

# Collaborative Interaction through Spatially Aware Moving Displays

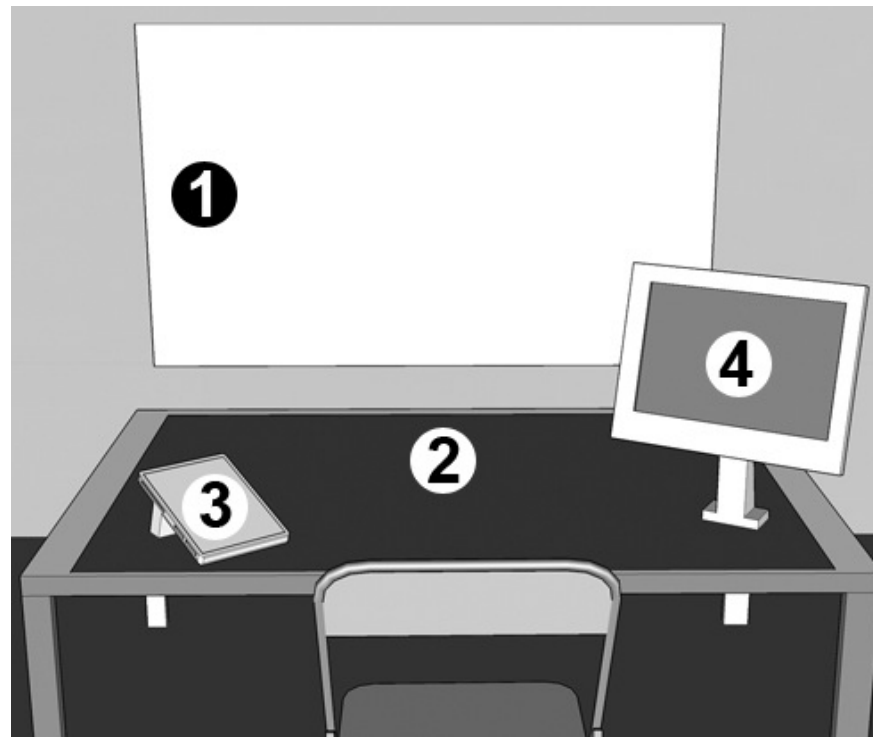
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# Outline

- Motivation and Goal
- Prototype: Interacting through Moving Displays
- Case study: Game Application
- Experimental Evaluation
- Results
- Conclusions
- Future work

# Motivation

- More and more people depend on both computers and information sharing for professional or personal purposes



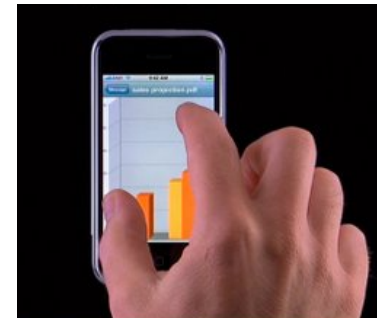
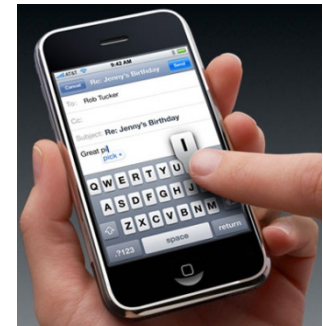
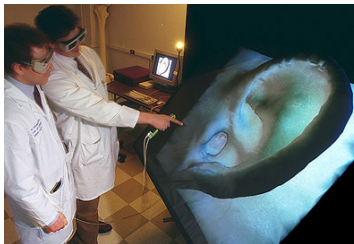
# Motivation

- New reality
  - Laptops, GPS, smartphones, large LED TVs, interactive surfaces, etc. = mobile and pervasive computers
- Interaction among people placed in a common physical space



