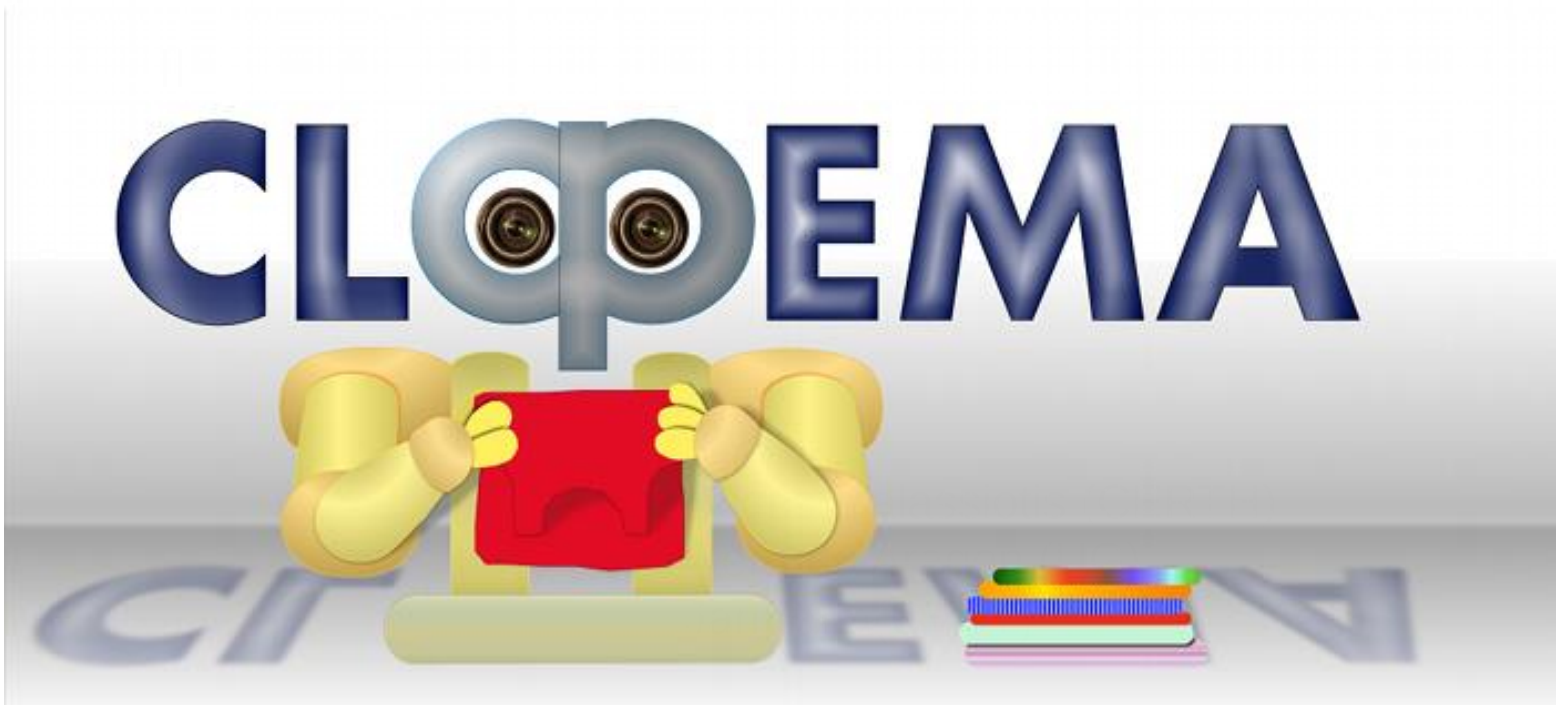

Step changes in: Clothes Perception and Manipulation

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UNIVERSITÀ DEGLI STUDI DI GENOVA

NEOVISION
Industrial Vision Systems

SEVENTH FRAMEWORK PROGRAMME

The project at a glance

- Duration: 1 Feb 2012 – 31 Jan 2015
- Budget: 2.8 M Euro
- Consortium
  - Center for Research and Technology Hellas (CERTH)
  - Czech Technical University in Prague (CVUT)
  - University of Genova (UniGe)
  - Univeristy of Glasgow (UG)
  - Neovision (NEO)

CloPeMa: Step Changes

- State-of-the-art results on robotic manipulation of limp materials
- Novel sensors and material perception techniques
- Improved dexterity for soft material handling

Why is it hard to manipulate clothes ?

- Deformable materials exhibit a huge space of possible configurations
- Modeling is prohibitive for limp materials and difficult for soft ones.
- Humans rely mostly on their dexterity.

