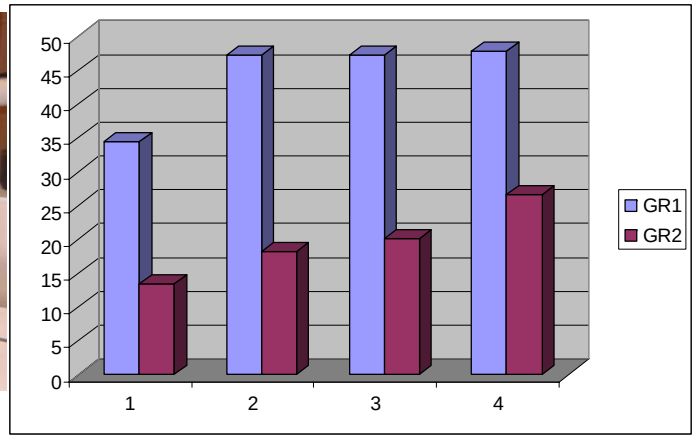
Robotica in riabilitazione

The “GENTLE” robot

The “GENTLE” robot provides therapy for upper limbs by real tasks with **an active grasping mechanism at the end of a robot arm and also through virtual reality with computer graphics where the user manipulates objects on a computer screen through a simple ‘reach and touch’ technique**

The GENTLE system has been developed by a European Consortium coordinated by the University of Reading. The prototype has been recently tested at the Battle Hospital with 11 patients affected by stroke (Amirabdollahian et al., 2003)

Motricity Index

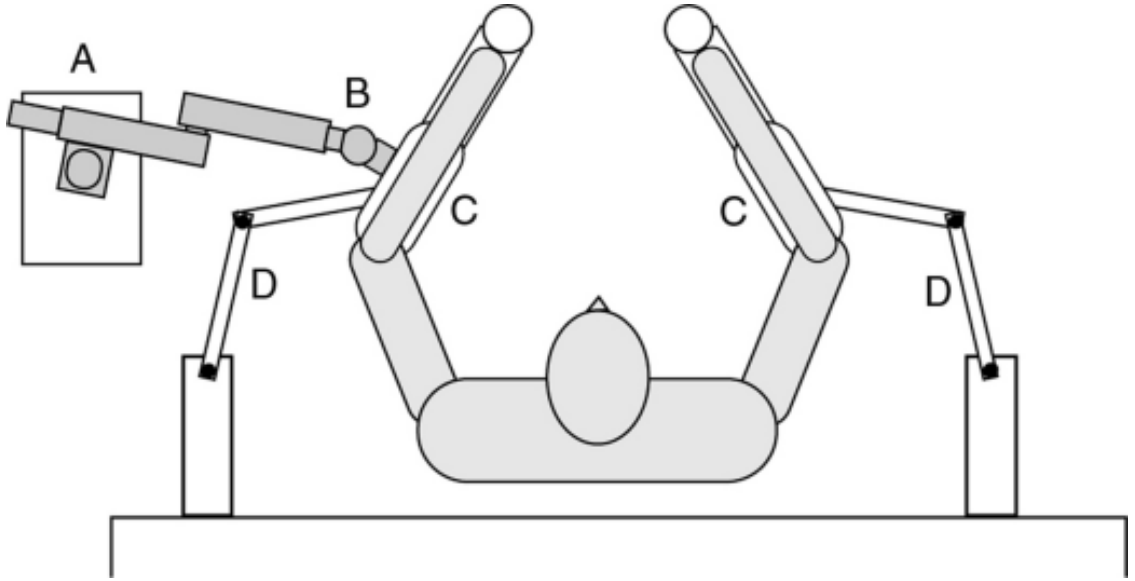


The subjects were randomly divided into two groups (GR1 and GR2) which used the robot before and after another rehabilitation procedure

The two groups showed an increased motor ability (as measured by motricity index)

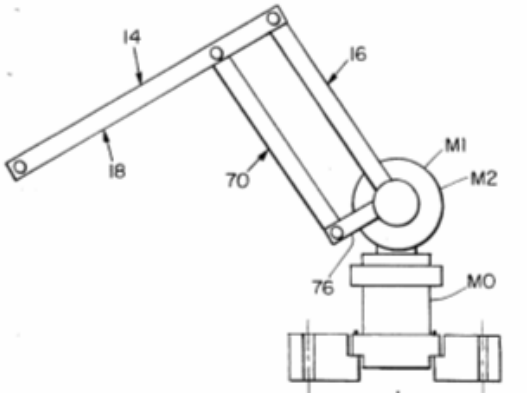
The “MIME” System

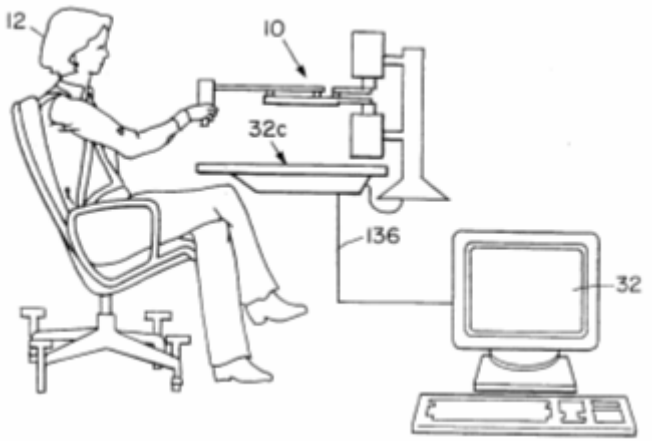
- The MIME system was developed in the framework of the Stanford Robotic Aid Project in collaboration with the US VA Spinal Cord Injury Service
- The MIME uses two standard mobile arm supports that limit the movements to the horizontal plane, and a 6DOF robot arm that applies forces and torques to the arm of the patient



The MIT-MANUS System

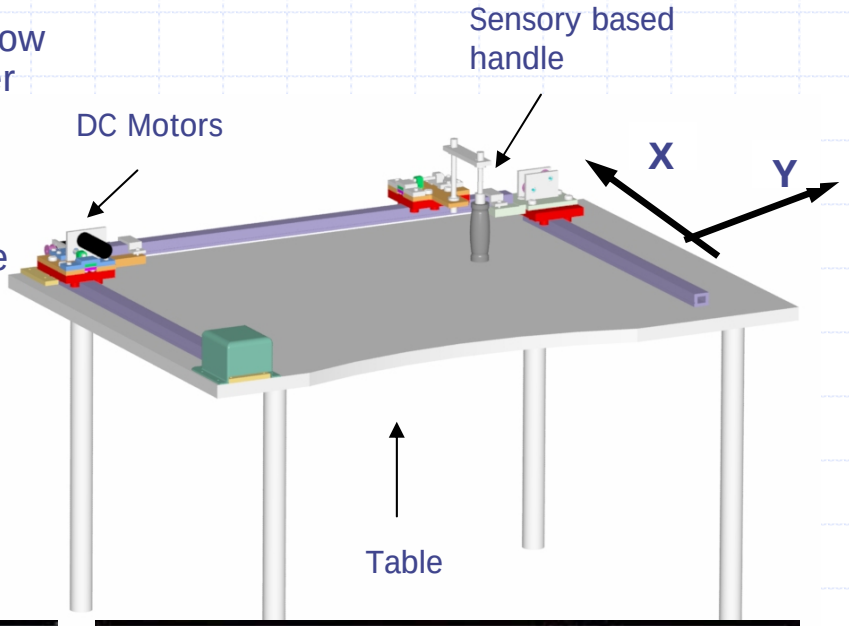
- This system has been developed in the laboratory directed by prof. Neville Hogan at MIT
- The MANUS is configured for safe, stable and compliant operation in close physical contact with humans by developing the impedance control which modulates the way the robot reacts to mechanical perturbation from a patient or clinician and ensures a gentle compliant behavior
- The machine was designed to have a low intrinsic end-point impedance (i.e., be back-driveable), with a low and nearly-isotropic inertia (1 0.33 kg, maximum anisotropy 2:1) and friction (0.84 0.28 N, maximum anisotropy 2:1), and be capable of producing a predetermined range of forces (0–45 N) and impedances (0–2N/mm).

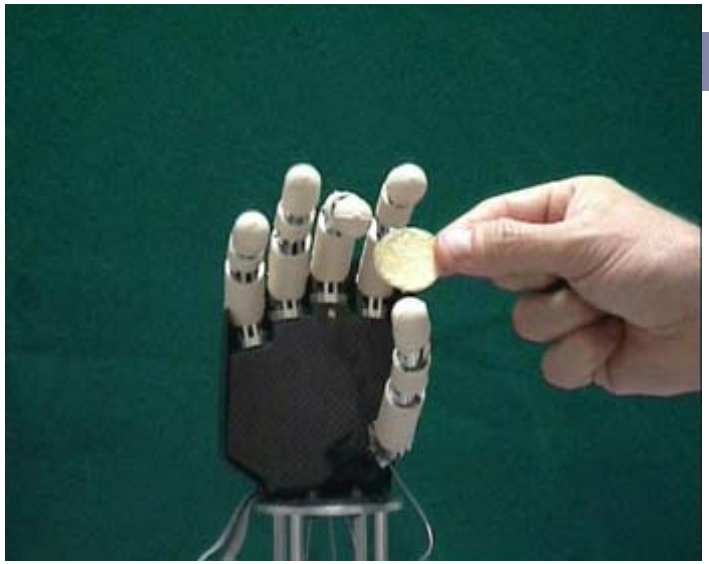




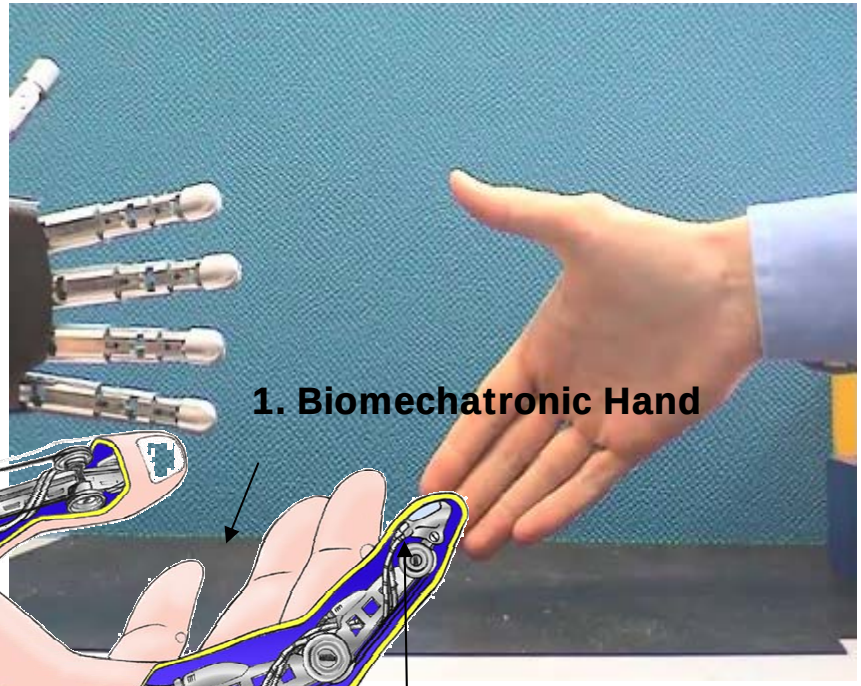
MEMOS project: *A MEchatronic system for upper limb MOtor recovery after Stroke*

