Inteligencia Artificial en el Ámbito de la E-salud.

U. Cortés

2010

Disclaimer

¡Gracias por invitarme!

No soy MÉDICO

Soy un profesor universitario que coordina proyectos europeos en el área de las TIC aplicadas a la medicina

Puedo estar equívocado

ICT & Ageing: A social necessity an economic opportunity

- 80+ population: doubles until 2050
- 60+ population: from 20% in 1995 to 25% in 2020
- 50+ population: 21% has severe vision/ hearing/ dexterity problems
- Today 4 working for 1 retired, in 2050 only 2 working for 1 retired
- Cost of pensions/health/long-term care: up by 4-8 % of GDP (2025)
- Shortfall of care staff

ICT & Ageing: A social necessity an economic opportunity

Wealth and revenues in Europe of persons over 65 is over 3000 B€

Smart homes market will triple between 2005 and 2020

Early patient discharge by tele-health: reduced cost of 1,5 B€ p.a. (DE)

Tele-care technology at home: Empowerment of elderly and efficiency gains of 25% (UK)

ICT and AI in support (elder) citizens

At work

Staying active and productive for longer

Better quality of work and work-life balance

At Home

Overcoming isolation & loneliness

Keeping up social networks

Accessing public services

In Community

Better quality of life for longer

Independence, autonomy and dignity

AI Tools (after Pollack's seminal ideas)

Assurance tools

To provide continuous information about user's environment and his/her status/localization

Compensation tools

Navigational Support

Schedule Management

Activity guidance

Assessment Systems

To provide continual, naturalistic assessment of their cognitive status

Cognitive Aids

Para ver esta película, debe disponer de QuickTime™ y de un descompresor


HARE
it

Index

Target Population

Objectives

To develop next generation assistive systems that empower persons with (in particular cognitive) disabilities and aging citizens to play a full role in society, to increase their autonomy and to realize their potential.

To Whom

- **Individuals with disabilities**
- **Post - Stroke patients**
- **Demented patients (Alzheimer disease)**

BUT not only

User profile

- Hemiparesis
- Neglect
- Aphasia
- Apraxia
- Agnosia
- Memory deficits
- ....

Physical

Cognitive

Mixed

Mild

Moderate

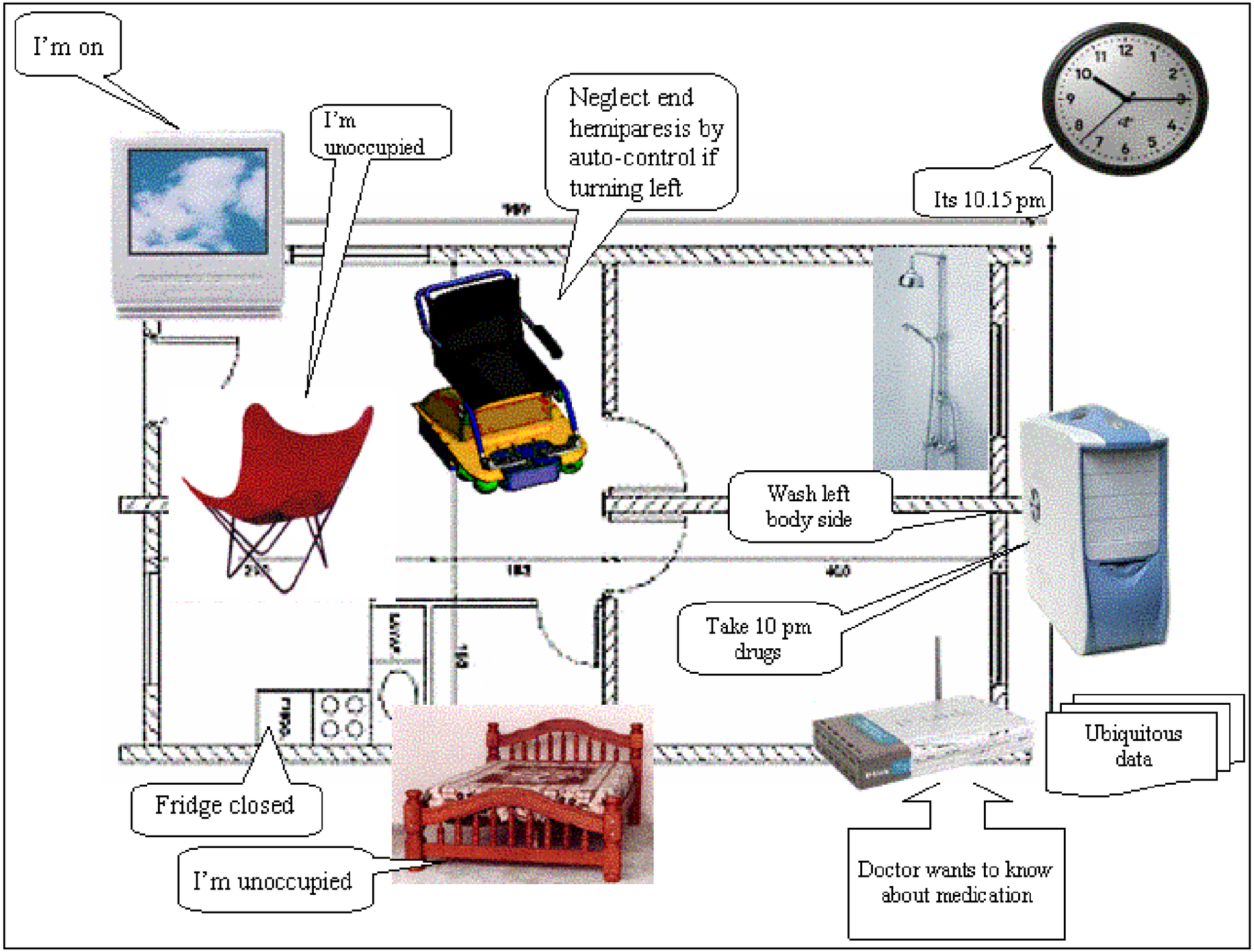
Severe

Patient sample

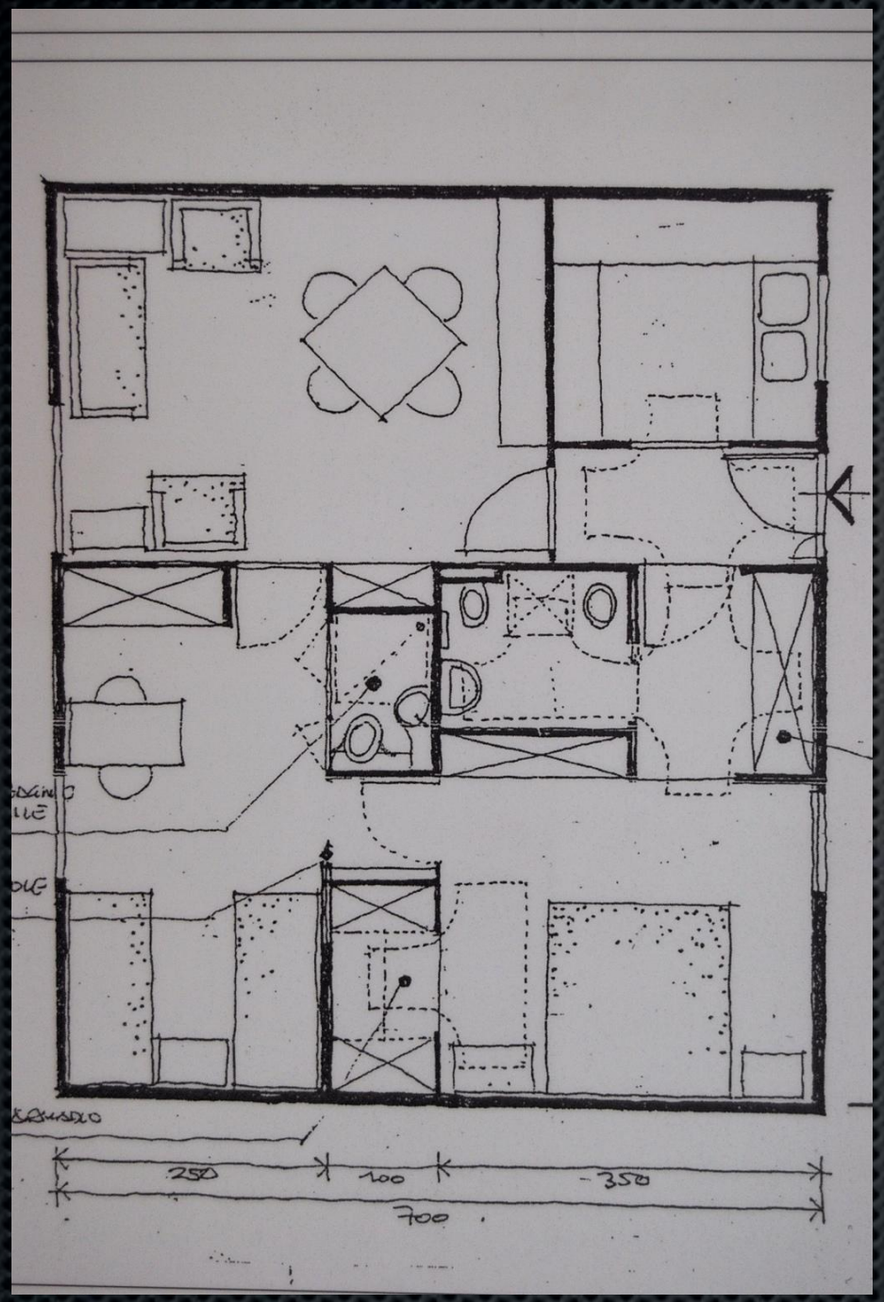
- **21 patients:**
  - **5 cognitive with Alzheimer Disease**
    - **4 mild impaired**
    - **1 moderate impaired**
  - **16 mixed post-stroke**
    - **8 mild impaired**
      - **1 neglect**
      - **2 aphasia**
    - **8 moderate impaired**
      - **5 neglect**
      - **1 aphasia**

