Summer 2024 - ECEN 299 - Course Description Title : Implementation of Human-Robot Handover Tasks from Human-Object-Human using Imitation Learning

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1 Motivation

Collaboration, at its core, embodies the synergy of individuals working together towards a common goal, pooling their expertise and resources to achieve greater outcomes than what could be accomplished individually. In various contexts, from business to research, collaboration has become essential for innovation and progress. Within the dynamic environment of hospitals for instance, collaboration takes on a heightened significance as healthcare professionals strive to provide optimal care to patients. Here, the collaboration extends beyond human-to-human interaction, as increasingly, robots are integrated to assist medical staff in various tasks.

In hospitals, where precision and efficiency are important, the handover of tasks between humans and robots emerges as a crucial aspect of collaboration. This exchange ensures a seamless transition of responsibilities, optimizing workflows and enhancing patient care delivery. Leveraging robotic assistance for tasks like delivering medication, transporting supplies, or aiding in surgeries not only streamlines operations but also augments the capabilities of healthcare professionals. By incorporating standardized procedures for task handover, hospitals can ensure that the integration of robotic assistance aligns seamlessly with existing workflows, ultimately leading to safer and patient-centered care.

2 Course Description

Human-robot collaboration has several tasks, part of which includes: grasping, pre-grasping and handover. In this course, handover tasks as described in this paper [1] will

be implemented using Imitation learning techniques. Imitation learning, also known as learning from demonstration, is a type of machine learning where a robot learns to perform tasks (handover) by observing and mimicking the behavior of an expert (Human). The expert demonstration gotten is based on the Human-Object-Human (HOH) [2] dataset. The dataset comprises a comprehensive collection of human-human handover scenarios, featuring 2,720 handovers involving 136 different objects and 40 people, including 20 pairs with role reversal. Captured with full markerless 360-degree technology, the dataset includes 4-viewpoint 30FPS Kinect RGB-D videos with approximately 3 million images and 4-viewpoint 60FPS FLIR RGB videos totaling around 2.8 million images. Additionally, it provides OpenPose skeletons extracted from the Kinect videos, amounting to 1.6 million skeletons. A significant component of the dataset, and the primary focus of my research in this course, is the fused spatiotemporal 3D point clouds, with 250,000 point clouds available. This is complemented by the 790,000 segments of 3D point clouds specifically for the giver hand, object, and receiver hand handover.

The course output will be a result of the paper that will be published in IEEE International Conference on Robotics and Automation (ICRA) [3].

3 Task and Timeline

The course is scheduled to span 5 weeks, from June 20th to July 26th, 2024, during the summer semester for section 2. Table 1 outlines the tasks and goals to be accomplished each week.

Table 1 Timeline and Tasks to be completed during the course

Timeline	**Tasks**
Week 1 (Including two days) - (June 20th - 28th)	Literature Review - Reviewing the ICRA papers and identifying correlations or patterns in the acceptance criteria for published papers. Additionally, it involves searching for papers in the ICRA repository that are specifically relevant to the main project: Human-Robot collaboration handover tasks.
Week 2 - (July 1st - 5th)	Creation of the starter project (ROS, Gazebo, Overleaf, Github etc.).
Week 3 - (July 8th - 12th)	Dataset Preprocessing - Understanding the HOH ([2]) dataset and preprocessing it for the model implementation
Week 4 - (July 15th - 19th)	Project Implementation Strategy - Getting the resources and comparing their compatibility with each other. Also, adjusting to the constrain of the project.
Week 5 (July 22nd - 26th)	Project Implementation - Training, testing and evaluation

4 Conclusion

This course on human-robot collaboration focuses on implementing handover tasks using imitation learning techniques, leveraging a comprehensive point cloud dataset for training. With a structured timeline spanning five weeks during the summer, the course aims to start a project which will eventually involve submitting a paper to the IEEE International Conference on Robotics and Automation (ICRA).

References

[1] Christen, S., Yang, W., Pérez-D'Arpino, C., Hilliges, O., Fox, D., Chao, Y.-W.: Learning Human-to-Robot Handovers from Point Clouds (2023)

[2] Wiederhold, N., Megyeri, A., Paris, D., Banerjee, S., Banerjee, N.K.: HOH: Markerless Multimodal Human-Object-Human Handover Dataset with Large Object Count (2024)

[3] IEEE: IEEE International Conference on Robotics and Automation (ICRA), Atlanta (GA), USA (2025). retrieved: may 15th, 2024. https://ieeexplore.ieee.org/xpl/conhome/1000639/all-proceedings