RoMaNS – Robotic Manipulation for Nuclear Sort and Segregation

UNIVERSITY OF BIRMINGHAM

TECHNISCHE UNIVERSITÄT DARMSTADT

NATIONAL NUCLEAR LABORATORY

UoB, UK (lead)	**Rustam Stolkin** **Ales Leonardis** **Marek Kopicki**
TUDa, Germany	**Jan Peters** **Gerhard Neumann**
CEA, France	**Mathieu Grossard** **Yvan Measson** **et al.**
CNRS, France	**Paolo Robuffo Giordano** **François Chaumette**
NNL, UK	**Jeffrey Kuo** **Bob Bowen**

1st May 2015 – 31st March 2018

Coordinator: Rustam Stolkin r.stolkin@cs.bham.ac.uk

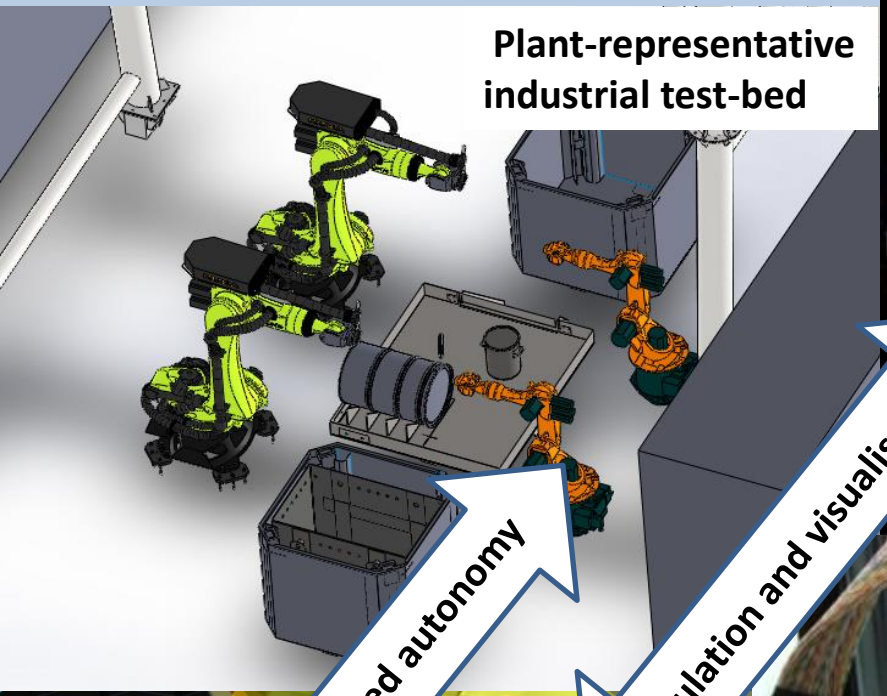
Nuclear sort & seg. problem

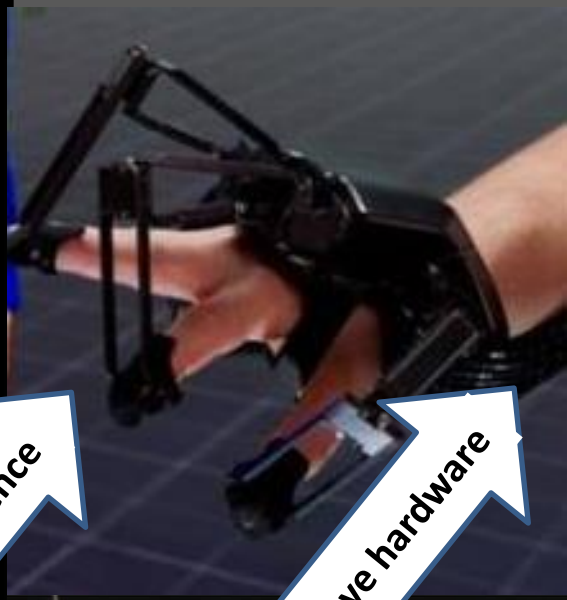
- Cleanup of “legacy” nuclear waste is largest environmental remediation project in whole of Europe.
  - UK has 1.4million cubic metres of intermediate level waste (ILW) alone.
  - At a single UK site (Sellafield), 69,600 cubic metres of ILW waste will have to be placed into 179,000 storage containers in near future.
- Much of this was stored decades ago, in containers with unknown contents and mixed contamination levels.
  - Old containers must be cut open.
  - Their contents must be examined, sorted and separated.
  - Highly contaminated waste must be extracted and placed into special new storage containers.
- This poses an enormous challenge for remote manipulation.
  - Waste comprises a vast array of objects and materials, with a vast complexity of shapes, appearances, properties.
  - Each object must be recognised, identified, grasped and manipulated.
  - Tangled objects must be pulled apart – perhaps by bimanual manipulation.
  - Current state of the art is either 1960s style mechanical MSM devices, or tele-operated arms typically controlled joint-by-joint by human operator.
- Hypothesis - required throughput rates cannot be achieved safely and efficiently without:
  - Increased autonomy .
  - Enhanced tele-presence, force-reflection and bi-lateral feedback, HRI, and situational awareness.
  - A new generation of robot hardware is needed.