Scenarios

Scenarios allow to model mission-critical applications inside home



Environment: *Casa Agevole*



Casa Agevole

Para ver esta película, debe disponer de QuickTime M y un descompresor

Narrative Description

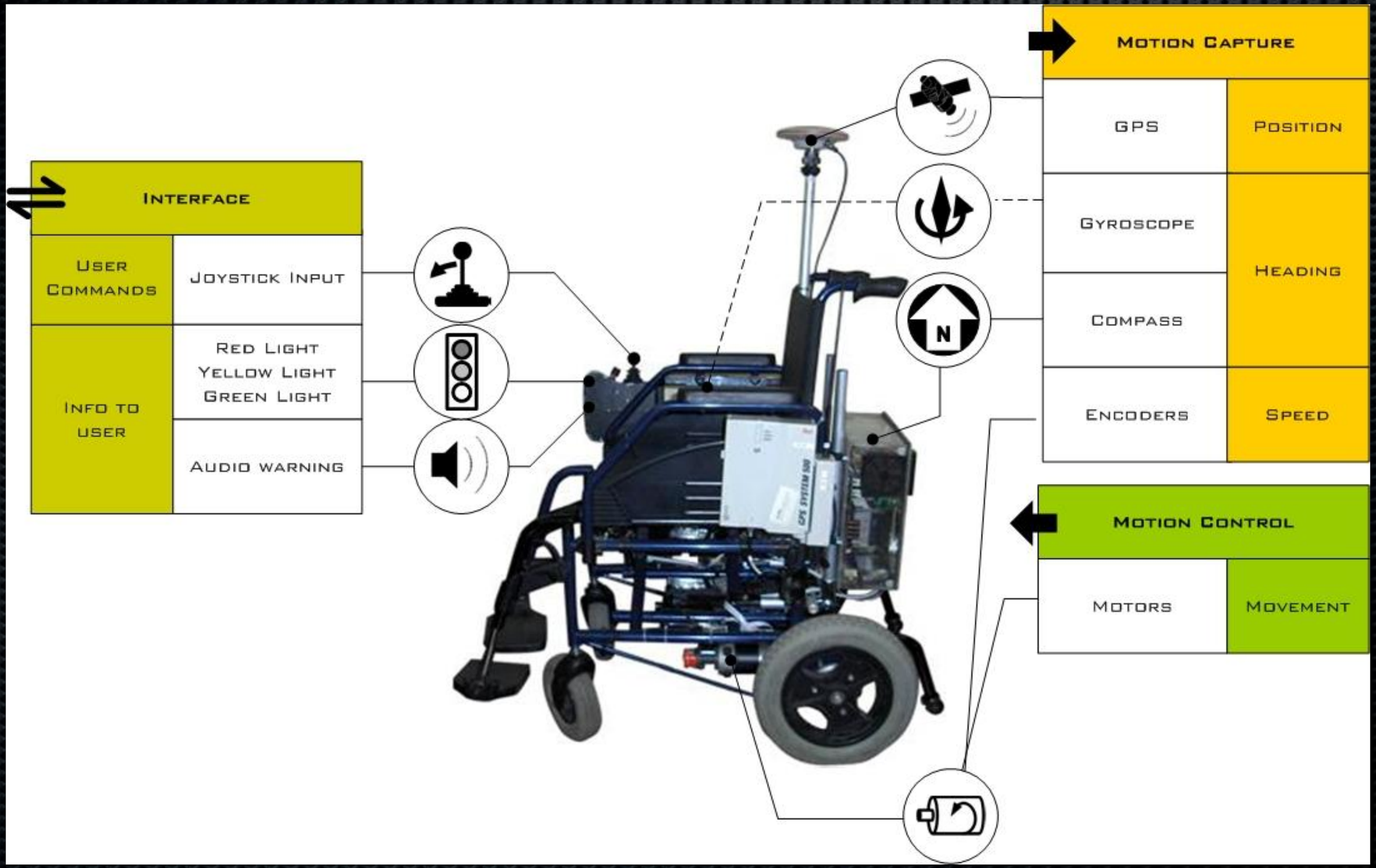
Alberto uses an i-Walker: he has *not a real deficit of the gait*, but – as many cognitively impaired patients – he feels much more confident if he can rely on a walking aid. He usually wakes up at 9 a.m. After having had his breakfast, Alberto has to take some pills, as part of his drug therapy but – since he suffers from memory impairment – he cannot always remember that. The same situation repeats three times: after breakfast, in the middle of the afternoon, and at dinner. Early, in the morning, before leaving home Alberto's daughter subdivides the proper amount of the different drugs that have to be taken during the day in three boxes – one for each medication episode – different for colour and shape. This requires minimum effort from the caregiver and the support of the system will allow Alberto to manage his therapy alone. At 10:00 a.m. the screen mounted on *the i-Walker shows the system reminder; it consists of both a visual suggestion and a sound alarm*, inviting Alberto to take his pills. *The system asks then Alberto to confirm to have taken his drugs. If the system does not receive it, it will send an alarm message (via SMS) to the caregiver*. The same procedure will be repeated every time Alberto has to take his therapy...

Mobility Platforms

Intelligent mobility platforms

- **Enhancing user's autonomy**
- **Different ways of interaction**
  - **–Voice**
  - **–Touch-pad**
  - **–Traditional controllers**
  - **–Pre-programmed**
- **Adaptable to the user**
- **Adaptable to the environment**
- **Reactive**
- **Proactive**
- **Safe**

A mobility platform as sensor

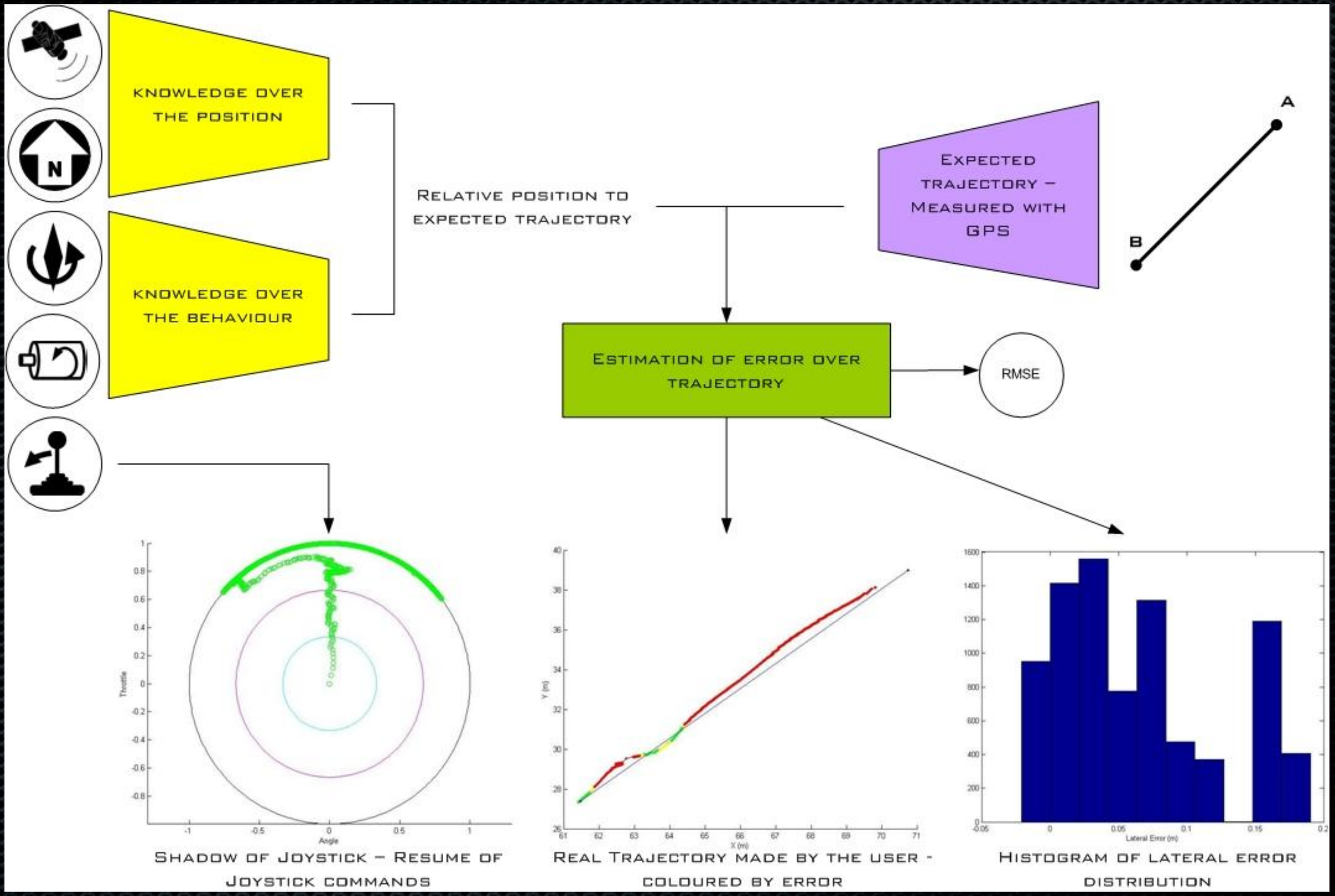


Mobility platform data mining sources

	Data Adquisition Rate			
GPS	1 second		Adquires Absolute position of the chair	Combined provides knowledge over the position
Compass	1 second		Adquires absolute heading of the chair	
Gyroscope	5.85 milliseconds	171 times / second	Senses the variation of the heading angle of the chair	Combined provides knowledge over the behaviour
Encoders	5.85 milliseconds	171 times / second	Adquires the current velocity of each wheel	
Joystick	5.85 milliseconds	171 times / second	Interfaces the user. his/her commands are registered	

	Action Update Rate			
Motors	5.85 milliseconds	171 times / second	Provides Boost to each wheel. Differences in each wheel's speed allows the chair to turn and rotate	
Warning lights	5.85 milliseconds	171 times / second	Visually warns the user if he/she is heading out the predefined path	Combined warning
Auditive warning	5.85 milliseconds	171 times / second	Audio warning if the user is heading out the predefined path	

Data mining results



SHADOW OF JOYSTICK – RESUME OF JOYSTICK COMMANDS

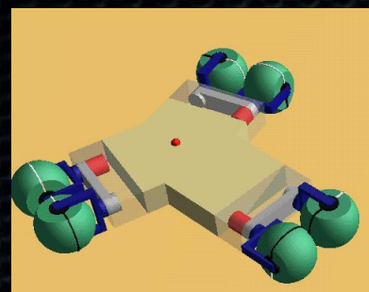
REAL TRAJECTORY MADE BY THE USER - COLOURED BY ERROR

