



2016 CHISTERA meeting

Bern, April 28, 2016

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www.i-dress-project.eu/



Institut de Robòtica
i Informàtica Industrial



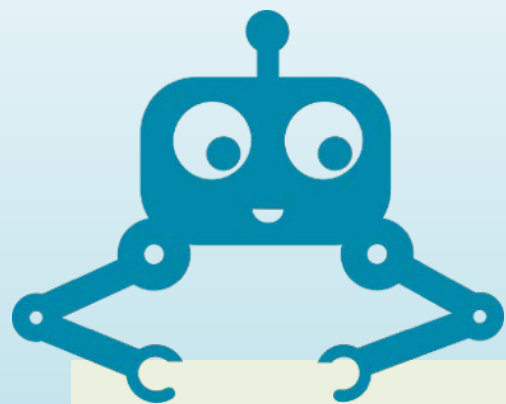
CSIC



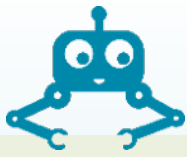
UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH



University of the
West of England

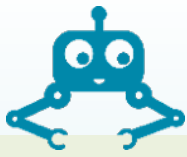


Project description
Key challenges



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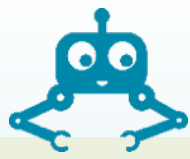
- Goal: providing **PROACTIVE** dressing assistance to
 - disabled users
 - high-risk healthcare workers



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- Scenarios – demos:
 - Putting on / taking off a shoe (1 arm task)
 - Putting on / taking off a medical gown or a coat (2 arms)



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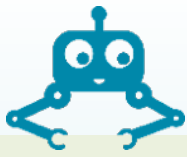
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- Set-ups
 - WAM arms – IRI, BRL
 - Baxter robot – IDIAP, BRL

Kick-off meeting: December 2015

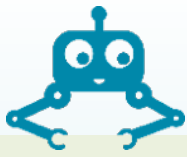




Previous work on robotic dressing assistants

- Adapting a template motor skill
 - Tokyo: failure detection and recovery
 - NAIST: reinforcement learning





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- User modelling for personalised dressing assistance
 - ICL: pose estimation (RDF) and motion modelling (GMM)
 - CMU: personalize repositioning requests by adapting to user's motion limitations (Kinect+Baxter)





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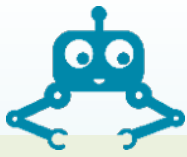


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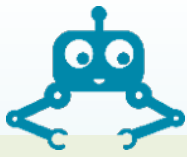
- Estim./Sim. of human-clothing dynamics
 - NAIST: GP-LVM using Optitrack+Kinect
 - GaTech: simulation-based motion optimization





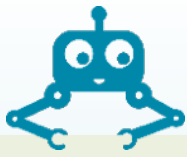
Specific objectives and challenges

- O1: Detection and tracking of garments and human body parts
 - Occlusions, real-time, generalisation



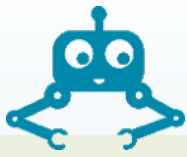
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 - Multimodal approach to understand user



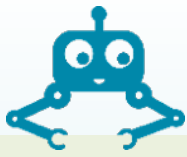
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- O3: LfD for safe motion, speed and proximity
 - Adapt learned skills to new situations/preferences



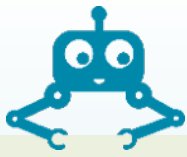
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 - Fluid and safe dressing: environment, user reliability, ergonomic limits