- MEMOS is a mechatronic device specifically designed to allow intensive physical therapy to improve the recovery of upper limb motor function after stroke;
- The structure lets the handle movement in a plane (2D structure);
- Two Dc motors, by means of a pulley/belt system, displace the handle and they can work in active or passive mode;
- Therapists will use this device:
  - To provoke passive movements of patient upper limb who will hold the handle grip of the device;
  - To assist the patient during active movements;
  - To record information about the motor performance;
  - To control tele-rehabilitation of several patients.





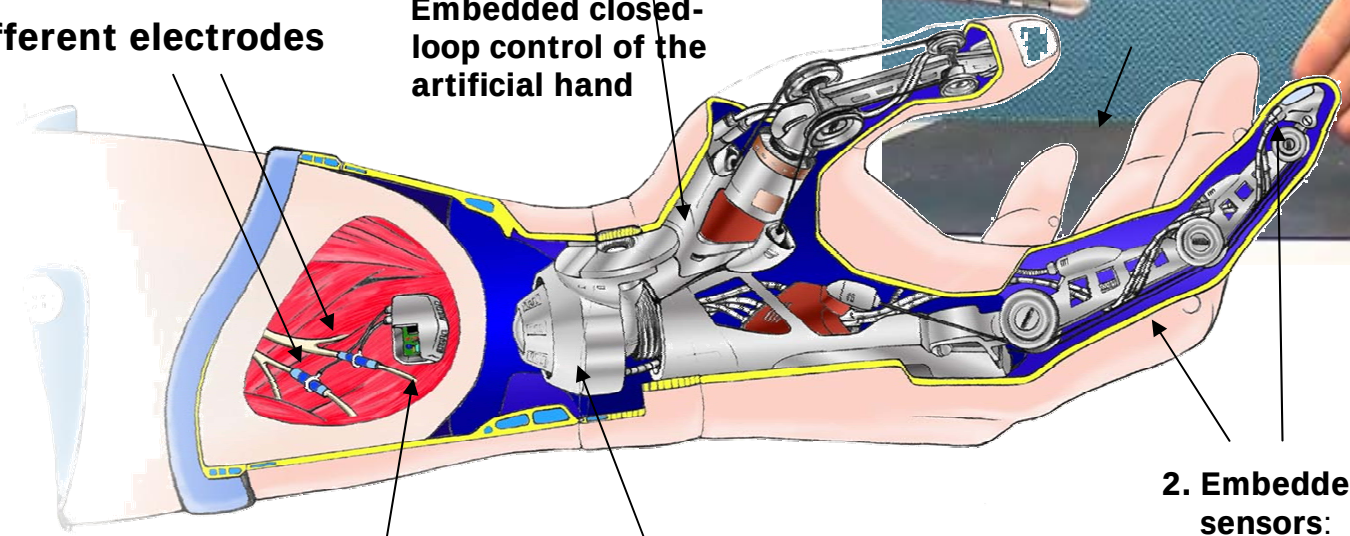
Protesi di mano



1. Biomechatronic Hand

8. Decoding patient's intentions and Embedded closed-loop control of the artificial hand

Different electrodes



Stump

Implanted neural interface:

- ENG efferent signals recording (patient's intention detection)
- Afferent nerves stimulation (to provide sensory feedback to the patient)

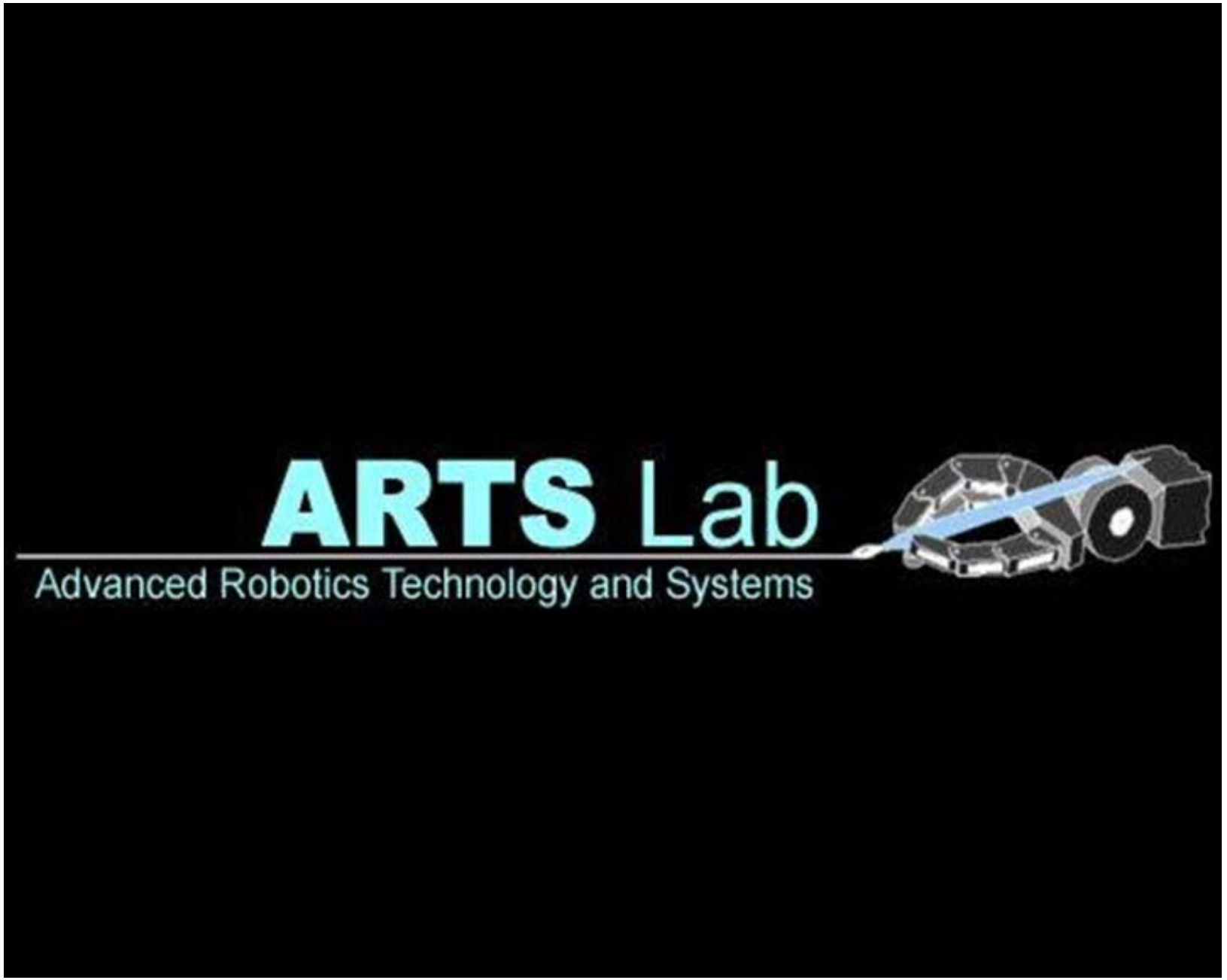
6. Receiver

7. Transmitter

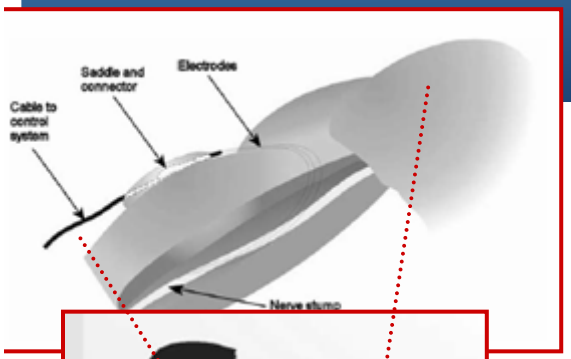
2. Embedded Biomimetic sensors:

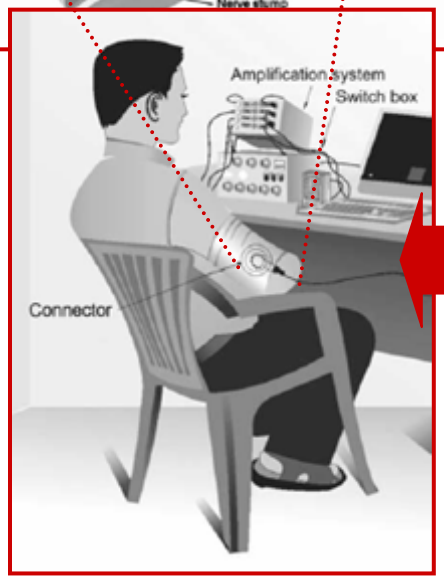
- within the structure
- within the glove