HISTOGRAM OF LATERAL ERROR DISTRIBUTION

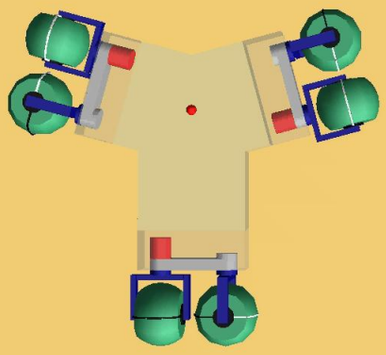
Rolland III

Spherik

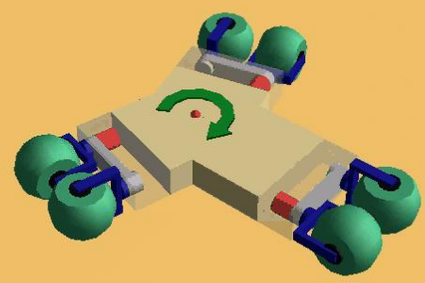
Spherik Kinematics



Longitudinal



Transversal

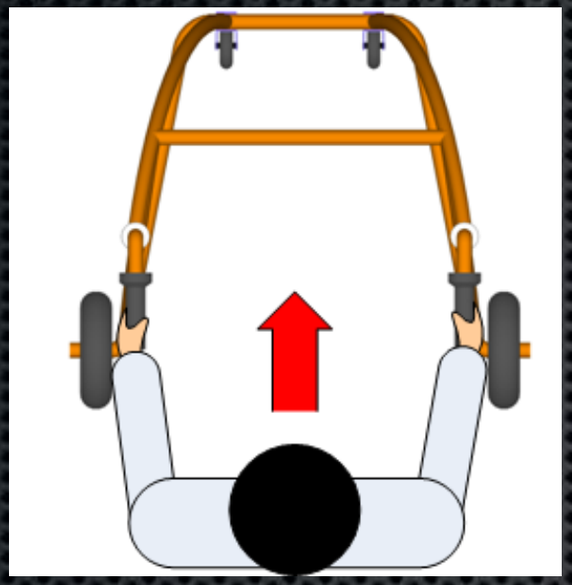


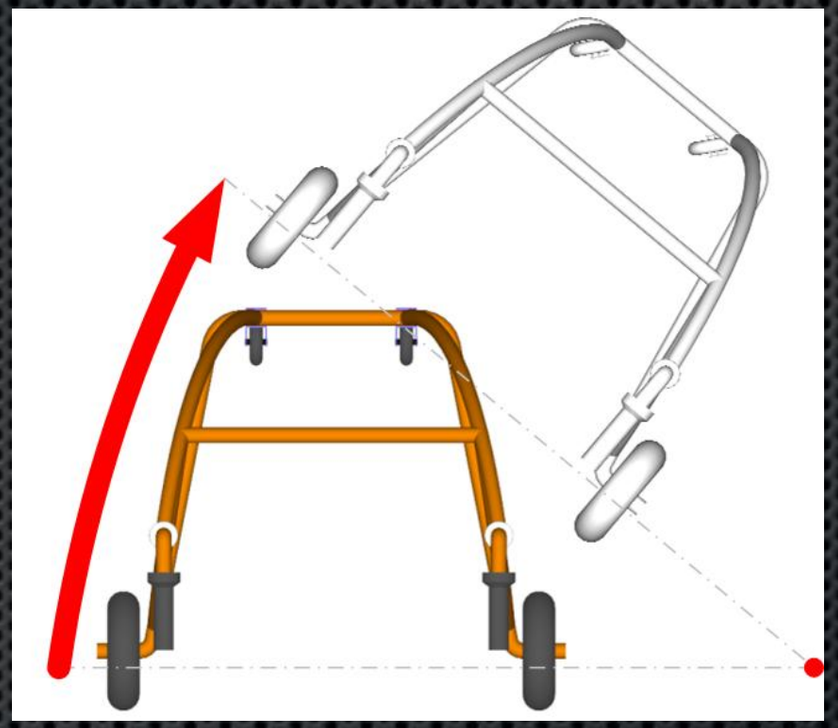
Turn

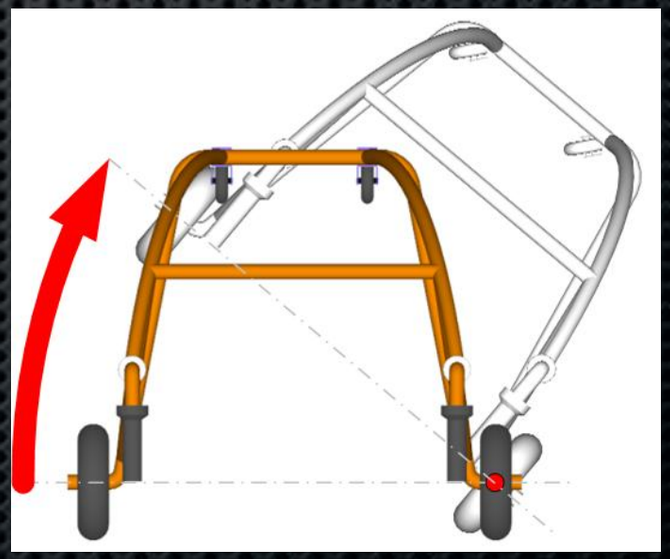
CARMEN

i-Walker

Computer-controlled brake actions





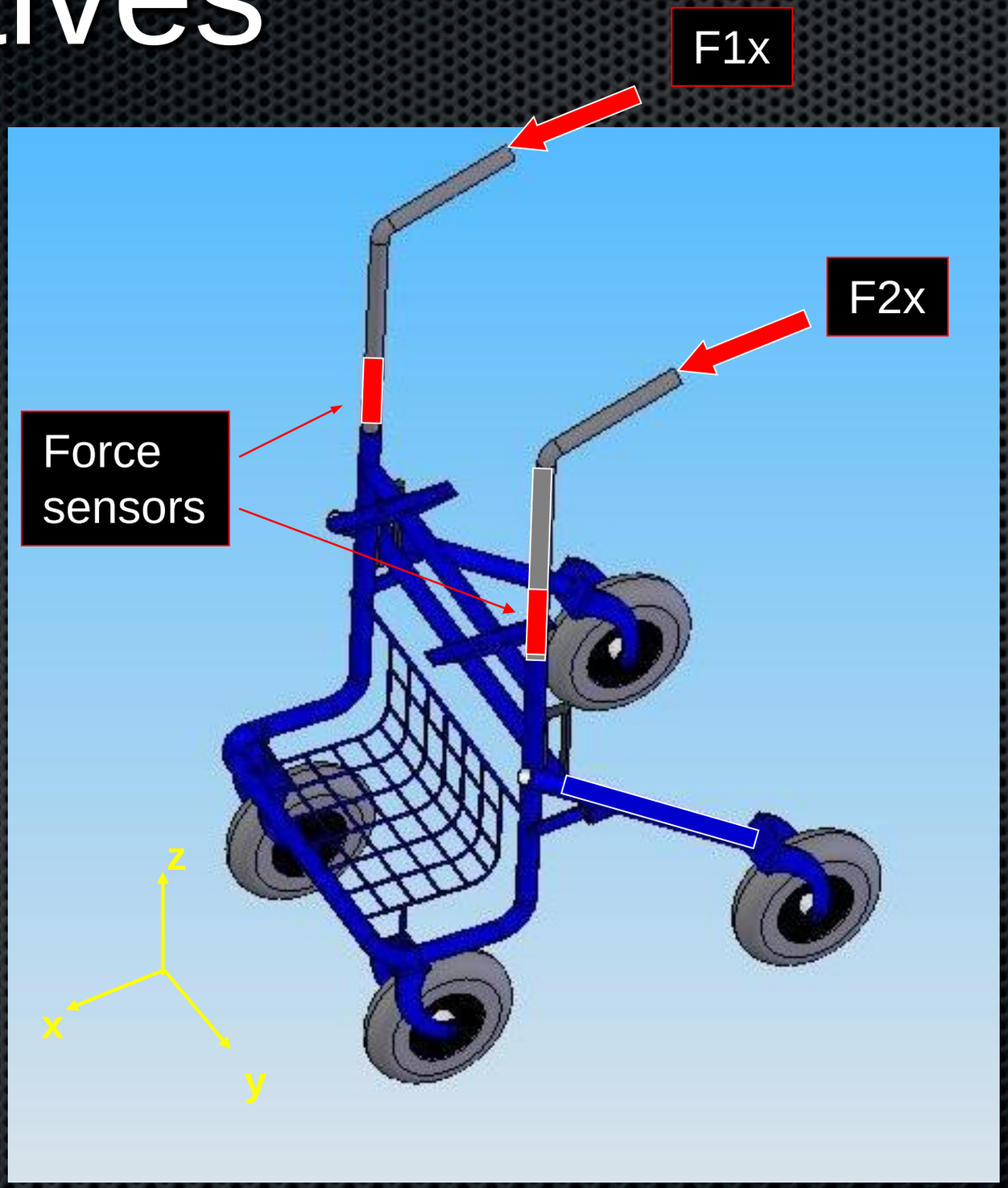


The i-Walker can guide the user when his/her orders are wrong

Setting Definition & Objectives

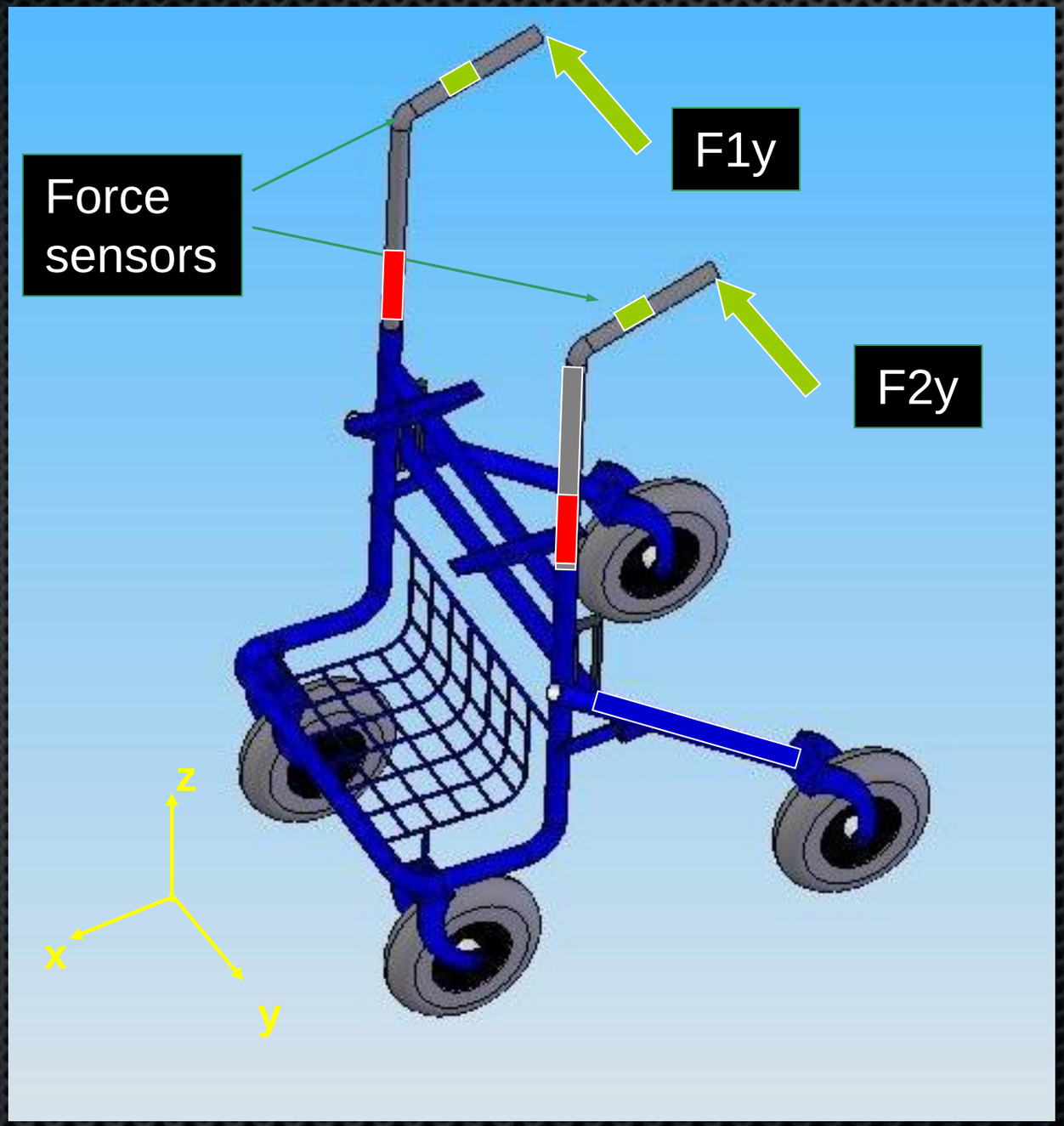
Measurement of the forces.

