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## Visualization of Off-Screen Objects in Mobile Augmented Reality

# Commercial augmented reality on mobile phones



Wikitude

# Commercial augmented reality on mobile phones



Wikitude

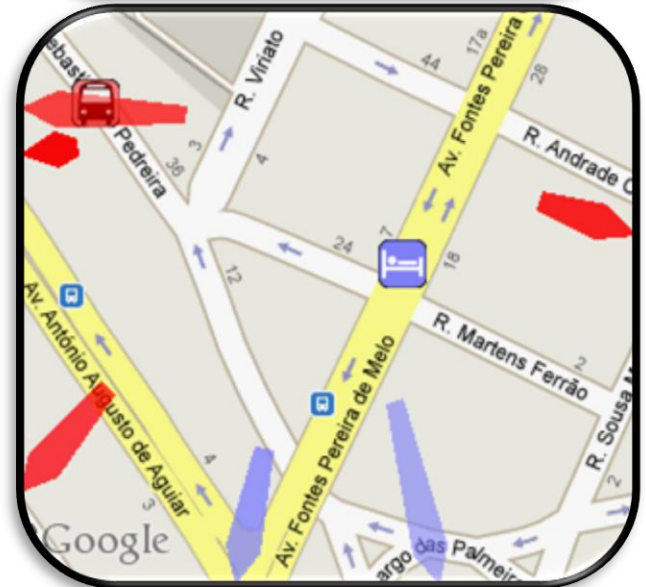
# Could off-screen visualizations help?

## Assumption

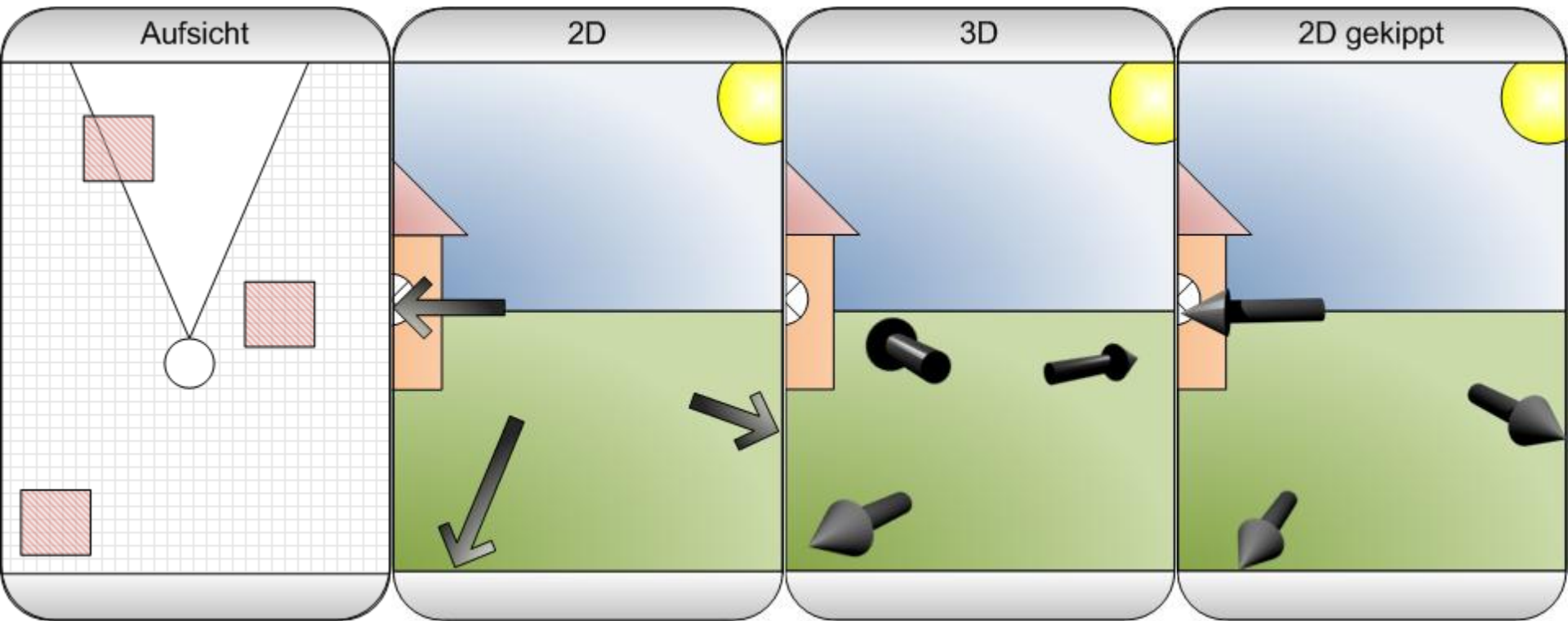
- Mini-map provides a high accuracy
- Demanding to mentally align the presentations

