



# Mechanism science and assistance to elderly

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**COPRIN**: a team of 15 people, 6 staff, 9 phd, postdoc  
located at Sophia-Antipolis

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**2011**: INRIA launches the Large Scale Initiative **Personally Assisted Living (PAL)**



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- **why ?**: the specific problem(s) we target



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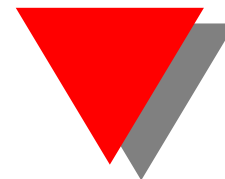
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- **when ?**: all the time ? on demand ?
- **how ?**: the mean. universal ? specific ?

# Objectives and priorities





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**2006-2009:** discussion for establishing our objectives and priorities



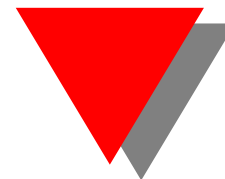
# Objectives and priorities

**2006-2009:** discussion for establishing our objectives and priorities

- personal of retirement houses: nurses, staff
- doctors
- elderly and handicapped people associations
- local authorities
- individuals

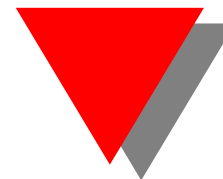
Over 200 individuals have been interviewed

# Objectives and priorities



Some of the established needs:

# Objectives and priorities



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# Objectives and priorities

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- End-users: **low intrusivity**
- End-users/Doctors: **adaptability**
  - to the end-user needs, evolving in time
  - to the environment of the end-user
  - to the uncertainty of the real world



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  - **robot must adapt to the user, not the opposite!**



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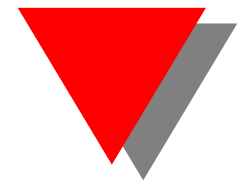


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- **Roboticists:** connectivity

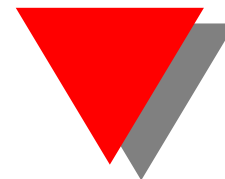


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- Doctors: monitoring for prevention
- Roboticists: connectivity
- Roboticists: not a single "universal" device

# Objectives and priorities



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- **easier and more human communication systems**



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- **transfer**: especially in the toilets!
- **fall prevention/detection**
- **mobility aid**: but no **navigation aid**
- **large variety of interfaces**
- **easier and more human communication systems**
- **monitoring**: give information to doctor for prevention, objective assessment and diagnostic



# The role of mechanics

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MMT will play an important role in assistance devices



# The role of mechanics

transfer and fall prevention

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transfer and fall prevention

- involve large forces

# The role of mechanics



transfer and fall prevention

- involve large forces
- safety issues

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transfer and fall prevention

- involve large forces
- safety issues
- a difficult task for non-intrusive humanoid robots





# The role of mechanics

Designing low cost devices

# The role of mechanics



**Guidelines** for designing low cost, easy to install and maintain devices



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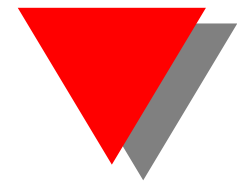
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  - guarantees the performances of the system



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- propose a dimensioning methodology that:
  - allows to adapt the hardware to the end-user and its surrounding
  - guarantees the performances of the system
  - facilitate the installation by providing several design solutions



Transfer aid: **MARIONET-ASSIST**



# Transfer aid: **MARIONET-ASSIST**



- wire-driven parallel robot
- 3 to 6 dof
- lift 150kg anywhere
- stowed in the ceiling when not in use
- a manipulation robot
- rehabilitation robot
- **Cost:**  $\approx$  1000 euros





## Design problem:

- crane must be able to lift the elderly whatever is his location in the room



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## Design parameters

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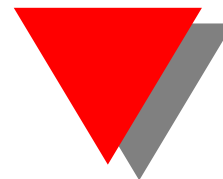
- maximal forces of the winch (within a catalog of standard hardware)
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## Design methodology

