



# **The GlobeFish and the GlobeMouse**

## **Two New 6-DOF Input Devices for Graphics Applications**

---

**Bernd Fröhlich  
Jan Hochstrate Verena Skuk Anke Huckauf**

**Virtual Reality Systems Group  
Faculty of Media**

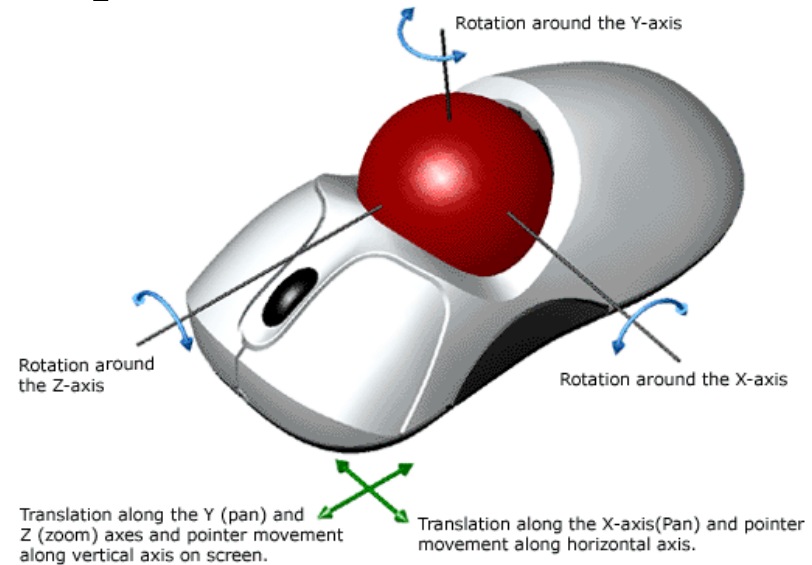
***[www.uni-weimar.de/medien/vr](http://www.uni-weimar.de/medien/vr)***

**Bauhaus-Universität Weimar**

# 6-DOF Desktop Devices



SpaceMouse [1x6DOF] elastic



Dimentional Mouse [3DOF+2DOF+1DOF] isotonic



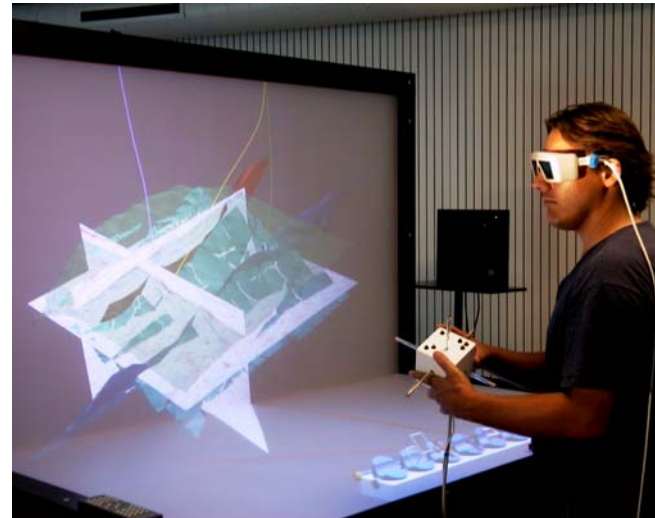
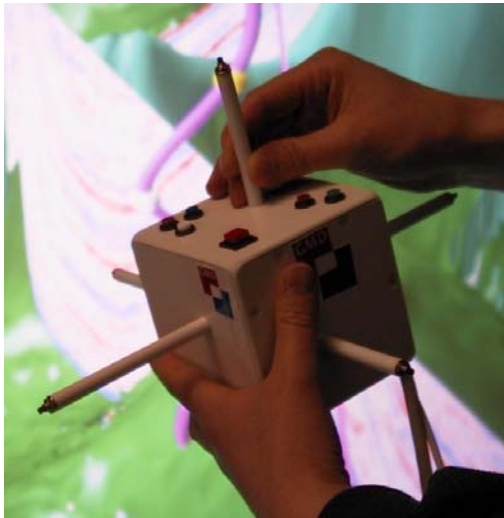
SpaceBall [1x6DOF] isometric



Dialbox [6x1DOF] isotonic

# Other 6-DOF Devices

- ❑ CAT [Hachet et al. 2002]
- ❑ Tracking sensor based
  - ❑ Fingerball [Zhai 1995]
  - ❑ Cubic Mouse [Froehlich et al. 2000]
  - ❑ ...



# Task Analysis Driven Design

- ❑ **[Jacob et al. 1994]**
  - ❑ Device compatible to separate and integral attributes of task
- ❑ **[Masliah and Milgram 2000]**
  - ❑ 6 DOF docking task
  - ❑ Which DOF are used simultaneously?
  - ❑ Rotational and translational DOF as separate subsets!
- ❑ **Conclusion**
  - ❑ Integrated 6 DOF controller for 6 DOF docking task might not be necessary
  - ❑ [3 DOF + 3 DOF] design might perform better

