

Coláiste na Tríonóide, Baile Átha Cliath Trinity College Dublin Ollscoil Átha Cliath | The University of Dublin

Creating multi-modal interfaces for Domestic Robots

ESR 9. HASSAN ZAAL





Video-Based Technologies and Services for Active and Assisted Living (AAL)







Healthcare Robots for Older People



ASTRO



Jaco



Care-O-bot 4



ReWalk







Astro (Amazon)











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Use Case Scenario



Cara, 87 years old, Ireland

"I am looking for technologies to help me to be more independent, and they can understand me."

- Retired, Ex-kindergarten teacher
- Widowed, 1 son died 3 years ago, 3 grandchildren
- Suffers from osteoarthritis.
- Suffer from lung cancer.
- Suffer from visual impairment.

Cara, 87 years old, used to work in a kindergarten as a teacher. Her husband died 15 years ago and her son died 3 years ago. Her grandchildren work overseas, so she does not see them that much. Cara has lung cancer and she is under medication.

Cara wears glasses to correct her visual impairment. Unfortunately, she always forgets them after a bath, waking up, etc. She usually spends time looking for her glasses, key, etc. Cara likes gardening, but she cannot carry on the gardening tools.

What she would like is a personal assistant robot that can interact with similar to the interactions between humans. She would like the robot to understand her spoken language and allocate to her missing glasses or a missing key, etc. She wants the robot to carry her gardening tools and other items. She would like the robot to help her with her self-management needs.





Evaluation of Healthcare Robots for Users' Needs

Users' Needs: ADLs/IADLs/Social	ASTRO	Jaco	Care-O-bot 4	ReWalk	PARO	AIBO	Astro (Amazon)*	Bomy
Dressing								
Personal Hygiene								
Feeding		Х						
Toileting								
Transferring/ Walking	Х			X				
Transportation/ Shopping								
Managing Medications			Х					Х
HouseWork								
Social					X	X	Х	Х
Indoor Objects Transferring			X				X	



Work Aim and Objective

• Effective interaction between older adults and Personal Assistant Robots (PARs).

- Understand and execute user commands for a domestic robot adapting to:
 - what the robot can/can't do.
 - what the robot can/can't sense.







Research Questions

 How to analyse tasks initiated by user voice instructions in terms of the *affordances* of the robot in a *partially observable environment*?

Can we resolve the *uncertainty* in task interpretation via *dialog* with the user?







STO<u>A</u>



visuAAL



Grounding Language Visual Scenes

- By the time we reach the opposite <u>bank</u>, the <u>boat</u> was sinking fast.
- I had to take out a <u>bank</u> loan to start my own <u>business</u>.

Captioning: a cat staring out the window at a group of birds.

FOIL: a dog cat staring out the window at a group of birds.

Referring Expression Recognition: Bird to the left of the feeder.

Visual Question Answering: Q: How many birds are there? A: four



image, and at least two cats are black. A: True

Visual Dialog:

A-Bot: Image shows a cat staring out the window at a group of birds.

Q-Bot: How many cats are there ? **A-Bot:** 1

Q-Bot: Can you see its face? [*it* = *cat; visual coreference*] **A-Bot:** no

Q-Bot: I think we were talking about **Image 2**.













Simulation to build solutions

Robots to validate Sim2Real









PAL Tiago





PhD workflow





PhD Timeline





Planned Contributions

- 1. A survey paper on path planning and task execution based on verbal and non-verbal (i.e., gesture) commands provided to the robot.
- Novel method to map high-level verbal instructions onto low-level robot navigation commands by associating the verbal symbols with objects detected via the camera(s) and the constraints imposed by the robot's affordances.
- 3. If the robot cannot **resolve symbol ambiguity**, initiate a dialogue with the user to seek their assistance.
- 4. To evaluate the acceptance of the robot interface by older adults using videos of the sim2real tests.





Research Training and Activities

- Research Methods. 01/2022 [Completed]
- TCD Postgraduate Certificate in Statistics. 2022/2023 [still in progress]
- Co-creation Methodology Workshop. 14/11/2022
- SciFi: From Scientists to Innovators for Industry. 09/2022-12/2022
- I was a tutor in the lab of Programming for Digital Media. 09/2022-12/2022
- Co-organising the first workshop on Context Representation in User Modeling (CRUM), which is co-located with the 31st ACM Conference on User Modeling, Adaptation and Personalization (UMAP2023). It is taking place on 26/06/2023. Proposal Submitted in 01/2023





1st Secondment in Alicante





 Building digital twins in domestic setting for Activity Recognition using omnidirectional camera

• Using digital twins and synthetic data generation to improve performance of pose estimation and human activity recognition using omnidirectional camera





Digital Twins (DTs)

• Apollo 13: The first Digital Twin.

 Isaac Sim is a robotics simulation toolkit for the NVIDIA Omniverse[™]

















Thank You for Listening