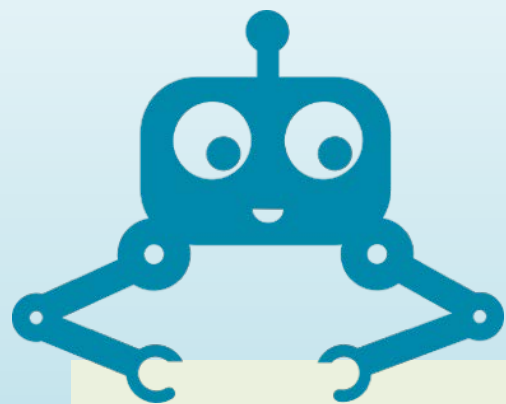
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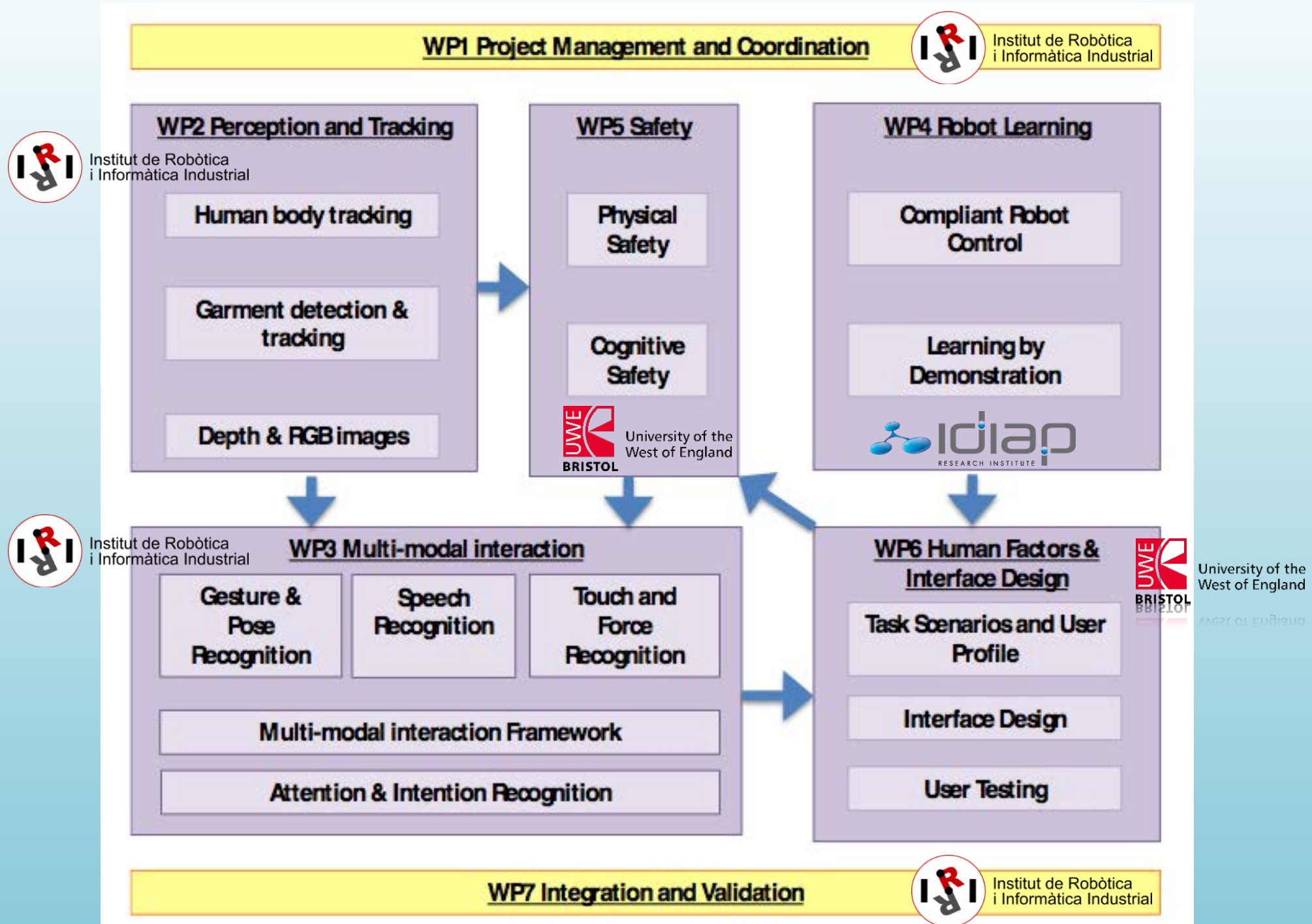


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- O6: Integration and test on commercial platforms
 - Generalisation, transfer



Work description



IRI will work on cloth and user recognition, multi-modal human-robot interaction and system integration.

BRL will provide the expertise in robot safety, human factors and interface design.