# The GlobeFish

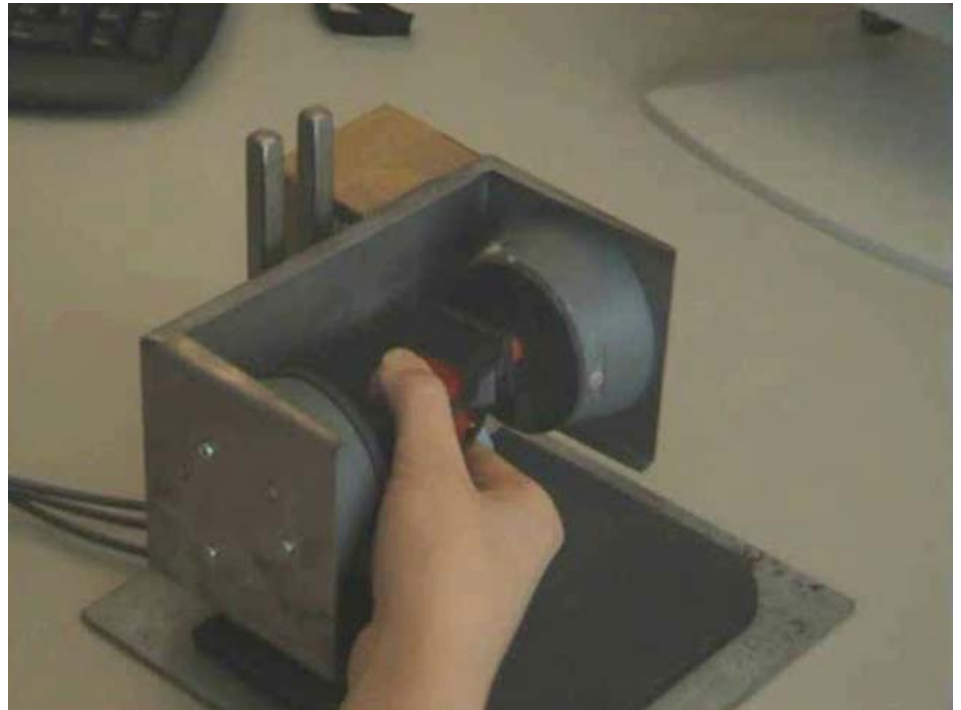
[3DOF+3DOF] Design



# The GlobeFish

## [3DOF+3DOF] Design

- ❑ **3 DOF Trackball**
  - ❑ **Isotonic rotation**
  - ❑ **2 trackball sensors**



# The GlobeFish

[3DOF+3DOF] Design

- ❑ **3 DOF Trackball**
  - ❑ Isotonic rotation
  - ❑ 2 trackball sensors
- ❑ **3 DOF spring frame**
  - ❑ Elastic translation
  - ❑ Based on SpaceMouse





# The GlobeFish

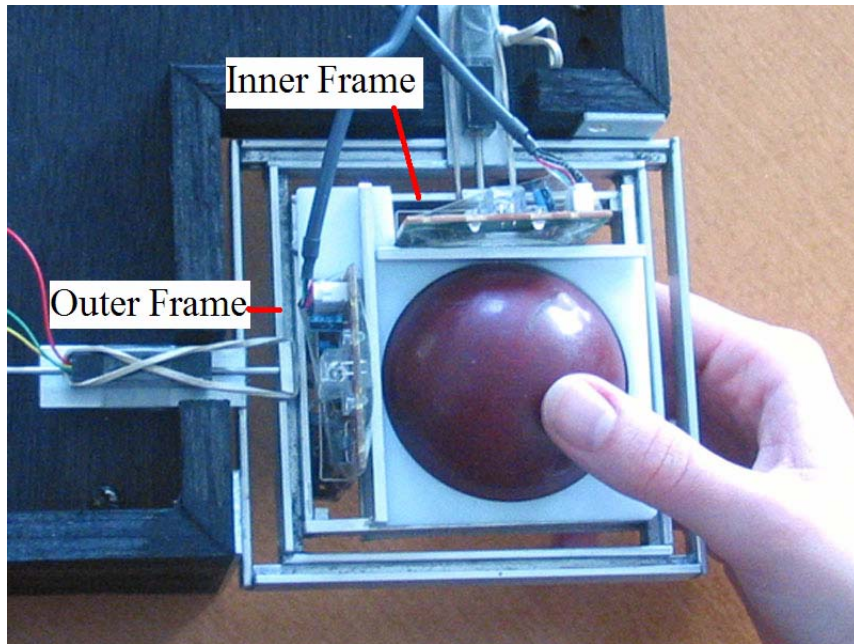
## [3DOF+3DOF] Design

- ❑ **3 DOF Trackball**
  - ❑ Isotonic rotation
  - ❑ 2 trackball sensors
- ❑ **3 DOF spring frame**
  - ❑ Elastic translation
  - ❑ Based on SpaceMouse
- ❑ **[3DOF+3DOF] Design**
  - ❑ Fast switching
  - ❑ Separation by force / no force
  - ❑ Fine manipulation
  - ❑ Uniform handling of translations





