Orientation-Aware Artifacts

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Motivation

Invisibility and ubiquity are key objectives in pervasive and ubiquitous computing

Technological advances enable integration of sensors in everyday artifacts

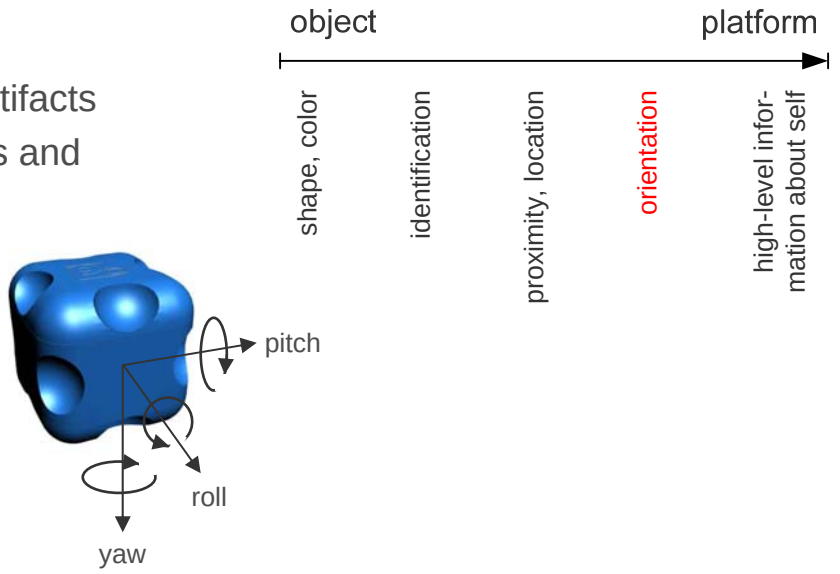
- MEMS technology + ad-hoc wireless communication technologies

How to use such artifacts for interaction?

- What information can be acquired about artifacts (self-description)?
- Our focus: artifacts which are aware of their orientation

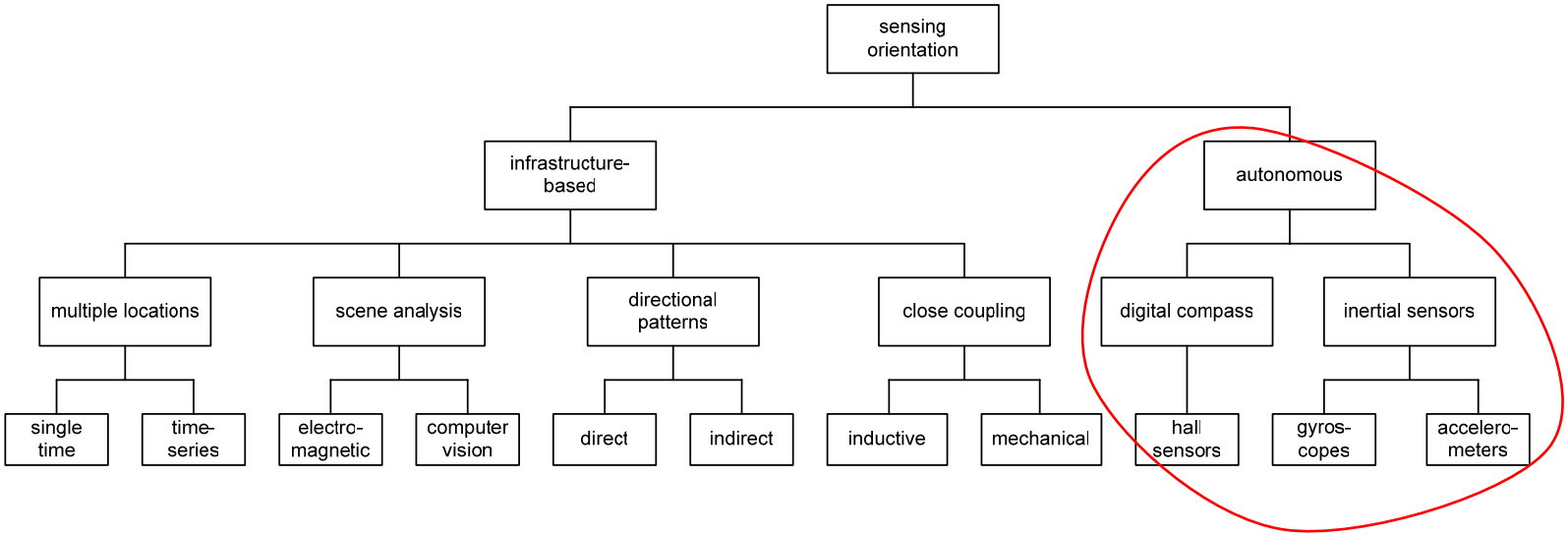
Why orientation?

