Bremen

# KINOPTIK

CG VR

## Techniques and Insights for Creating Competitive Accessible 3D Games for Sighted and Visually Impaired Users

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# Motivation

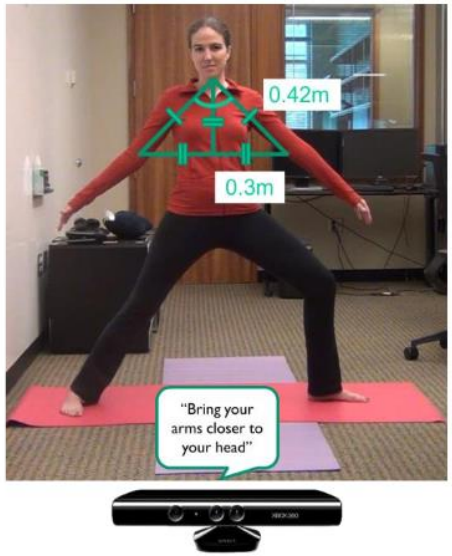
125.000 blind and highly visually impaired in Germany

# Related Work

## Audioquake


Atkinson et.al., 2005

## Eyes-Free Yoga




Rector et.al., 2013

## VI-Tennis


Morelli et.al., 2010

## Audiopolis

Sanchez et.al., 2014

## AudioBattleShip

Sanchez, 2004

# Our Goal

- Is it possible to create a mutual funny and competitive 3D multiplayer game for both sighted and blind people?
  - Shared 3D virtual environment
  - Real-time interaction
  - Same winning chances for either player
  - 3D visualization for the sighted player
  - Touchless interaction for the sighted player

=> Asymmetric input/output devices

=> Asymmetric Tasks

# KINOPTIK: Basic Gameplay

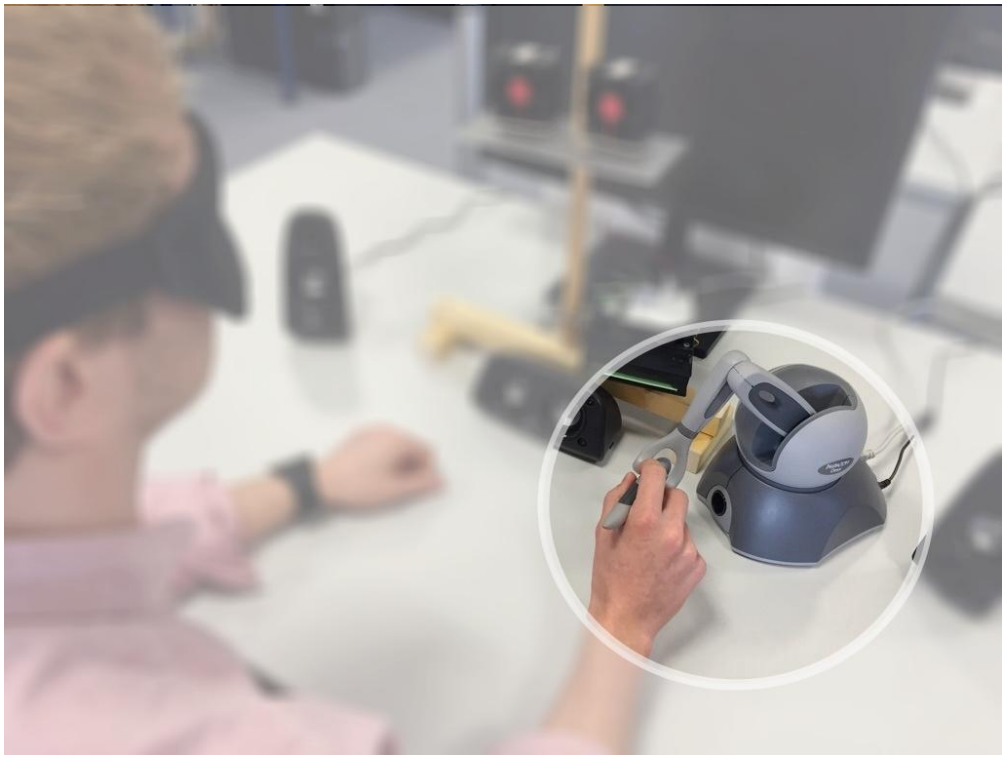
- Sighted player tries to escape
  - Digs a tunnel with his whole body
  - Wins if distance to the blind player is too large
- Blind player tries to catch him
  - Controls an avatar flying through the tunnel
  - Wins if he catches the sighted player