# Other GlobeFish Designs



First prototype



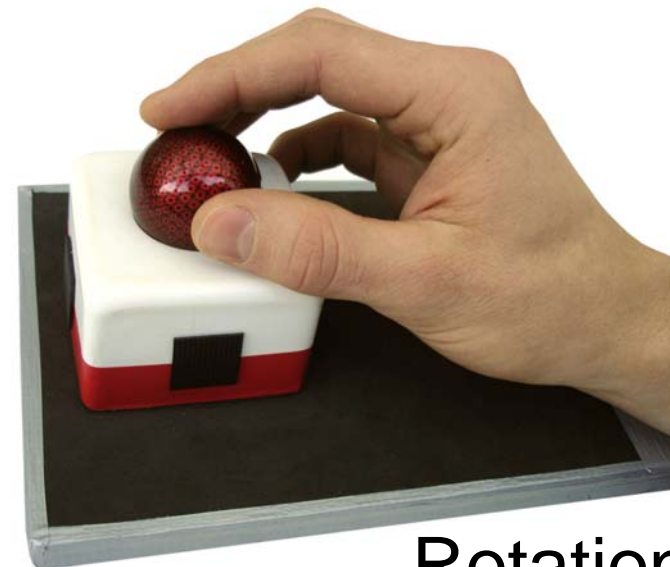
55mm trackball

# The GlobeMouse

- ❑ 3 DOF trackball
- ❑ SpaceMouse socket



Translation

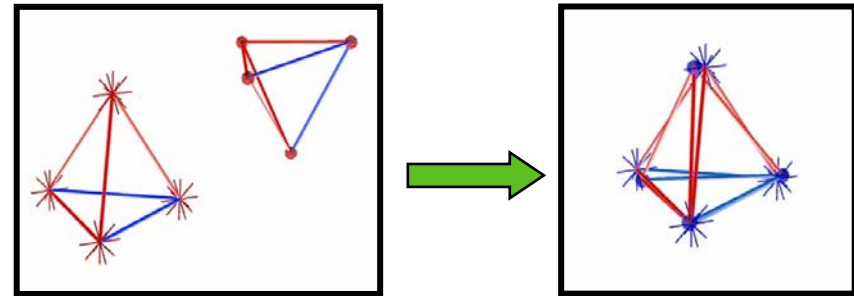


Rotation

# User Study: Methods

## □ Stimuli

- Zhai's docking task
- Stereoscopic monitor
- Negative parallax

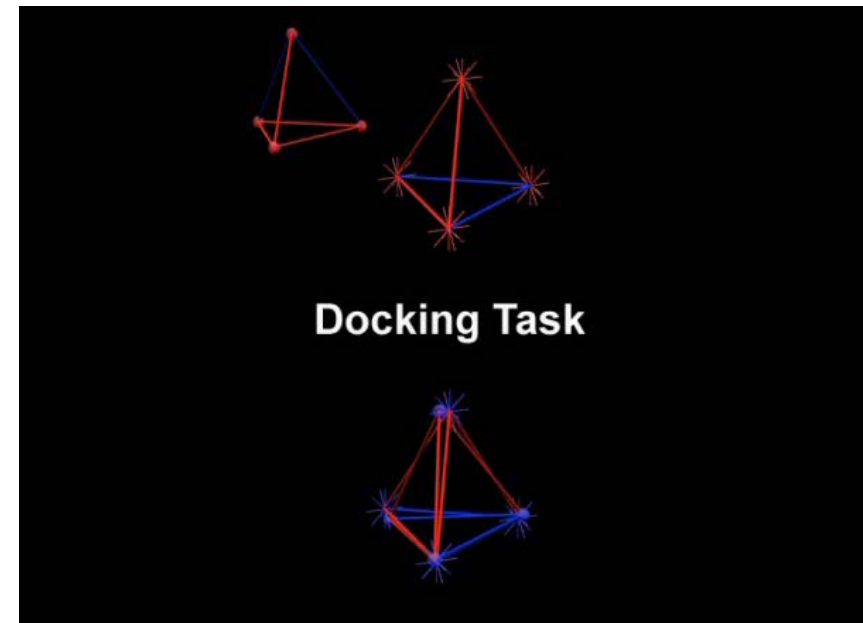


## □ Participants

- 16 volunteers
- Only right-handed
- Stereo vision

## □ Hypothesis

- $[3\text{DOF}+3\text{DOF}] > [1 \times 6\text{DOF}]$



# User Study: Design and Procedure

- ❑ **Within-subjects design**
- ❑ **Latin square design**
  - ❑ **Order of the devices balanced**
- ❑ **4 blocks of 12 trials per device**
- ❑ **Questionnaire after each device**
  - ❑ **Ease of translations/rotations**
  - ❑ **Manual motor fatigue**
  - ❑ **Directness of control**
  - ❑ **Device preference**