Setting Definition & Objectives



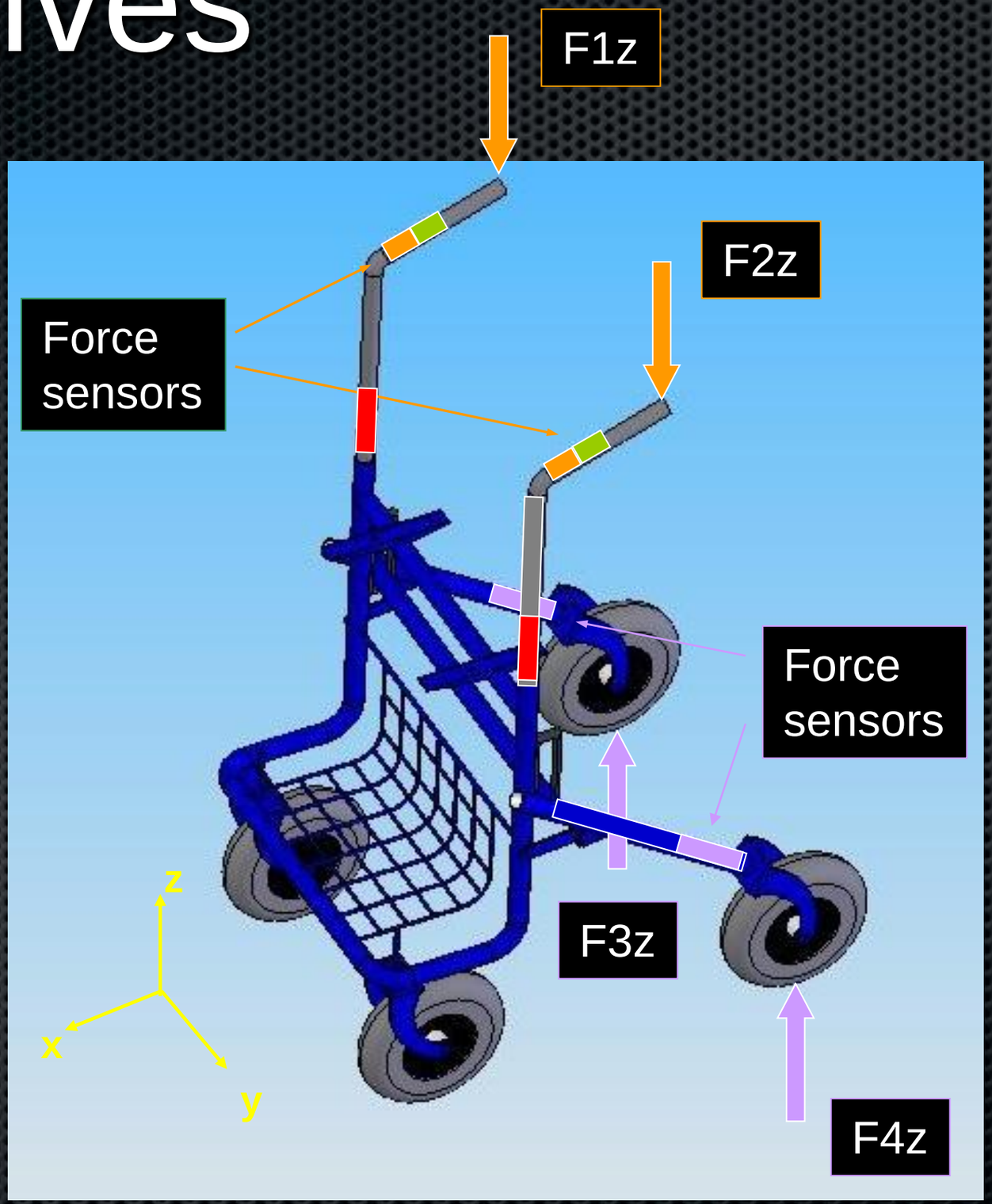
Measurement of the forces..

Setting Definition & Objectives



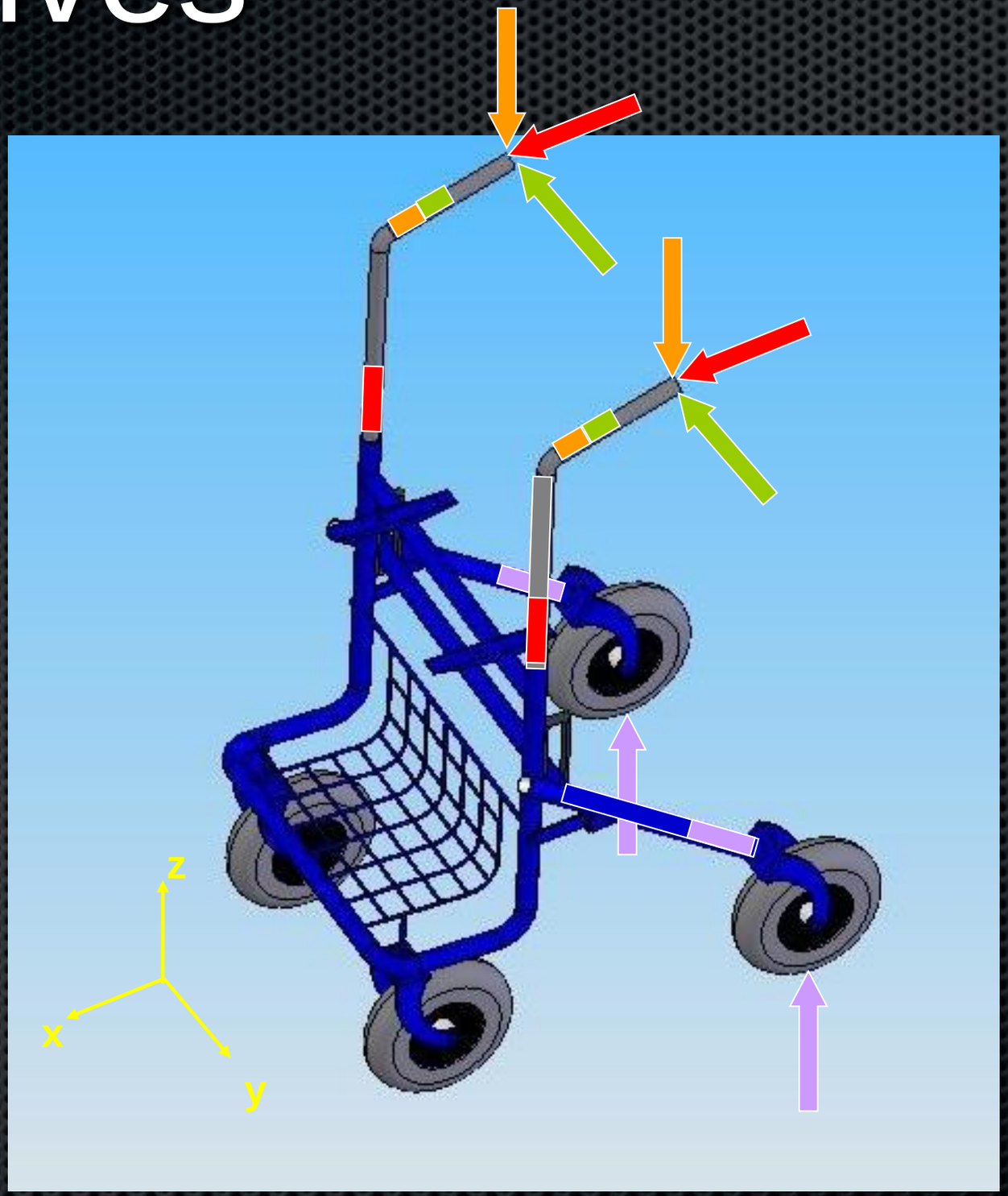
Measurement of the forces.

Setting Definition & Objectives



Measurement of the forces.

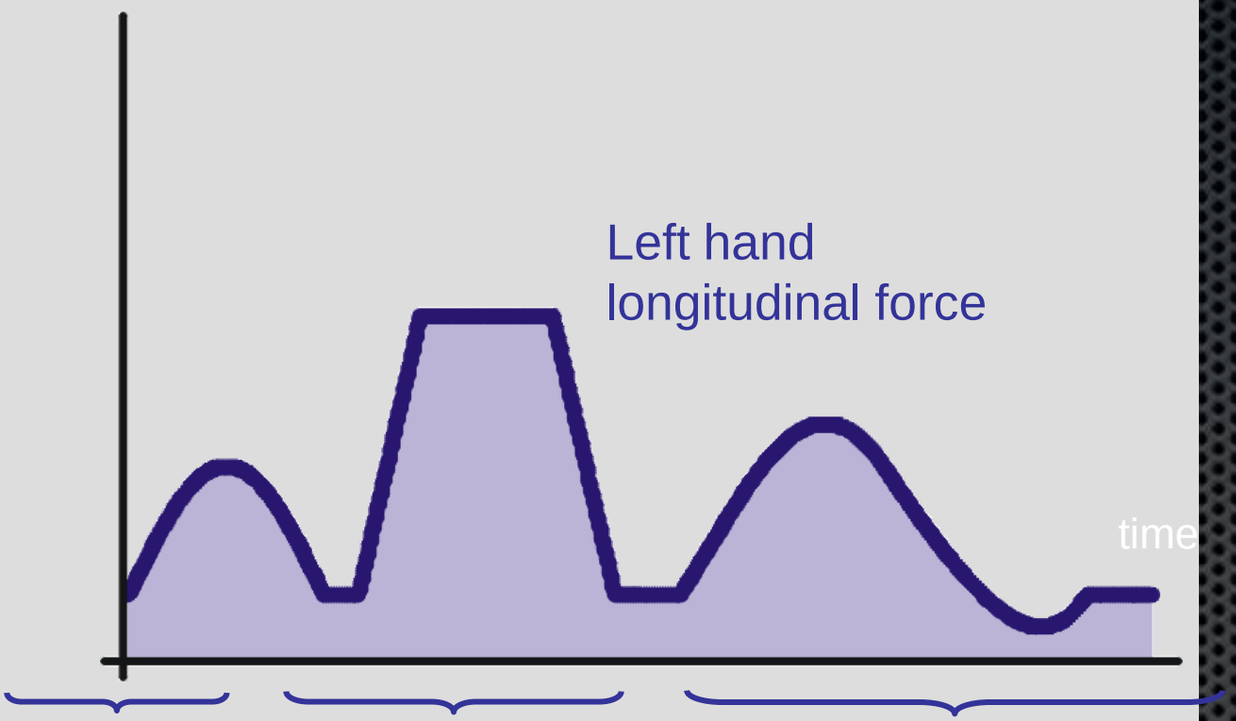
Setting Definition & Objectives



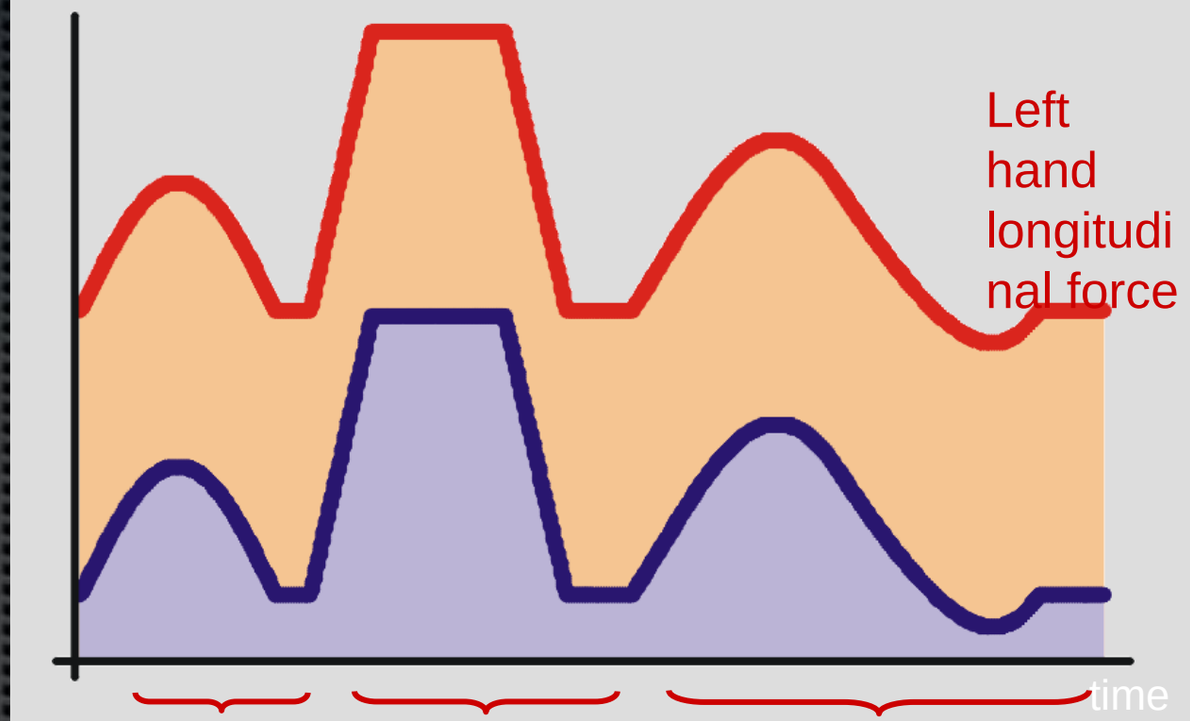
Measurement of the forces.