The CYBERHAND Project
IST/FET-2001-35094


ARTS Lab
Advanced Robotics Technology and Systems

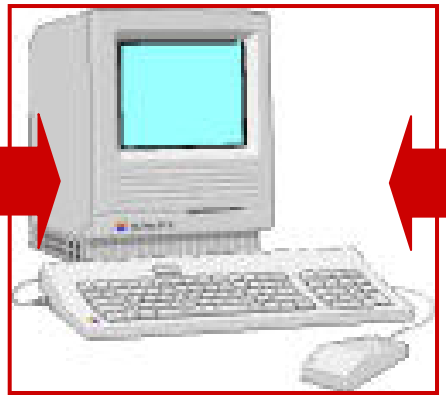
Schema dell'impianto
Del sistema CYBERHAND





tfLIFE electrodes with a **transcutaneous** connection

Recording and Stimulating Circuitry (**outside the body of the subject**)



Efferent processing, control, afferent stimulation (on a PC platform)

CYBERHAND prosthesis

Robotica per Assistenza

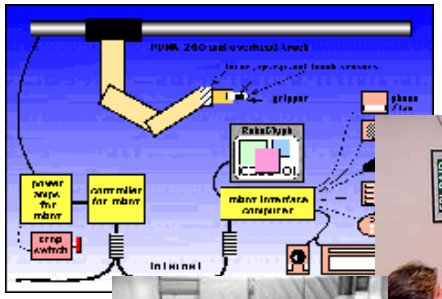
Obiettivi:

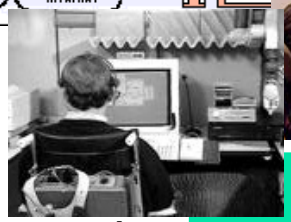
- Favorire il reinserimento sociale e professionale dei disabili
- Migliorare la qualità della vita di disabili ed anziani
- Incrementare il livello di autonomia personale
- Riqualificare il ruolo degli assistenti personali

Robotica per l'assistenza a disabili

- Stazioni robotiche fisse
- Manipolatori su carrozzina
- Carrozzine intelligenti
- Robot mobili
- Sistemi robotici distribuiti ed ambienti intelligenti

Evolution of Robotics for Personal Assistance

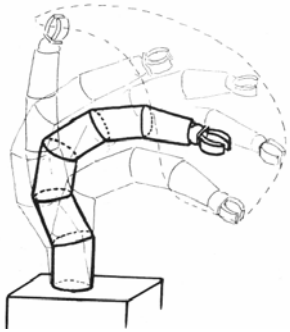




Devar/Provar

Fixed Workstations

Master-Raid



TOU

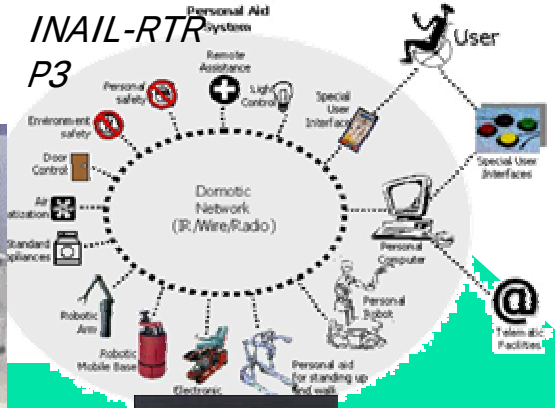
TIDE-Omni

Wheelchair Mounted Manipulators and Intelligent Wheelchairs

Sprint Immediate

Modular Distributed Systems

INAIL-RTR P3



HWRS ERC system

Helpmate

Mobile Robotic Systems

URMAD Project

TIDE-MOVAID

CareOBot

Stazioni robotiche fisse

Un manipolatore robotico impiegato presso una stazione di lavoro fissa

DeVar/ProVar

VA R&D Rehabilitation Center, Palo Alto, CA

First prototype: 1982
First evaluation: 1985

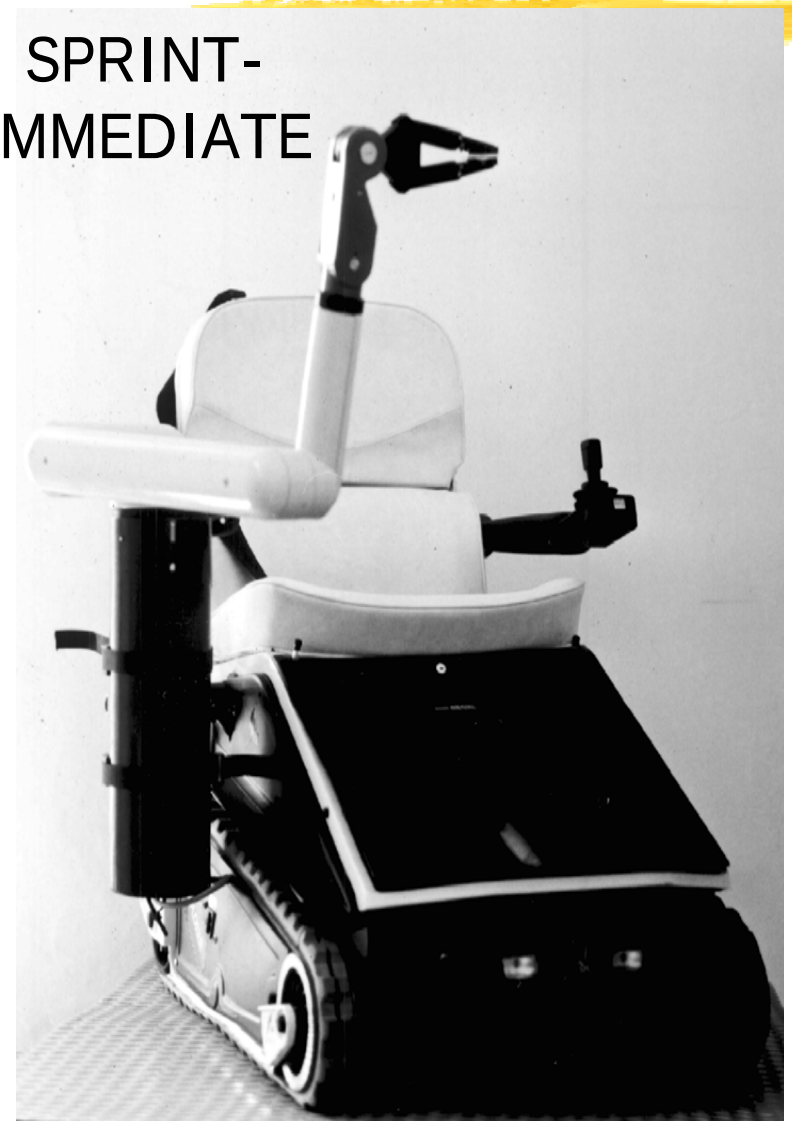
Stazioni robotiche fisse per disabili: EU TIDE Programme, “RAID” Project

First prototype: 1993
First evaluation: 1995

A robotic workstation for persons with physical disabilities in a computerized office environment

Manipolatori su carrozzina

SPRINT-
IMMEDIATE

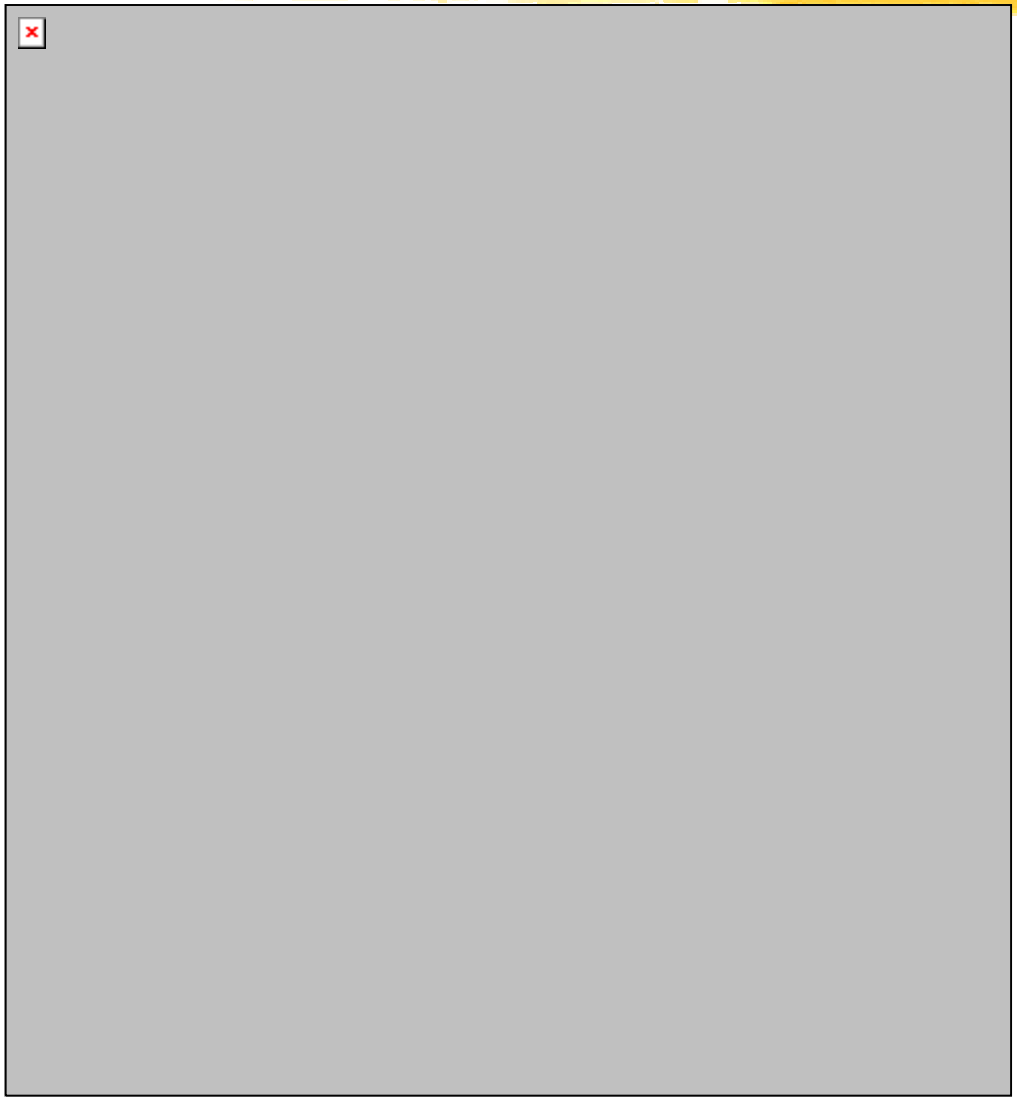


Manipolatore a bordo di una carrozzina elettrica ad assetto variabile per il superamento delle barriere architettoniche