# User Study: Devices



Small GlobeFish



GlobeMouse



Large GlobeFish



# User Study: Devices



Small GlobeFish



GlobeMouse



Large GlobeFish



SpaceMouse



# User Study: Devices



Small GlobeFish



GlobeMouse



Large GlobeFish

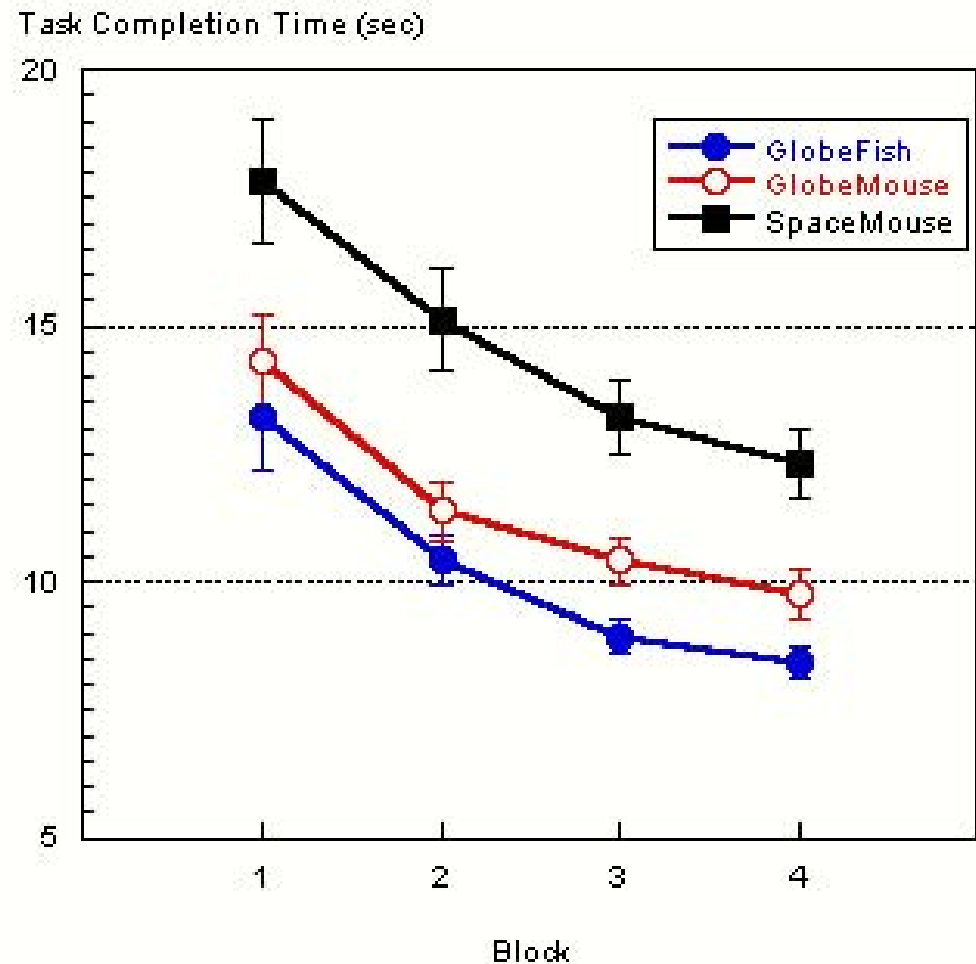