# Goal

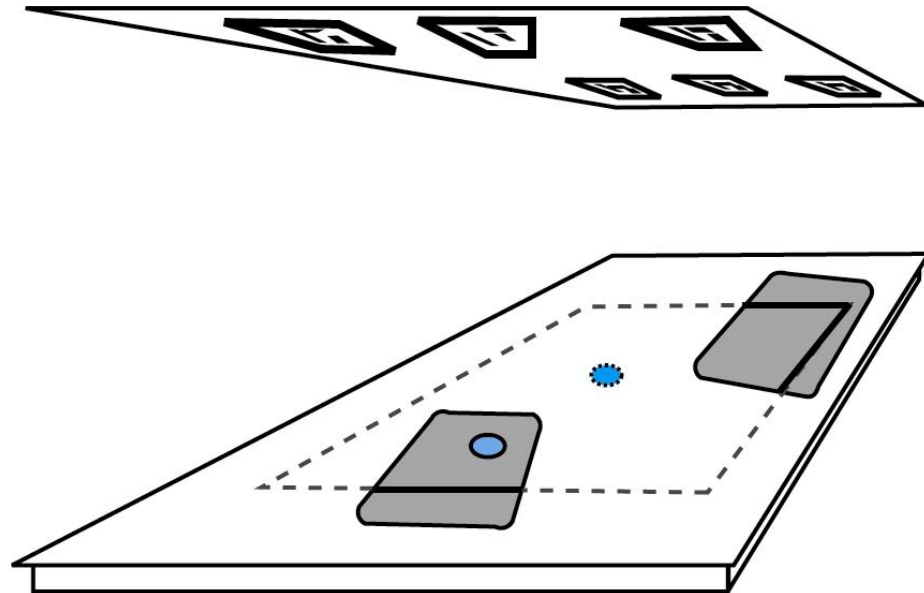
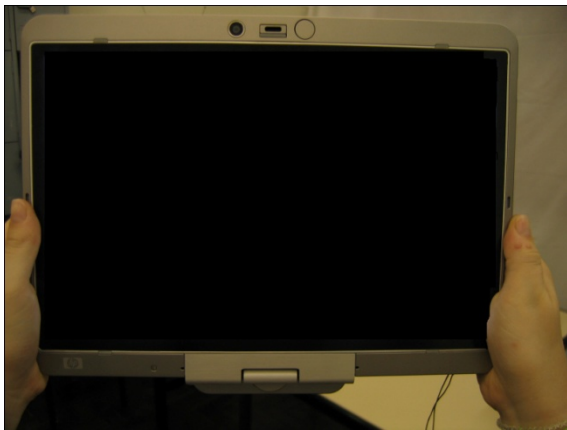
- Allow collaboration through the interaction with objects in a common virtual workspace





# Prototype: Moving Displays Interaction

- Application features
  - HP Tablet PCs model 2710p
  - Camera tracking
  - OpenGL
  - UDP protocol to exchange messages between the tablet PCs



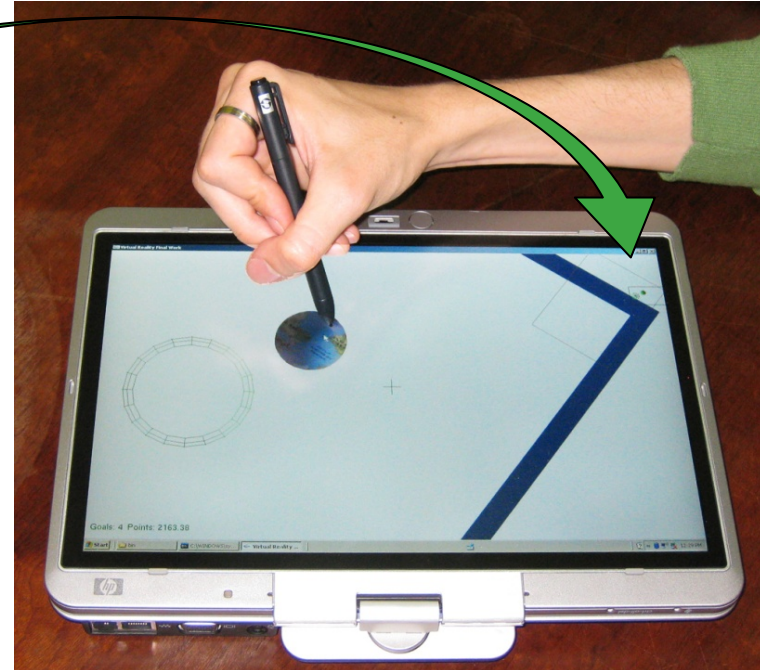
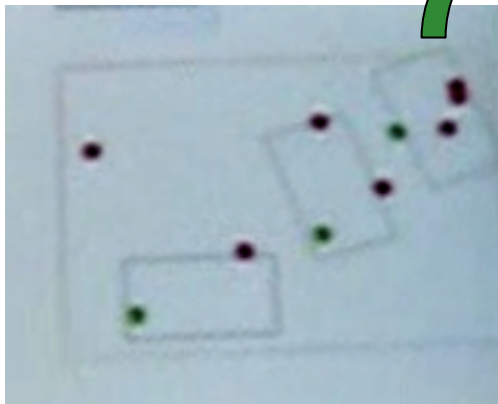
# Prototype: Moving Displays Interaction