## Idea

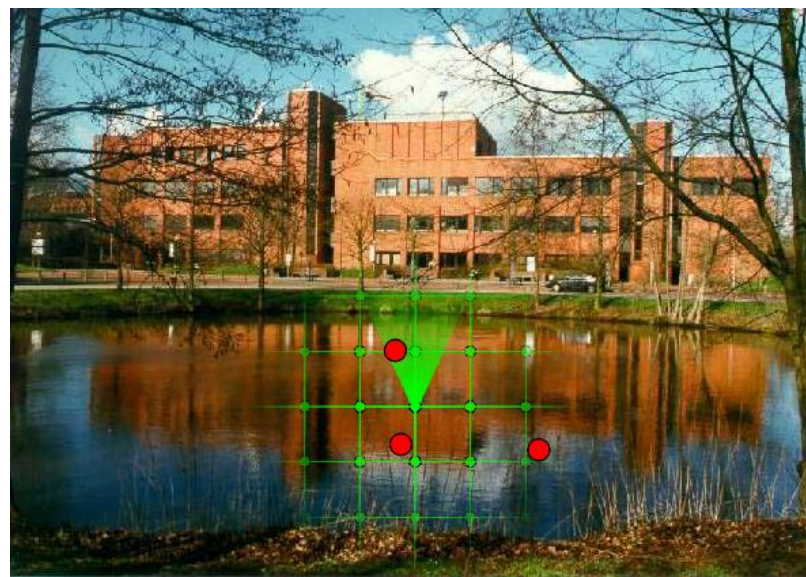
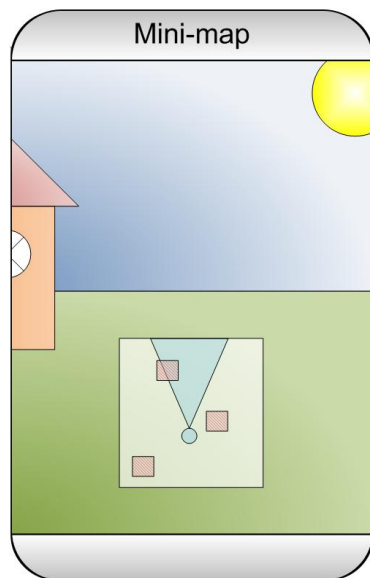
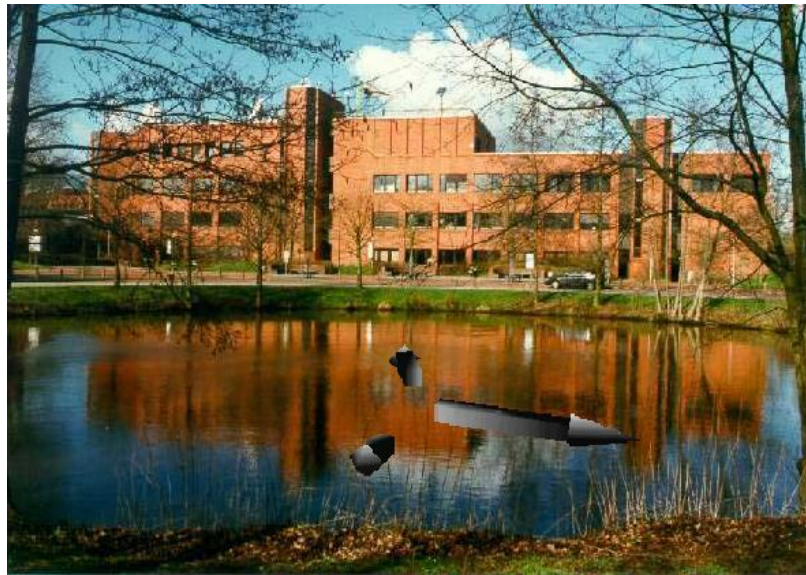
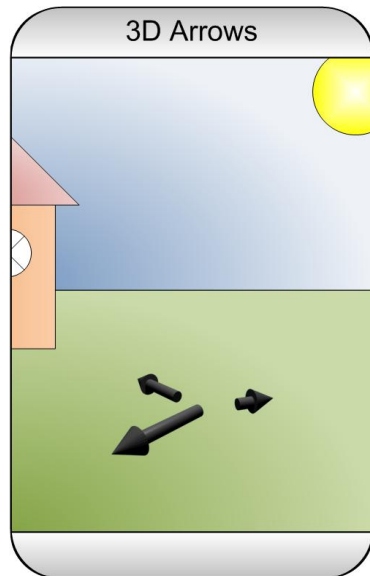
- Use off-screen visualization as used for digital maps
- Transformed into 3D
- Using the same reference system