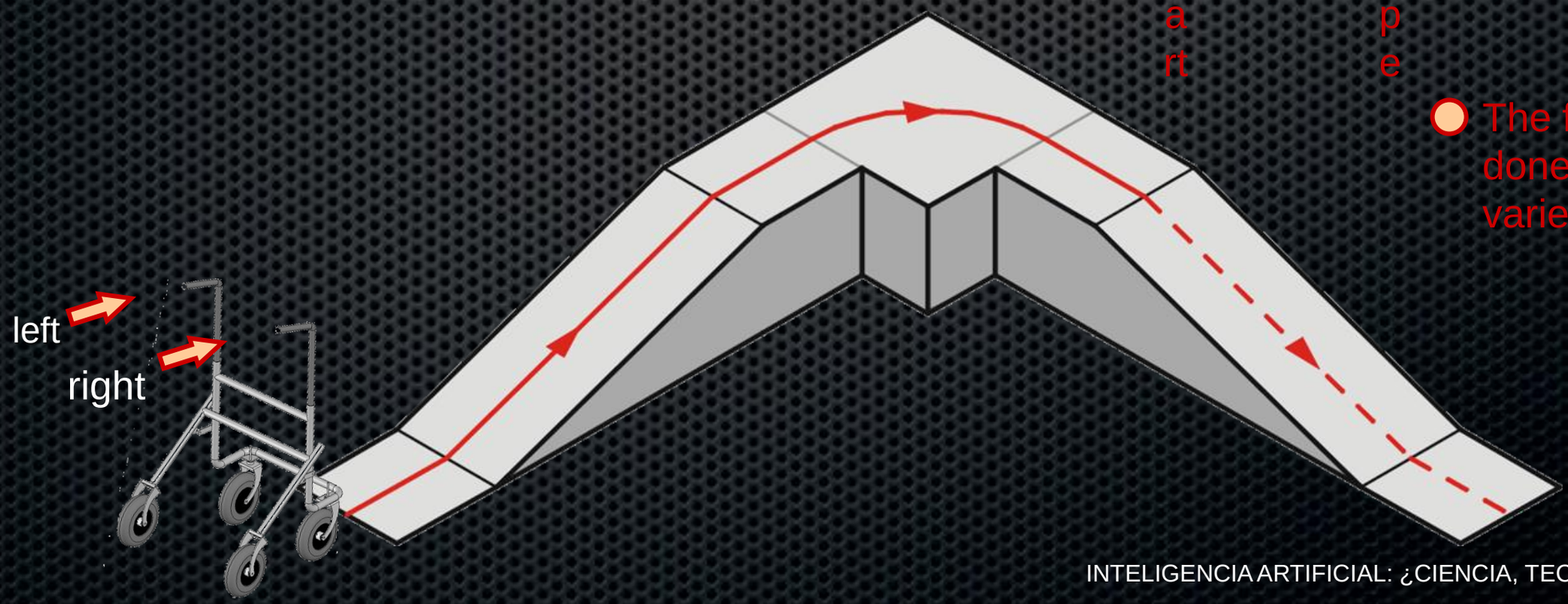
Mechanical Analysis. Motor torque strategies (I)

Without motor torques



With constant braking torques

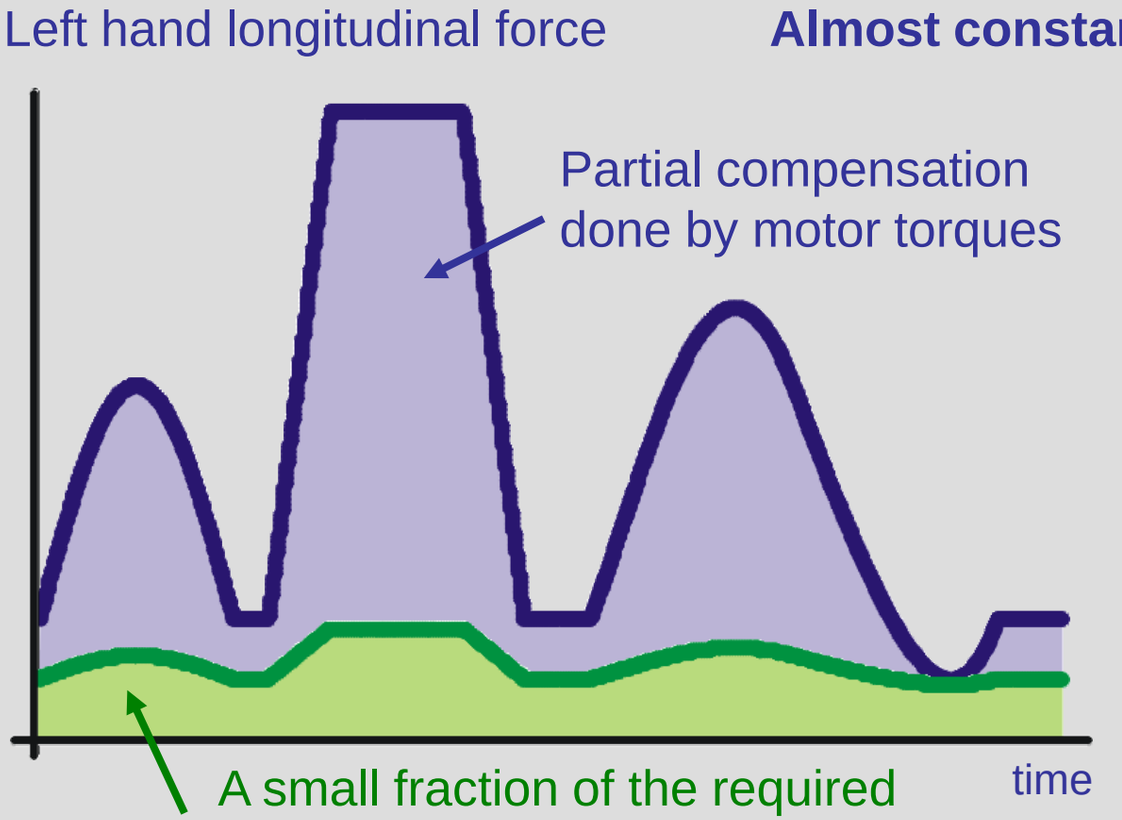


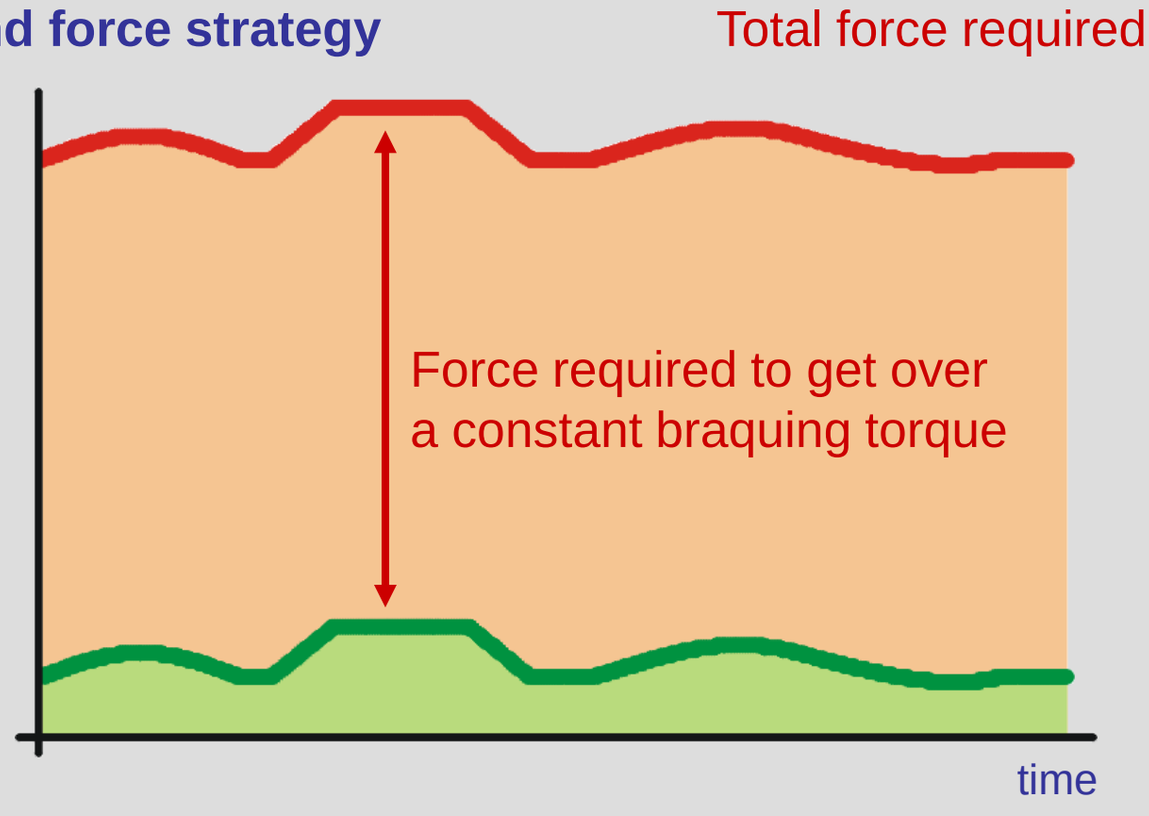


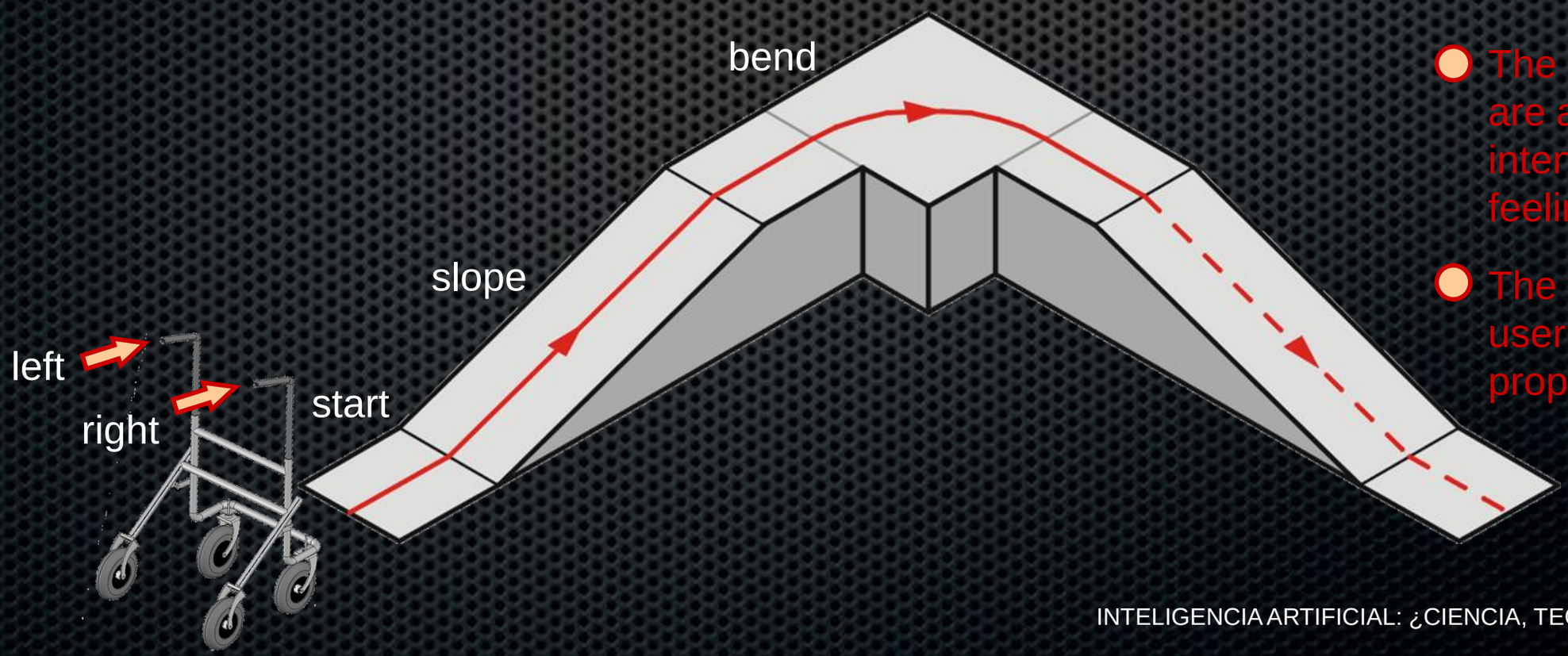
- The force, and work, done by the user varies along the path.

