Robot Companions for Citizens

A new generation of soft, sentient embodied machines

presenter
Paolo Dario
Scuola Superiore Sant’Anna, Pisa, Italy

We have a dream …
Robotic automation has enabled worldwide economic and social progress

Now society is facing new challenges

Ageing  Growing urban centers  Environment
... Robot Companions for Citizens
for a better quality of life and
a new affordable welfare

Advancement in current robotic artefacts

- Nowadays robots are:
  - accurate
  - fast
  - dexterous
- Robots can perform many tasks:
  - effectively produce goods
  - perform surgery
  - explore Mars
  - serve humans as prostheses
- Nevertheless, robots are modestly able:
  - to experience and interact with unknown environments
  - meaningfully and safely interact with humans
  - to autonomously realize tasks at any level of complexity...

Active from January 25, 2004
from 90 to 2300 sol (Martian day)
Up to 80'000 hours with no failure

Icub, the 3 years-old robot's cub
Brain-controlled bionic hand, neural implant on human subject, December, 2008
... on the other hand, human beings and living organisms, and even lower animal species, can ...

... perform complex tasks ...

- simultaneously execute and coordinate multiple tasks
- effectively explore their external environment
- adapt to novel situations
- show evidence of individual and collective intelligence
- survive injuries, adapt and/or self-repair

... in spite of:

- the neural system’s **huge delays** (in comparison with robots) in **transmitting** and **processing information**
- stringent physical world constraints and unexpected events
- energy **rationing**

... by making use of “**simplicity**”,

(A. Berthoz: simplification mechanisms for controlling complex systems and behaviors)

The key question is:

“**which features of living beings do robot companions need?**”

and specifically:

“**which features of living beings would we like to see** in our robot companions?”
Ambition
of the FET Flagship “Robot Companions for Citizens”

The grand challenges of this FET Flagship are:

1. to unveil the secrets of the embodied intelligence of living beings (“simplexity”) that makes them capable to act, behave and adapt effectively in their environment and to be cognizant and sentient of this relationship

2. to exploit these principles to develop and deploy the Robot Companions for Citizens: sentient and interactive machines embedding the softness and compliance of living beings

Grand Scientific Challenges
at crossover between ICT and pure science
that the FET Flagship “Robot Companions for Citizens” will address

- Embodied intelligence
  - adaptive behaviour emerging from the complex and dynamic interaction between the body morphology, sensory-motor control, and environment
  - tight dependance of the information processing of the brain on the morphology, the materials and the actions

- Softness and compliance
  - soft body (skin, muscles, joints) – non-rigid, bio-hybrid
  - perceptual, cognitive, behavioural and emotional compliance to any dynamic change of the world of which Robot Companions are part

- Interactiveness and sentience
  - exploiting the understanding of human behaviour and intentions: robot must interact in a natural way with humans (e.g. gesture, language interpretation, shared attention)
  - recognition of human emotions and empathy
  - experience of the feeling of body ownership
  - purposefulness
“How will we develop physically embodied, soft, sentient machines?”

Robot Companions

Control, learning, HMI, supervision
Sentient and subjective
Neuromorphic control
New actuators low energy (human like)
Coping with uncertainty
Tuneable actuation
New sensors and improved perception

Embodiment ICT-2007.8.5
Brain-inspired ICT ICT-2010.8.5

Steel tendon cables
DC motors
Centralized computing
Steel & aluminium frames
Ball bearings
Load cells

Science of companionship
New mechanical body & skins
Smart and soft body
Distributed sensing
Energy efficiency

Current Robotics
Ambition
of the FET Flagship “Robot Companions for Citizens”

- Robot Companions for Citizens demands the development of radically new ICT technologies for:
  - sensing and actuation, control, learning, powering, design methodology, hyper-redundant mechanisms and smart materials, electronics

Impact
of the FET Flagship “Robot Companions for Citizens”

- New Science of ‘companionship’
  - Principles of embodiment of mind (perception, cognition, emotion, behaviour ...) at nano-, micro-, and macro-scale
  - New tools for science, according to the synthetic methodology (‘understanding by building’) 