First prototype: 1994

First evaluation: 1995

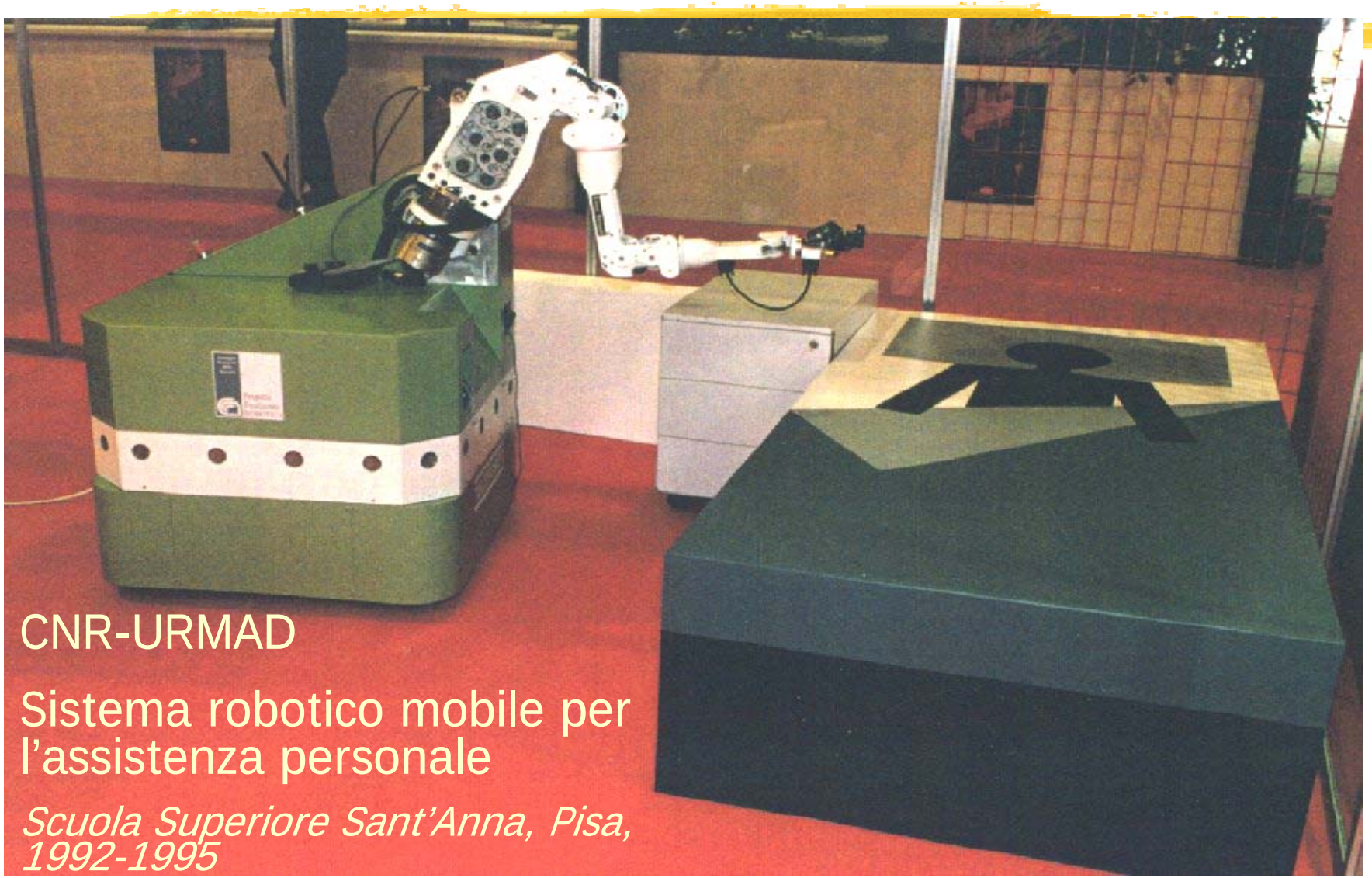
Smart wheelchairs: EU TIDE “OMNI” Project



First prototype: 1995
First evaluation: 1996

Omnidirectional wheelchair with ‘smart’ navigation system based on ultrasound and infrared sensors for obstacle detection