SpaceMouse

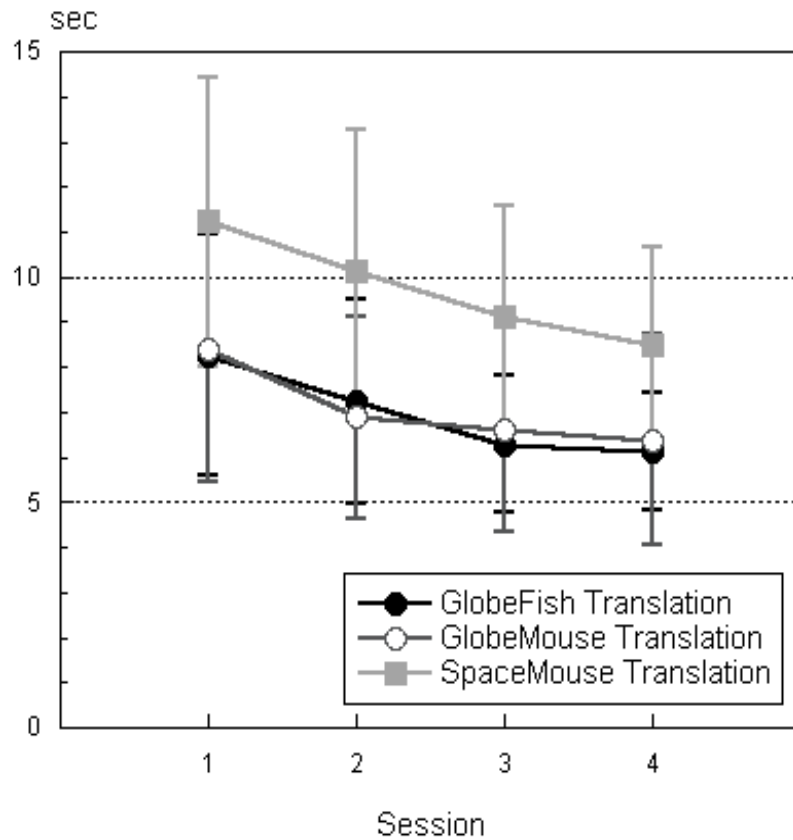


# Results: TCTs

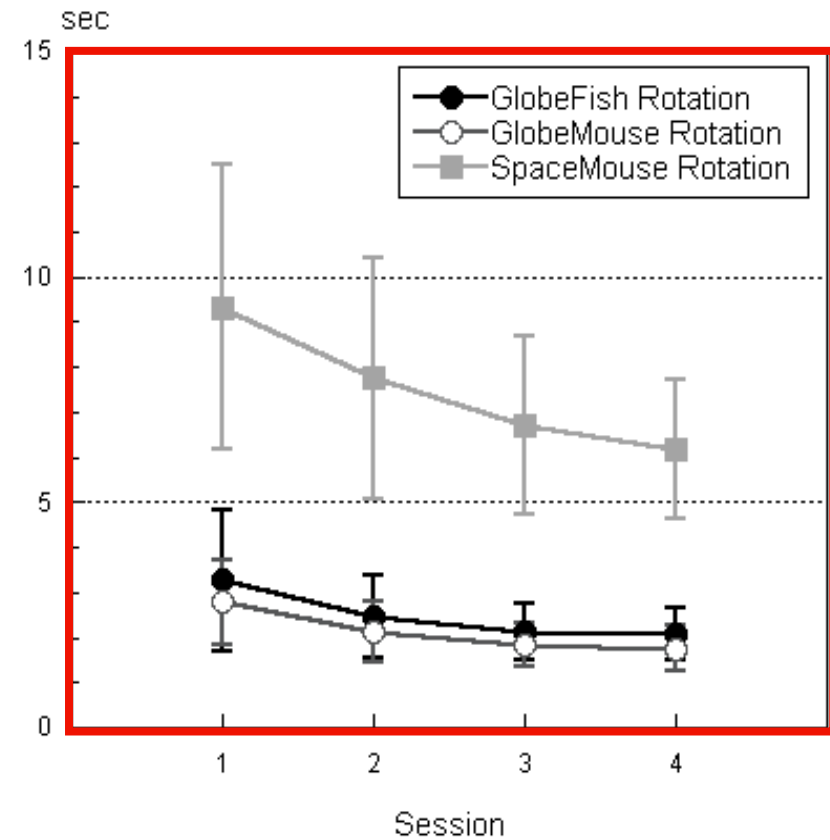
- ❑ 3x4 ANOVA
- ❑ Order of devices no main effect
  - ❑ Transfer similar
- ❑ Significant performance differences of 20%-30%
- ❑ Decrease of TCTs similar
  - ❑ Learning similar