# KINOPTIK: Basic Gameplay

# Setup – The sighted player

- High definition stereoscopic display
- Depth camera

# Setup – The blind player

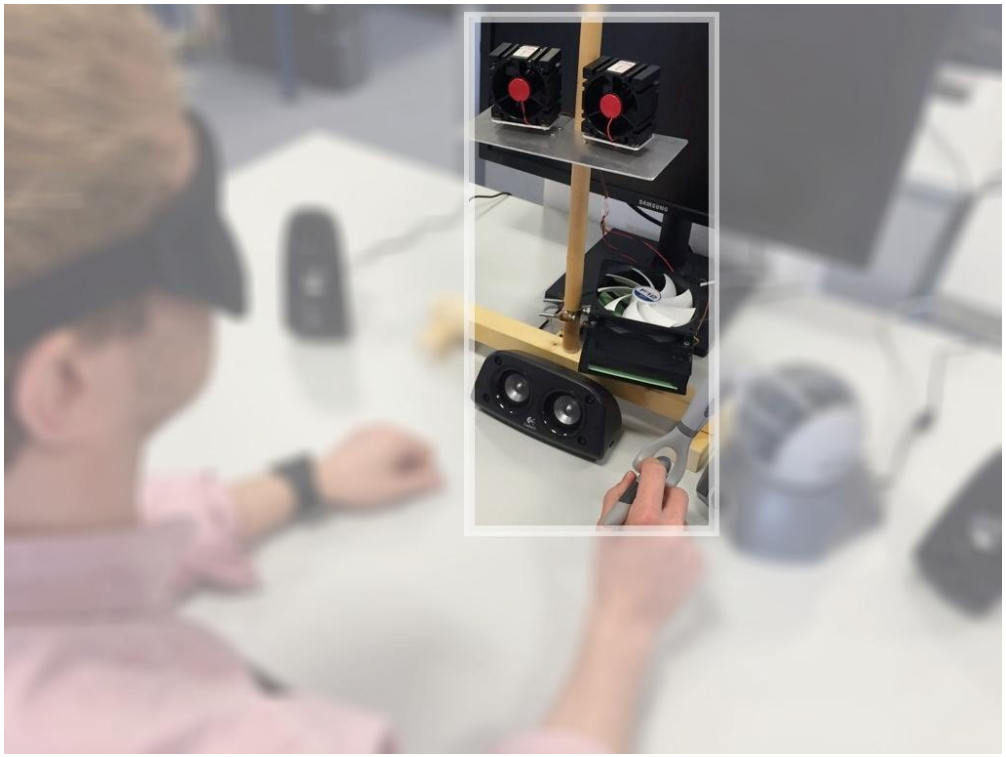


- Haptic Device