# Case study: 2D Game Application

- Virtual 2D room without doors or windows
- A ball must to be thrown or dragged to a target which is a circular ring
- 2 modes: individual and collaborative

- Mini-map





# Case study: 2D Game Application

- Single-player mode
  - Both the ball and the target are randomly placed at initialization, and replaced just after a goal is scored



# Case study: 2D Game Application

- Collaborative mode
  - Tablets communicate through a wireless network
  - Target is the center of one tablet → one of the players moves the target
  - Second player controls the ball



# Experimental evaluation

- Will collaboration improve performance?
- Hypotheses
  - It is faster to hit the target in multi-player mode than in single-player mode (less time to accomplish the task);
  - It is easier to hit the target in multi-player mode than in single-player mode (less number of ball manipulations or clicks on the ball).

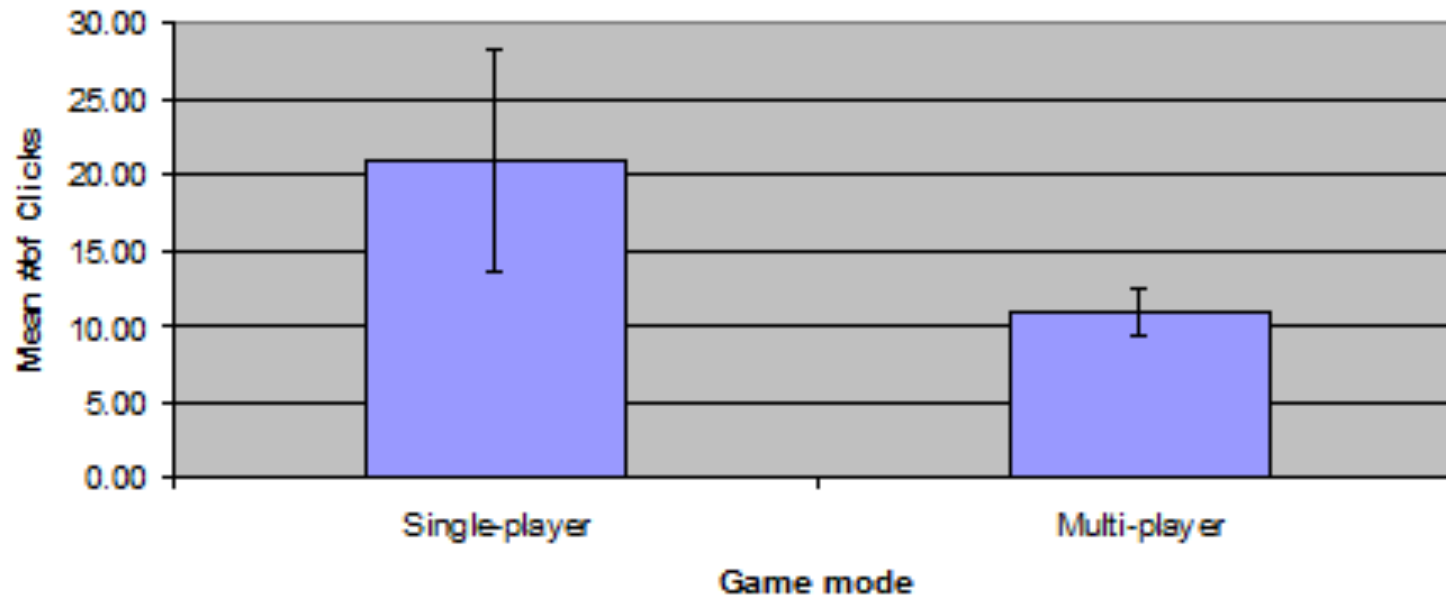
# Experimental Evaluation

- 16 subjects
  - Undergraduate computer science students
- User tests
  - **Single-player mode performance test**
  - **Multi-player mode performance test**
- Two groups
- Questionnaire



# Results

Single player			Multi player	
Player id	Time (s)	Clicks	Time (s)	Clicks
$i$	....	....	....	....
Mean	95.2	20.9	89.4	10.9
Std. deviation	37.8	7.4	20.1	1.5
Median	85	20.5	89	10.5

