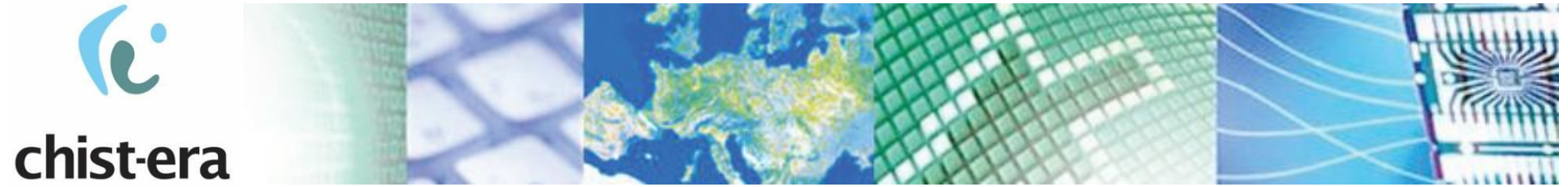

CHIST-ERA Projects Seminar 2021
Object recognition and manipulation by robots: Data sharing and experiment reproducibility (ORMR)

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Introduction: Projects of the Topic

- **PeGRoGaM:** Perception-guided robust and reproducible robotic grasping and manipulation
- **InDex:** Robot In-hand Dexterous manipulation by extracting data from human manipulation of objects to improve robotic autonomy and dexterity
- **IPALM:** Interactive Perception-Action-Learning for Modelling
- **HEAP:** Human-Guided Learning and Benchmarking of Robotic Heap Sorting
- **BURG:** Benchmarks for UndeRstanding Grasping
- **LEARN-REAL:** Learning Physical Manipulation Skills with Simulators using Realistic Variations
- **CORSMAL:** Collaborative Object Recognition, Shared Manipulation and Learning

Major Achievements and Outputs

- Tools to create and annotate real & synthetic data
- Object datasets with annotations (objects in their particular poses, grasps incl. grasp score, object part, task relevance)
- Benchmarking protocols
- Methods for interactive scene manipulation, grasping and human-in-the loop-learning
- Sharing baselines and pre-trained models for these benchmarks
- Organisation of two Challenges.
- Integrating individual components for object/scene modeling developed in various settings into a system working with hardware and real scene
- Investigated the roles of variations in sim-to-real learning challenges
- Engagement with external researchers that use ORMR data and models, publish using ORMR data, and, in turn, shared their models and annotations

Possible Roadmap

- Long-term availability of website and GitHub
  - ✔ Hosting of links to ORMR datasets in a dedicated CHIST-ERA webpage
  - ✔ Exploitation of datasets created in related projects
  - ✔ Continue building upon our data and models beyond projects
- Joint initiative of ORMR consortia to push the field towards specific goals

Upcoming Challenges and Needs

- Standardisation of representations and interfaces in the robotics community
  - ✔ Reproducible setups and dataset integration with documentation and maintenance after project end
  - ✔ Combining learning modalities (orchestrating learning by interaction and self-refinement)
  - ✔ Integration and engineering effort not available in academia
- Fusion of audio, visual, and tactile sensing.
- Adaptation of the pre-trained models across labs and conditions.
- Robustness to uncertain conditions.
- Benchmarks that can exploit the different types of variations studied in the project
  - ✔ Benchmarking human involvement
- Uptake of techniques by industry
  - ✔ especially in conservative industries such as nuclear
- Close the virtual-to-real gap for object grasping
- Methods to exploit object symmetry and parts for effective grasping
- Engagement with the community after the project ends

Role of the CHIST-ERA Support

- Help encourage Spanish and Italian funders to finalise funding schedules as delays can impact the whole programme
  - ✔ Overall project output relies upon components from partners
- Organise more frequent meetings (e.g. 6-months) for projects within the call would be desirable
  - ✔ Organize different topics on different days for cross field collaboration
- Allow multiple international partners (>2) to collaborate (in contrast to bilateral research programs)
- Organise calls on topics with great potential if the collaboration between projects/sharing and collating outputs can be realised.
  - ✔ More robotics topic calls would be appreciated :)
- Foster cross-project expertise with calls-for-projects targeting specific research topics

Responsible Research & Innovation

- **Ethics:**
  - ✓ Approvals required for all studies involving human participants,
  - ✓ Researchers informed about ethical implications at the institutional level.
  - ✓ Transnational hosting and attribution of large datasets.
- **Gender Equality:**
  - ✓ Very male-dominated field, hard to realise gender equality among researchers, although some projects have female investigators.
  - ✓ Unsure whether the developed methods affect different genders differently (not much research on that, but many operators etc. in teleoperation are often male)
- **Governance:**
  - ✓ University-led initiatives to embed RRI practices following EPSRC AREA framework and ORBIT