- 5.1 Sound System
- Wind Simulation

# Setup – The blind player

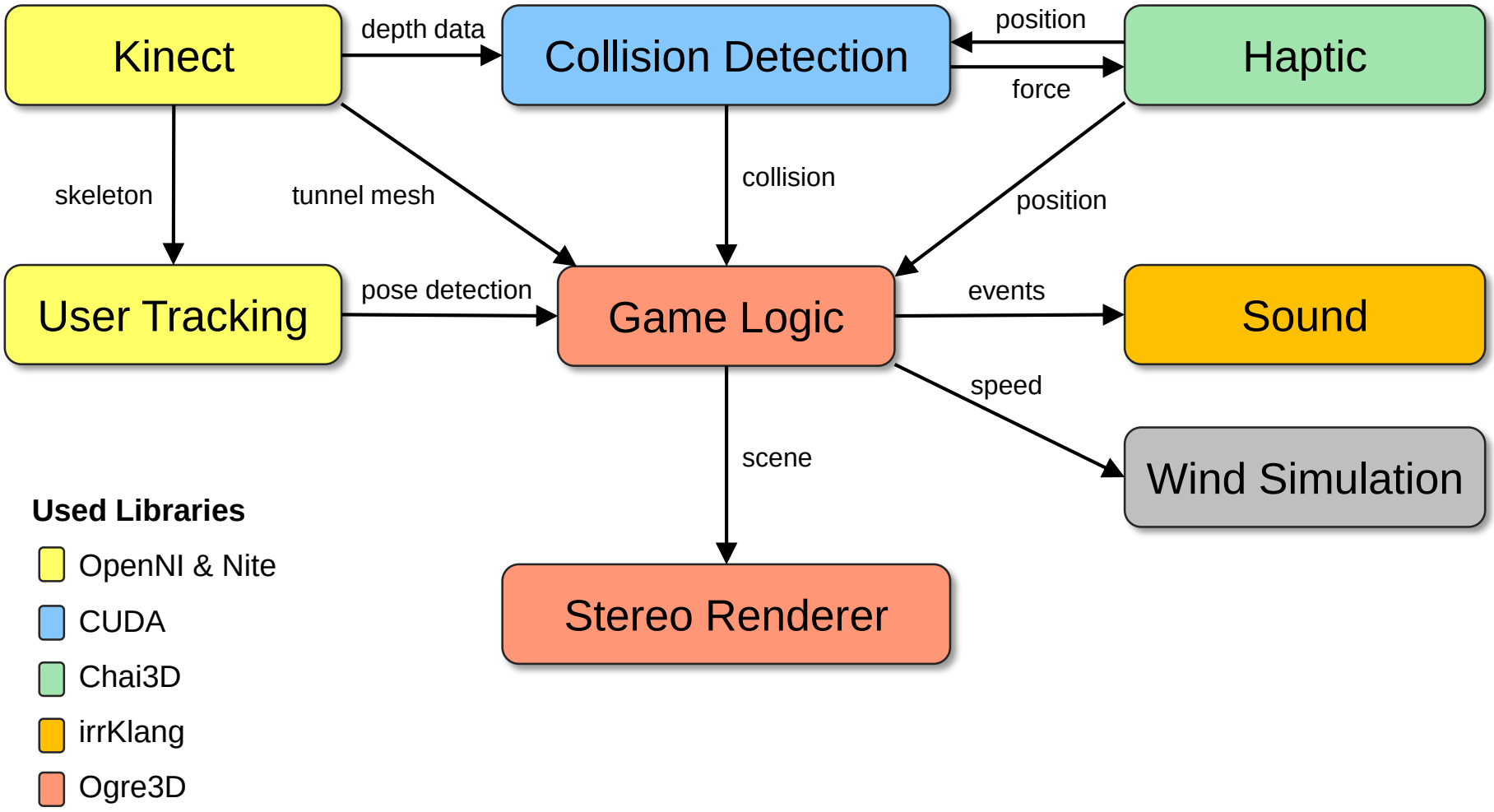
- Haptic Device
- 5.1 Sound System
  - Voice
  - Ambient sound
  - Sonar sound
- Wind Simulation