# Translations vs. Rotations

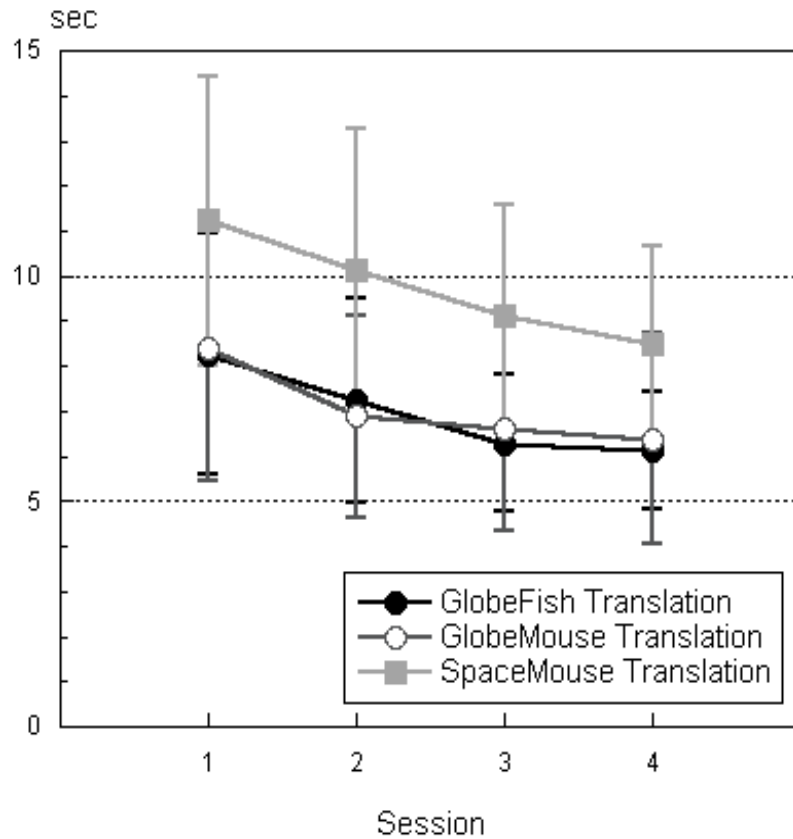


Translation

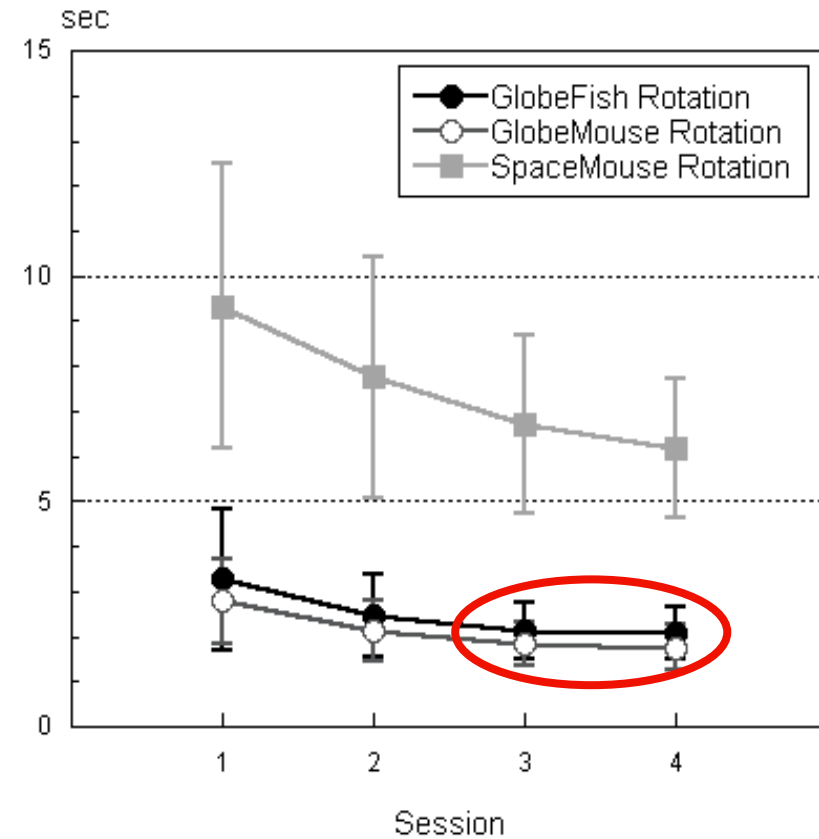


Rotation

# Trackball Rotations vs. Mental Rotation Test

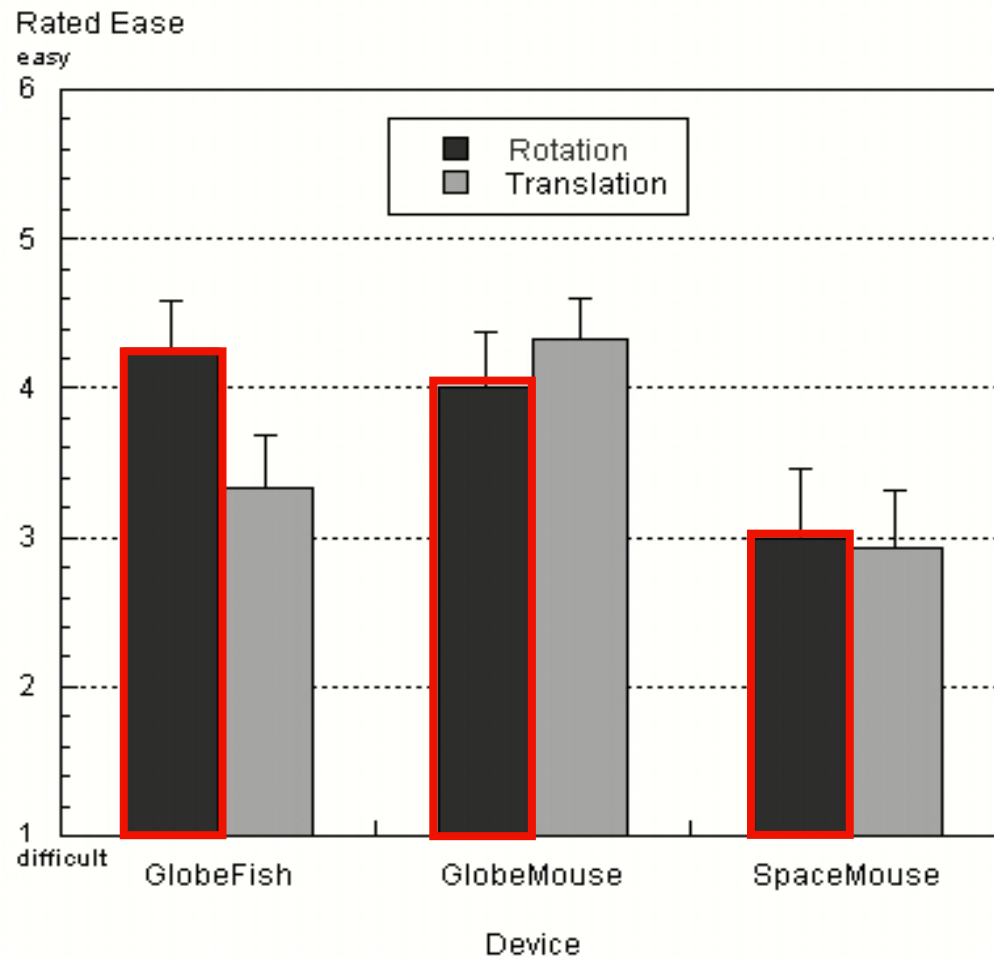


Translation



Rotation

# Subjective Preferences



**GlobeFish**  
**53%**

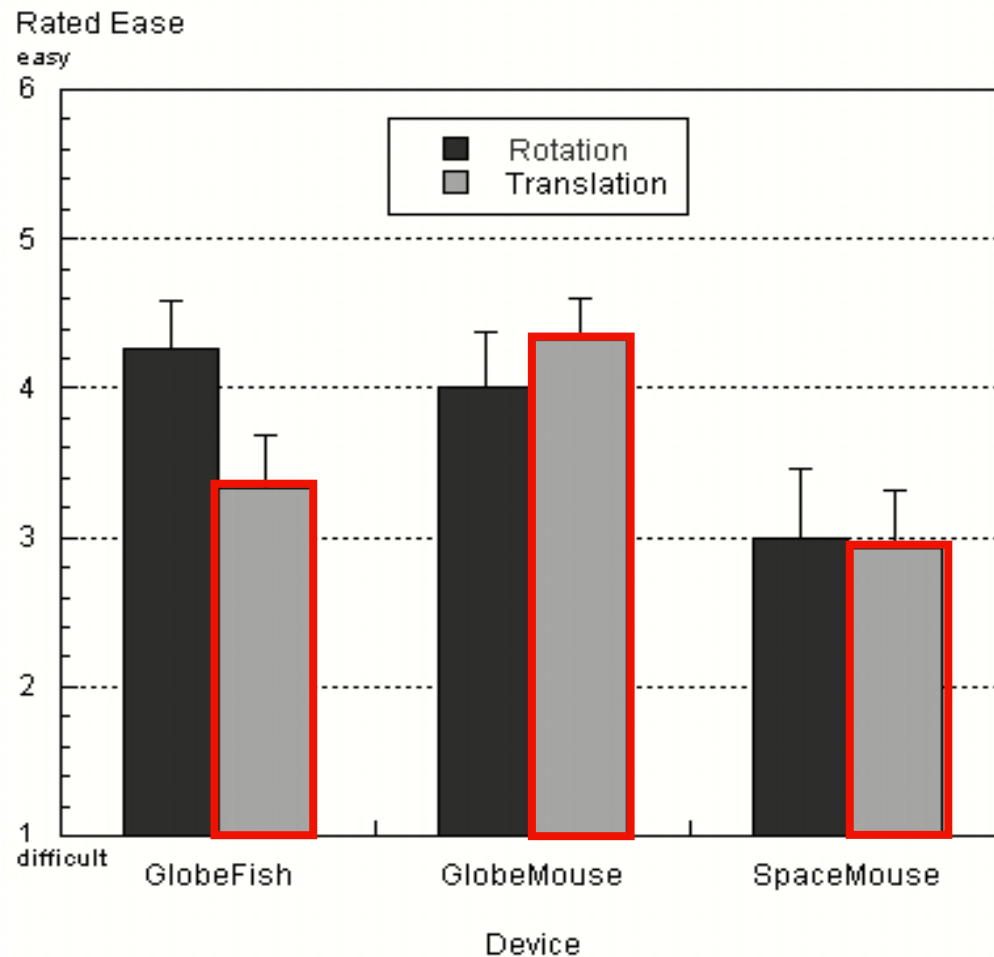