- New Technology
  - ICT and Robotic Technologies ICRT
  - New generation of robots as active media with multiple potential instantiations from the real world to cyberspace
  - Soft-bodied sentient machines capable of physical, safe interaction and adaptation to the real and social world
  - New technologies for preserving and repairing human body and functions
Impact of the FET Flagship “Robot Companions for Citizens”

• Society
  – New affordable welfare for all EU citizens in the future:
    • ubiquitous, user-friendly, inclusive technology
    • will preserve human capabilities and experience and extend the active, independent life of citizens
    • will maintain our environment and the planet
    • psychological, anthropological, ethical and societal aspects taken into account
  – From information-based to action-oriented services
  – A tremendous opportunity for the educational system, given the highly interdisciplinary nature of this endeavour

• Industry
  – New ICRT business opportunities
    • both “old” ICT and “new” ICRT entrepreneurs could explore new markets
  – Increased competitiveness by developing cross-sector technologies
  – International co-operations with emerging technology countries, creating common standards and expanding market-shares

Integration of the FET Flagship “Robot Companions for Citizens”

• Robot Companions will smoothly integrate, but substantially extend, existing initiatives, infrastructures and communities …
  – Initiatives and infrastructures
    • strong links with many scientific communities and different research programs, for instance NMP and Challenge 2
    • creation of an extended European Robotics Agency (?) embracing existing networks, SRAs, know how, links with stakeholders
  – Scientific communities
    • robotics, material science, physics, neuroscience, life science, nanotechnology, philosophy, psychology, physics, social sciences, energetic efficiency, chemistry
    Synergy and convergences through common objectives
  – Industries and end-users
    • key role in fostering and developing a new multi-sector supply network
    • progressive delivery of the new ICT and ICRT technologies
• Regulation and policy for practical use of Robot Companions
Plausibility of the FET Flagship “Robot Companions for Citizens”

- Europe has a very good competitive position in worldwide robotics
  - Robot Companions can take advantages of this
  - Europe must spend its best efforts in consolidating and exploiting this competitive advantage
- Our FET Flagship will be open to strategic alliances and collaborations with other initiatives and scientific communities. Robotics is INCLUSIVE!
- The governance model will be studied and defined in the CA phase, considering novel models of organization of the research (e.g. competitions?)

...from dreams to plans

![Diagram showing the flow of activities from European Commission, European Society, European Industry, and Other Initiatives towards design and development of robotic platforms, implementation of different aspects of the robot, and integration of major platforms of robot companions, with time progression from foothill results to eventual implementation.]
Robot Companions for Citizens is **use-inspired**

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<td>New scientific issues</td>
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<td>New affordable welfare</td>
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**Pasteur’s Quadrant**

**ICRT**

**Backling experts and organizations**

of the FET Flagship “Robot Companions for Citizens”

- Networks and clusters
  - Laboratoire d’Intégration des Systèmes et des Technologies (LIST - CEA)
  - Convergent Science Network (CSN)
  - Cognition for Technical Systems (CoTeSys)
  - Robotics Netwerken (RoboNED)
  - French National Robotics Network (GDR) supported by CNRS
  - Virtual Research Centre in Personal Robotics, supported by the EPSRC in the UK
  - Swiss National Center of Competence of Research in Robotics (NCCR Robotics)
  - Italian Institute of Technology (IIT)
  - German Robotics Research Society (DGR)
  - French National Image, Vision and Signal Network (GDR ISIS) supported by CNRS
  - Spanish Technological Platform of Robotics (HispaRob)

- Experts
  - 90+ experts (from academia and industry) support “Robot Companions for Citizens”, and they are from different disciplines: Robotics, Life/neo/cognitive science, Material Science, Informatics, Physics, Medicine
Conclusion

Why a FET Flagship on Robot Companions for Citizens?

- A grand scientific challenge: unveiling the secrets of embodied intelligence in living beings
- A grand technological challenge: developing break-through ICRT
- A grand societal challenge: providing a solution for societal needs

A wide scope and an ambition that need a federated effort, a critical mass of (human and economic) resources, an adequately wide time horizon, and that cannot be faced with STREP or IP projects

Robot Companions for Citizens

A new generation of soft, compliant, sentient embodied machines