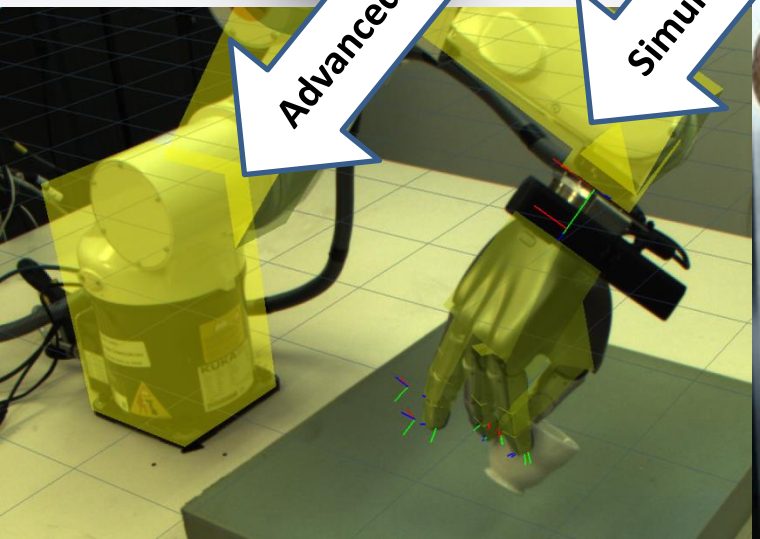
The RoMaNS project will:

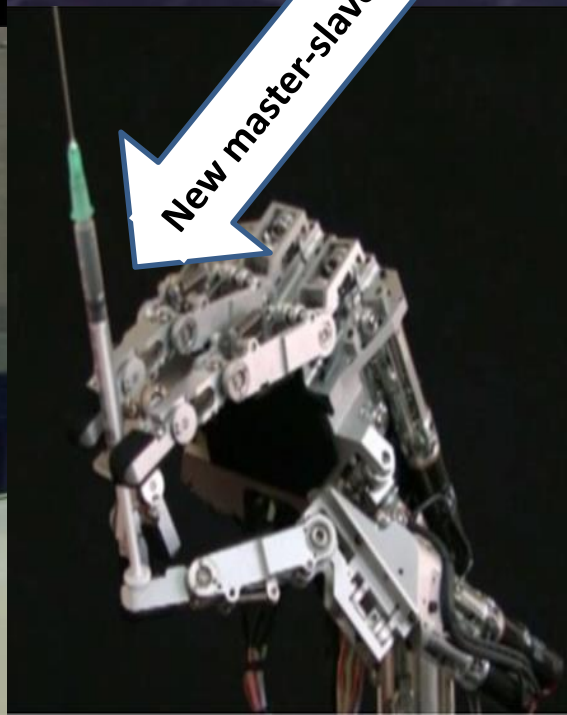
- Develop novel arms, hands, grippers (slave robots):
  - MUST work in high radiation environment (kills delicate electronics).
  - BUT still offer low inertia, back-drivability, compliance, force-reflection.
- Develop advanced haptic feedback master devices:
  - New exoskeleton hand haptic controller.
  - Enhanced haptic master arm.
- Develop advanced autonomy methods:
  - Multi-sensor perception of complex cluttered scenes.
  - Object detection, segmentation, recognition, modelling in difficult clutter.
  - Autonomous grasp/manipulation planning of arbitrary object shapes.
  - Learning from human tele-op actions/demonstrations/annotation.
  - Active perception – combining vision with robotic exploration of scenes.
- Combine autonomy and tele-operation methods:
  - Mixed initiative planning, variable autonomy and shared control approaches.
  - Enhanced situational awareness by fusing autonomous vision outputs and VR simulators.
  - Autonomy as push-button human-assistance tools.
  - Human subject experiments with end-users.
- Build and demo industrial test-bed:
  - Plant-representative environment at National Nuclear Lab.
  - Representative of new Box Encapsulation Plant at nearby UK Sellafield nuclear site.
  - TRL 6 demo of tele-autonomy perception and manipulation tools.

RoMaNS activities









Advanced autonomy

Simulation and visualisation

Advanced tele-presence

New master-slave hardware