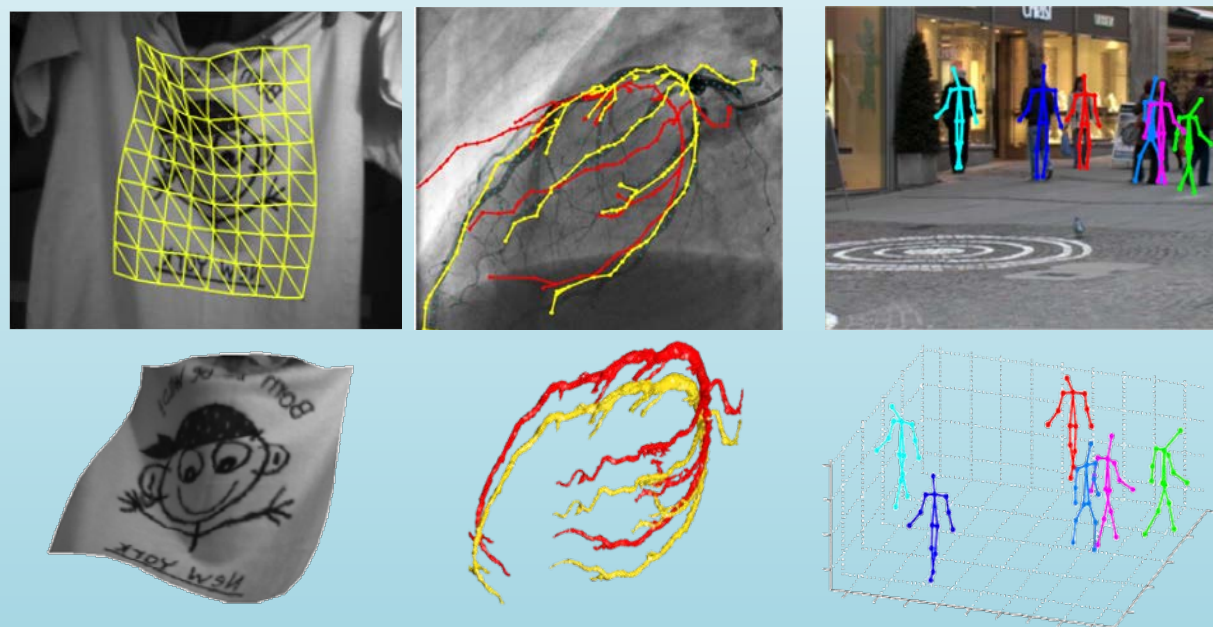
IDIAP will contribute to robot learning.



WP2 Perception and Tracking - Background

Non-Rigid Detection

[PAMI'14,15, CVPR'12,13,15, ICCV'11,15]



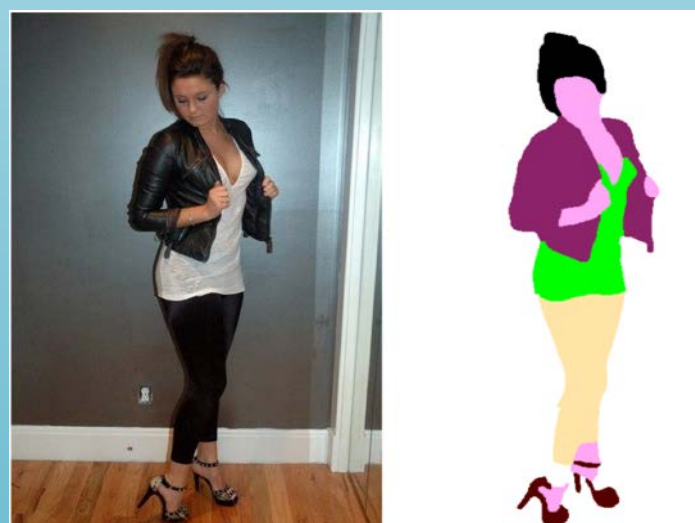
Local Descriptors

[IJCV'15, CVPR'13,14, ICCV'15]