**GlobeMouse**  
**40%**



**SpaceMouse**  
**7%**

# Subjective Preferences



**GlobeFish**  
**53%**



**GlobeMouse**  
**40%**



**SpaceMouse**  
**7%**

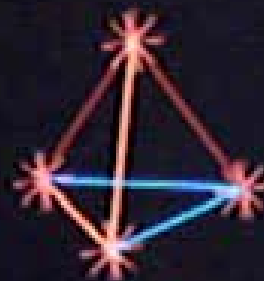
# Recent Developments



Powered By  
OpenGL *Performer*

sgl

PRESS SPACE TO CONTINUE



26.200

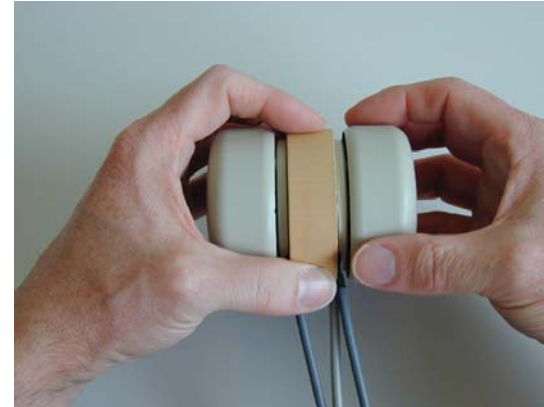
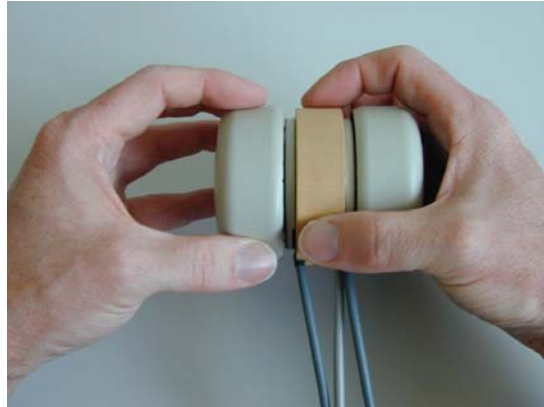
Trial 8