The state-of-the-art

2001 - 2009

Various groups in Japan
(K. Kita, S. Hirai)

2010 - 2013

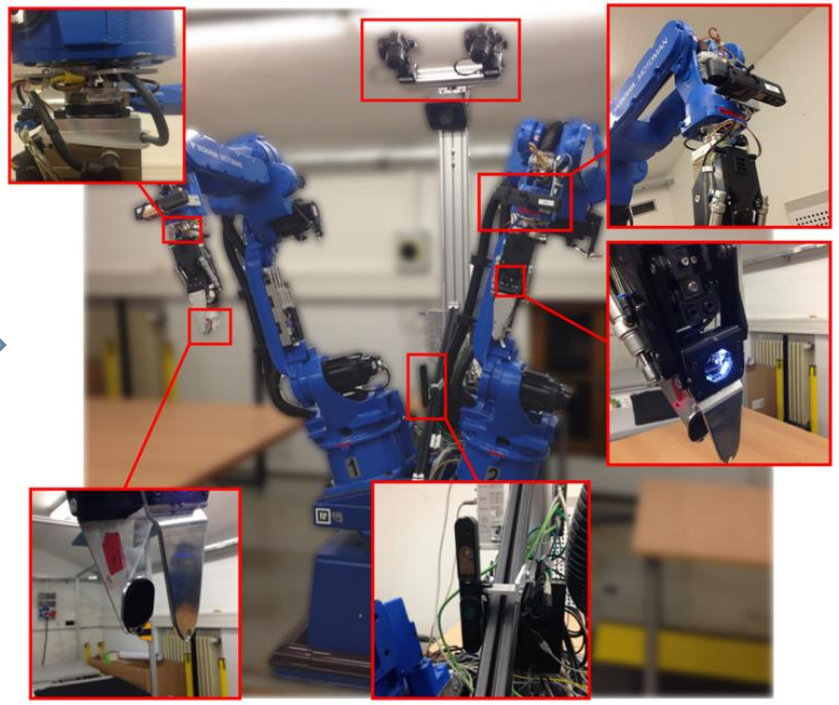
Berkley, USA (P. Abbeel)
Clemson, USA (B. Willimon)
UPC, Spain (C. Torres)

2012 - 2015

CloPeMa, EU
Columbia, USA (P. Allen)

Step Change: CloPeMa testbed

PR2: 400k $



CloPeMa: 65k €

- 13 DOF industrial manipulators
- Three Asus Xtions
- 2 Force/Torque sensors
- Stereo head (2 Nikon cameras)
- Photometric Stereo camera in the gripper
- Tactile, proximity sensors and microphone
- All software in ROS

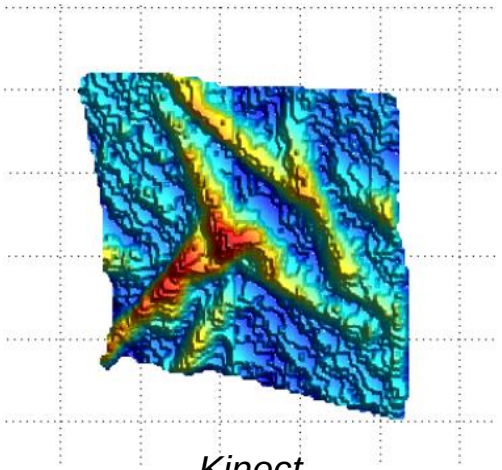
Step Change: 3D sensing

- *Low-cost*
- *Real-time*
- *Low resolution*
- *Limited accuracy*

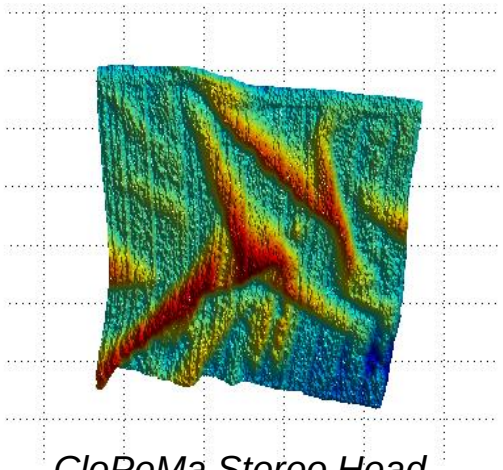
- *Medium-High cost*
- *Not real-time*
- *Small scanning volume*
- *Medium resolution*
- *High accuracy*

- *Medium-cost (Off-the-shelve SLRs, PTUs)*
- *Not real-time (3s per scan GPU)*
- *Very high resolution (10MP)*
- *Sub-millimeter accuracy*
- *Automated gaze control and foveation*