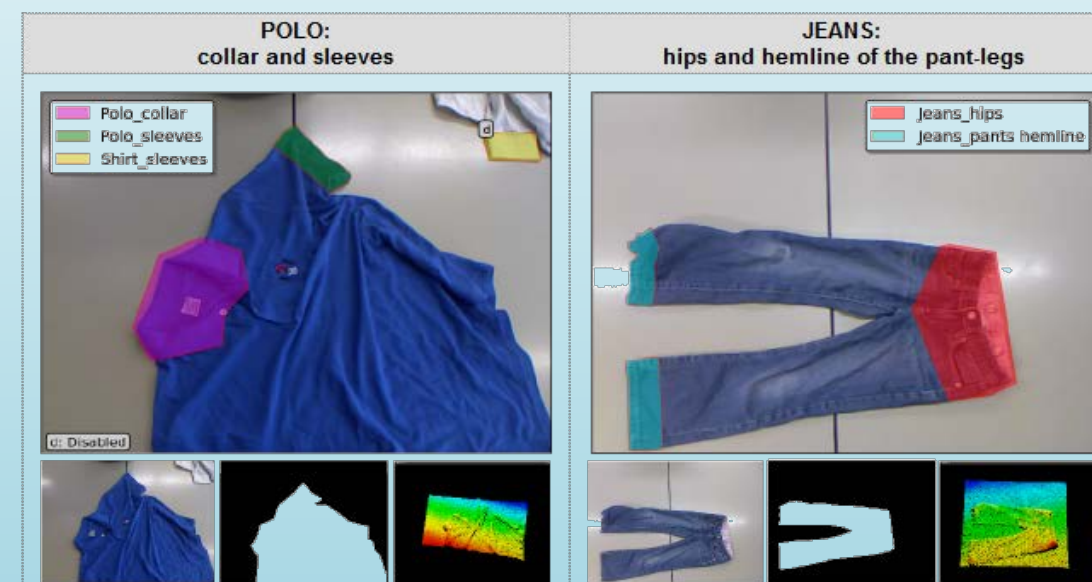
Cloth Segmentation

[ACCV'14, CVPR'15]



Cloth Part Recognition

[ICRA'12, IROS'13, EEAI'14]



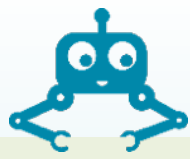
Vision and Language

[VL'15, EMNLP'15]



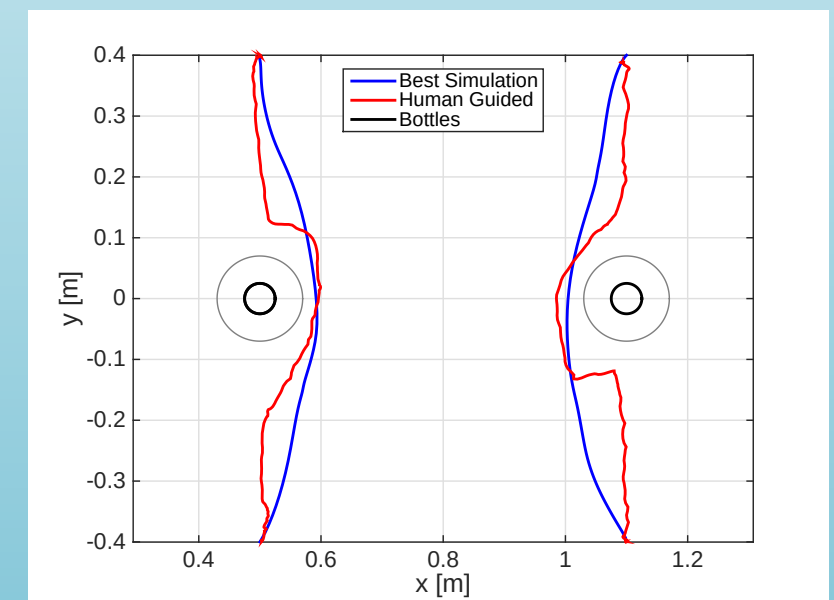
<a:dog,p:run,l:grass>

<a:boy,p:play,l:field>



WP3 Multi-modal interaction - Background

- Robot guidance:
 - gesture recognition [1]
 - user following [2]
 - guidance by pointing [3]
- Intervention [4,5]



- [1] Doisy, G., Jevtić, A. and Bodiroza, S. (2013) Spatially unconstrained, gesture-based human-robot interaction. *HRI 2013*.
- [2] Doisy, G., Jevtić, A., Lucet E. and Edan Y. (2012) Adaptive Person-Following Algorithm Based on Depth Images and Mapping. *IROS 2012*.
- [3] Jevtić, A., Doisy, G., Parmet, Y. and Edan, Y. (2015) Comparison of Interaction Modalities for Mobile Indoor Robot Guidance: Direct Physical Interaction, Person Following, and Pointing Control. *IEEE Tran. HMS*, Dec. 2015.
- [4] Jevtic. A, Colomé A., Alenyà G. and Torras C. (2016) Robot Adaptation through User Intervention and Reinforcement Learning (under review)
- [5] Jevtic. A, Colomé A., Alenyà G. and Torras C. (2016) Evaluation of an Interactive Learning Framework for Robot Manipulators (under review)



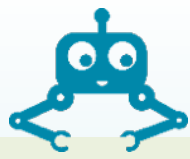
WP3 Multi-modal interaction - **Envisaged**

- **Main Tasks:** Gesture, speech and force recognition
Multimodal interaction unified framework
Attention detection, intention recognition
- Integration of interaction modalities: **visual, audio and tactile.**
- Allow users to move **seamlessly between different modalities**, from visual to spoken to tactile.
- Adapt to **user preferences** and **scenario requirements.**
- Automatically **determine the ability users** to help with dressing.
- **Existing frameworks** will be considered as an initial point [1-3].

