



DEXterous and autonomous dual-arm/hand robotic manipulation with sMART sensory-motor skills: A bridge from natural to artificial cognition

Large-scale integrating project ICT-216239 supported by the
European Commission under the 7th Framework Programme

Duration: 01.02.2008 – 31.01.2012

Cost: 8.1 M€ | Funding: 6.3 M€







Coordinator: Bruno SICILIANO

www.dexmart.eu



The Consortium



 <p>PRISMA Lab/DIS & DSF, UNINA Università di Napoli Federico II, Italy</p> <p>Prof. Bruno Siciliano siciliano@unina.it</p>	 <p>LAAS, CNRS, France</p> <p>Dr. Daniel Sidobre daniel.sidobre@laas.fr</p> <p>CNRS</p>
 <p>Institut für Robotik und Mechatronik, DLR, Germany</p> <p>Dr. Gerhard Grunwald gerhard.grunwald@dlr.de</p> <p>DLR</p>	 <p>Forschungszentrum Informatik FZI an der Universität Karlsruhe, Germany</p> <p>Dr. J. Marius Zöllner zoellner@fzi.de</p>
 <p>OMG plc, United Kingdom</p> <p>Dr. Andrew Stoddart a.stoddart@omg3d.com</p> <p>OMG</p>	 <p>DII, Seconda Università di Napoli, Italy</p> <p>Prof. Giuseppe De Maria giuseppe.demaria@unina2.it</p> <p>SUN</p>
 <p>DEIS & DIEM, Alma Mater UNIBO Studiorum Università di Bologna, Italy</p> <p>Prof. Claudio Melchiorri claudio.melchiorri@unibo.it</p>	 <p>LPA & EPO, Universität des Saarlandes, Germany</p> <p>Mr. Chris May c.may@lpa.uni-saarland.de</p> <p>USAAR</p>



The goal



DEXMART has the ambition to fill the gap between the use of robots in industrial environments and the use of future robots in everyday human and unstructured environments, contributing to reinforce European competitiveness in all those domains of **personal and service robotics** where **dexterous and autonomous dual-hand manipulation capabilities** are required



The background



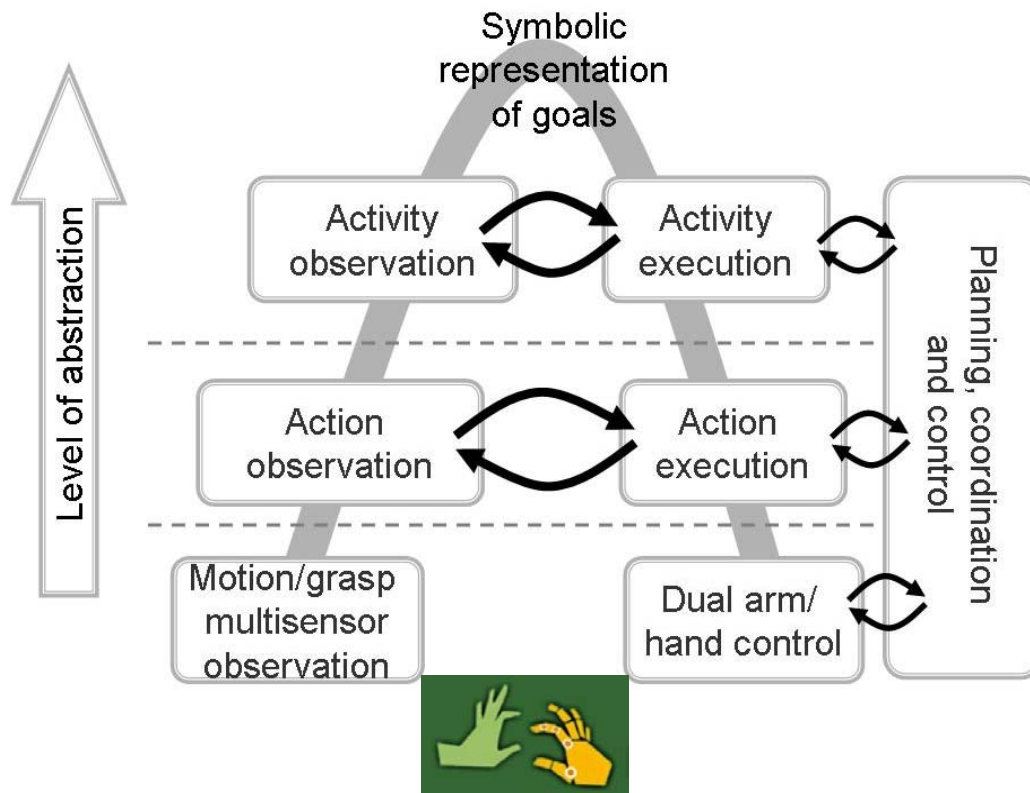


The contribution



DEXMART will primarily contribute to the **development of robotic systems endowed with dexterous and human-aware dual-arm/hand manipulation skills for objects, operating with a high degree of autonomy in unstructured real-world environments**