- allow to determine a safe 3D region for the location of each winch

## VIDEO

# Walking aids



# Walking aids



- **who ?**: elderly having still some motricity



# Walking aids

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- **when ?**: any walking period





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  - provide gait information for the doctors



# Walking aids

- **who ?**: elderly having still some motricity
- **when ?**: any walking period
- **why ?**:
  - **fall detection**
  - provide **gait information** for the doctors
- **how ?**: accepted mechanical design

# Walking aids

## ANG-light:

- gait monitoring through trajectory reconstruction
- fall detection: accelerometer
- wifi, phone, gps
- **Cost:** 400 euros





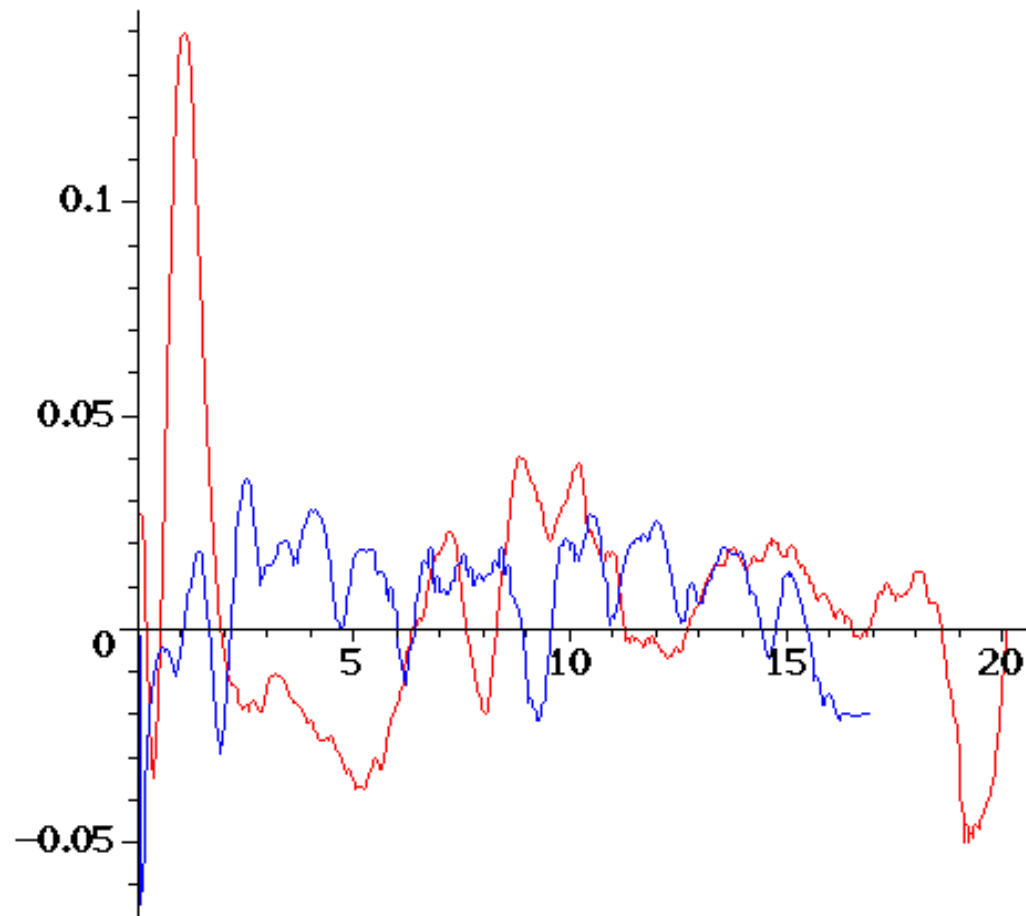
# Walking aids

- MMT is used to determine the walker trajectory based on the wheels rotation and accelerometer measurements
- currently being tested with real patients at Nice hospital