Mechanical Analysis. Motor torque strategies

Almost constant hand force strategy







- The small fluctuations are associated to user intent detection and feeling.
- The work done by the user is almost proportional to the path.

Areas/domains supported by SHARE-it services

- Security Assistant
- Driving Assistant
- Route Assistant
- Multimodal driving Assistant
- Multiobjective navigation
- Shared control

Cognitive Aids

Areas/domains supported by SHARE-it services

- Mobility
- Transfer
- Take a medication
- Preparation of meals
- Shopping
- Dressing
- Reminders
- Safety (Alarm)
- Exchange of information

Servicies

- Remainders
- ADL
- Help request
- Tutorials

Shared control (some ideas)

- **Autonomy**, in an agent, can be defined as the ability of performing a activity
- *Sharing* own **autonomy** implies the will to give someone some permissions to perform in our behalf

- **Why to share?**
- **When to share?**
- **With whom?**

Shared control (maybe an answer)

- **Autonomy**, in an agent, can be defined as the ability of performing a (desired) activity

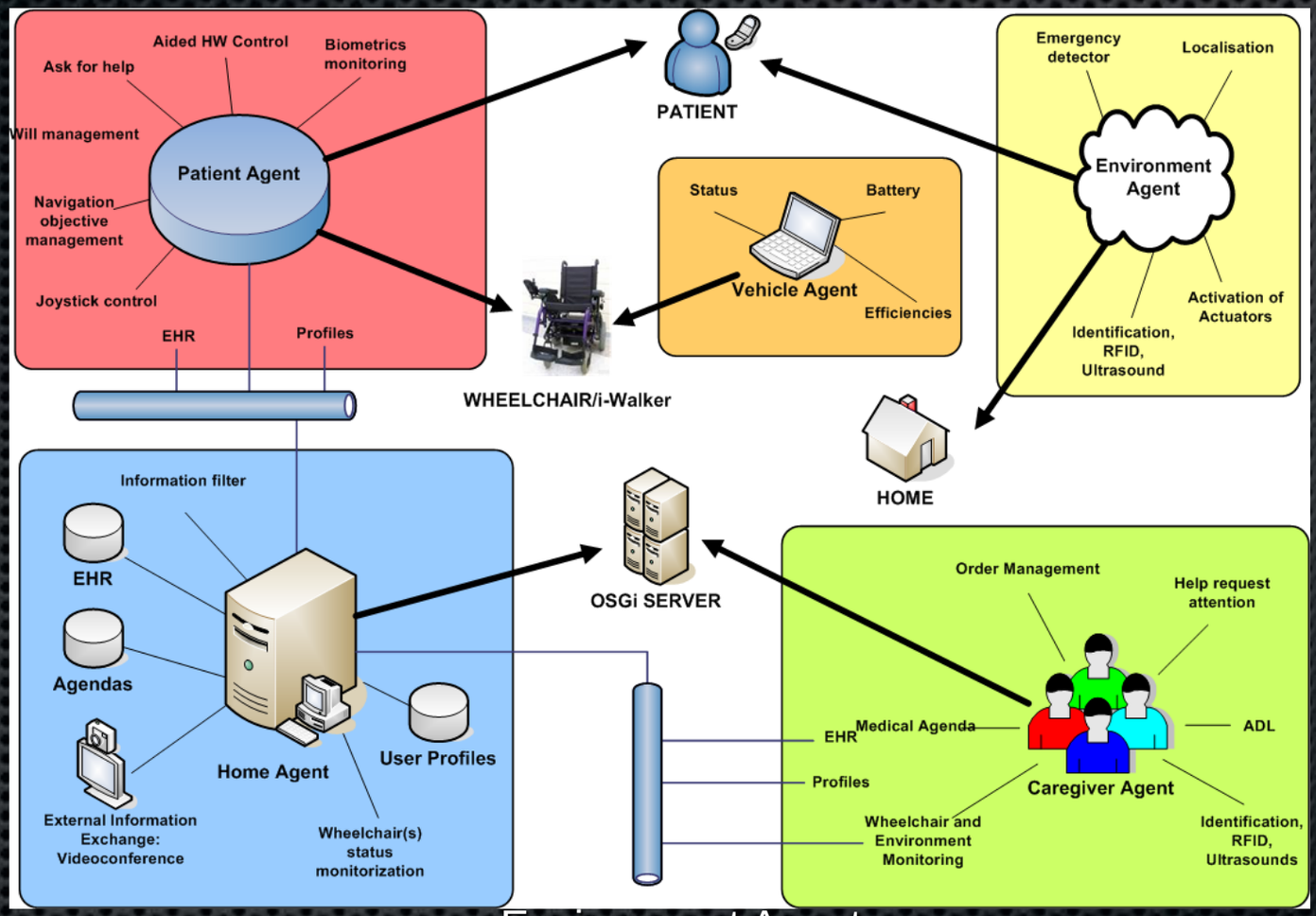
- ***Sharing*** own **autonomy** implies the will (compromise) to give someone *some* permissions to perform in our behalf

- Why to share? **I know that I have problem and/or comfort**
- When to share? **[Never, When need, only at some point]**
- With whom? I **trust you**

SHARE-it MAS

Patient Agent provides all the available and permitted services to each user (security, mobility, help, monitoring)

Home Agent has the objective of monitoring the users and managing their profiles



Environment Agent processes information from all available sensors and distributes it to all the agents interested

Vehicle Agent is intended to manage route requests, plan making, contribute to shared control.

Caregiver Agent permits the caregiver to monitor some user's data

Environment agent

Beliefs	Goals	Plans
•Sensing environmental set •Acting environmental set •Date	•Sensor connection •Check readings •Add capability •Remove capability •Add sensor •Remove sensor •Add capability interaction	•Sensor server •Sensor connection •Check sensor readings •Add capability •Remove capability •Add sensor •Remove sensor •Add capability interaction

Vehicle Agent

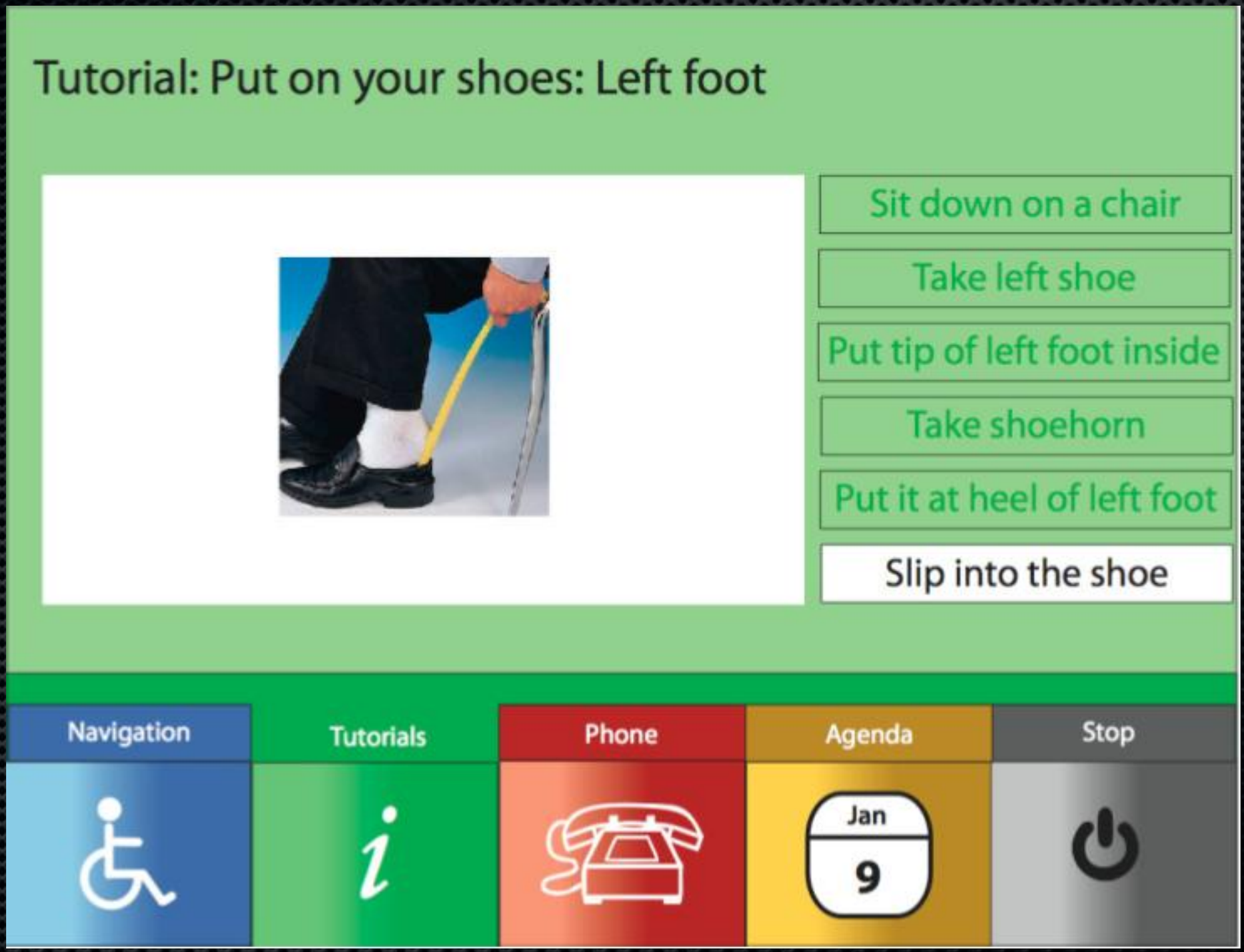
Beliefs	Goals	Plans

• Status monitor set
• Fall detection
• Battery monitor
• Self-diagnoser set
• Case set
  • Profile
  • Efficiency
  • Spatial situation
  • Disagreement
  • Navigation control
	• Monitor status
	• Detect fall
	• Handle fall
	• Low battery inform
	• Change battery
	• Monitor resources
	• Hardware failure management
	• CBR navigation management
		• Check status
		• Stop vehicle
		• Caregiver inform
		• Hardware failure inform
		• CBR navigation

Patient Agent

Beliefs	Goals	Plans
•Current ADL •Current time •Location •Duration •Activity •Tutorial •Learning •CBR	•Show Tutorials •Counter •Reminder •Review ADLs •Help Request •Learn	•Get Tutorials •Reminder •Counter •Register ADL •Review ADLs •Help Request •Learn

Tutorials


Tutorial: Put on your shoes: Left foot
Sit down on a chair
Take left shoe
Put tip of left foot inside
Take shoehorn
Put it at heel of left foot
Slip into the shoe
Navigation
Tutorials
Phone
Agenda
Stop
Jan
9

Tutorials

- Dressing (different code depending on the season)
- Cook Pasta (cook with me)
- Making coffee
- Toilet (washing hands/head… combing)
- Cleaning house (washing/ironing, vacuuming, etc)