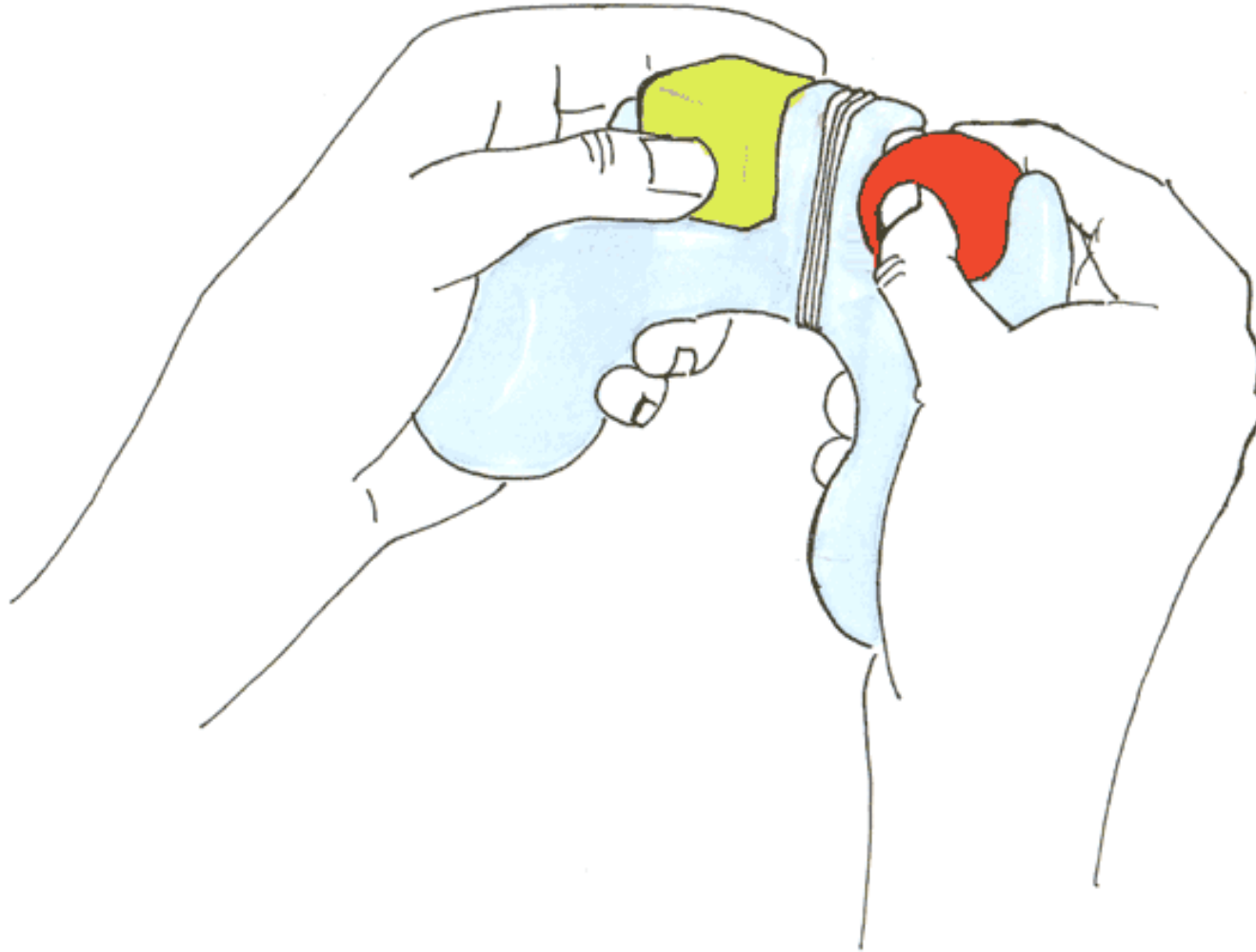
# The Yoyo Family

## [2x6DOF] + Tracking



A. Simon, B. Fröhlich: Interact 2003  
Huckauf et al. : Interact 2005

# Twist 'N Turn

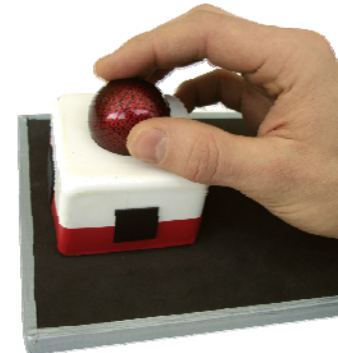


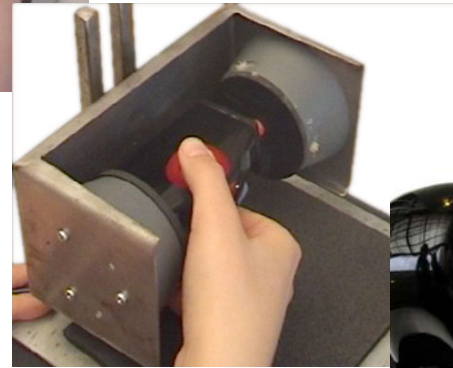
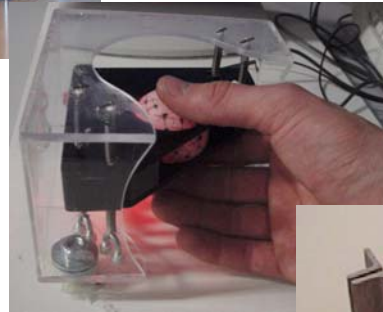
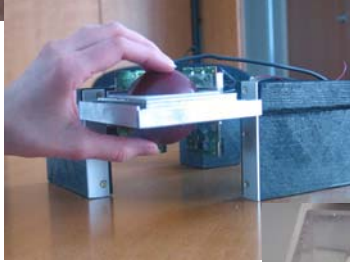
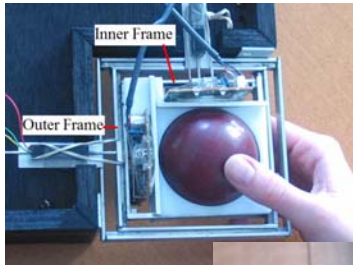
# Summary

- ❑ **[3 DOF + 3 DOF] design**
  - ❑ **GlobeFish: elastic translation vs. isotonic rotation**
  - ❑ **GlobeMouse: + grip change**
- ❑ **Performs better than the SpaceMouse**
  - ❑ **TCTs**
  - ❑ **Subjective ratings**
  - ❑ **Most likely due to**
    - ❑ **Facilitation of rotations**
    - ❑ **Separation of translation and rotation**
- ❑ **Use of the GlobeFish sensor for other devices**
  - ❑ **Handheld**
  - ❑ **One-handed vs. two-handed**

# Future Work

- ❑ **Evaluation for other tasks**
  - ❑ Navigation
  - ❑ Navigation + object manipulation
  - ❑ Combination of 3D and 2D tasks
  - ❑ Compare to standard mouse
- ❑ **Redundant DOF**
  - ❑ **GlobeMouse**
    - ❑ Rotation through trackball or SpaceMouse
    - ❑ Use devices for 2D applications
- ❑ **Application domains?**
- ❑ **Explore the design space!**





# Thank You!

---

**End**