Sistemi robotici mobili: URMAD

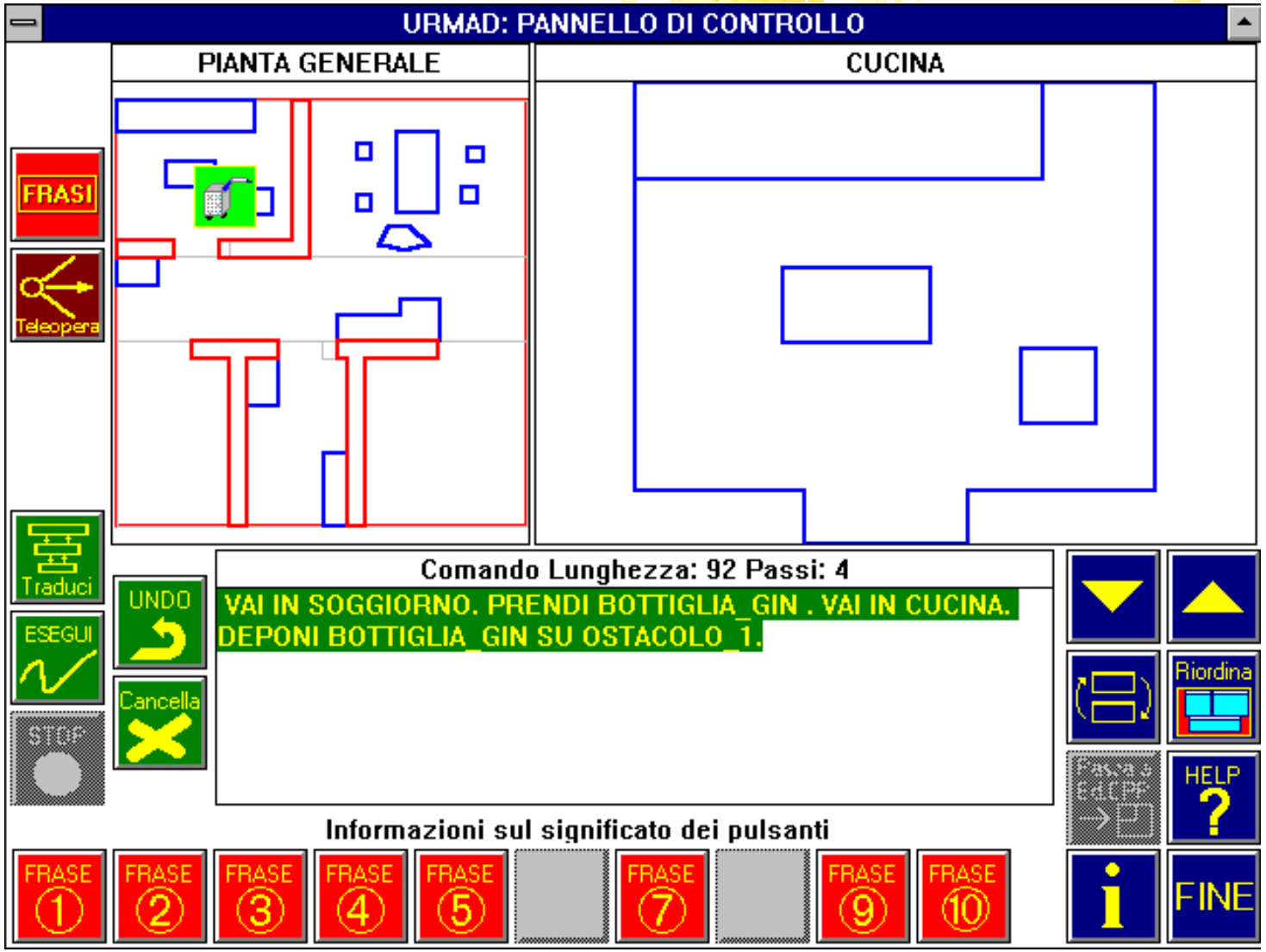


CNR-URMAD

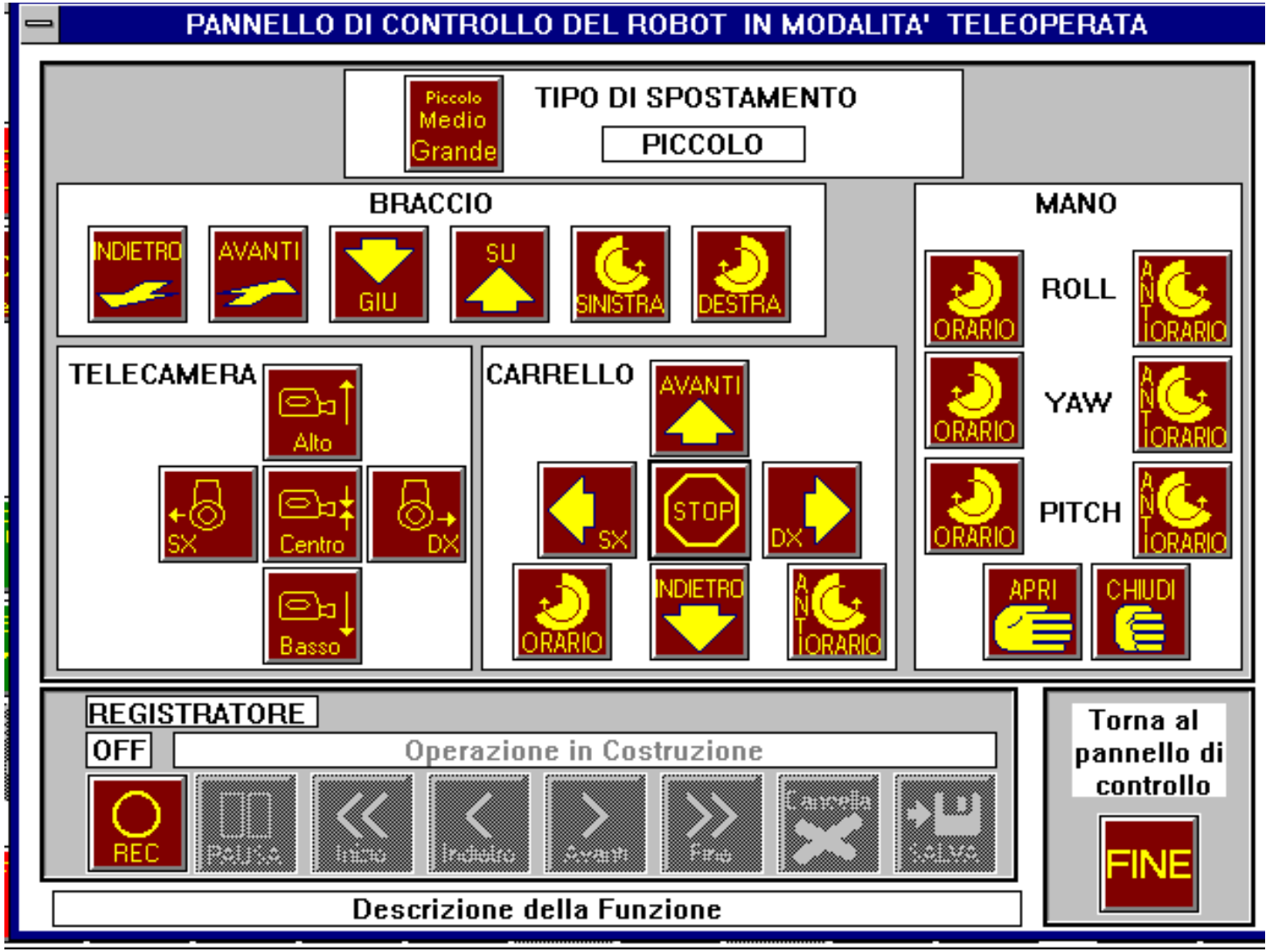
Sistema robotico mobile per l'assistenza personale

Scuola Superiore Sant'Anna, Pisa, 1992-1995

L’interfaccia utente di URMAD: modalità autonoma



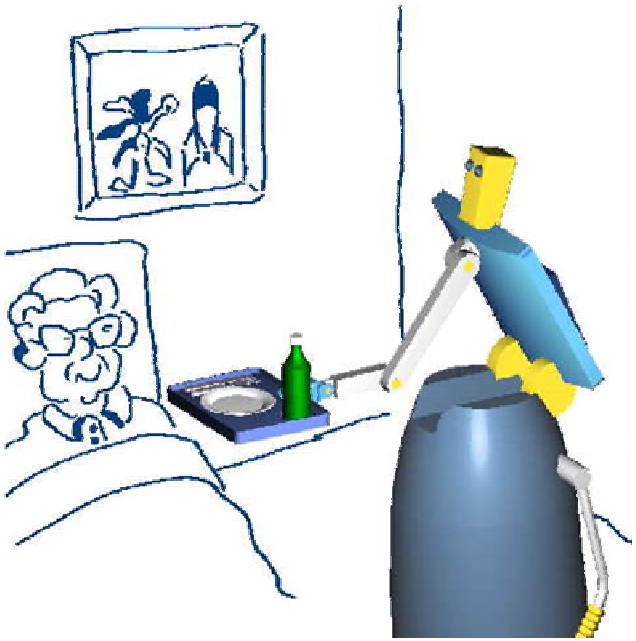
L’interfaccia utente di URMAD: modalità tele-operata



Care-o-Bot

IPA, Stuttgart (Germany)

- Household tasks
- Fetch and carry-tasks
- Mobility support
- Communication and social integration
- Monitoring and safety
- Home Management



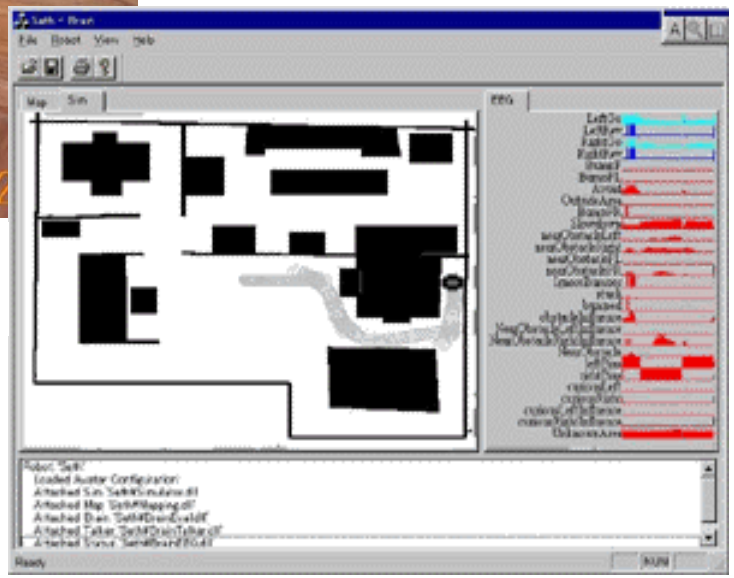
CARE-O-BOT

CareBot by Gecko Systems, (USA)

CareBot Serving Refreshments

CareBot Navigating Kitchen

The CareBot ™

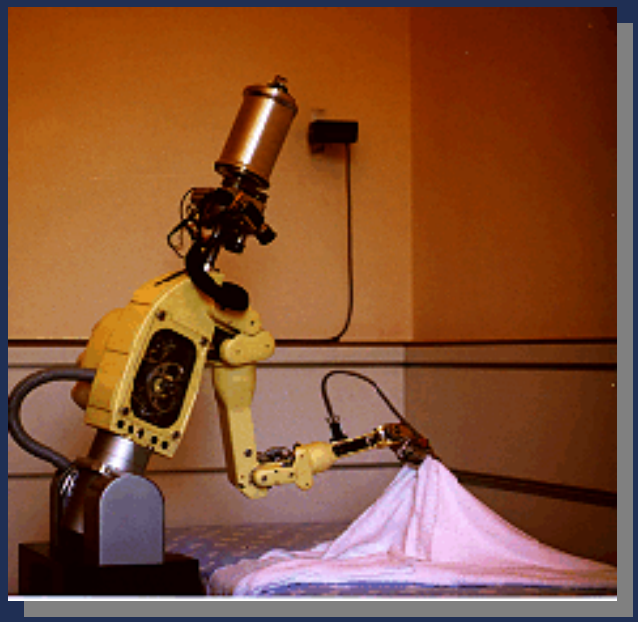


Evoluzione del concetto di robot personale

URMAD

- Massima Autonomia
- Centralizzazione delle risorse
- Pesante e Ingombrante

MOVAID



- Semi-Autonomo
- Sistema Distribuito (Docking)
- Più semplice e compatto

Il robot per l’assistenza ai disabili MOVAID

TIDE-MOVAID: Sistema robotico mobile per l'assistenza domestica

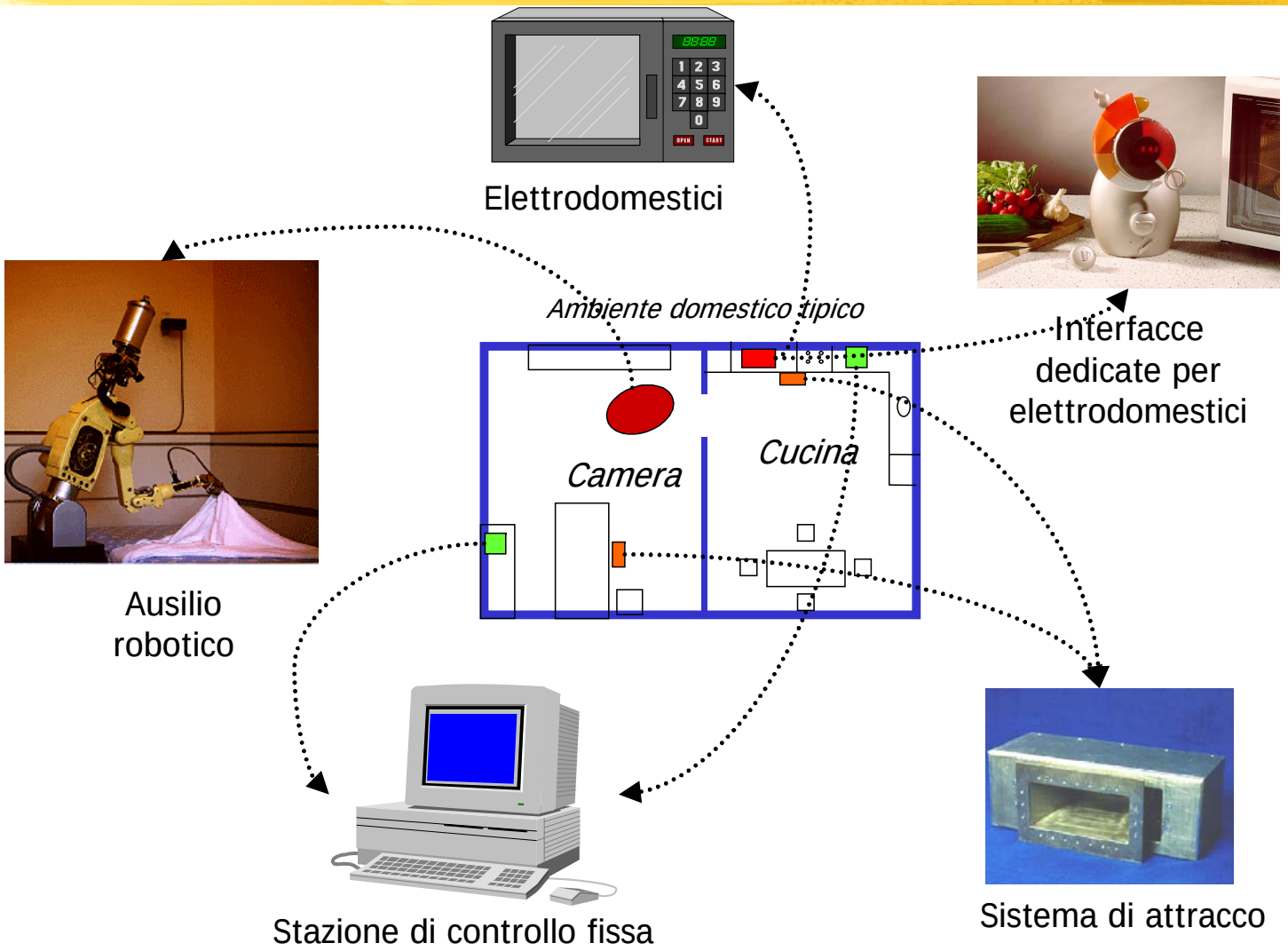
Scuola Superiore Sant'Anna, Pisa, 1994-1997