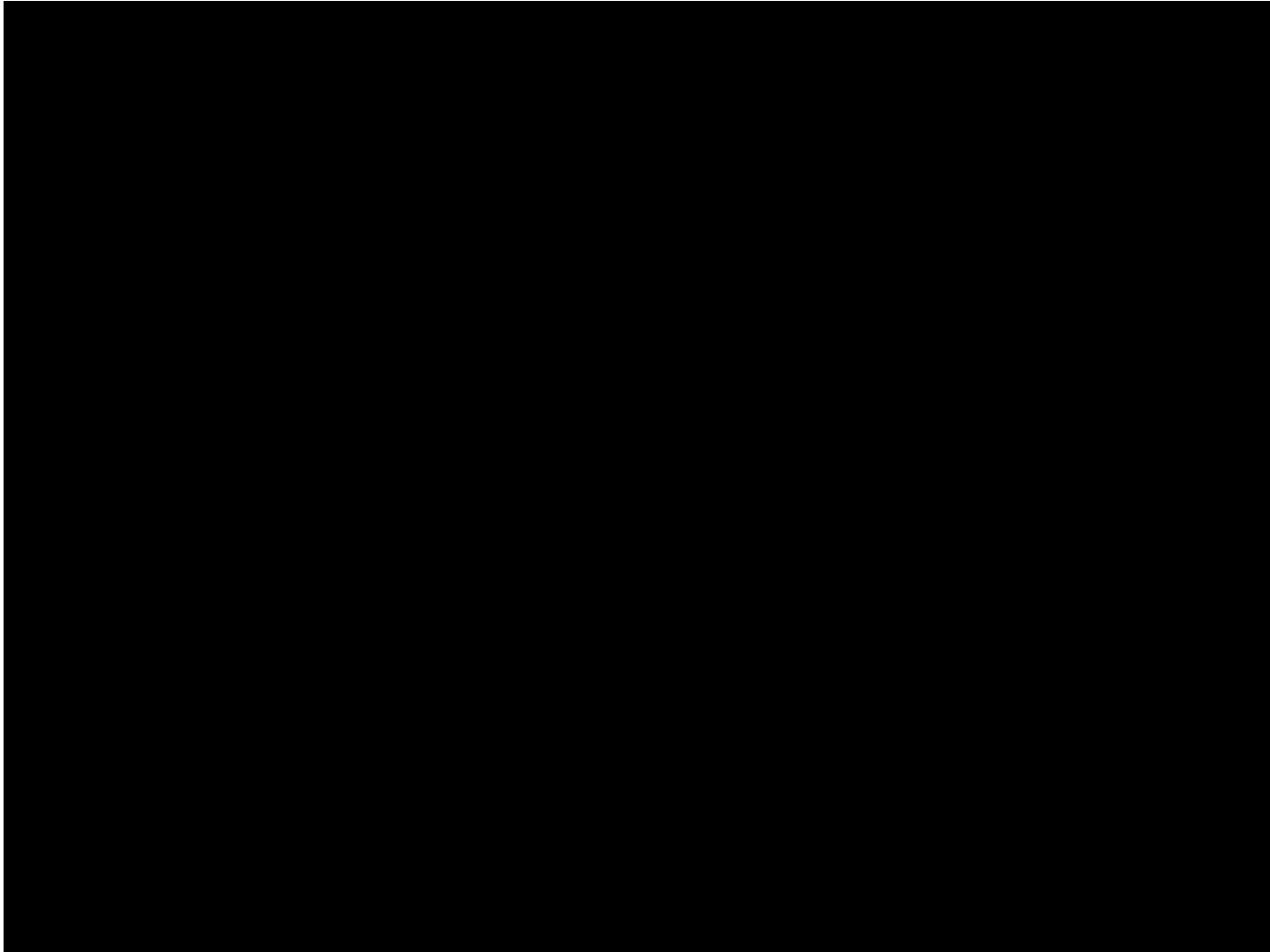


# Results

- Single-Factor Analysis of Variance (ANOVA)

	Time		clicks	
	Single pl.	Multi pl.	Single pl.	Multi pl.
Mean	95.25	89.37	20.94	10.88
Std. Dev.	37.83	20.11	7.4	1.5
P	0.5874		0.00000912	
F	0.3008		28.4325	

# Concept application



# Summary and Conclusions

- Interaction technique to facilitate collaboration and information sharing in a common virtual workspace
- Experiments involving user performance in a simple task in different modes
- Collaboration could not be proved to reduce interaction time but it reduces interaction effort
  - From the questionnaire: users think collaborative task is faster
- Spatial position awareness is key for a number of applications
  - Photo sharing, social networks, games, advertising, etc.



# Future Work

- Design new experiments with different user profiles
- Comparing the current design to a large horizontal surface with a projected digital image
  - the entire work surface visible in lower resolution and the tablets providing windows of higher resolution for interaction
- Test other applications of dynamic multi displays:
  - google maps, educational tools, computer aided design, etc.
- Explore other tracking strategies
- Explore other mobile surfaces as displays
  - T-shirts, car bodies, bags, etc.

# Acknowledgements



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