

# Low Cost 3D Rotational Input Devices: the Stationary Spinball and the Mobile Soap3D

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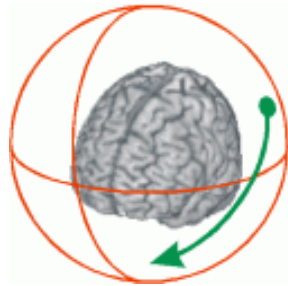
## Overview

- Devices for 3D rotational Input
- Optical Sensors for Tracking
- The *Spinball* – a Desktop Device
- The *Soap3D* – a Mobile Device

## Devices for 3D rotational Input

- Desktop interaction

- Arcball



- Maps mouse: 2D -> 3D

- Spacemouse



- Provides velocities

## Devices for 3D rotational Input

- Desktop interaction

- Globefish



- Provides

- Translation (velocities)
    - Rotation (absolute)

B. Fröhlich, J. Hochstrate, V. Skuk, and A. Huckauf. *The GlobeFish and the GlobeMouse: Two New Six Degree of Freedom Input Devices for Graphics Applications*. In Proc. of CHI, pages 191–199, 2006

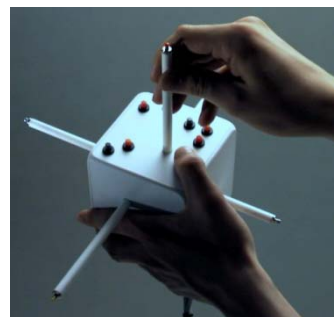
## Devices for 3D rotational Input

- Mobile interaction

- Outside-In tracking markers



- Cubicmouse



- Occlusion
- Requires to change the grip on larger rotations
- Rotation thus generates positional jitter
- Two handed device

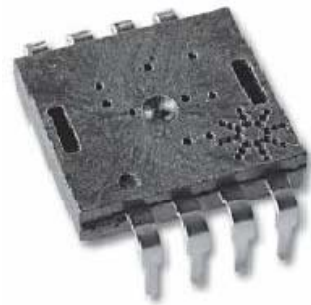
B. Fröhlich, J. Plate. *The Cubic Mouse - A New Device for Three-Dimensional Input*. In Proceedings ACM CHI 2000, pp 526-531, April 2000

## Requirements for a 3D Rotation Device

- For desktop input devices
  - Intuitiveness
    - Clear mapping of degrees of freedom
    - Absolute measurements (no relative velocities)
  - Low-cost
- For mobile input devices (in addition)
  - Occlusion free
  - Smoothness of motion for large rotations
  - Single handed