I compiti di MOVAID

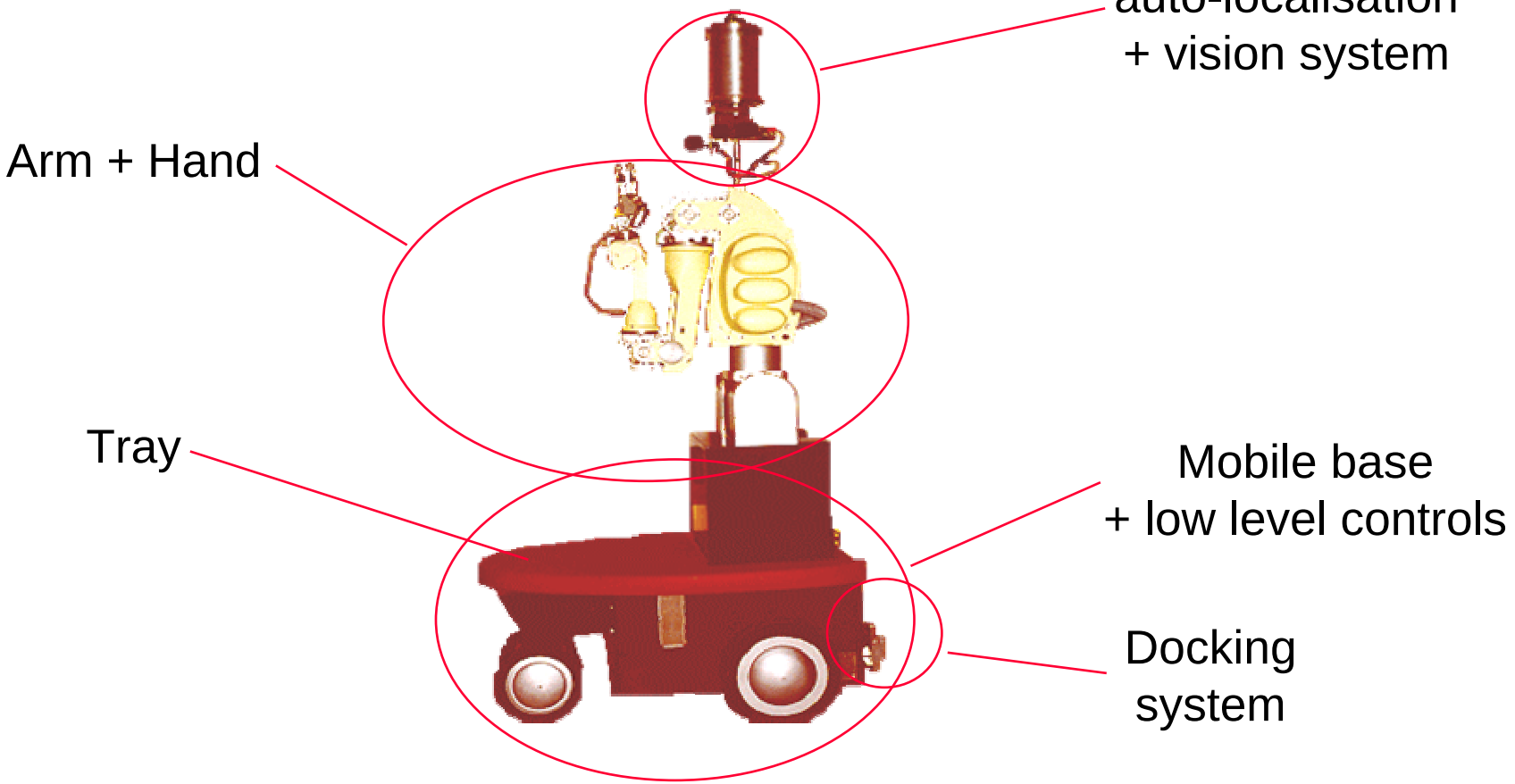
"Centro Auxilia"
Casa Famiglia
O.A.M.I.
v.Bonaini, Livorno

Con il supporto della Cassa di Risparmi di Livorno

Il sistema MOVAID: un'unità robotica mobile in grado di 'attraccarsi' a stazioni fisse



MOVAID mobile unit



Il sistema di ‘attracco’ (docking) di MOVAID

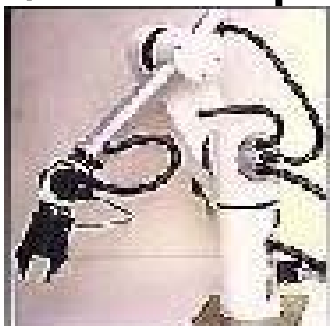
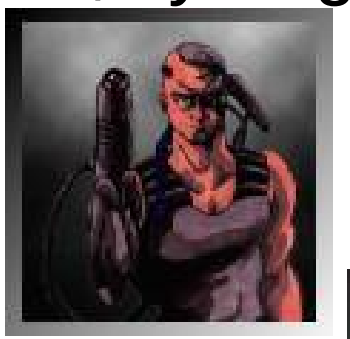
Un caso di studio: la progettazione del sistema robotico MOVAID

- Determinare la predisposizione degli utenti verso la robotica
- Personalizzare il livello di autonomia del sistema
- Identificare le funzionalità del sistema
- Disegnare l'aspetto del robot

...coinvolgendo 140 utenti potenziali (disabili e loro familiari ed assistenti), in 3 paesi, attraverso questionari ed interviste

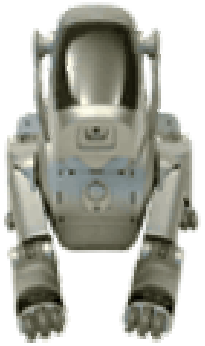
Ricerca iconografica

- TRISTEZZA: robot industriali, ‘Metropolis’, cyborg

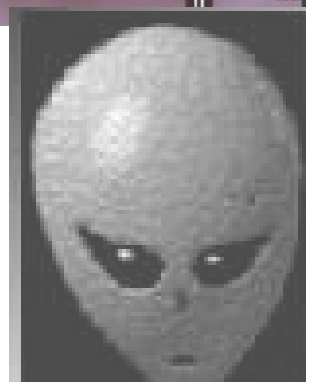




- SORRISO/AMMIRAZIONE: automi, uomo di latta, robot animali

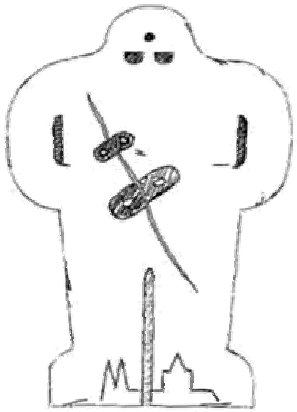




- PAURA: ‘Mazinga’, ‘Alien’