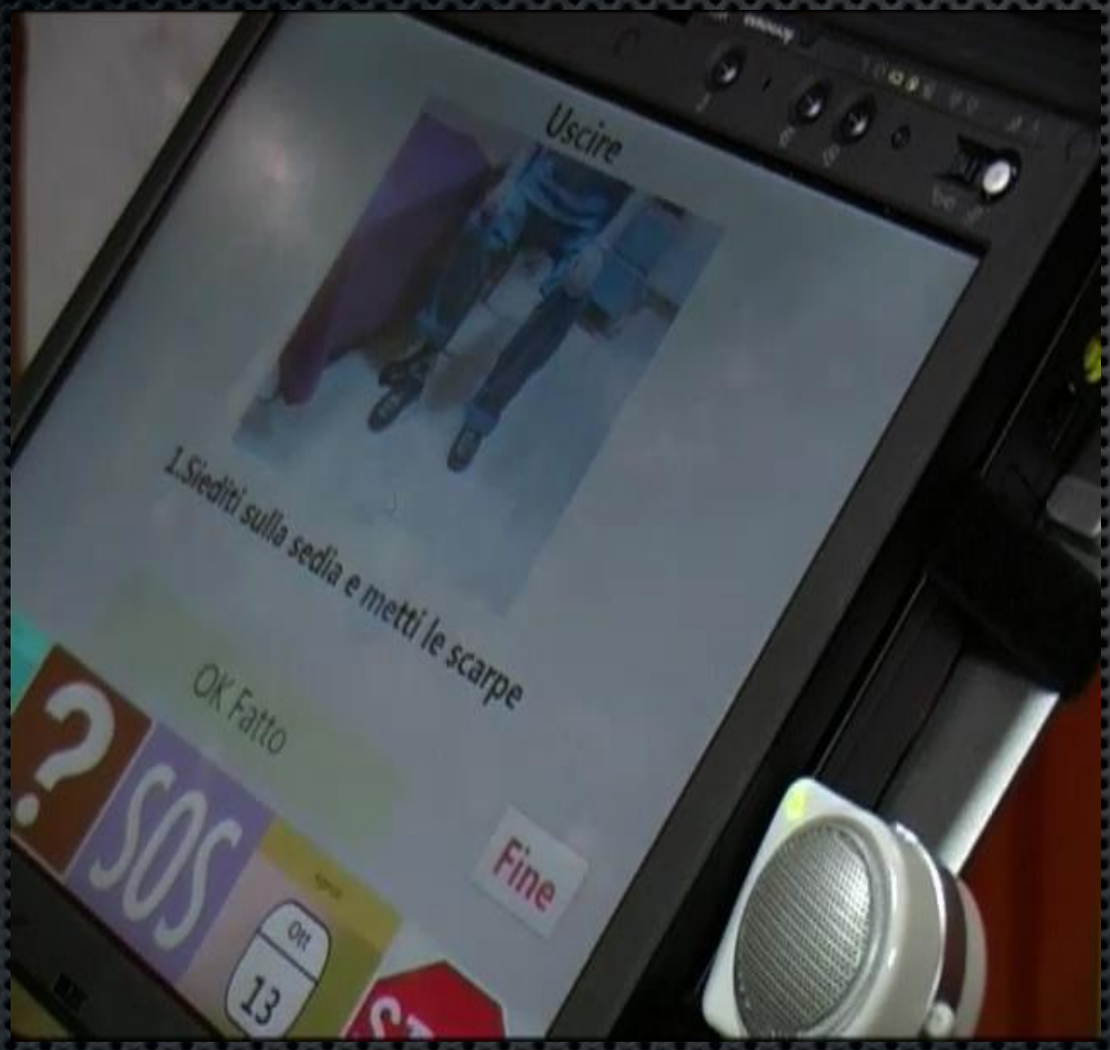
Tutorials

- Different resources:
  - Text
  - Sound
  - Images
  - Video

Tutorials

- Tailored to the user:
  - Different number of steps
  - Different *media*
  - Confirmation step
  - Built *on-demand* user's profile may change over time
- Context dependent

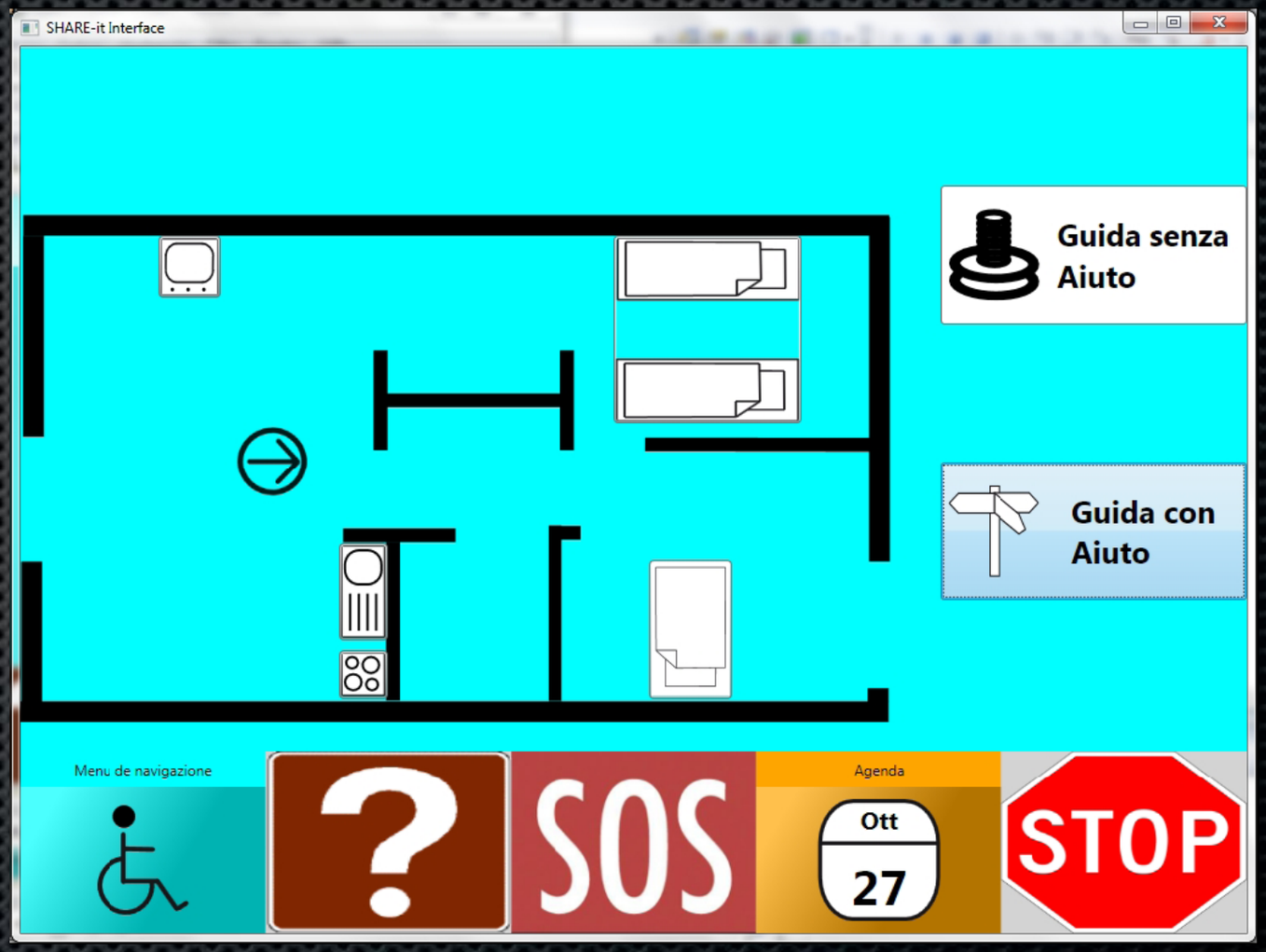
Interface touch-screen



- ✓ Orientation
  - spatial (navigation)
  - temporal
- ✓ Memory
  - Agenda
  - Reminder
- ✓ Tutorial
- ✓ Help

Interface touch-screen

- ✓ Orientation
  - spatial
  - temporal
- ✓ Memory
  - Reminder
  - Agenda
- ✓ Tutorial
- ✓ Help



Interface touch-screen

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  - Agenda
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- ✓ Help

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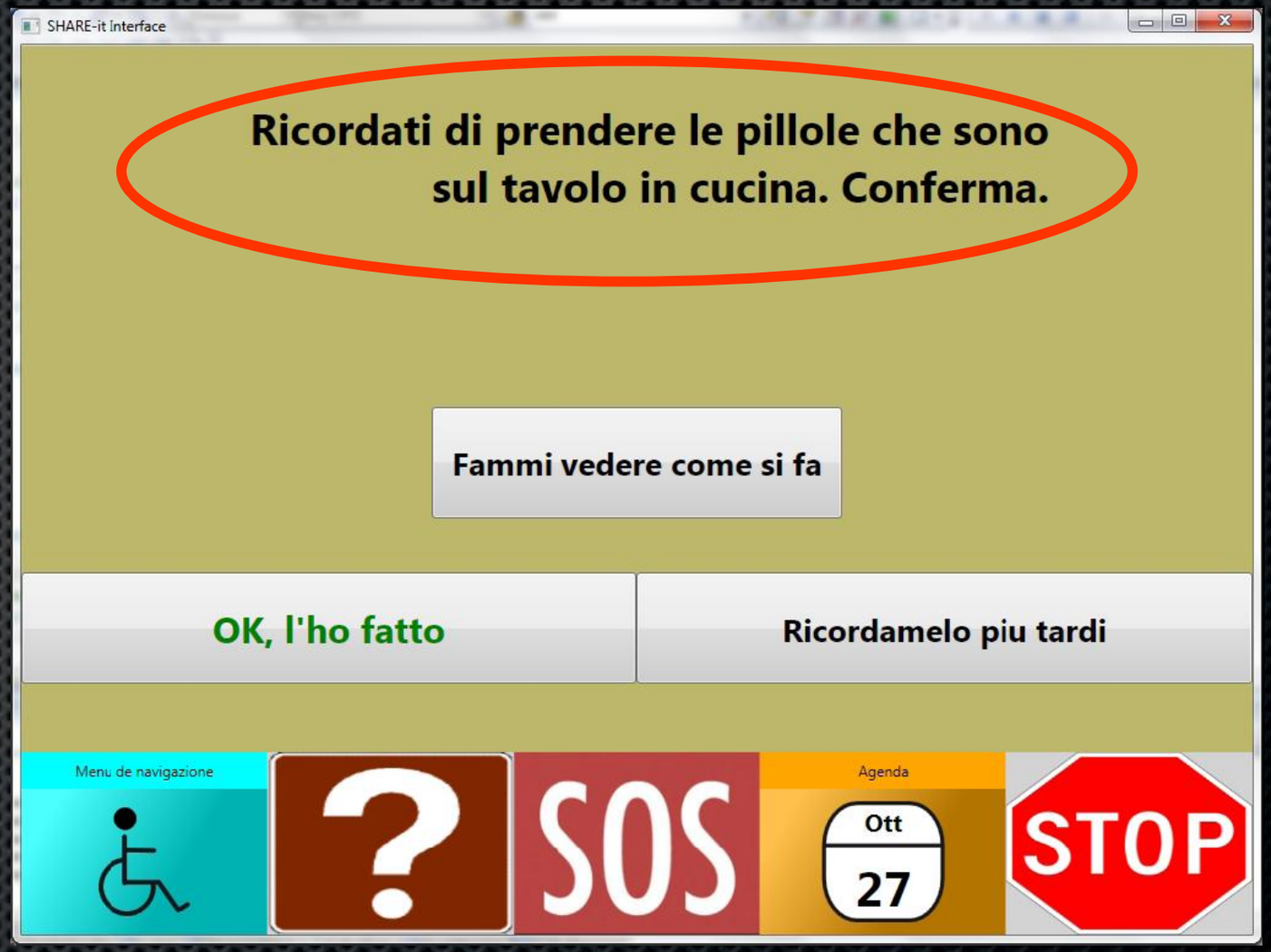

