Assistive Intent Recognition And Manipulation
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Motivation & Goal
According to statistics, there are more than 19.9 million Americans suffer from upper body limitations. Our goal is to help patients who are struggling with upper-body dysfunction to perform everyday tasks like picking up an object. We created an assistive robot by constructing shared autonomy, which means to predict intention through the trajectory of the gaze and control a manipulator to complete the task.

System Architecture

Cyber-physical Architecture

Intent Prediction Subsystem-Gaze Tracker

Testing Procedure & Results
Procedure:
- Re-arrange objects.
- Give the subject the start signal.
- Predict subject’s intention by tracking gaze
- Start the manipulator.
- The arm moves the obstacles and reaches for the target.

Use Case Scenario

Step 1: User with upper body dysfunction is sitting on a table for lunch and wants the green soup can; she stares at it for 5 - 10 seconds
Step 2: The Intent Bot tracks the gaze of the user and sends this intention to the manipulator
Step 3: The manipulator plans in the cluttered environment to give to the user the desired object

Manipulation Subsystem

Environment Perception

Object Localization

Object Localization

Planning Pipeline

Future work
- Deep learning based signature detection approaches
- Onboard data processing and adaptive planning
- Please visit our website for more information

LSTM Baseline Model: Use AlexNet as a feature extractor. Use LSTM to process the gaze sequence. Simply concatenate gaze and image features and feed to the MLP.

Multiple Attention Model: Add temporal attention layer to assign different weights for each frame based on the spatial attention model.

Spatial Attention Model: Add spatial attention layer to assign different weights to each region based on the baseline model.

Simple Classification Model: Use the position of gaze to crop the world image. Use AlexNet as a classifier.

Intended Object
User’s View and Gaze
Predict the Intention
Planning

User’s View (Actual World)
Robot’s View (Simulation)

Step 1:
Adjust the camera to make sure the eye is in focus and all range of the eye movements are visible.

Step 2:
Calibrate the gaze to establish a mapping between pupil and gaze coordinates.

Step 3:
Show the gaze position as the red spot. Publish the position and possibility to analysis.

Procedure:
- Make a Footprint map of the objects
- Find obstacle-objects in the Target’s way; their new locations
- Action! Plan to intended object using TSR and CBiRRT

Hardware:
Pupil Labs gaze tracker with two inward cameras to detect pupil and one outward camera to represent the first-ego view.

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