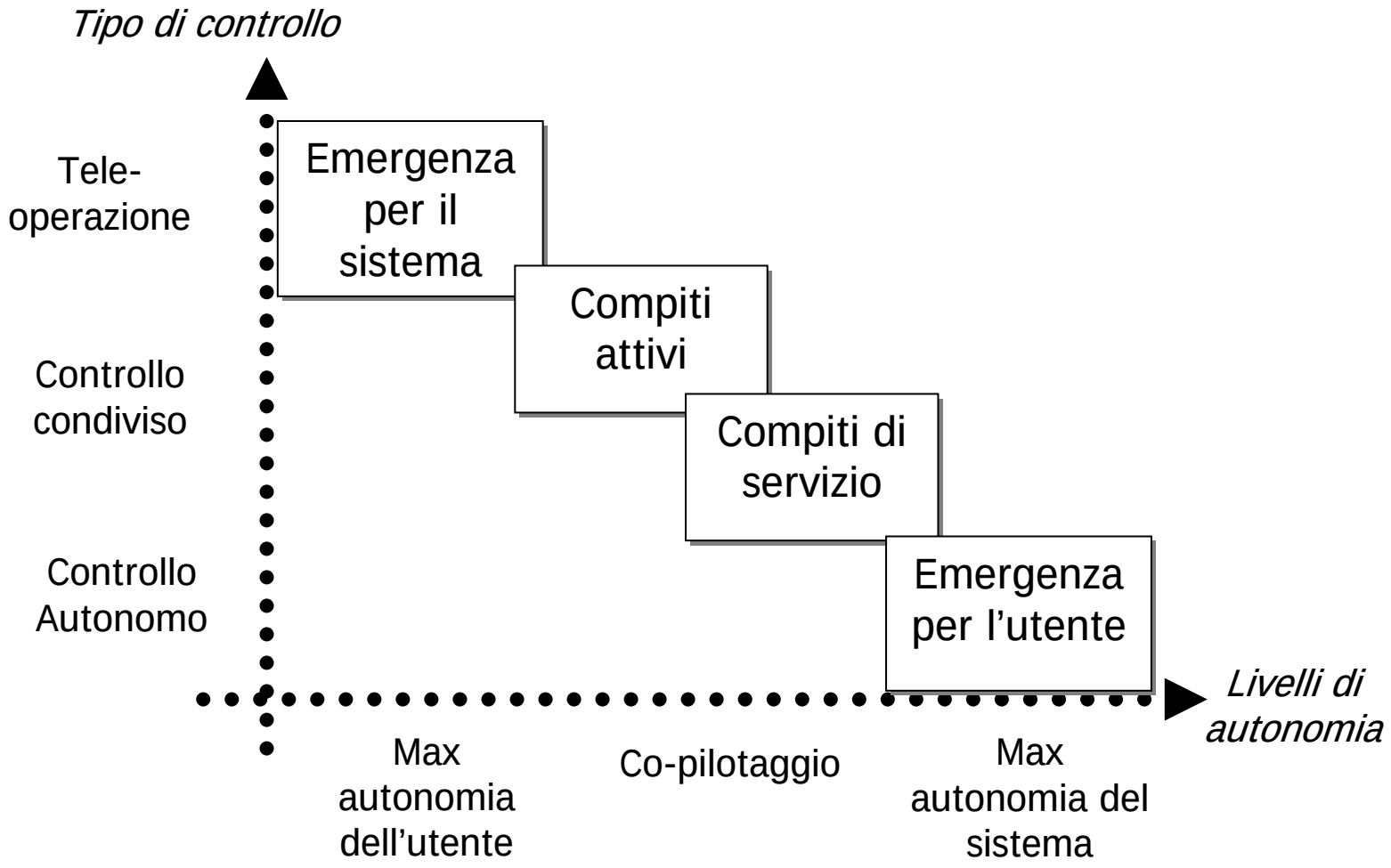
- GOLEM



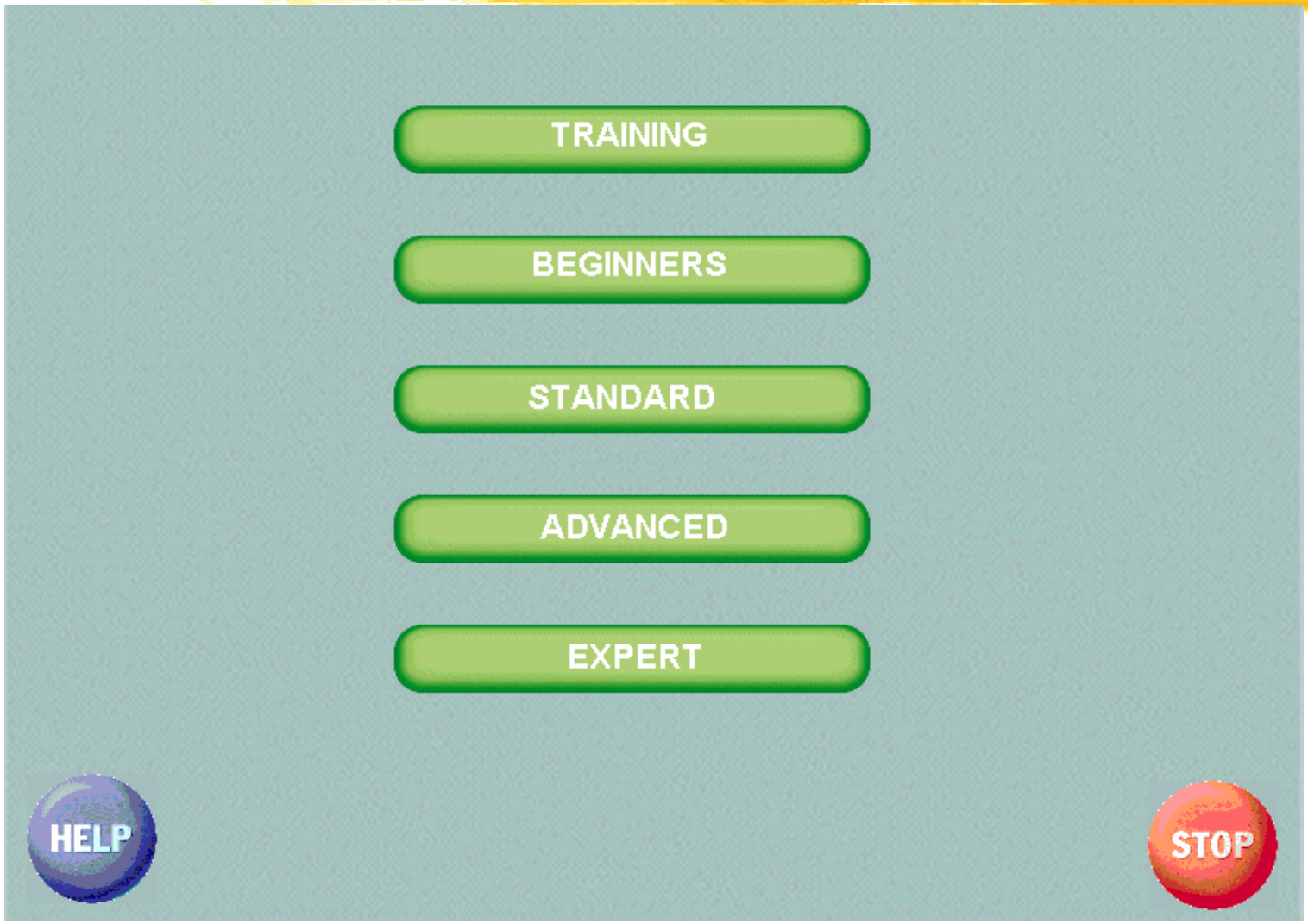

Desirable characteristics of a personal robot according to users analysis

- the robot should look clearly **artificial**, never biomorphic nor anthropomorphic;
- a careful balance should be kept between the technical look and some **'softer'** elements suggesting a feeling of humanism and friendliness;
- 'caricature' elements (pet-robot, puppet) should be generally avoided, as they could create a sense of unreliability (should I be helped by a toy?);
- the robot should 'sleep' in a reassuring position and, when waking up, it should warn and start with a gentle movement;
- the robot should never move in the darkness, or should warn with a light before moving;
- the arm should possibly offer objects from a lower position, avoiding coming toward the user with a 'threatening' attitude.

Modularità nell'autonomia



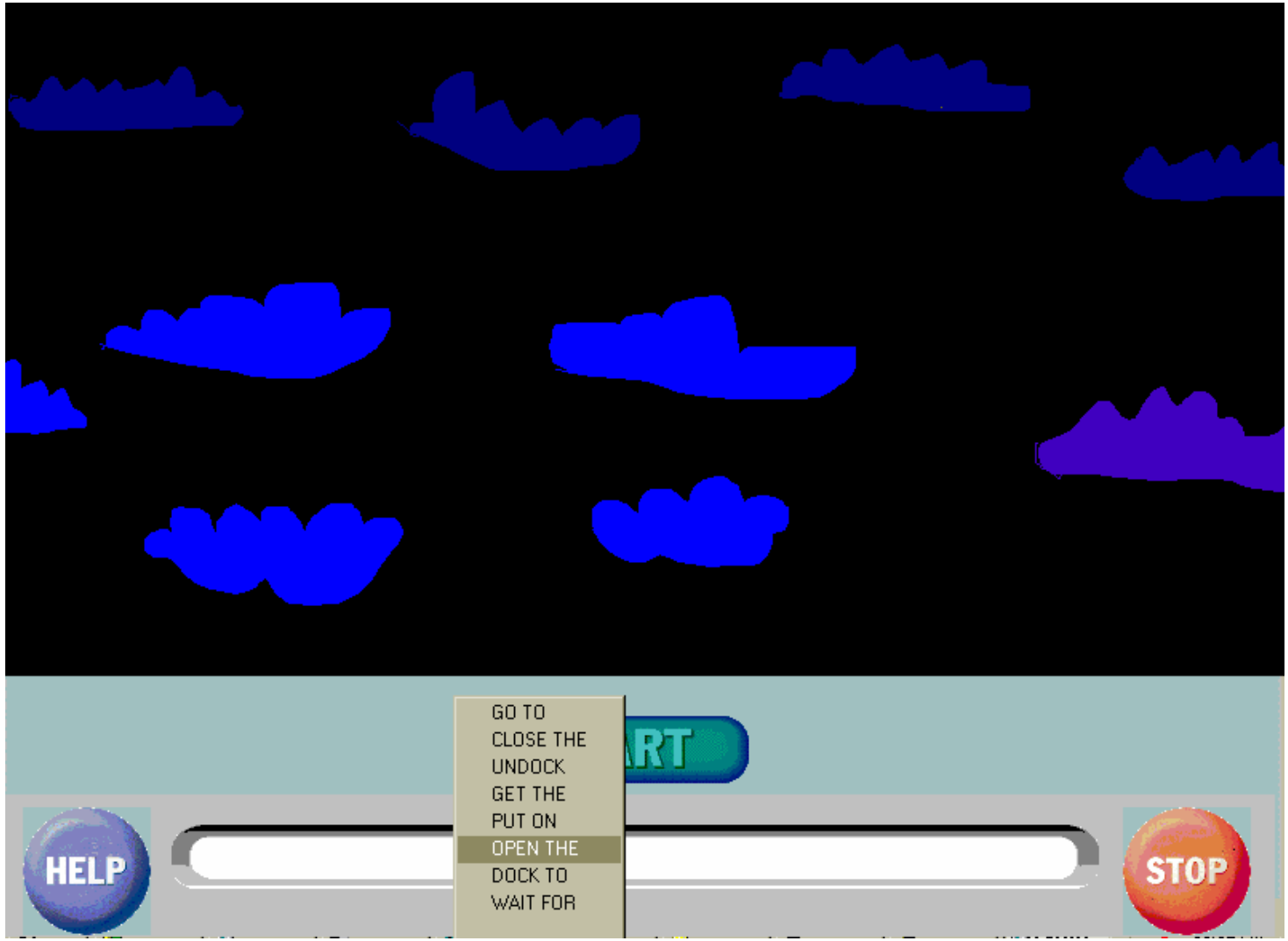
L’interfaccia utente di MOVAID



L’interfaccia utente di MOVAID

L’interfaccia utente di MOVAID

L’interfaccia utente di MOVAID



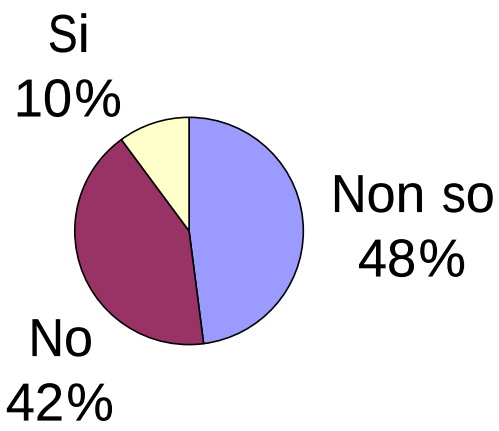
L’interfaccia utente di MOVAID

Co-operazione nell'esecuzione dei compiti

Validazione del sistema MOVAID

Prima di MOVAID

Immagini l'assistenza di un Robot?