Interface touch-screen

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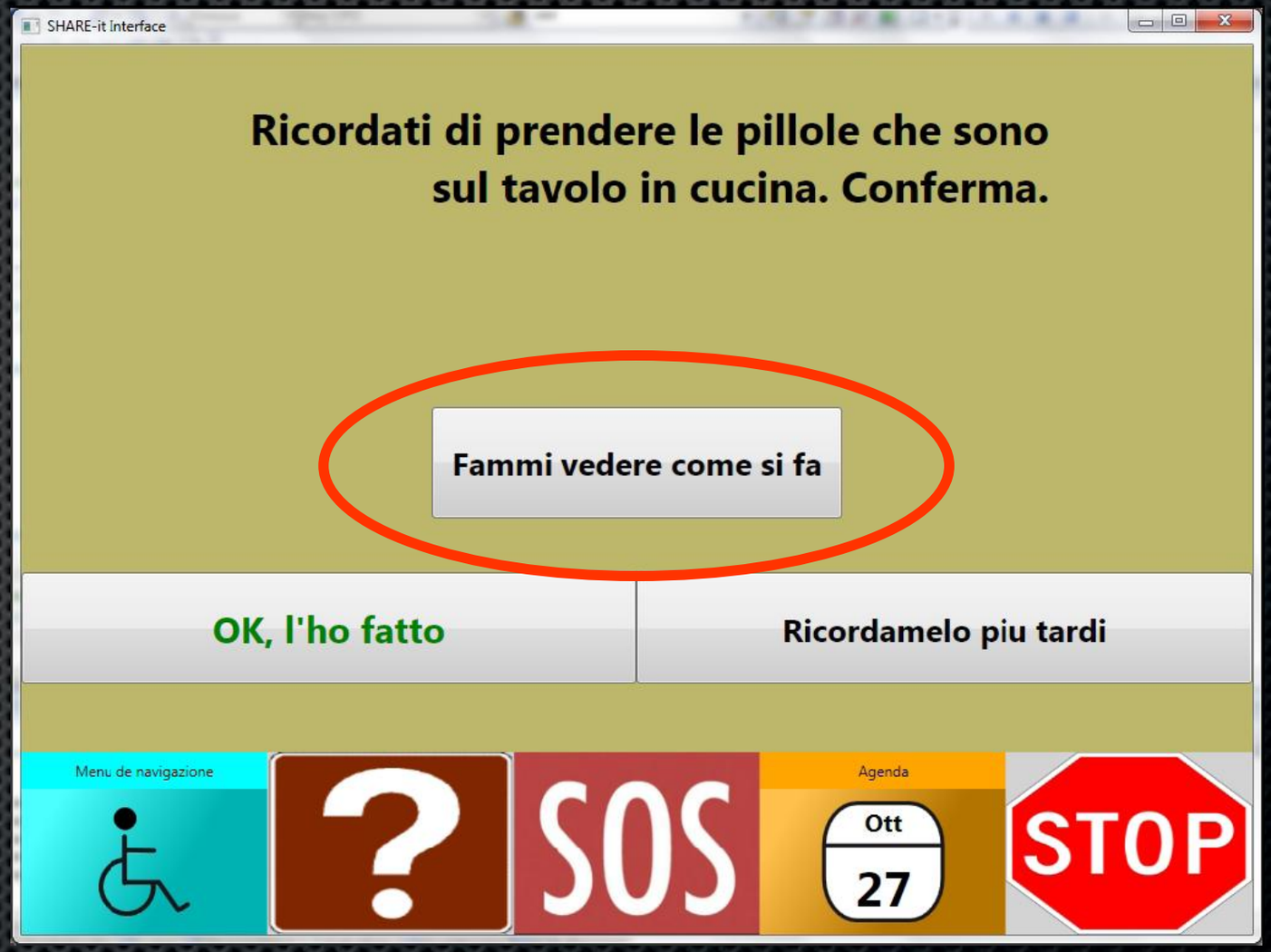

Interface touch-screen

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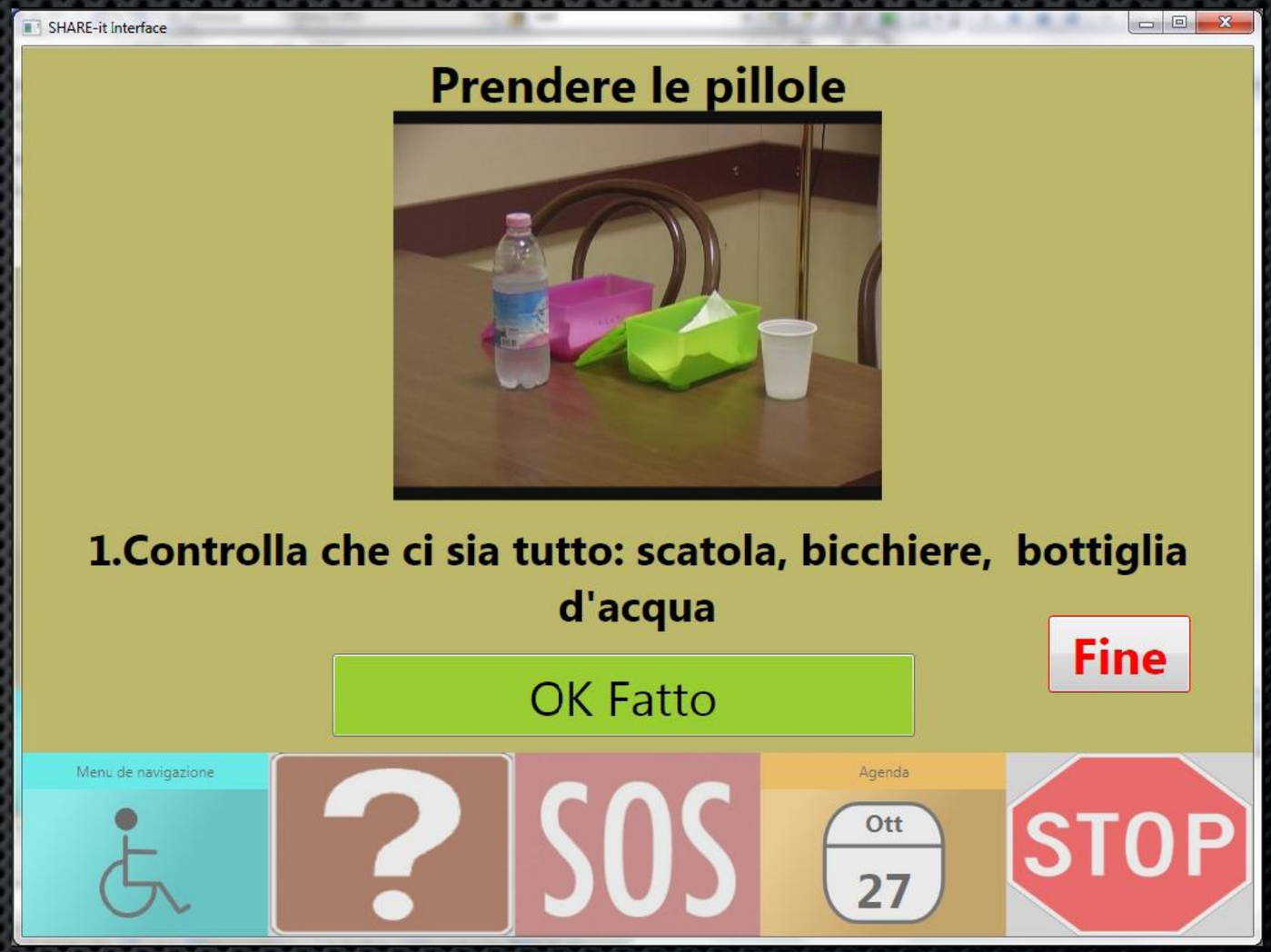


Interface touch-screen

- ✓ Orientation
  - spatial
  - temporal
- ✓ Memory
  - Agenda
  - Reminder
- ✓ Tutorial
- ✓ Help

Scenario 7: Alberto takes his drugs

- **Alberto** uses an **i-Walker**: he has *not a real deficit of the gait*, but – as many cognitively impaired patients – he feels much more confident if he can rely on a walking aid. He usually wakes up at 9 a.m. After having had his breakfast, Alberto has to take some pills, as part of his drug therapy but – **since he suffers from memory impairmen**t – he cannot always remember that. The same situation repeats three times: after breakfast, in the middle of the afternoon, and at dinner. Early, in the morning, before leaving home Alberto's daughter subdivides the proper amount of the different drugs that have to be taken during the day in three boxes – one for each medication episode – different for colour and shape. This requires minimum effort from the caregiver and the support of the system will allow Alberto to manage his therapy alone. At 10:00 a.m. the screen mounted on ***the i-Walker shows the system reminder; it consists of both a visual suggestion and a sound alarm***, inviting Alberto to take his pills. ***The system asks then Alberto to confirm to have taken his drugs. If the system does not receive it, it will send an alarm message (via SMS) to the caregiver***. The same procedure will be repeated every time Alberto has to take his therapy...

Scenario 7: Alberto takes his drugs

- Assistive device: i-Walker/CARMEN
- Disability profile: Cognitive
- Severity cluster: Mild

Scenario 7: Alberto takes his drugs

Escenario 3: Pietro goes to the church with the i-Walker

- Two years ago, Pietro suffered from a stroke. He recovered well and at moment he needs only a light support to walk, because he has left a mild decrease of strength in his left leg. Sometimes he is not confident enough in the sequence of actions needed to reach a goal. Today is Sunday and his caregiver has his day off. At eleven in the morning Pietro gets a reminder from the GUI that – if he wants to go to church – it is time to get ready. He is also reminded to put on his shoes, the overcoat, to turn off the lights, and to lock the door. He gets to the church, and while trying to open the church's door, he gets hampered and falls on the pavement. The i-Walker detects the fall. It is also detected that Pietro is lying motionless. At the same time, the BCM detects stress. Pietro's caregiver is informed via SMS of the alert. The SMS message includes Pietro's position information.

Scenario 3: Pietro goes to the church with the i-Walker

- Assistive device: i-Walker
-
- Disability profile: Mixed (physical + cognitive)
- Severity cluster: Mild
- Limitative symptoms: Aphasia

Scenario 3: Pietro goes to the church with the i-Walker

Real Scenarios

Para ver esta película, debe disponer de QuickTime™ y de un descompresor .

Medical Analysis

- Wheels are ideal for internal and external walks
- The height of the iWalker with respect to the user is correct.
- The angle of the user’s arms is correct (slightly flexed)
- The user’ feet position is correct
- The user’s body position (his back) during the parade is correct.

Medical Analysis (2)

- iWalker breaks so the user has not to retain the weight with his own effort.
- User’s arms remain in the same *normal* position. It is clear that he is making not an extra effort
- User’s feet keep in the same *normal* position
- User’s body remains in a correct position. He is not bouncing to the front.

Conclusions

- Disability is a condition in which an individual is unable to perform a *necessary* activity

- *SHARE-it* can compensate or expand the activity of a disabled subject through new forms of human-computer interaction

- *SHARE-it* improve users' autonomy

- *SHARE-it* improve professionals/users interaction

Conclusions

- *SHARE-it* may contribute to

- to improve home care (medical and social aspects)

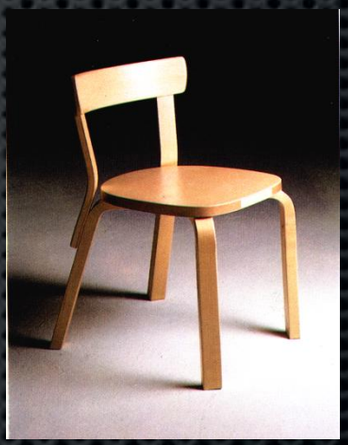
- to enhance the quality of life of disabled, senior citizens and their families

- to lengthen the time spent at their preferred environment and to postpone the need for institutionalization

- to reduce institutional and social costs

“The best way to predict the future is to invent it.”

Alan Kay



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