# Walking aids

Typical record



# Walking aids

## ANG

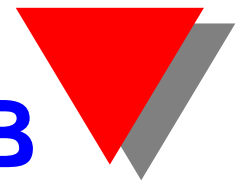
- 150W motors
- electric clutches
- > 50 sensors
- solar panel
- active fall prevention
- control: tv remote, radio, IR, ..
- automatic homing
- fallen object recovery
- GPS, wifi, bluetooth
- **Cost:** 2000 euros

VIDEO

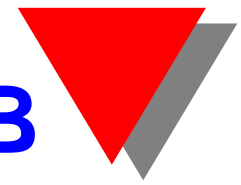




# Rehabilitation: **MARIONET-REHAB**



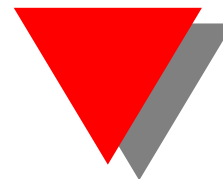
# Rehabilitation: **MARIONET-REHAB**



At home rehabilitation, with the following modes:  
**passive** (monitoring), **semi-active** (decreasing fatigue),  
**active** (sophisticated rehabilitation protocol)



# Conclusion

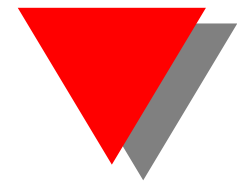




# Conclusion

The **components** of an assistance device:

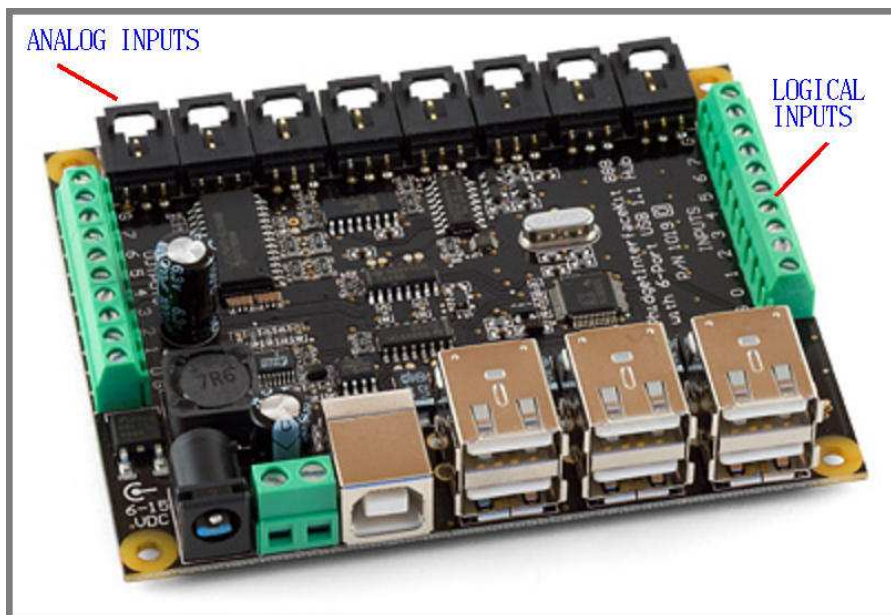
- computers
- sensors and actuators
- communication
- mechanism



# Conclusion

computers: new embedded computers allow to

- manage and control easily sensors and actuators
- are low-cost and wearable





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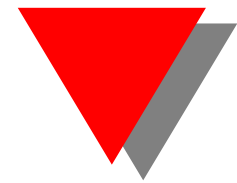
sensors: low cost sensors are already available

communication chips are almost common



# Conclusion

Hence MMT will play a central role in assistance devices



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- innovative design:
  - that are intrinsically safe
  - whose control is simple (**design for control**)





# Conclusion

Hence MMT will play a central role in assistance devices

- innovative design
- modular/adaptable design
  - low-cost
  - easy to install and maintain



# Conclusion

Hence MMT will play a central role in assistance devices

- innovative design
- modular/adaptable design
- design methodology:
  - that takes **uncertainties** into account to guarantee performances
  - that provides several set of solutions to be able to manage unexpected installation constraints



# Conclusion

Hence MMT will play a central role in assistance devices

- innovative design
- modular/adaptable design
- design methodology

**Let's go to work!**