I-DRESS

Assistive interactive robotic system for support in dressing

**Consortium:**

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Health & social care account for more than 10% of UK GDP (Ramanauskas, 2019)* and public spending on healthcare has been continually increasing.

Source: The King's Fund analysis of HM Treasury data • Direct Covid-19 spending from 2022/23 onwards has not been separately identified yet

I-DRESS in BRL

HHI study with 18 people
Focus on disambiguation of deictic language
Algorithms for dressing error detection

HRI study with 41 people
Focus on distraction and safety during dressing
Rich dataset for model and prediction development

Chance, G., Jevtić, A., Caleb-Solly, P., Alenyà, G., Torras, C., Dogramadzi, S., Elbows Out - Predictive Tracking of Partially Occluded Pose for Robot-Assisted Dressing, IEEE RAL, 2018
Hazard Identification / Risk Assessment / Safety Analysis

Internal, human factors and mission-related functional hazards can be identified by conventional techniques: HAZOP, FMECA, SHARD, HEART, HTA.

Internally- or mission-focused, do not address the issue of non-mission interactions and hazards, which is a major concern for physically assistive autonomous systems

41 user-error based hazards, 105 robot error based hazards

The high and medium risks associated with the user are collision, obstruction or occlusion, sudden movements, distractions and change of intention.

The high risk hazards were wrong actions or wrong information received, invalid information and timing of the actions, and understanding of the dressing start and end.
I-DRESS continuation projects in BRL:

2016-2020

Social Cognitive Robotics in The European Society
Cognitive Overloading and Distractions on Human Behaviour and Movement during Robot-Assisted Dressing
Learning from Therapists to inform safe collaborative robot behaviour

Evaluate trust and the older adults’ ability and willingness to collaborate during the assistive task through tactile, visual and verbal cues to discern a measure of collaboration and assistance accordingly

| Hazards Identified by Carers and Health Care Professionals |
|---|---|---|---|---|
| 1 | Failure to adapt speed of the task for patients with low blood pressure. | Tactile | Visual | Verbal | Tools | Patient Knowledge | Ability Required |
| 2 | Patient commands not interpreted correctly. | | | | | | |
| 3 | Failure to adapt to patients’ different abilities on both sides of the body. | | | | | | |
| 4 | The patient does not have appropriate support. | | | | | | |
| 5 | Failure of communicating continuous sub-goal of assistance | | | | | | |
| 6 | Failure to check for stability. | | | | | | |
| 7 | Failure of communicating which leg to use. | | | | | | |
| 8 | Disturbances from the environment. | | | | | | |
| 9 | Non-even floor levels. | | | | | | |
| 10 | Patient sudden changes of speed. | | | | | | |
| 11 | Patients might need to stop for catching their breath. | | | | | | |
| 12 | Failure to ask the patient to stop. | | | | | | |
| 13 | Patients with cognitive impairments are triggered to sit wherever even when there is no seating area around | | | | | | |
| 14 | Patients with cognitive impairment might think that darker areas of the floor are non-levelled. | | | | | | |
| 15 | Patient can change their mind during the task | | | | | | |
| 16 | Patient crash lands on the chair or in an inappropriate posture. | | | | | | |
| 17 | Inappropriate footwear and clothing for the assistive task | | | | | | |
| 18 | Patient not turning appropriately to conclude the task | | | | | | |
| 19 | Patient not placing hands for support in the right place. | | | | | | |
| 20 | Sitting chair is not appropriately set for the body shape and height of the patient. | | | | | | |
| 21 | Fall of the patient. | | | | | | |
| 22 | Patient reluctant to do the assistive task without holding a valuable item. This will cause instability if the equipment requires holding or using both hands. | | | | | | |
| 23 | The patient has a swollen foot – requires a change of footwear. | | | | | | |
| 24 | Patient with a lack of control of lower knee requires more assistance. | | | | | | |
| 25 | The patient standing chair does not have the breaks on. | | | | | | |
| 26 | The patient is not wearing his glasses – obstructed vision (user-model not valid). | | | | | | |
CHIRON project – multi-purpose physical assistance
Funded by Innovate UK (2017-2019)

Overhead robotic system for sit to stand and fetch and carry

Based on the hoist overhead system

Difficult and expensive verification towards commercialisation
REASON project – funded by EPSRC in UK

Resilience Node in Trustworthy Autonomous Systems programme

- Experimental study with healthy participants (mimicking physical impairments) and therapists
- Elicit contextual information from occupational therapists
- Probabilistic methodology to predict failures based on human and environment observations

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<thead>
<tr>
<th></th>
<th>Pattern I</th>
<th>Pattern II</th>
<th>Pattern III</th>
<th>Pattern IV</th>
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<tbody>
<tr>
<td>Shoulder</td>
<td>Internal rotation/adduction</td>
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<td>Elbow</td>
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<td>Forearm</td>
<td>Supination</td>
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<td>Neutral</td>
<td>Pronation</td>
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<td>Wrist</td>
<td>Flexion</td>
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I-DRESS continuation projects:

2018-2023

CLOTHHILDE
ERC Advanced Grant
Cloth manipulation learning from demonstrations

CLOTH manipulation Learning from DEMonstration

2016-2020

SOCRATES
Social Cognitive Robotics in The European Society

Social Cognitive Robotics in The European Society

Carme Torras @ I-DRESS Project Exploitation
CLOTHILDE

CLOTH manipulation Learning from DEmonstrations

Topology + Machine Learning in three application domains:

- housekeeping and hospital logistics
- automation in the clothing and internet business
- increasing the autonomy of the elderly and disabled
Usability

Learning from demonstration and reinforcement

Uncertainty
Gripper design and probabilistic grasp planning for textiles

User modeling
Taking into account user preferences for better assistance

Understanding

Capturing the situation to engage the user

Turn taking:

"It's your turn, please move a token"


I-DRESS continuation project: for Idiap partner

SWITCH project
Learning by Switching Roles in Physical Human-Robot Collaboration
(Lead Agency programme, SNF, 2020-2023, https://switch-project.github.io/)

Targeted challenge: assisting a person to stand up and sit down

1st step: Mathematical model for learning personalized assistance behaviors from diverse sets of human-human recordings
I-DRESS continuation projects: for Idiap partner

**SWITCH project**
Learning by Switching Roles in Physical Human-Robot Collaboration
(https://switch-project.github.io/)

2\textsuperscript{nd} step: Applying the developed models to the TALOS humanoid robot available at JSI
**Conclusions and Future work**

Robot Physical Assistance and HRI can be effective, consistent and accurate.

Research Challenges persist in:

1. Understanding the user state (user model)
2. Adapting to user requirements/needs/preferences
3. Embedding safety to compensate for user and environment disruptions
4. Handling soft and unstructured objects – garments
5. Understanding regulations and standards for safe adoption, implementation and commercialisation