# Setup – The blind player

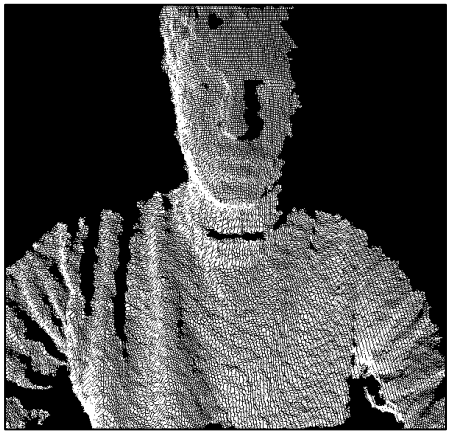


- Haptic Device (6 DOF)
- 5.1 Sound System
- Wind Simulation

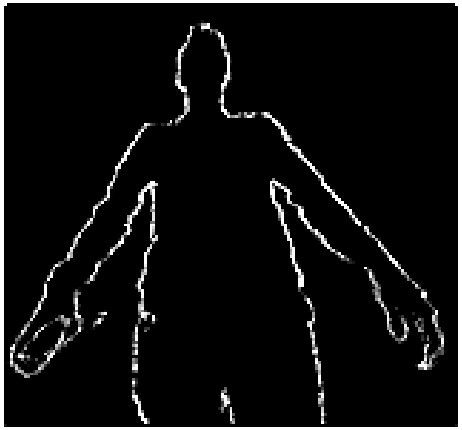
# Software System Overview



# Component Highlights: Tunnel Creation



*Point cloud*



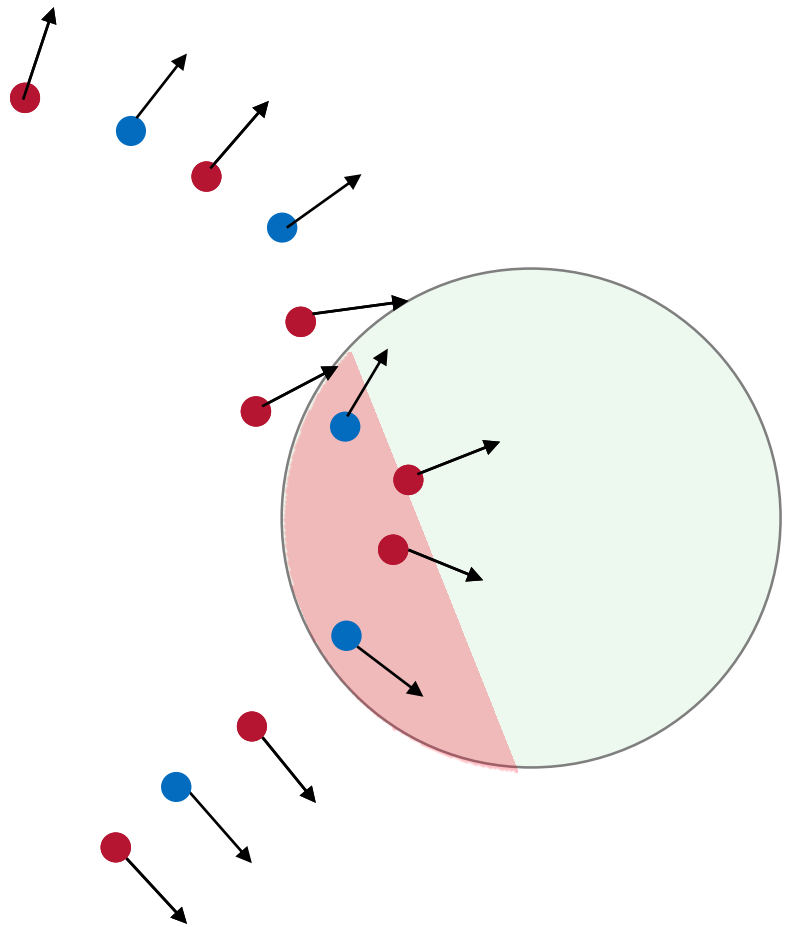
*Silhouette extraction*

*Silhouette simplification*

*Mesh generation*

*Mesh smoothing and bump mapping*

# Component Highlight: Force Rendering



- Adaptive insertion of points
- Parallel force computation on the GPU:

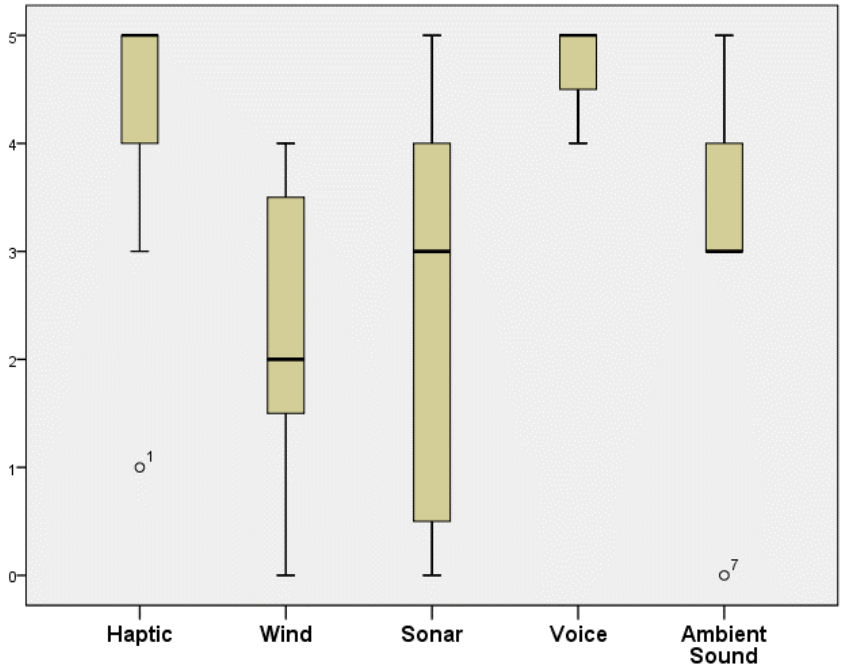
$$\overrightarrow{force} = V_{avg} \cdot \vec{n}_{avg}$$