- Allow a dual-arm robot including two multi-fingered redundant hands to **grasp and manipulate the same objects** (different shape, dimension and weight) **used by human beings**
- Manipulation will take place in **unsupervised, robust and dependable manner** so as to allow the robot to **safely cooperate with humans** for the execution of given tasks
- Robotic system able to **autonomously decide between different manipulation options**, and to **learn new action sequences** aimed at creating a **consistent and comprehensive manipulation knowledge base**
- Possible exploitation of high power-to-weight ratio of **smart materials and structures**, aimed at design of new hand components (finger, thumb, wrist) and sensors for **next generation of dexterous robotic hands**



- **Hybrid control mechanisms for dexterous manipulation** – Account for high dynamics and stochastic scene behaviour, use of kinematic redundancy for optimization
- **Next generation robotic hands** – Blend of robustness with dexterity, development of new smart actuation and sensing system

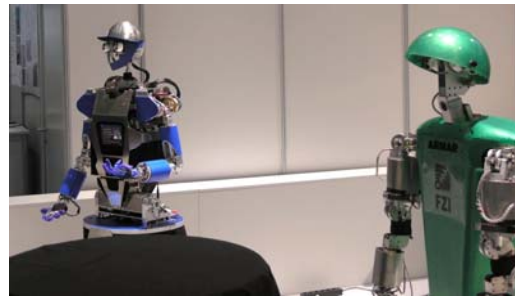
- **Dual-hand manipulation models at different levels of abstraction** – Sensorimotor control, actions and activities, symbolic goals
- **Observation and execution in close coupling** – Congruency between methods and representations for action/activity observation and execution with incremental enrichment of knowledge base
- **Bridge the gap between complex task modelling and dexterous manipulation capabilities** – Manipulation models as probabilistic compound of motions, constraints, strategies, goals and scenes
- **Observation and analysis of human demonstrations** – Activity recognition for bimanual manipulation with focus on analysis of concurrent movements, strategies and goals
- **Task planning and coordination** – Knowledge based flexible task composition, execution monitoring, decision making and adaptive planning on different levels