- Changes through manipulation of artifacts
- Enhances description of movements and static states in euclidean space
- Different types of orientation
- Opens up a plethora of application scenarios
- There are many open issues



Orientation Sensors Overview

State-of-the-Art



Fields of Application

- Context-aware computing
- Mobile computing
- Distributed computing
- Human computer interaction
- Augmented and virtual reality
- Automotive computing

wireless 3DOF orientation tracking
supports up to 4 cubes per receiver
integration of 10 sensor elements
180Hz update rate
1200°/sec max. angular speed
6-9V battery
31.2 mm x 43.2 mm x 14.8 mm

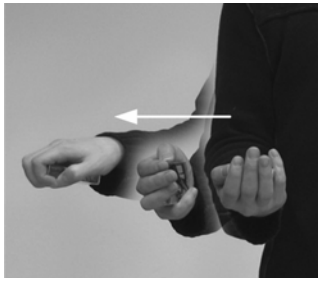
wireless 3DOF acceleration tracking
based on Analog Devices ADXL2XXJE
1kHz update rate (all three channels)
±10g, shock limit of 500g
3,6V Li-Ion AA size internal battery
25 mm x 25 mm x 5 mm

Gesture Recognition Framework

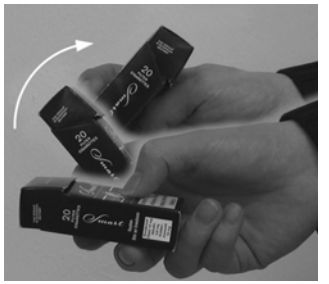
3 categories of gestures

Category	Timing	Type of object	Dynamics of movement
Hand of the user	Continuously	Hand	High
Object the user holds permanently	Continuously	Artefact (small)	Static-high
Object manipulated occasionally	Occasionally	Artefact (large)	Static-low

$G_n \equiv$ (<object>,<name>)



$G_3 \equiv$ (right_hand, throw)



$G_{12} \equiv$ (six_face_box, shake_face_1)

$G_{42} \equiv$ (window, rotate_10)

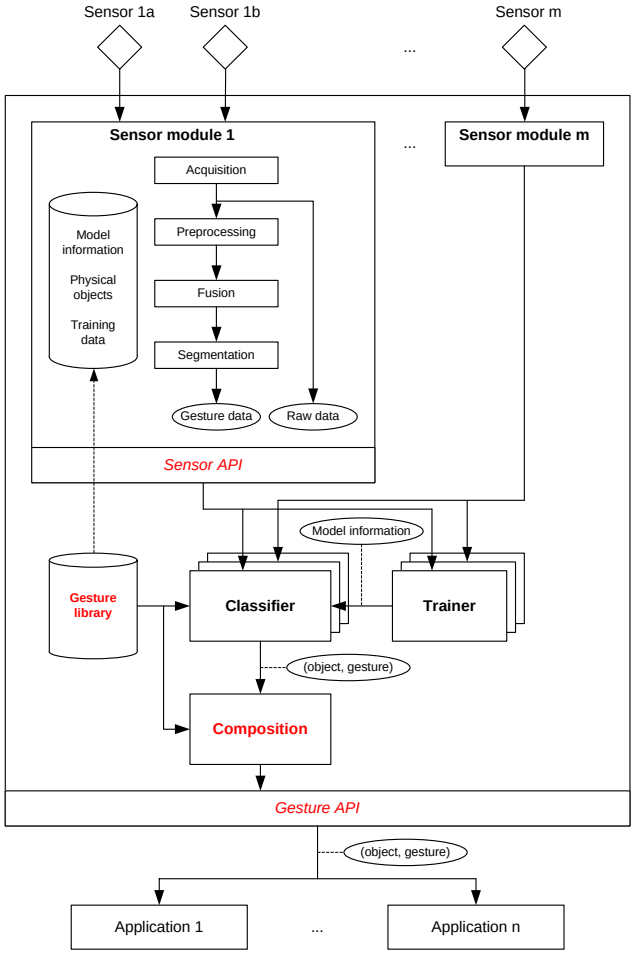
Framework for orientation sensor-based gesture recognition

- Core component: gesture library which contains an application-independent set of gestures
- Independent of sensor technology / classification methods
- Acommodates a variable number of sensors
- Provides composition of elementary gestures

A. Ferscha, S. Resmerita, C. Holzmann, M. Reichör: **„Orientation sensing for gesture-based interaction with smart artifacts“**. To appear in Computer Communications Journal, 2005.