## Low-Cost Approach

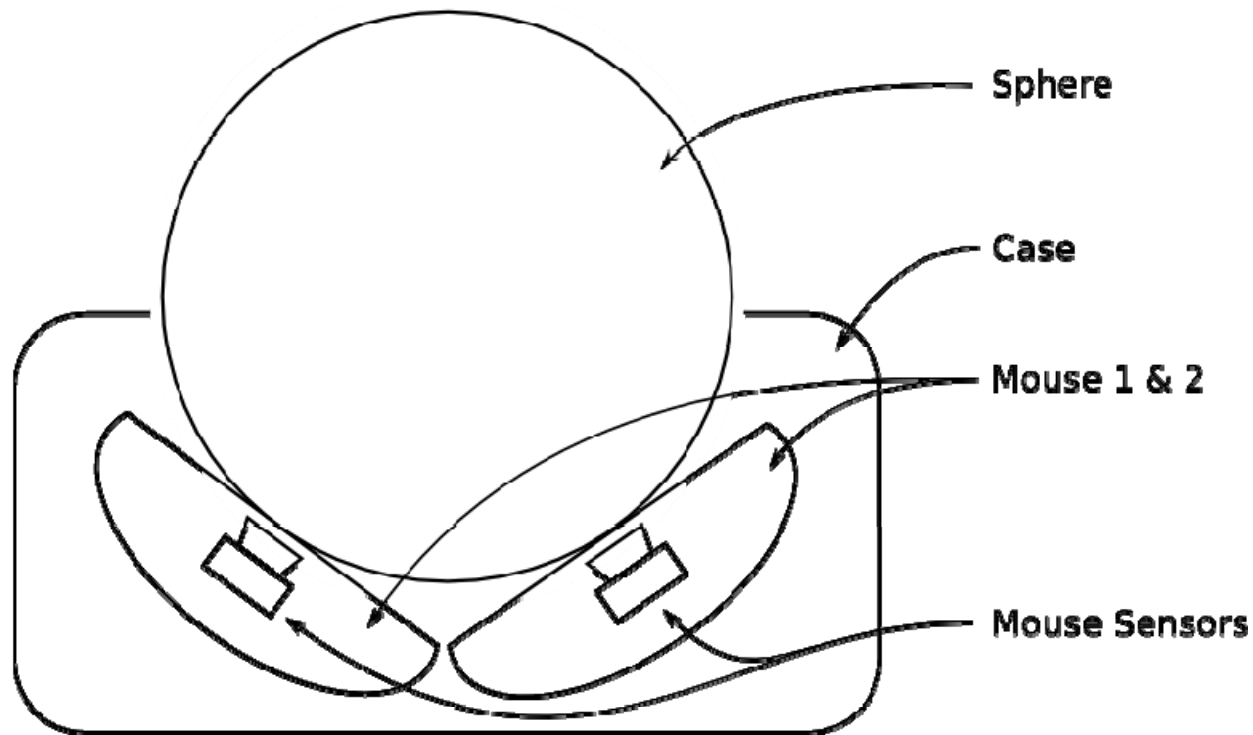
- Optical sensors as in computer mice



- But: One sensor provides only 2D data
- To what extent can we solve the other requirements?

## Approach

- Two sensors (not colinear aligned)
- A ball





## Computing the Rotation

- Count *ticks* for full rotation around all three axes and compute tick length:

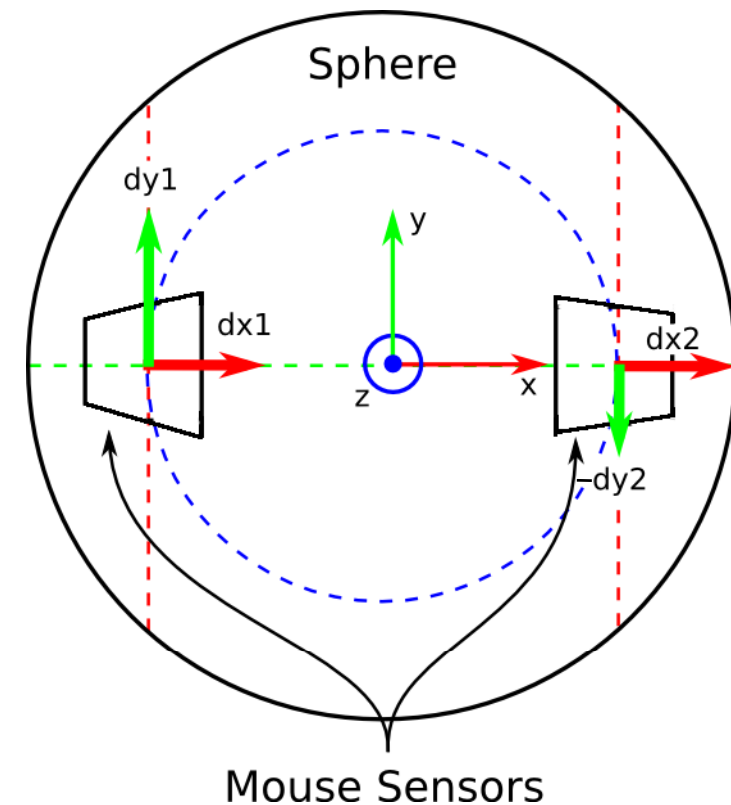
$$f_x = \frac{2\pi}{n_x}, f_y = \frac{2\pi}{n_y}, f_z = \frac{2\pi}{n_z}$$

- Thus rotations are:

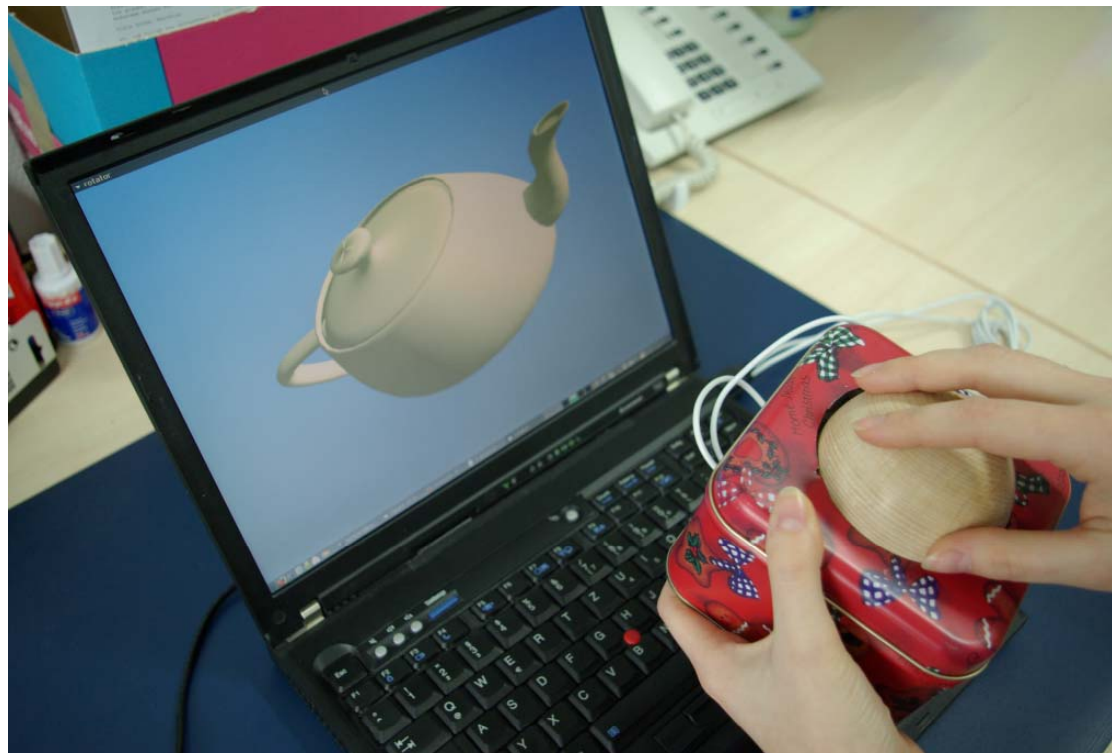
$$r_x = f_x \frac{dy_1 + dy_2}{2}$$

$$r_y = f_y \frac{dx_1 + dx_2}{2}$$

$$r_z = f_z \frac{dy_1 - dy_2}{2}$$



## The *SpinBall* – A Stationary Device



### Price (Euro):

- 2x Mouse 3.95
- Ball 3.30
- Box 1.50
- Mounting 0.50
  
- **Sum: 13.20**

## The *SpinBall*



## The Soap3D – A mobile Device

- Turn setup outside-in
- Cover case in elastic fabric
- Let users turn the inside



Inspired by the 2D version:  
P. Baudisch, M. Sinclair, and A. Wilson. *Soap: a mouse-like pointing device that works in mid-air*. In *User Interface Software and Technology Symposium*. ACM Press New York, NY, USA, 2006

## The Soap3D – First Experiences

- Pouring soap forms with acrylic



- Cosmetic bottles



- Kid socks



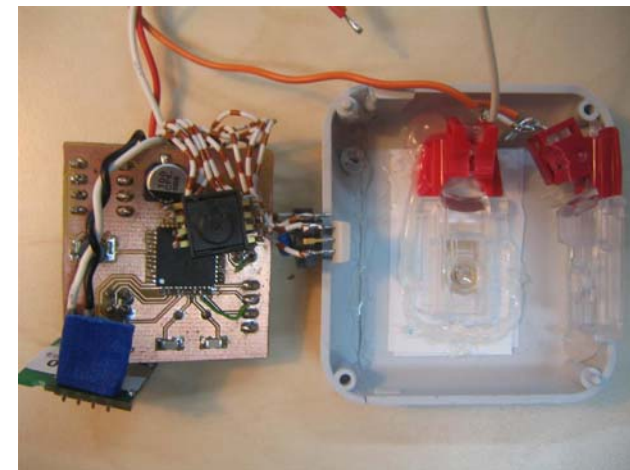
## The Soap3D – Construction

- First prototype
  - Case rounded on edges  
8.0 x 5.6 x 2.4 cm
  - 2 wireless optical mice  
27 MHz and 2.4 GHz
  - Button cell battery
- Price: Euro 57.55
  - Bluetooth mouse: Euro 40.00



## The Soap3D – Construction

- Second prototype
  - Case shortened to 5.6 x 5.2 x 2.4 cm
  - Custom made hardware
    - Only optical sensors of 2 mice: Avago ADNS-5020
    - Micro-controller: Atmel Atmega644
    - Serial to Bluetooth: Parani ESD-200
- Price: Euro 69.75
  - Serial to Bluetooth: Euro 40.00
  - Expected price with custom data link: Euro 34.00



## Interaction 1 – Closed-Hand Interaction

Keep fabric hull stationary in hand and turn inside case





## Interaction 2 – Grip-Change Interaction

Drag fabric on opposite sides in opposite directions



## Interaction 3 – Two-Handed Interaction

Put both flat hands on opposite sides and move hands in opposite directions



## Soap3D - Issues

- Handling
  - Device still too large
  - Smoothness of surface
  - Fabric: Elasticity and stiffness
- Power
  - Button-cell empties too fast
  - Components operate on 3 V and 5V

## Conclusion

- Summary
  - The Spinball enables intuitive and immediate use
  - The Soap3D already is usable but requires further work
  - Both devices show: Optical mouse sensors are alternatives for tracking in low-cost user devices
- Future work
  - Custom data link: enabling to run on only 5 V, reducing cost and size
  - Casing and fabric hull:
    - Ergonomic size and form
    - Investigate other materials
  - Incorporate position tracking

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