The context

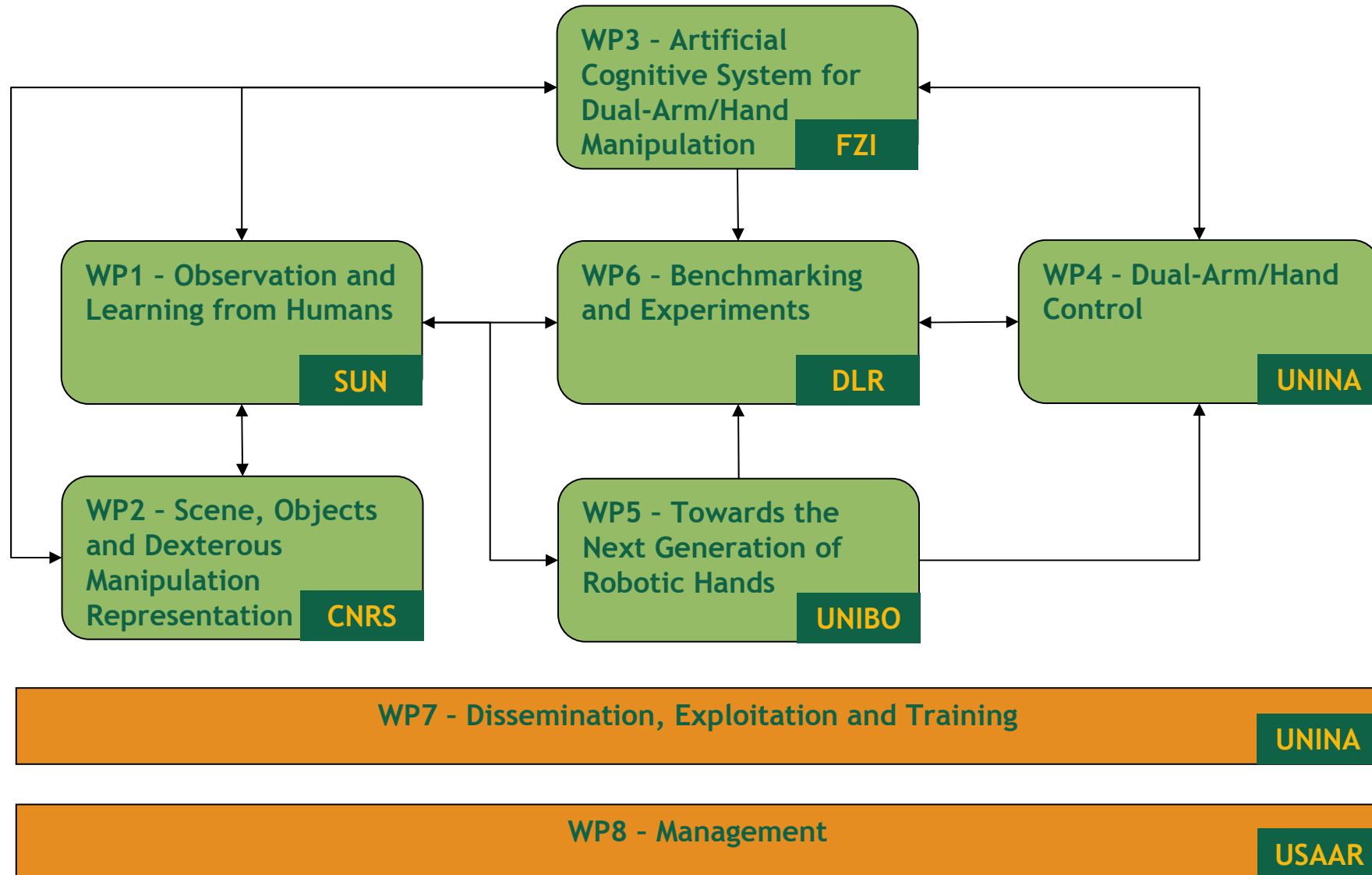


- Research domains
 - Observation, interpretation, learning and modelling
 - Task planning and coordination
 - Feedback control
 - New robotic technologies
- Benchmarking and experiments





The work plan

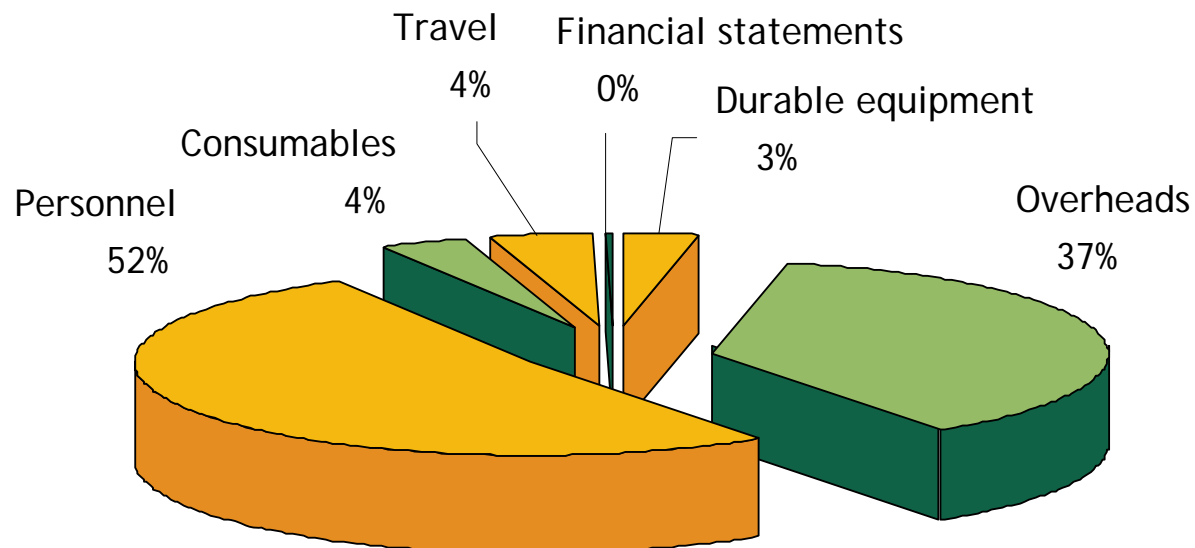




The figures



- 866 person months (30 key scientists)
 - 798 pm on research and development
 - 23 pm on management
 - 45 pm on dissemination, exploitation, training
- 23 deliverables
- 38 internal reports
- 22 milestones
- Budget breakdown





The impact



- Great relevance for leading-edge European robot manufacturers
 - KUKA Roboter GmbH as external observer and advisor
 - New dimension in industrial and professional service robotics
 - Lightweight robot: result of close cooperation with DLR
- Bimanual manipulation useful in automotive industry
 - Typical assembly procedures constituted by tasks requiring manipulation of objects and tools similar to those used in general everyday environments
 - Tight collaboration between human operator and robotic system during design process
 - Designer of assembly line or technologist checking and validating maintenance procedure
- Human-centered tasks
 - Robot companions
 - Helper at family homes
 - Executing tasks in offices, public environments and in services





The end

www.dexmart.eu