AEROSPACE ENGINEERING
ENGINEERING

RESEARCH OPPORTUNITIES FOR UNDERGRADUATE students

APPLICATION DEADLINE: September 22, 2025

PROJECT TITLE: <u>Design of a human-robot interface for robots to learn grasping from humans</u>

Physical Requirement :
Hardware design is required. Materials costs will be covered by IRAS Lab

Project's Technical Skills Requirement :
Mechanical engineering and electrical engineering

Project's Available Positions : 1

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Project Description

Background:
Programming a robotic manipulator to reliably grasp an object without knowing its exact pose is a challenging problem. The difficulty increases significantly when the object is moving along multiple axes, as the robot must continuously adapt its target pose and grasping force in real time to account for the object's dynamic motion. One potential solution is to leverage AI-based learning from human demonstrations, enabling the robot to acquire grasping strategies by observing human performance. However, directly replicating human motions often fails due to the substantial capability gap between human hands and robotic grippers — including differences in sensing, dexterity, speed, force, and torque control. State-of-the-art approaches overcome this limitation through indirect learning, where the gap is reduced by introducing a human-robot interface. Such an interface enables a human operator to directly control the robotic gripper during grasping tasks, effectively allowing the robot to collect high-quality, task-relevant data for training.

Objective:
The goal of this project is to design and develop a hand-held human-robot interface that connects a human hand to a robotic gripper, enabling the human to directly perform grasping tasks using the robotic system. The interface will be equipped with various sensors to record motion, force, torque, and other relevant data during these demonstrations. These data will then be used to train a learning-based robotic control policy, enabling a robotic arm and gripper to autonomously execute similar grasping tasks in dynamic environments. A good example of this learning-based robotics technology can be found inhttps://www.youtube.com/watch?v=ycJmfBdPRv4&list=PL9Hnb9qlvGkQX_Xu-

BuzbUMgrRy2jQ-KL&index=36

Requirements

(a) The interface shall be lightweight, so that a human uses it without too much extra burden.

(b) The interface shall have a mechanical, power and data connection to the robotic gripper.

(c) The interface shall have vision sensors to collect visual data from grasping operation.

(d) There shall be one or more video displays for a human to view when doing grasping operation.

(e) There shall be a software to process the collected data to the form ready for robot to learn.

Deliverables

(1) A prototype of the human-robot interface which can readily connect to one robotic gripper.

(2) A data collection system (hardware and software) for collecting data from grasping operation.

(3) Demonstrations of a human doing grasping tasks using a robotic gripper through the interface

(4) A project report including the user's manual of the resulting control software.