Step Change: 3D sensing



Kinect

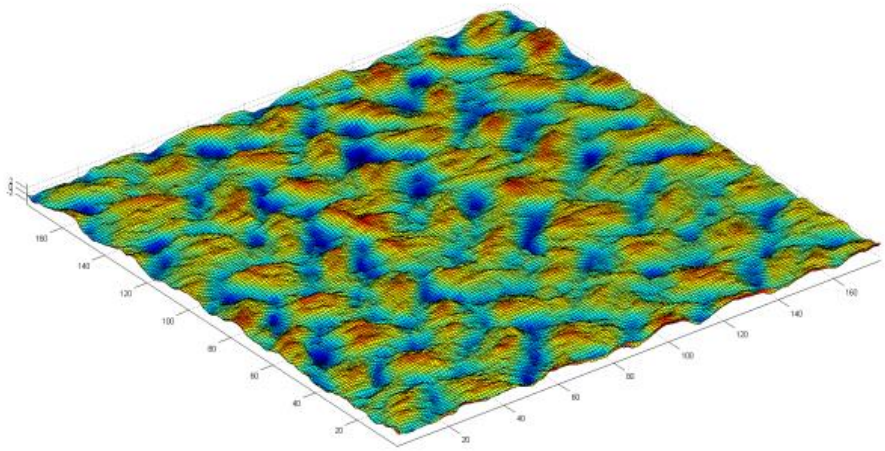


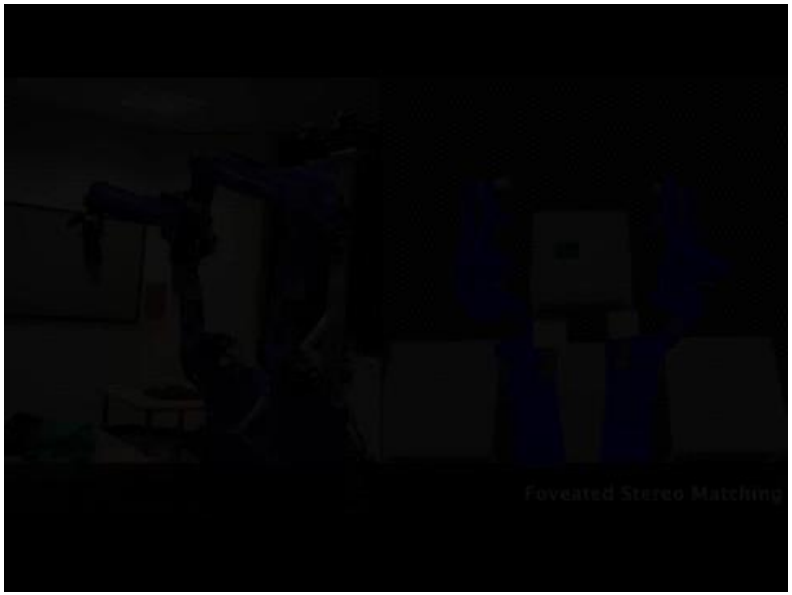
CloPeMa Stereo Head

Step Change: 3D sensing

- Photometric Stereo Micro-Geometry Scanner

- 720p webcam, LEDs arrays
- Arduino controller, USB hub
- 3D printed case
- 3x4 cm

