Towards safe human-to-robot handovers of unknown containers

CIS centre for intelligent sensing
http://corsmal.eecs.qmul.ac.uk/safe_handover.html

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1.Motivation

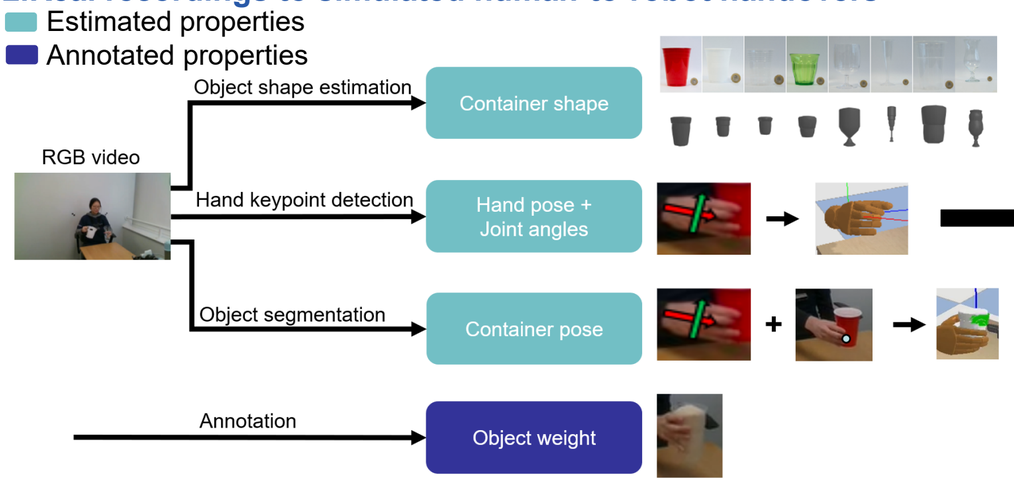
Human-robot interaction in the real world
- Unsafe for human
- Unsafe for the container

Simulation of human-robot interaction
- No safety concerns
- Faster than real time
- Automated environment reset

Limitations of existing simulators for handovers
- Visualization of trajectory only [1]
- Primitive shape objects or scan required [2]
- Static or limited dynamic setup [3]

[1] Fishman, A. et al., "Collaborative interactions models for Optimized Human-Robot Teamwork", IROS 2020.
[2] Liu, N. et al., "Real-sim-real transfer for real-world robot control policy learning with deep reinforcement learning", Applied Sciences 2020.
[3] Webster, M. et al., "A corroborative approach to verification and validation of human-robot teams" IJRR 2020

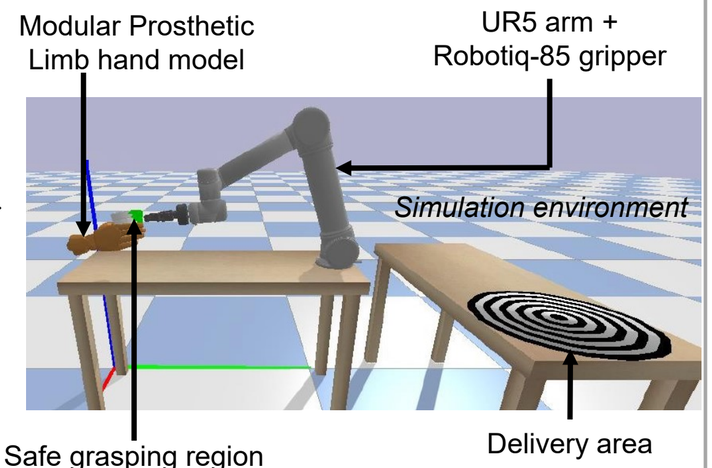
2.Real recordings to simulated human-to-robot handovers



Perception pipeline

Real estimation of the *physical properties of an object* **manipulated by a person** (no markers, no MOCAPs, no scanned 3D models)

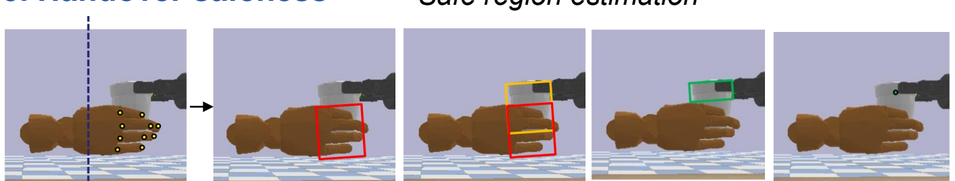
Modular real-to-simulation framework



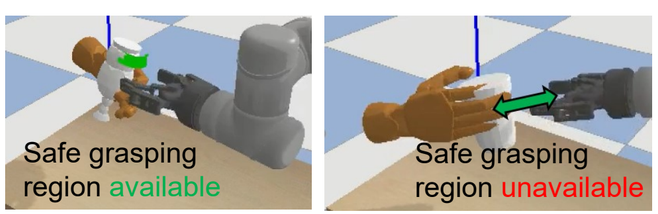
+ Handover simulation when *a real robot is not accessible*
+ Simulation of contact forces
+ Fully dynamic setup

3. Handover safeness

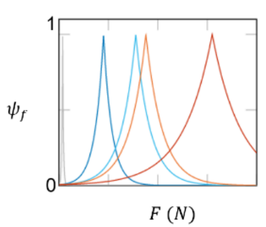
Safe region estimation



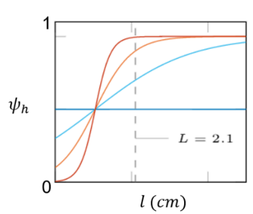
Extracting hand keypoints close to container | Obtain unsafe region | Initialize safe region | Remove unsafe region | Obtain grasping location



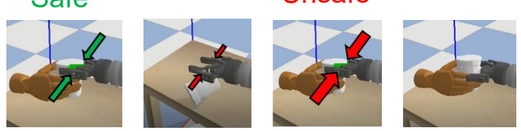
Object safety



Human safety

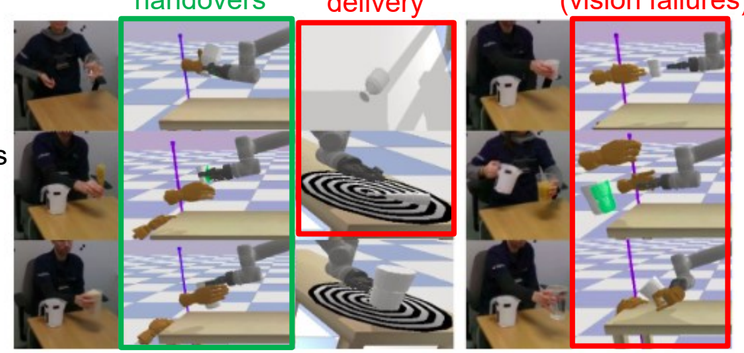


Safe | Unsafe



Insufficient or excessive force | Pinching the human

4. Results



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CORSMAL Collaborative object recognition, shared manipulation and learning

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