Learning-Based Anthropomorphic Servoing Framework for Supernumerary Limb Object Reaching

Goal

Our goal is to develop an agent that can autonomously control a robot arm designed for use as an extra limb in supernumerary limb scenarios.The robot arm should be able to autonomously reach for objects without relying on accurate pose estimation or prior pose information, by recognizing the target object and establishing a relationship between actions and changes in the image domain, just like how humans interact with their environment.

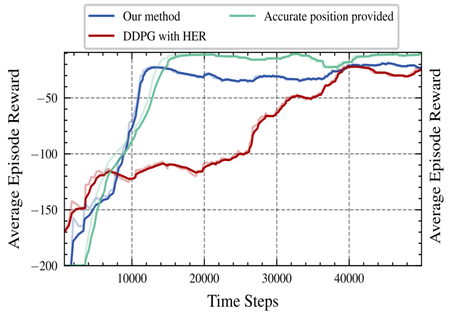
Our approach is inspired by **how humans interact with their environment** and adapt their actions based on **continuous sensory input**, allowing the robot to l**earn and improve over time**.

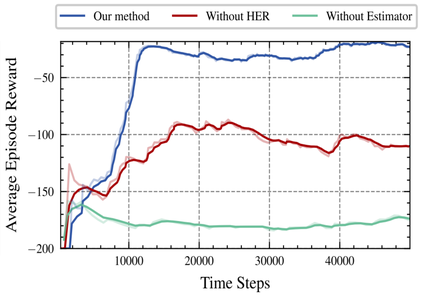
Experiment Details

We train and evaluate our method in PyBullet, using a 7 degree-of-freedom UR5e robot. We then validate the performance of our approach on a real-world UR5e robot, ensuring that our simulated results can be translated to real-world scenarios.

Results

Our framework provides a solution for robots to reach unseen objects in supernumerary limb scenarios without relying on accurate pose estimation. The proposed method allows for the robot to learn and improve over time through continuous interaction with the environment. In the future, this framework can be combined with electroencephalogram for more flexible human-robot interaction.



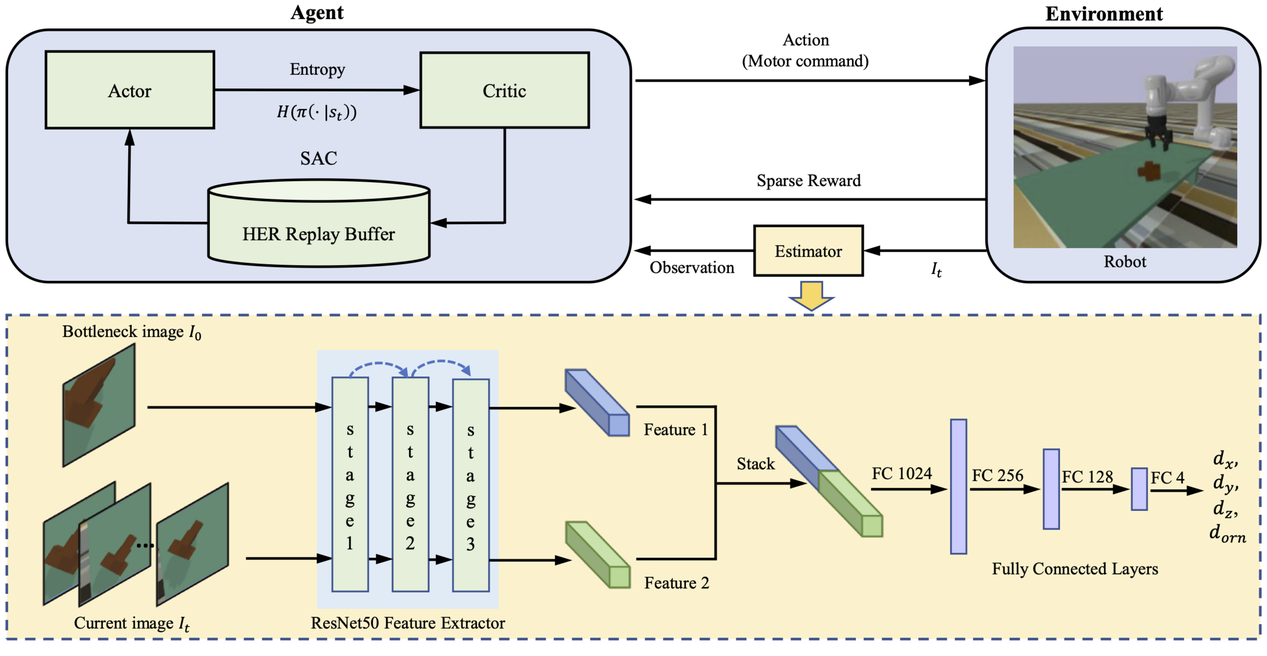


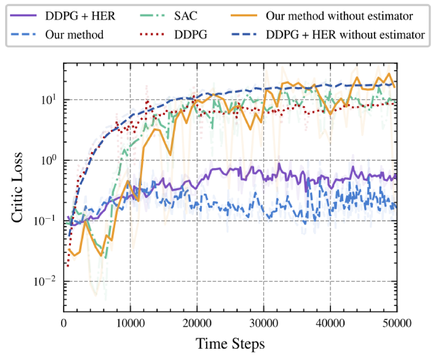
Proposed Approach

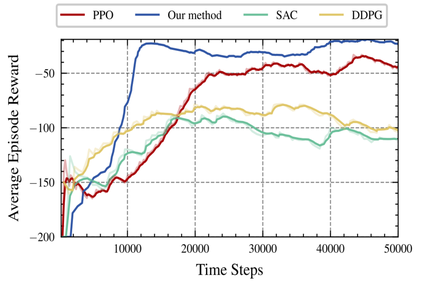
We use **Eye + Brain + Hand** to reach **unseen object without accurate pose estimation:**

Eye (camera) estimates the approximate position of the target object
Brain (RL agent) guides the robot arm to reach the object through iterations of eye estimation and action
Hand (robot arm) executes the command from the brain

In detail, this framework consisting of two interconnected components: (1) an **estimator** that calculates the positional difference between the current state and the target state, and (2) a **policy network** that generates the robot's next action using the estimator's output.







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