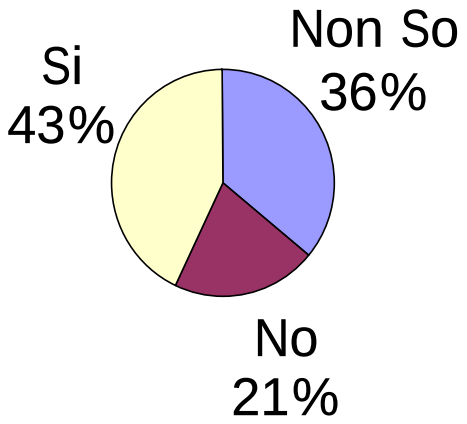


Prove Sperimentali

64 utenti coinvolti in prove e dimostrazioni in 3 diversi paesi Europei

Dopo MOVAID

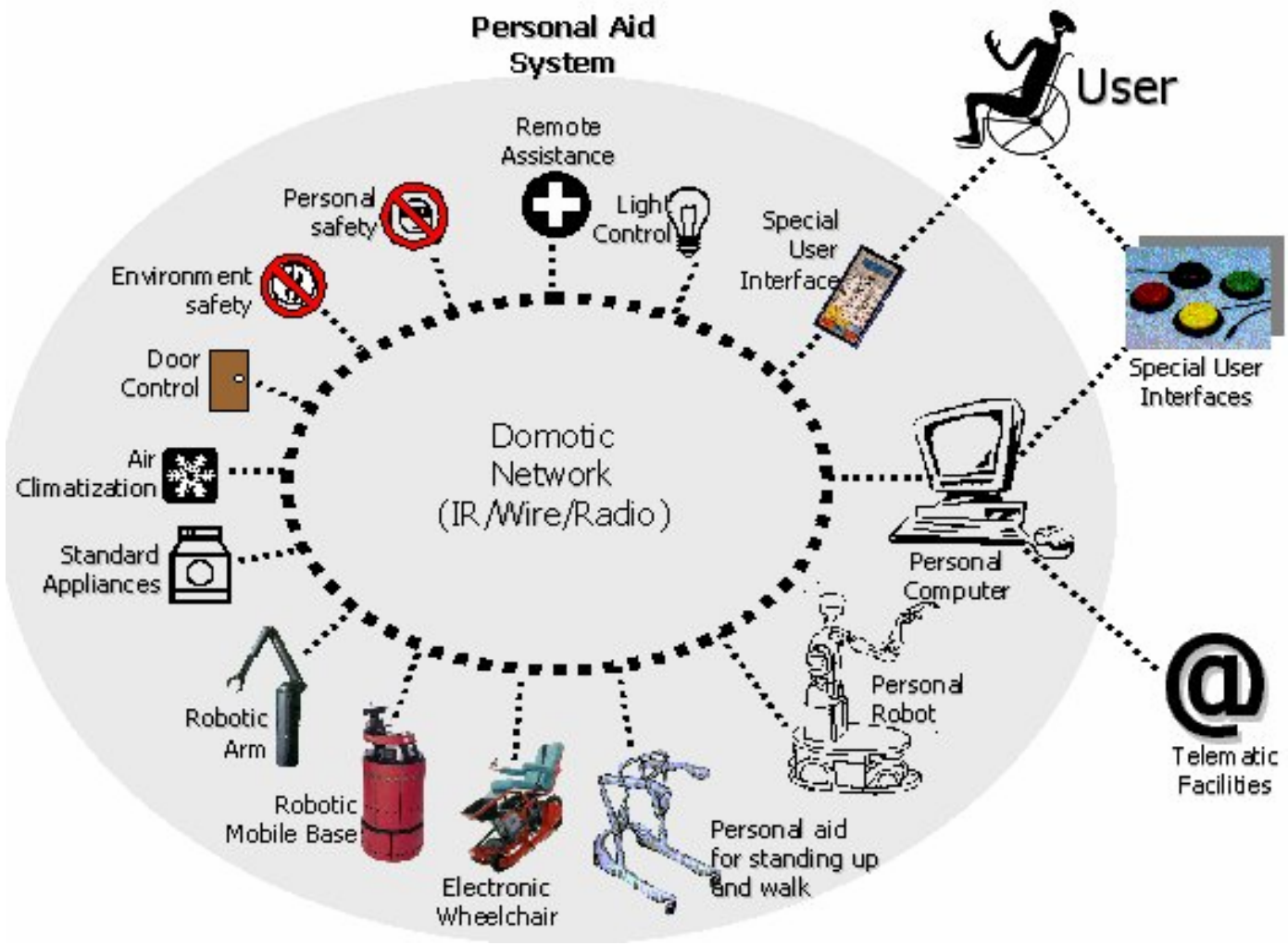
Vorresti avere un Robot come Assistente?



Domotica


A. Sensori antintrusione intelligenti
B. Sensori di luce
C. Distributore di cibo per animali
D. Sensore di presenza auto
E. Sensore di presenza posta
J. Luci intelligenti
M. Controllo computerizzato
P. Sensori per il monitoraggio ambientale
R. HVAC
S. Interfacce al sistema
T. Sistema telefonico intelligente
F. Telecamere
G. Sistema di sicurezza
H. Impianto citofonico
I. Sensori ad infrarosso per sicurezza
K. Home theater system
L. Annaffiatori intelligenti
N. Movimentazione tende
O.
U. Porta automatica per ingresso animali
W. Protezione per sovratensioni
X. Filtri per il segnale

Nuovo concetto di sistema modulare integrato



TMSUK IV by TMSUK Inc. (Japan)

A human body shaped robot able to do house work, such as cleaning up windows, remotely controlled

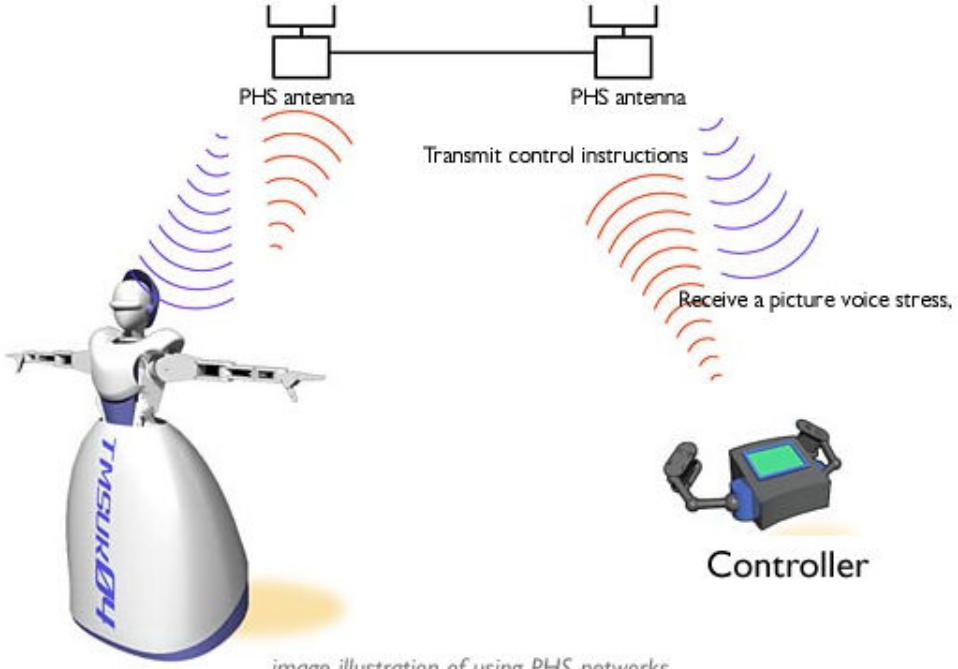


image illustration of using PHS networks

Humanoid Type Hyper Remote Control Robot.
TMSUK04

Task-specific Robots

Handy 1
Rehab
Robotics

MySpoon

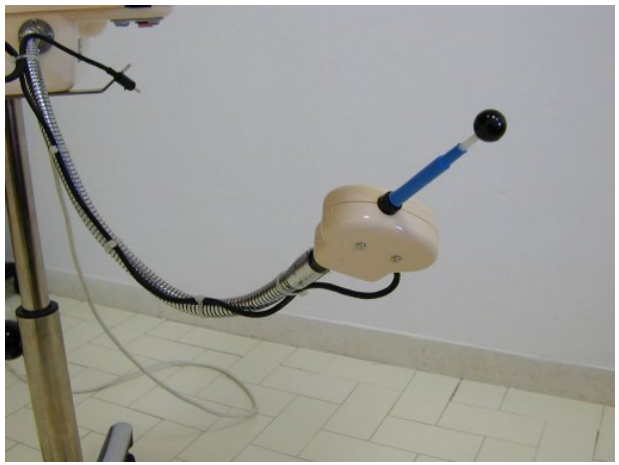
Cye Robot
ProRobotics

Roomba
iRobots

- ✓ **Pros:**
  - Natural evolution of today's appliances
  - Less invasive
  - Lower cost to benefit
  - More commercially viable
  - Shorter development cycle
- ✓ **Cons:**
  - Need many devices to meet total need
  - Less natural in human environment

Handy1: un robot per mangiare

By RehabRobotics, UK, 1997



Robotica per l'assistenza personale

Research trends for Assistive Robotics

- Two main paths for assistive robotics:
  - Long-Term: general purpose robotic servants, which MAY have human-like, humanoid appearance BUT IN ANY CASE SHALL BE capable of operating without heavy environmental adaptations, and of interacting at cognitive level
  - Medium/Short-Term: the robotic appliance. The concept of a novel generation of task-specific appliances taking full advantage of enabling micromechatronics and ICT technology, and of human-centred design