[1] Nigay, L. and Coutaz, J. (1995) A generic platform for addressing the multimodal challenge. In *Proc. of SIGCHI'95*.

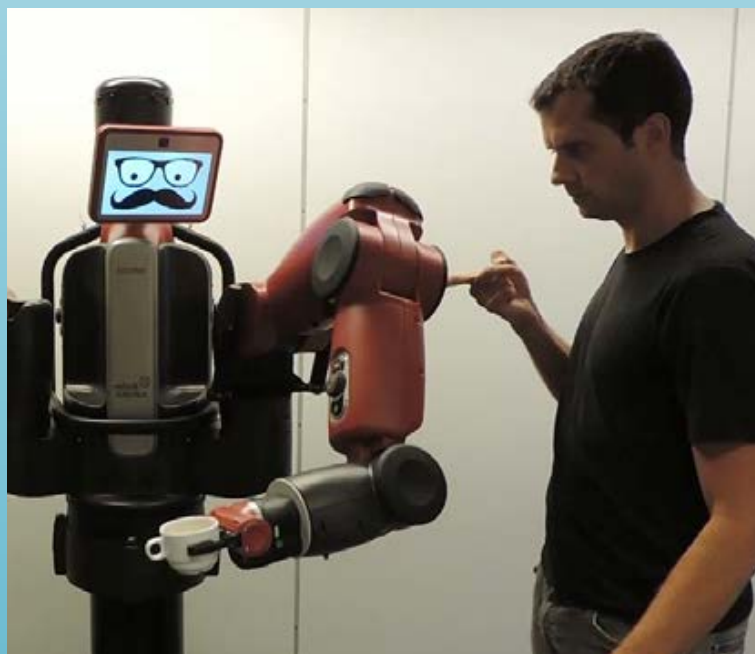
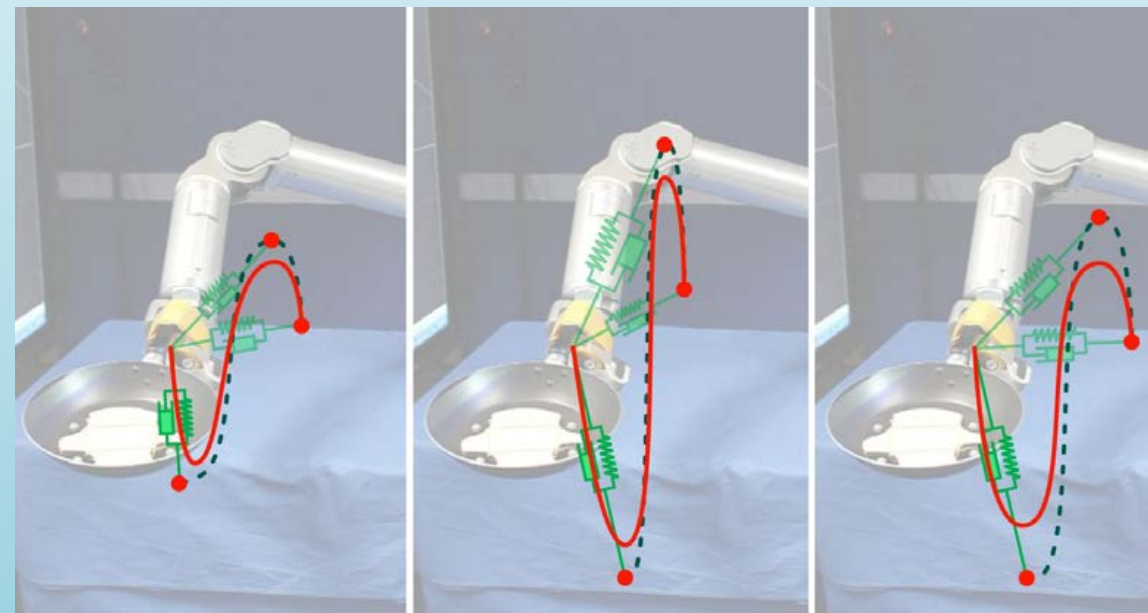
[2] Gorostiza, J.F., et al. (2006) Multimodal Human-Robot Interaction Framework for a Personal Robot. In *Proc. of RO-MAN 2006*.

[3] Stiefelhagen, R., et al. (2007) Enabling Multimodal Human-Robot Interaction for the Karlsruhe Humanoid Robot. *IEEE Tran. on Robotics*.