Responsible Research & Innovation

- **Open Access:**
  - ✓ datasets, tools etc. available as open source; e.g. using Zenodo (supported by CERN and EU OpenAire) for hosting and long-term sustainability (DOIs) [CORSMAL]
  - ✓ institution support for open access publishing due to funder requirements [HEAP]
  - ✓ additional support from SNSF for gold open access publishing (LEARN-REAL)
- **Public Engagement:**
  - ✓ industry talks, workshops, research open days
  - ✓ IET Children's Lecture (CORSMAL)
- **Science Education:**
  - ✓ integration of benchmark tools/datasets into curriculums
    -> strong impact potential to support science education
  - ✓ training of PhD and MSc students (CORSMAL+LEARN-REAL)

Open Science

- *Provide/Share*
  - ✔ datasets, software and tools as open source (e.g. website, GitHub)
  - ✔ baselines, pre-trained models, evaluation toolkits
  - ✔ DOIs for datasets (e.g. using zenodo)
- *Obstacles/Challenges*:
  - ✔ clear metadata and documentation accompanying datasets and codes
  - ✔ well-documented, understandable, easy-to-reuse/reproduce software
  - ✔ More effort to make science open/accessible/understandable to
    - teens/young people when they make their first career decisions.
    - the general public to prevent false/negative perceptions of (some) research activities (e.g. person/face recognition)
  - ✔ Development of new collaborations challenging due to legal work required
    - Differences in priorities or internal regulations of institutions in EU or companies

Technology Transfer

- *Often realised by*
  - ✔ Companies directly hiring experts that are trained within projects
    - More cost effective and legally easier
    - Researcher (CORSMAL) who contributed to the baseline hired by Medtronic
  - ✔ Academic start-ups acquired by large companies.
  - ✔ Joint industry/academia positions
- *Challenges*
  - ✔ Some industries are sceptical about open-source tools (e.g. ROS) and favor close architectures
    - Strong focus on verification/validation before any new technology can be deployed.
    - Nuclear industry
- *Potentials*
  - ✔ Industrial interest for bin picking, different types of objects from in-class variation to transparent

Questions

Questions ?

Possible Roadmap

BURG: start exploiting the different datasets created in the related projects

IPALM: joint initiative of ORMR consortia to push the field towards specific goals [+1 from CORSMAL]

CORSMAL: long-term availability of website and GitHub to allow external researchers and other users to build upon and extend our data and models beyond the end of the project.

CORSMAL: hosting of links to ORMR datasets in a dedicated CHIST-ERA webpage

HEAP: agree with all above

LEARN-REAL: agree with all above

Major Achievements and Outputs

BURG: creating benchmark datasets with annotations (objects in their particular poses, grasps incl. grasp score, object part, task relevance)

BURG: tools to create multiple real scenes groundtruth from robot

HEAP: Reproducible object dataset and benchmarking pipeline; Benchmarking state of the art approaches and development of novel methods for interactive scene manipulation, grasping and human-in-the loop-learning

LEARN-REAL: investigated the roles of variations in sim-to-real learning challenges

CORSMAL: open benchmark, baselines, datasets, and shared pre-trained models. Organisation of two Challenges.

CORSMAL: engagement with external researchers that use CORSMAL data and models, publish using CORSMAL data, and shared their models and annotation

IPALM: integrating individual components for object/scene modeling developed in various settings into a system working with hardware and real scene

Upcoming Challenges and Needs

HEAP+BURG: close the virtual to real gap for object grasping;

BURG: methods to exploit object symmetry and parts for effective grasping

HEAP: Benchmarking human involvement; generating fully reproducible setups and dataset integration with documentation and maintenance after project end (requires a lot of integration and engineering effort not available in academia); uptake of techniques by industries (especially in conservative industries such as nuclear) is very difficult

LEARN-REAL: Combining learning modalities (orchestrating learning by interaction and self-refinement)

LEARN-REAL: Benchmarks that can exploit the different types of variations studied in the project

- Standardisation of object representations and interfaces in the robotics community

CORSMAL: fusion of audio, visual, and tactile sensing. Adaptation of the pre-trained models across labs and conditions. Robustness to uncertain conditions.

CORSMAL: engagement with the community after the project ends.

Open Science

BURG: tools to create benchmarks and datasets are already openly available

HEAP+LEARN-REAL: datasets, simulation framework and software used in publications are made open where possible

CORSMAL: benchmark, list of objects available worldwide, baselines, datasets, shared pre-trained models, evaluation toolkit, DOIs for datasets. *Obstacles*: clear metadata and documentation accompanying datasets and codes.

BURG: software not only needs to be made available, it is also crucial that it is well-documented and accessible so that others can easily use it and advance on it - that takes time of course

IPALM: more effort to make science open/accessible/understandable to teens when they make their first career decisions.

Same for general public so that some research activities are not perceived in a negative way (person/face recognition)

Technology Transfer

IPALM: happens a lot by companies directly hiring experts that are trained within projects like in ORMR, more cost efficient and legally easier. Academics driven start-ups getting acquired by large companies.

Joint industry/academia positions are frequent.

CORSMAL: researcher who contributed to the baseline hired by Medtronic

HEAP: Nuclear industry is very conservative, with strong focus on verification/validation before any new technology can be deployed. As a result they are sceptical about open-source tools (e.g. ROS) and favor close architectures.

BURG: industrial interest for bin picking, different types of objects from in-class variation to transparent