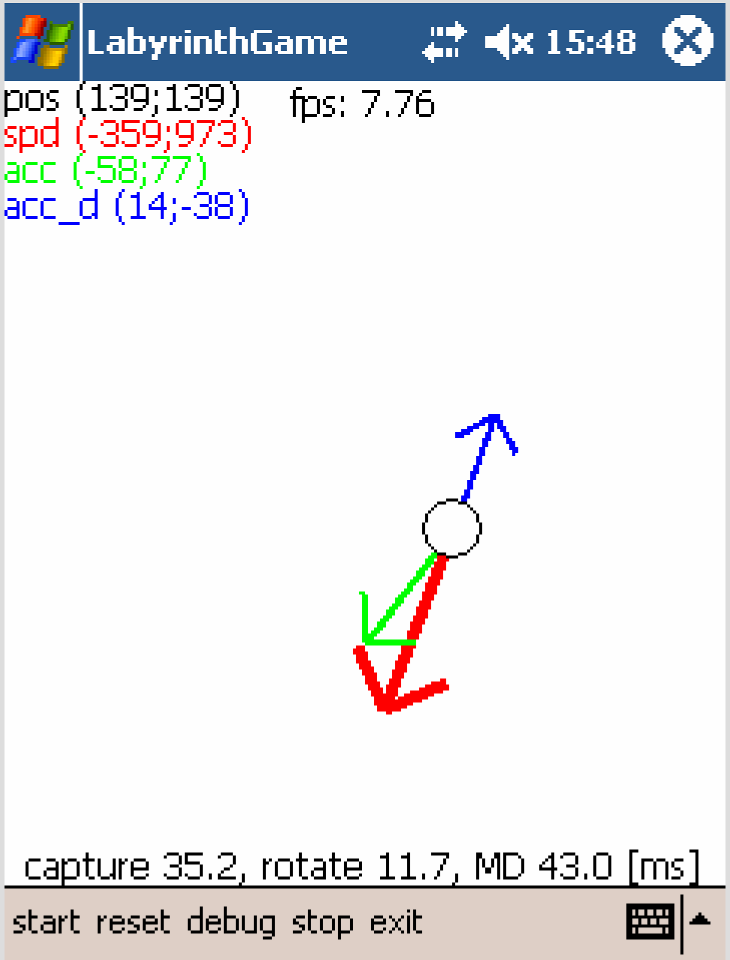
- **Multiple Camera Images combined to one**
- **Motion Information tells where to Accumulate the Captured Frame**
- **Works in Real-Time**



Demonstrators – LabyrinthGame

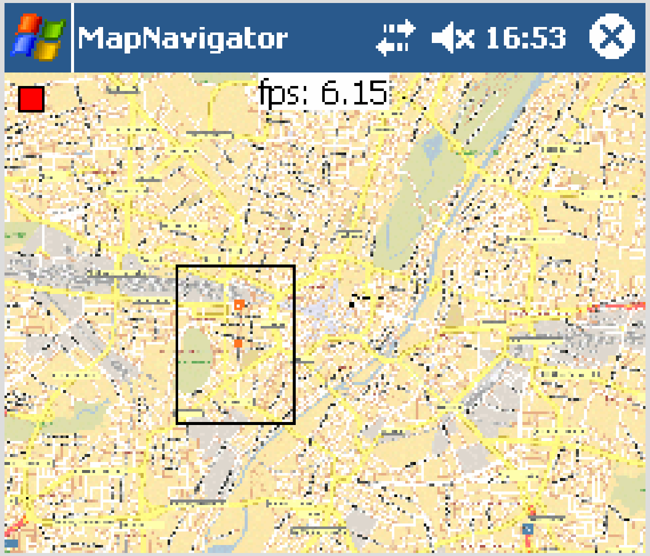
- **PhysicsDemo of Labyrinth Game (remake of the old style wooden version)**
- **Pitch of Mobile Device accelerates the sphere.**
- **Visualization of Motion Information acceleration, speed and position of sphere**
- **Further graphic enhancement needed, e.g.:**

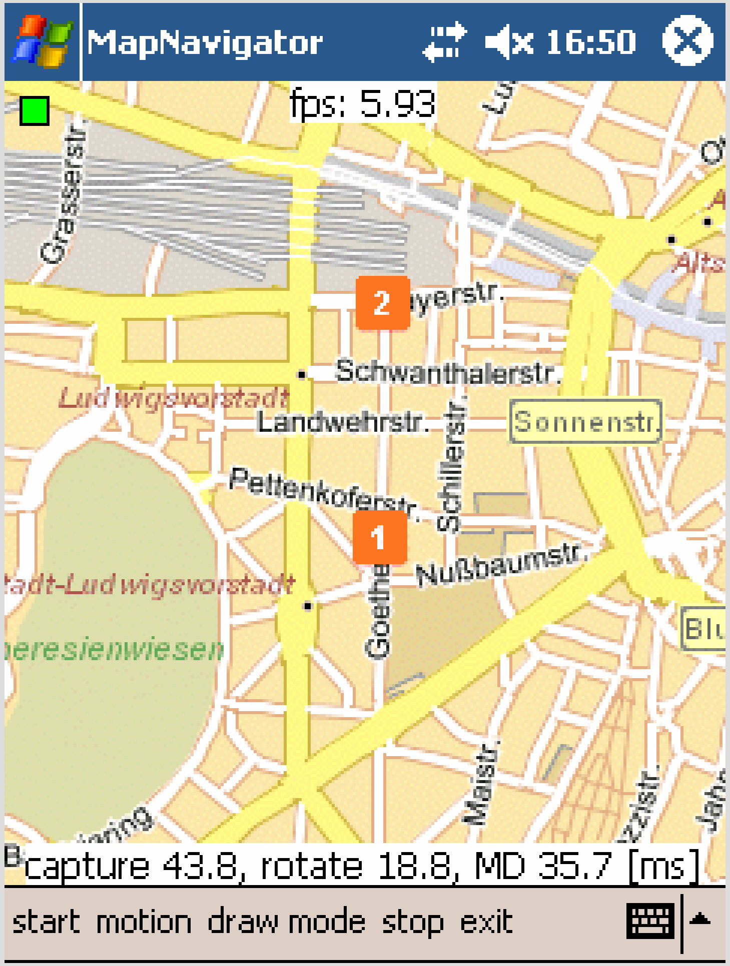




Demonstrators – MapNavigator

- **Map Navigation Tool**
- **Designed to view large maps**
- **Motion Information moves the viewing window**





Further Development & Future Work

- **User Tests regarding Usability & Acceptance**

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- **Integration of the Cursor Concept in the native GUI of WindowsCE**

Further Development & Future Work

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  - Further Optimization of the MotionDetection
  - Detection of Rotation and Scaling

- **Integration of the Cursor Concept in the native GUI of WindowsCE**

- **Motion Gestures**

End of Presentation

Any Questions?

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