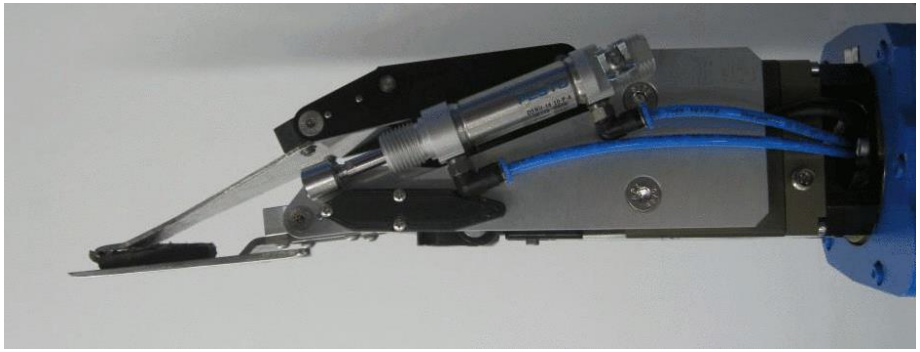




3D scan of cotton pants
0.5cm x 0.5cm

Step Change: Grasping

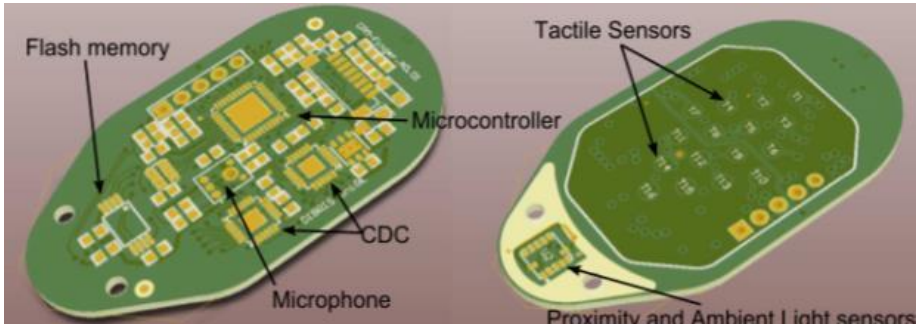
- Function
  - Picking and handling garment
  - Compliant to the hard contact surface
  - Fitted tactile sensors and photometric camera
  - Rubbing motion for sensing
  - Robust design (TRL 6)

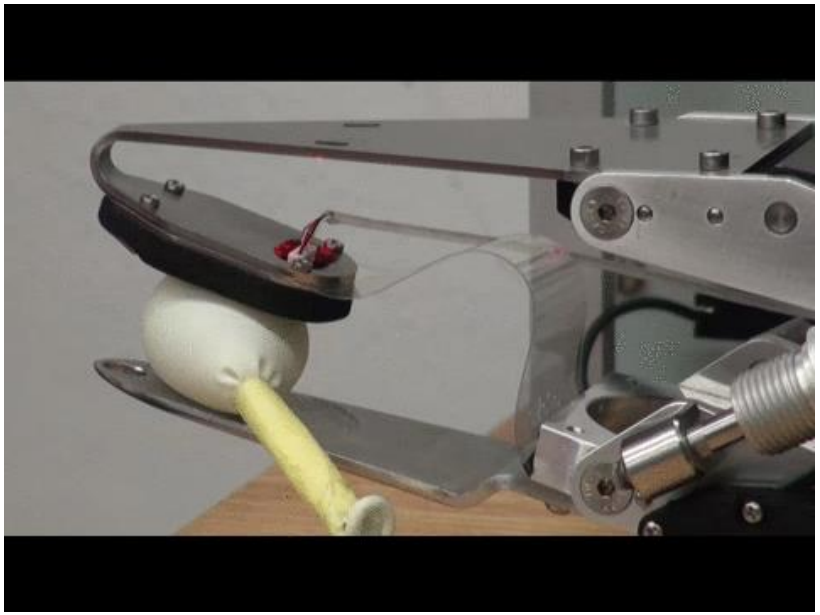


Patent pending

Version for Baxter

Step Change: Tactile Sensing





Tactile sensor:

- Building on ROBOSKIN results
- 16 pressure sensors distributed around the sensor center
- Sampling time around 27ms (including transmission)
- 2mm diameter and 4mm pitch designed for small details detection such as garment buttons or borders

Step Change: Manipulation

- First to demonstrate the complete “Laundry Folding Pipeline”
- Improved results (robustness and speed) in unfolding, folding and flattening tasks.
- Realistic scenarios with a large variety of real-sized garments.

- A. Doumanoglou, A. Kargakos, Tae-Kyun Kim, S. Malassiotis, “Autonomous Interactive Recognition and Unfolding of Clothes using Random Forests and Probabilistic Planning”, ICRA 2014, Hong Kong, 31 May - 5 Jun, 2014, **KUKA best service robotics paper award**.

Step Change: Manipulation

Step Change: Perception

- First to demonstrate:
  - use of machine learning techniques for recognition of deformable objects.
  - multi-sensorial explorative recognition of garment material

Lessons Learned

- **Dexterity** is important (e.g. tracing a seam, buttoning a shirt)
- **Physics modeling** is needed to achieve accuracy.
- **Perception** of **deformable** objects from ad-hoc techniques to generic framework.
- **Material** recognition proved quite challenging.
- **Dynamics** cannot be ignored.

Potential Impact: Service Robotics

- “Robotic Maid”
  - Tidy up capabilities (laundry, making the beds, ironing)
  - hospitals, hotels, elderly homes etc.
- Logistics
  - Warehouse, store, pick-n-place.
  - Packing (gift wrapping, cardboard box opening).

Potential Impact: Garment Manufacturing

- Highly automated but assembly still manual
- Mostly outsourced in cheap labor countries

- Short term: Fully automated made-to-measure garments (same day delivery)

Potential Impact: Laundry Services

- Domestic and commercial services
- High volumes by hospitals and hotels
- Pick-n-place only to be automated

Potential Impact: Automotive

Asphalt sheet placement

Car seat dressing

Others: Cable routing, rug, trim installation, insulating membranes

Thank you for listening

To probe further:

www.clopema.eu

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