# Testing different off-screen visualizations



# Final visualization design



# Implementation

## Platform

- Android 1.5
- HTC G1

## Localization

- Compass
- GPS
- Accelerometer

## Visualization

- Camera image in the back
- OpenGL ES for the overlay



# User study: Mini-map vs. Arrows

## City centre of Oldenburg

### Tasks

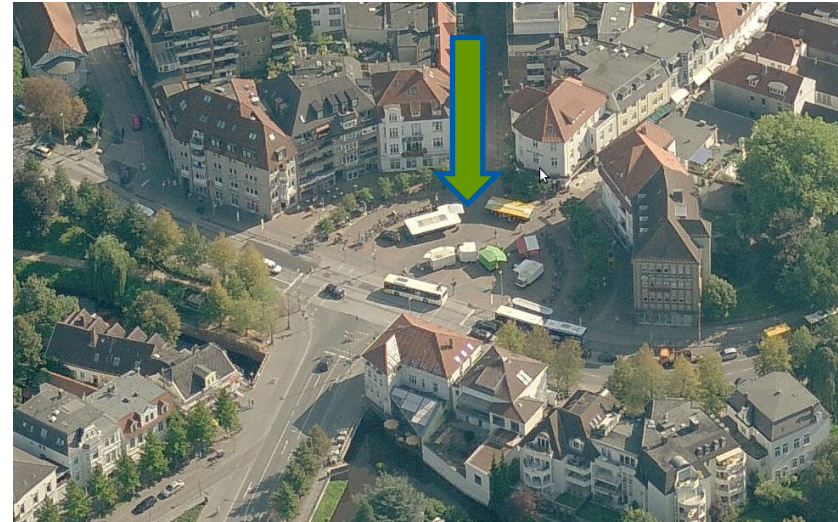
1. Search and read the names of 4 randomly distributed faked POIs
2. Memorize and localise 4 real POIs without turning around

### 26 Participants

- Picked up on the street
- Not familiar with AR

### Measured

- Task completion time & error rate
- Deviation from the correct position
- Subjective rating





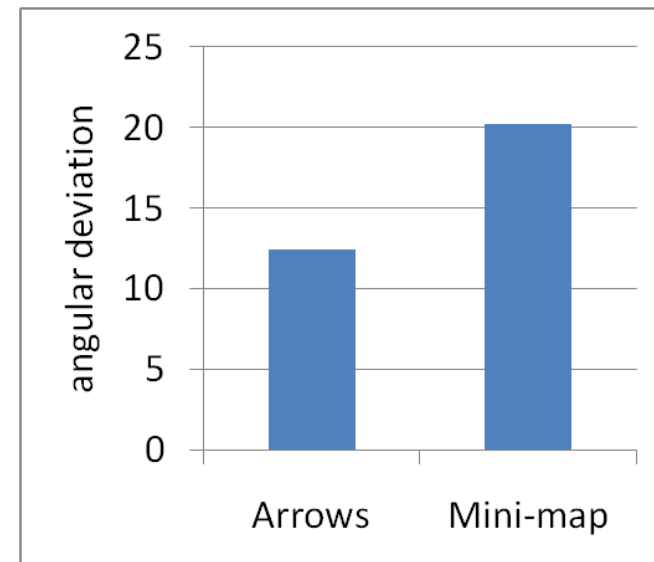
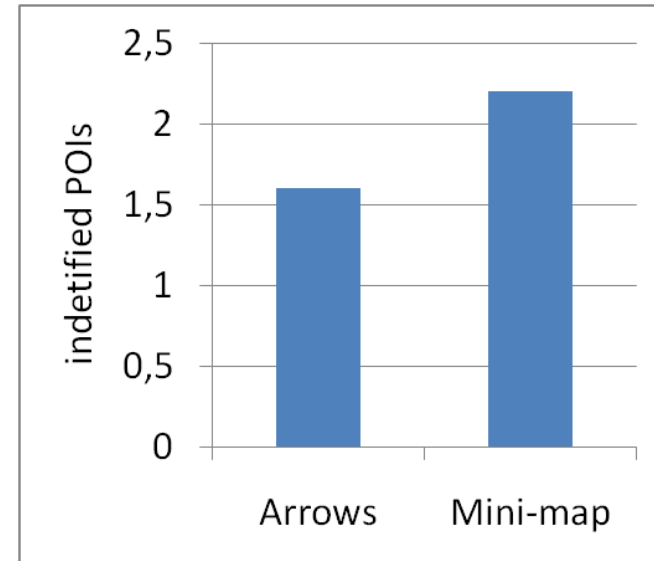
# Results

## No significant effects for the first task

- Noise due to lack of training?
- Low accuracy of the used compass?

## Second task

- Participants identified more POIs correctly with arrows ( $p < 0.02$ )
- The angular deviation is smaller with arrows ( $p < 0.05$ )
- Arrows outperform the map in other aspects (non significant)
- Equally rated



# Conclusion & future work

## 3D arrows outperform mini-maps

- For accuracy and error rate
- If four POIs are displayed

## Into the field

- Average strangers are eager to test handheld AR
- G1's compass is quite inaccurate

## Future work

- Support the results with a large scale study
- Investigate the scalability of the visualization techniques

# Questions?