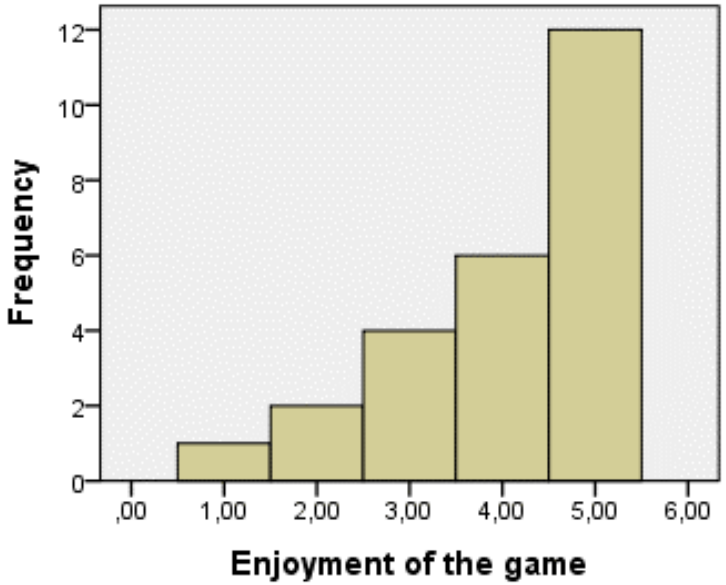
# User Study

- 14 participants
  - 7  7 
  - 11  3 
  - Age: 10 – 54 years
- Protocol
  - Pre-recorded audio introduction to the game
  - Open training phase until participants agreed that they understood the gameplay
  - Each participant played the game twice (against randomly selected opponents)
  - Questionnaire and recorded data

# Results and Discussion

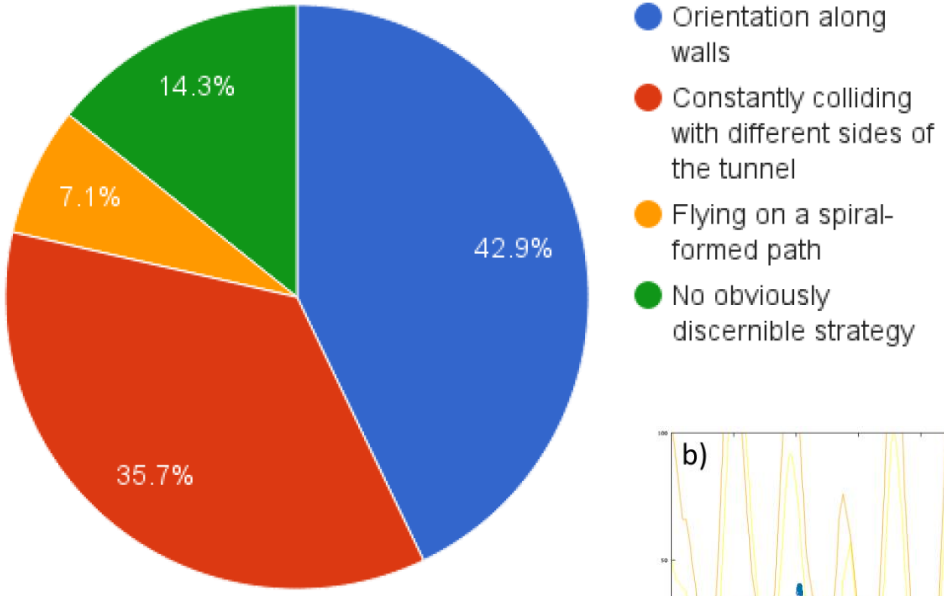
- Almost all players enjoyed the game
- Same winning probability for both players ($\chi^2(2, N=14) = 1, p<.05$)
- Haptics and voice where rated best
  for orientation in the 3D virtual environment

