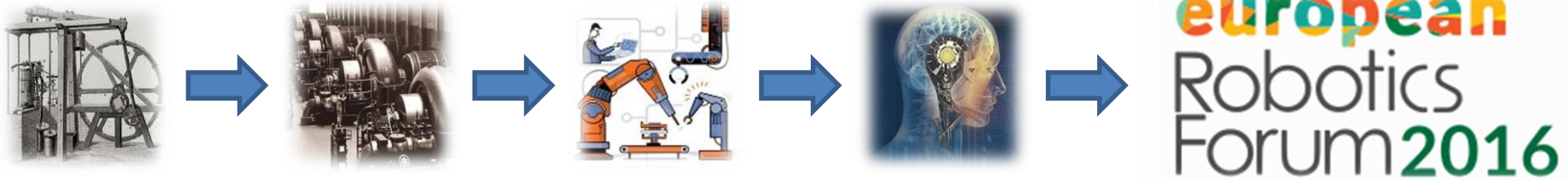# Cognitive Manufacturing with Soft Items
The CloPeMa project results

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WorkShop Work Flow

Robots 4.0

Adaptive Grippers

Dexterous Manipulators and Human Manipulation

Multi-Modal/Arms "drum-circle"

Manufacturing 4.0

Human Robot Collaboration

Cognitive Manufacturing

Cooperative Manufacturing

Flexibility 4.0

Service Oriented Approach in Flexible Manufacturing

Task Planning in Flexible Manufacturing

Open Dynamic Manufacturing Operating System in Flexible Manufacturing

Why it is 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

Project step changes

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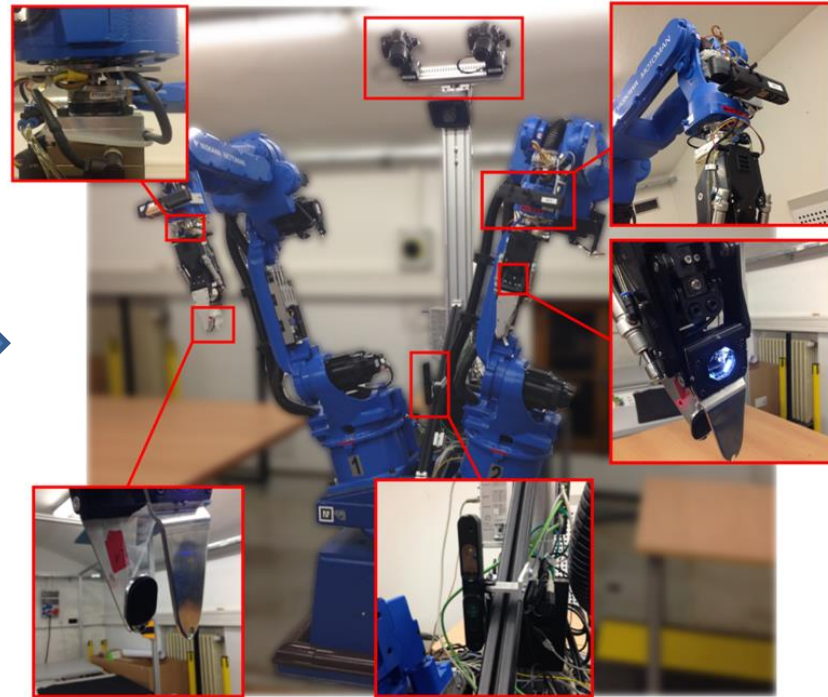- Improved dexterity for soft material handling

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
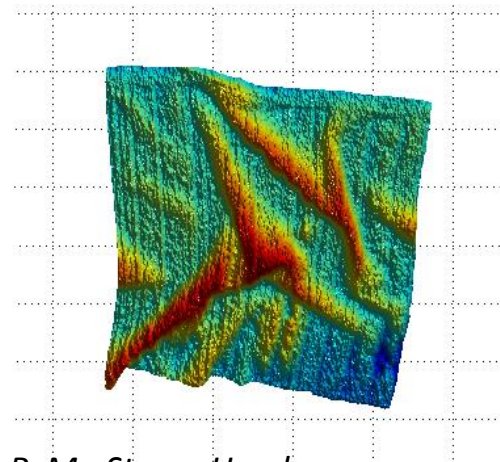- Tactile, proximity sensors and microphone
- All software in ROS