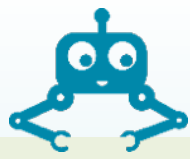


WP4 Robot Learning - Background

- Probabilistic approaches to encode movements and behaviours in robots evolving in unconstrained environments.

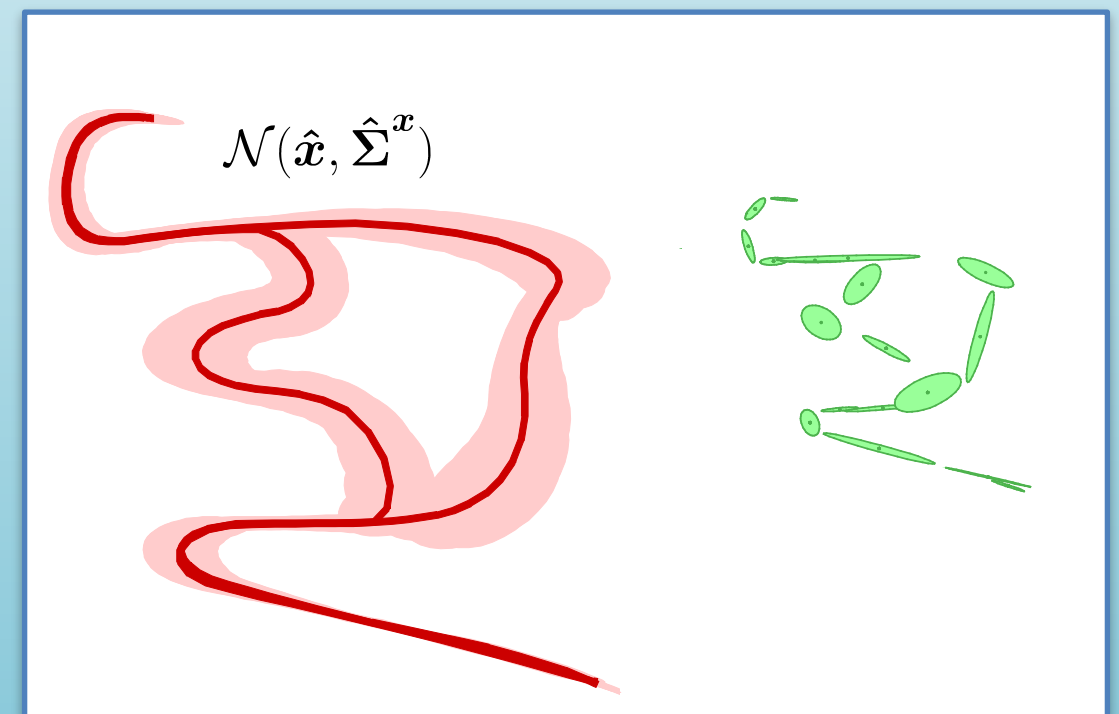


- Task parameterisation
- Stiffness regulation
- Exploration, self-refinement, practice
- Facilitate the transfer of skills



WP4 Robot Learning - Envisaged

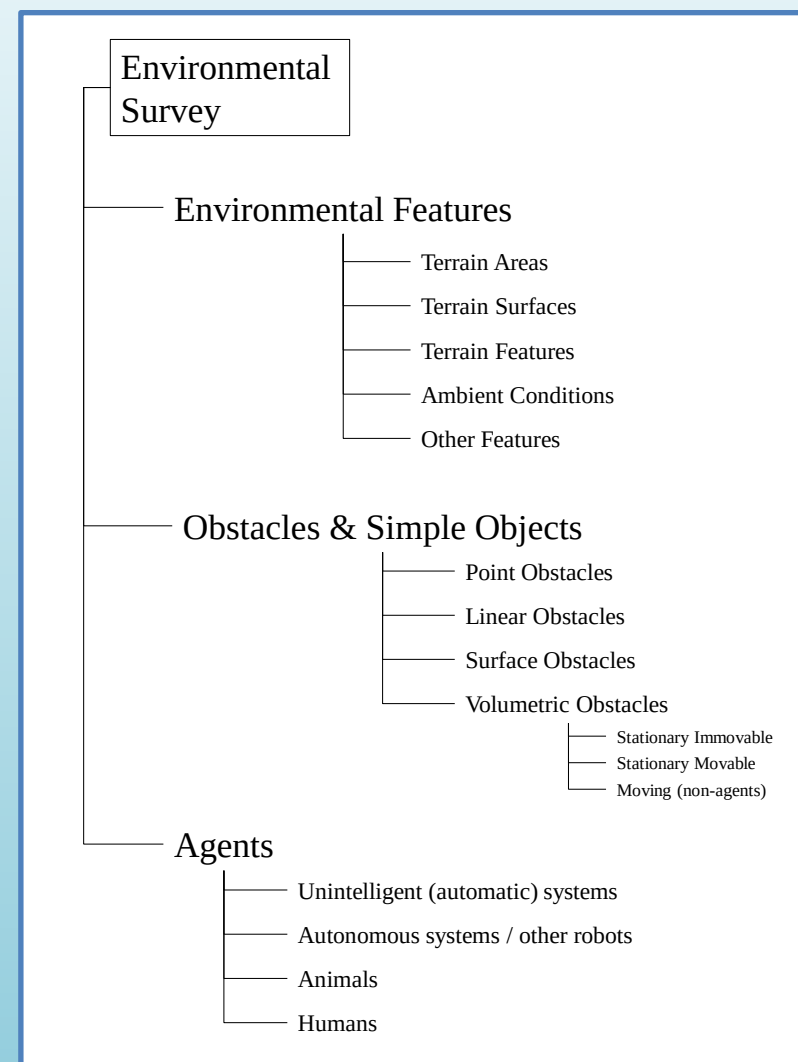
- **Main Tasks:** Learning from direct manipulation
Integration with multimodal interaction
- **Kinesthetic teaching** using force and position
 - Learn from **partial demonstrations**: Trajectory hidden Markov Models
- Exploit **attention and intention** cues when learning
- Detect relevant **local synergies**: subspace clustering