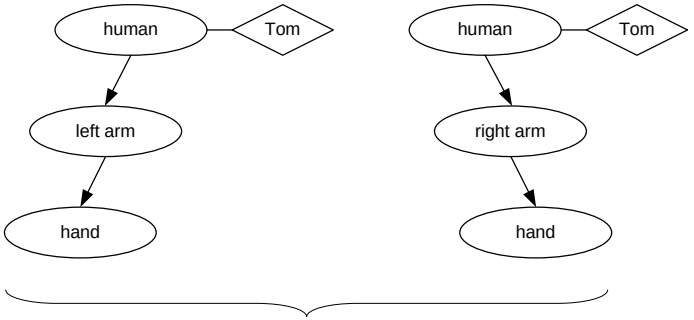
Gesture Recognition Framework

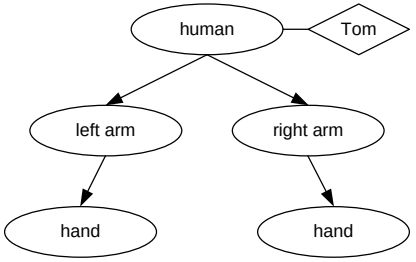
Framework for orientation sensor-based gesture recognition



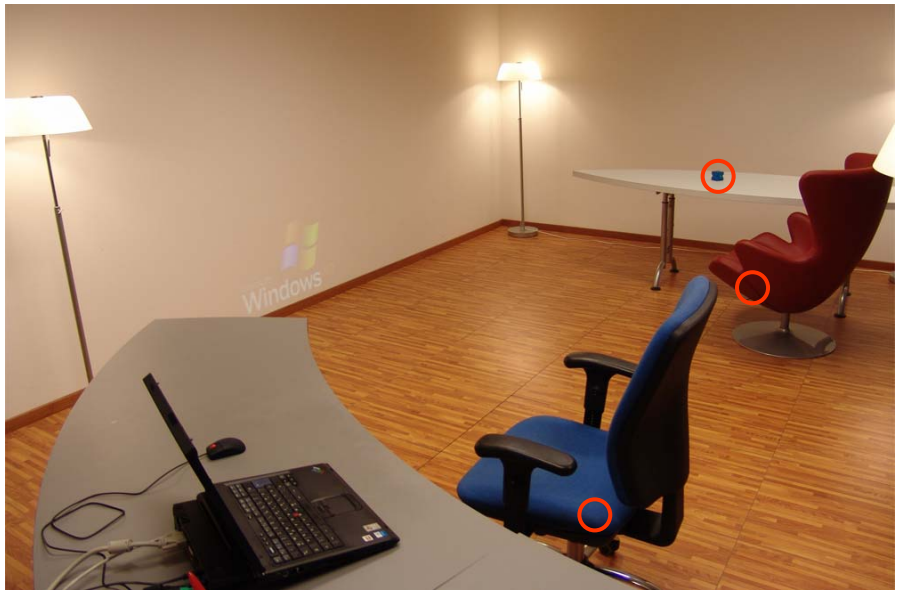
Composition Module

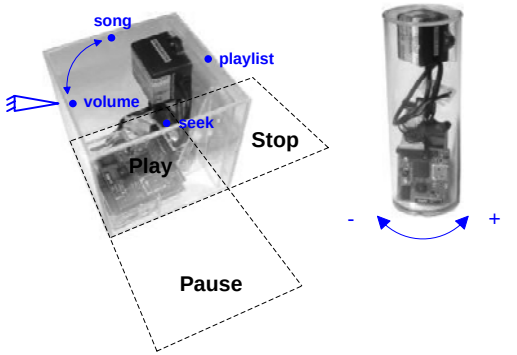
- Detect gestures which are composed from multiple elementary gestures