Step change
3D vision sensing

- *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*
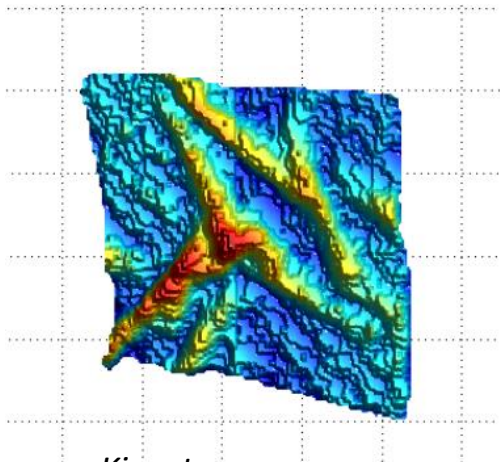
POSTER AT FLOOR -1

Kinect   *CloPeMa Stereo Head*
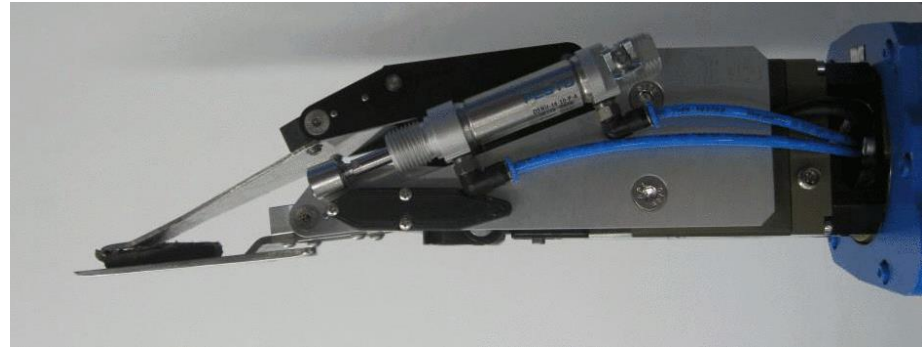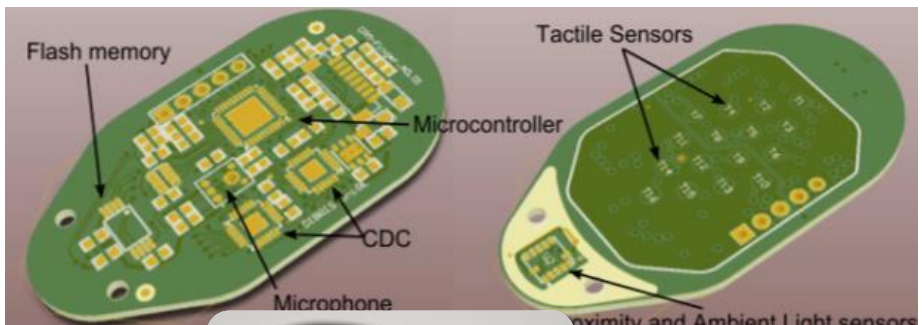
- Picking and handling garment
- Compliant to the hard contact surface
- Fitted tactile sensors and photometric camera
- Rubbing motion for sensing
- Robust design (TRL 6)
- 16 pressure sensors distributed around the sensor center
- Sampling time around 27 ms (including transmission)
- 2 mm diam, 4 mm pitch for small detection (buttons, edges)

Patent pending

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 large variety of real-sized garments

Manipulation.mpg

Step change Perception

First to demonstrate:

- use of machine learning techniques for recognition of deformable objects
- multi-sensorial explorative recognition of garment material

Sorting.mpg

Potential Impact

- Service Robotics
    - "Robotic Maid" (hospitals, hotels, elderly homes)
        - Tidy up capabilities (laundry, making the beds, ironing)
    - Logistics (Warehouse, store, pick-n-place)
        - Packing (gift wrapping, cardboard box opening)
- Garment manufacturing
    - Highly automated but assembly still manual
    - Mostly outsourced in cheap labor countries
- Laundry services
    - Domestic and commercial services
    - High volumes by hospitals and hotels
    - Pick-n-place only to be automated

Thank you for listening

To probe further:

www.clopema.eu