WP5 Safety - Background

- **Hazard identification analysis:** safety assurance during the requirements specification and early design stages of any safety critical system
- **Functional Hazard Analysis and Failure Modes and Effects Analysis**
- **Environmental Survey Hazard Analysis (ESHA)** identifies non-mission interactions and the potential hazards.

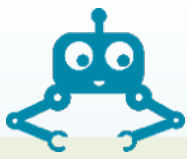


Object:	Details	Type	Interaction Failure Details	Consequence	Safety Measures
Burning rooms	Approach	Failure to interact	Don't find the fire	Injury Damage to robot	Inherent – temperature measurement



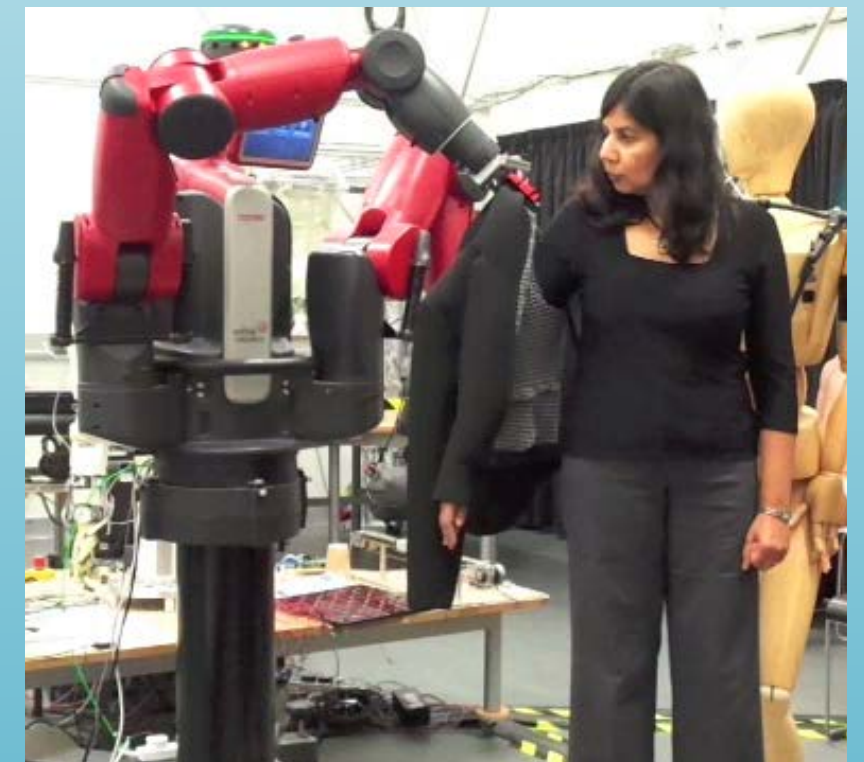
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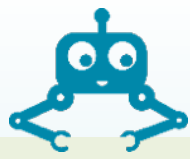
- **Main Tasks:** Hazard analysis and failure identification
Safety through human-robot communication
- Build **user and environment models** based on multi-modal sensing
- Decomposition of task scenarios into **action sequences**
- Modulation of **safety priorities** based on various task attributes (field of view, proximity, etc.)
- **Hazard analysis** in relation to each task attribute
- Distraction testing (will explore feasibility of using physiological response monitoring)
- Identifying the optimal modality(ies) for interaction
- Exploring how trust might be engendered by moving along a directed to autonomous control continuum
- Analysing the potential for the system to assess the user's physical and cognitive abilities and progressive changes in these