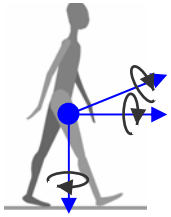




Application Scenario: Smart Home Environment

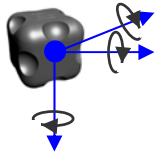






Lights are on if and only if person is walking

Steer video-projection on the wall with relaxation chair
Unlock the computer for authorized persons sitting in front of it

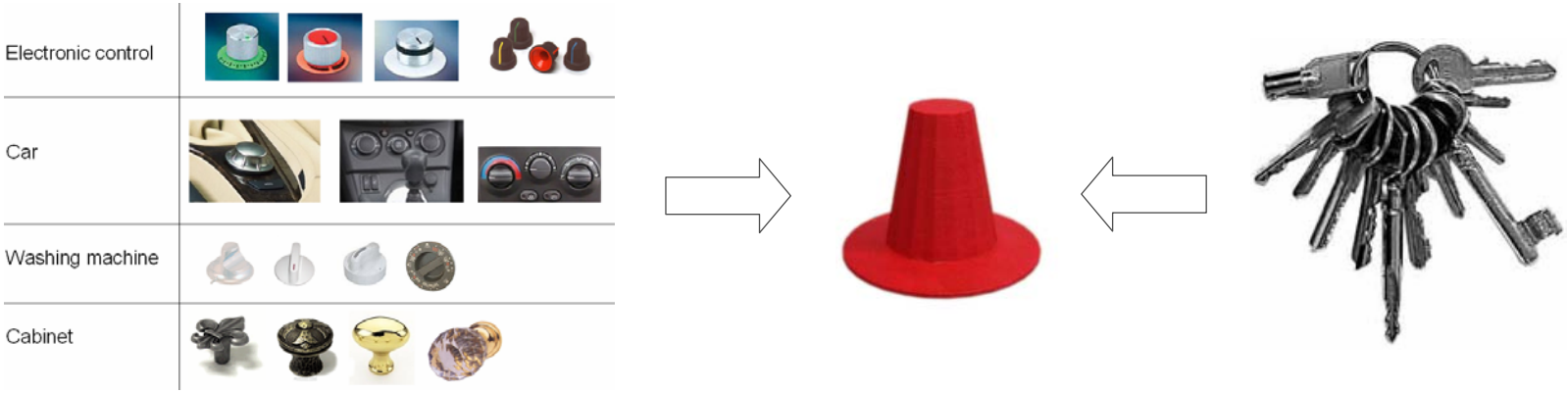


Control video-player (one artifact for discrete and continuous control)

Control video-player (cubic artifact for selecting discrete states, cylindric artifact for continuous control)

Application Scenario: Universal Turning Knob

Idea: replace common turning knobs with a „universal turning knob“



Features:

- Connection automatically established by spatial proximity to controllable device
- Authorization by unique ID of the context knob (“key-functionality”)
- Generates control signals of types on/off, multistage and continuous, whose meaning depend on the device to which the knob is connected (“turning knob-functionality”)
- Feedback on controlled device (e.g. integrated display) and/or via the turning knob (e.g. integrated vibrator)
- Embed biometric sensor for authenticating the user to the turning knob?
- Wearable, affordable, personalized

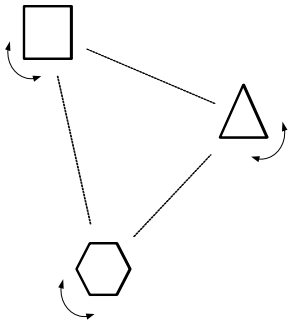
Towards Self-X Artifacts

Self-description

+

Self-management

Self-organisation



To enable interaction, artifacts have to describe themselves

- Describes the artifact's properties, interests, capabilities
- XML-based self-description, context-dependency, …

To enable autonomy, artifacts have to manage themselves

- Process controlling the behaviour of the artifact
- Dynamic rule-based process control, discovery of and communication with artifacts, interaction based on locality / proximity, matching of interests ↔ self-descriptions, …

Self-description and -management are a basis for self-organisation

- Multilateral interaction among a collective of artifacts
- Static / dynamic composition of artifacts, multilateral interest-matching, performance / energy contraints, …

How can spatial orientation and linear acceleration contribute?

- What knowledge can be inferred from static orientation or movements of a collective of smart artifacts?
- How can it affect self-management and self-organisation?
- Can new forms of interaction be found?

Thank you!

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