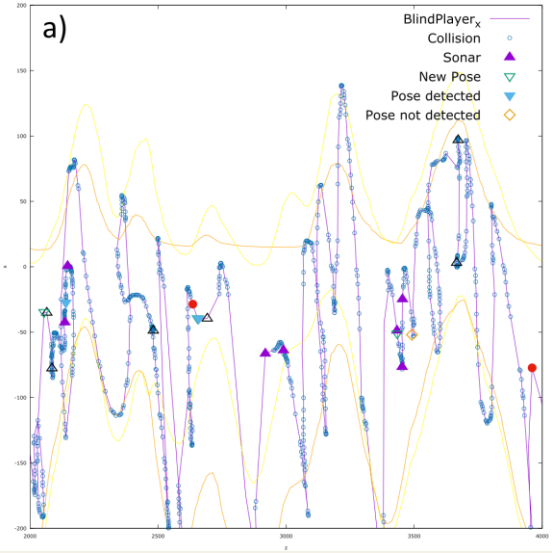


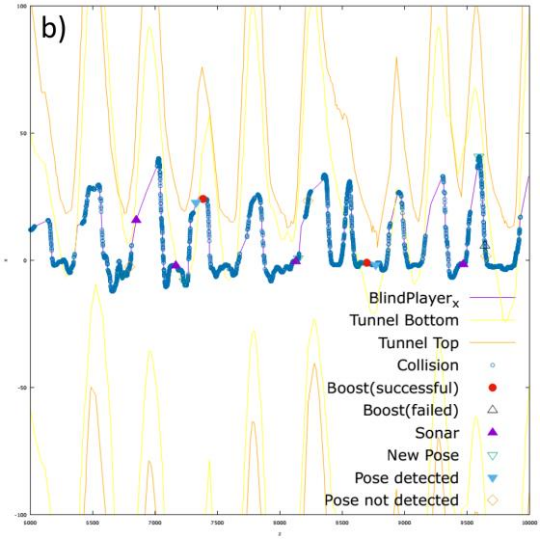



# Results and Discussion

- Different strategies of the blind players
  - No influence of the winning chance



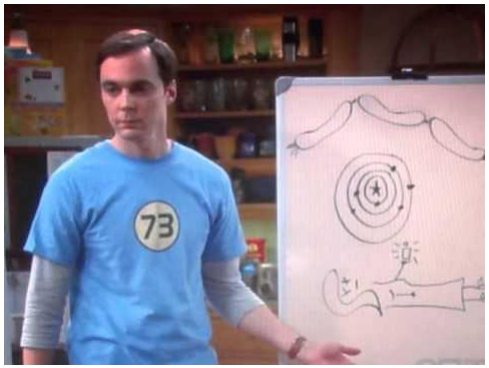



# Conclusions and Future Works

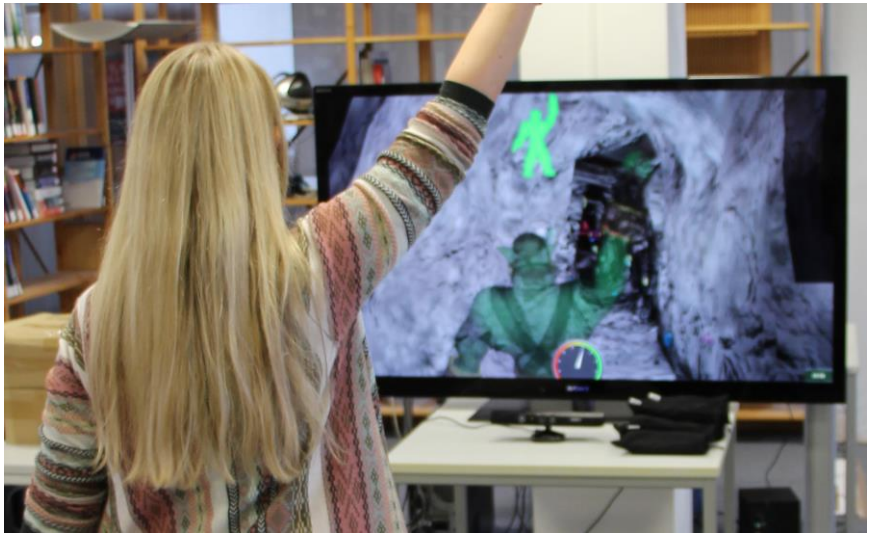
- Novel accessible game for blind and sighted people with
  - shared 3D virtual environment
  - competitive assymetric mulitplayer gamgeplay
  - equal winning chances for both players
- Results show positive effect of haptics and audio feedback

- In the Future
  - Develop more accessible games with haptics support
  - Investigate the strategies of the blind users
  - Improve audio rendering



# Thank You!

KINOPTIK



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