WP6 Human Factors and Interface Design - Background

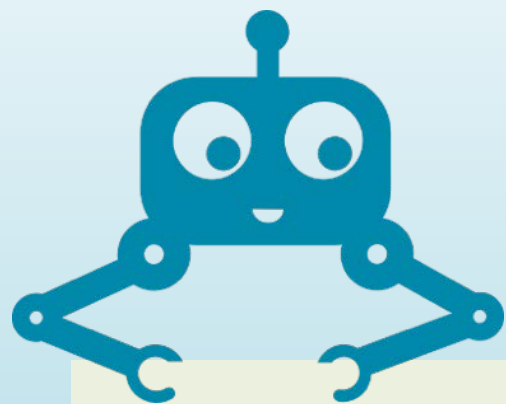
- Measuring efficiency in HRI
 - Impact of Environmental Distraction and Cognitive Load
- Evaluation of a Socially Assistive Robot
 - Simple fixed vocabulary for collaborative working
 - Semi-WOz for usability and user-experience evaluation
 - Exploring potential for human adaptation to facilitate improved HRI
 - Phased introduction to improve acceptance
 - Potential for task prompting and learning from the user to personalise the system



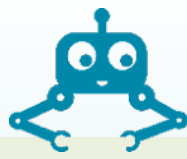


WP6 Human Factors and Interface Design - **Envisaged**

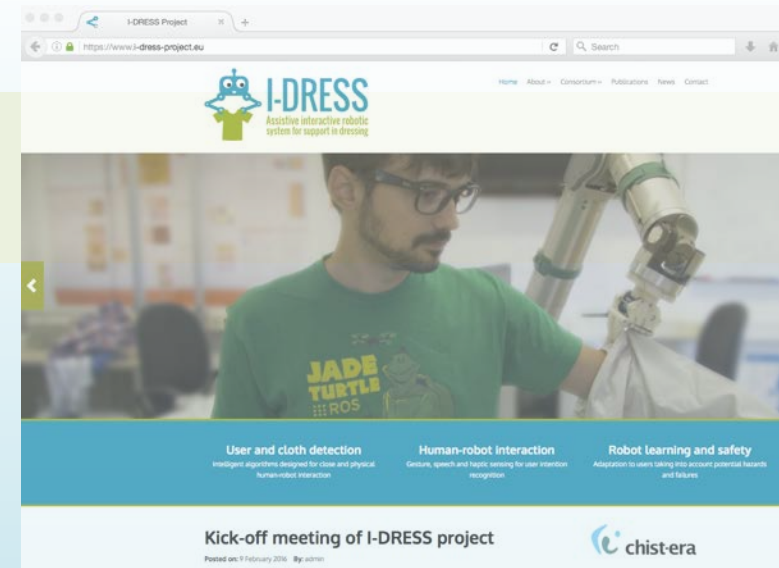
- **Main Tasks:** Scenario and user-profile specifications
Interface design and evaluation
- Use existing User Characteristic Descriptions (ICF) to develop key user-profile specifications
- Identify **level of support** required (user ability and context)
- Explore the continuum fully-guided (directed) to fully automated interaction
- Use WOz to elicit and map range and scope of multi-modal interaction and derive an **instruction vocabulary**
- Define **interaction sequences**, modalities and parameters for each task
- Where appropriate translate findings from Safety WP into a rule-base
- Develop **storyboards** and state diagrams
- Development of an **evaluation framework** (multi-factor metrics)
- **Ethics** application for user testing



Results and dissemination



Actions



www.i-dress-project.eu/



poster

IRI D1.3 M3 Project website

BRL D6.1 M6 Detailed **task scenarios and user profile specifications**

IRI D7.1 M6 Agreement on the specification of the **software architecture**

IRI D2.1 M12 **Garment detection and tracking** algorithms (software and report)

BRL D3.2 M12 **Speech recognition customised interface** and vocabulary

BRL D3.3 M12 **Touch and force recognition**

BRL D5.1 M12 **Hazard analysis and failure identification** for Dressing Assistant

IRI D7.2 M12 **Implementation of the basic architecture**



The I-DRESS family (is growing)



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