Progress Report

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1 To Do

- PVNet implementation: Update Cuda 9.0 code to 11.2.
- Implement pose estimation: Keypoint uncertainty, understand RANSAC.
- Look into methods of generating uncertainty data.
- Pose Estimation Servery: On pause.
- Vision-based robotic grasping from object localization, object pose estimation to grasp estimation for parallel grippers - a review, [1]: Will read after PVNet implementation.

2 Reading List

- [2]
- [3]
- [1]

3 Reinforcement Learning of Active Vision for Manipulating Objects under Occlusions

3.1 Metadata

- Authors: Ricson Cheng, Arpit Agarwal, Katerina Fragkiadaki
- Code: `https://github.com/ricsonc/ActiveVisionManipulation`
- Paper: `https://arxiv.org/pdf/1811.08067.pdf`

3.2 Introduction

In this paper, the authors propose a novel reinforcement learning method for monocular RGB grasping systems where camera pose is controlled through visual feedback to reduce occlusions. The task of simple object grasping has been fairly achieved but in the real world, there are often occlusions with other objects that needs . First, the authors pose the question of learning manipulation policies under occlusions and propose agents capable of hand-eye movement coordination with various distractors present in the scene. Secondly, they introduce a **modular actor-critic network architecture** based on [4] for active perception and action in Mujoco simulation environment, [5]. This paper examines various reinforcement learning modalities and highlights the importance of environment difficulty (distractors) in **curriculum learning** methods.

3.3 Problem Statement

The authors focus on the task of pushing an object to target locations in environments with distractors where an actor-critic architecture is deployed for eye-hand coordination. Hand-eye or camera-griper coordination is base on [6] and by integrating it, the authors, aim to achieve state estimation easier (train faster) by reducing an **information gap** or deficiency caused by static camera. First, they trained a vanilla CNN for the task of pushing an object with minimal distractors present, which failed. Then they integrated an object detector module in the actor-critic architecture which enabled effective learning. Secondly, they trained state-of-the-art reinforcement learning models with simple distractors present and occasionally occluded the target object, which also failed to learn. Then, they initialized the actor-critic network weights from policies learned in environments without distractors. This reinforces what is hypothesized by *curriculum learning*.

3.4 Method

The authors represent the mentioned problem in form a multi-goal Partially Observable Markov Decision Process (POMDP) which is a constraint satisfaction problem formulation. The reinforcement learning environment is modelled by the observations ($\mathcal{O}$), states ($\mathcal{S}$), goals ($\mathcal{G}$), gripper actions ($\mathcal{A}^{\mathcal{G}}$) and camera actions ($\mathcal{A}^{\mathcal{C}}$) spaces.

The critic network (a CNN) take RGB images as input and encodes low dimensional embeddings using what-where decomposition which is presents object appearances f_t. Moreover, a faster-RCNN [7] is used for object detection, followed by PnP for target object pose estimation, $\hat{o}_t$.

The authors use HER's [4] object-centric representation as it is shown to result in faster learning based on empirical data. HER also introduces the powerful idea of learning from failed experiences are encoded and stored in an **experience buffer** to draw heuristics from in possible future states.

This allows the agent to extract much greater level of information from previously seen data.

4 Progress

The following items are listed in the order of priority:

- Pose Estimation: Next I will update PVNet Cuda codes from 9.0 to 11.2 so I can compile those modules and test rest of the code.
- PVNet [8]: I tried reinstalling Cuda 9.0 again but I made a mistake and tried to install an old driver which comes with each Cuda package. This corrupts NVidia graphics driver and it is easier to reinstall ubuntu. I just did that once again. After talking to Quan, I decided to start working on the code and for Cuda parts I can either update the code to newer version or replace that module with a different implementation. It is not worth the time trying to get Cuda 9.0 code running; if anything, learning the latest version makes more sense. Quan mentioned updating Cuda from v9.0 to 11.2 should not be that difficult and I think he is right. Playing with GCC and G++ 6 (current version 9) is not worth it since it will disrupt every other build on the system.
- YCB Dataset [9]: Start with YCB data and look into Berk Calli's work.
- Normalized Objects [10]:
- Implement features from PoseCNN, DOPE, and BayesOD. - On pause.

5 Plans

The following items are listed in the order of priority:

- Pose Estimation in Simulation [11]: Use Nvidia Isaac SDK for in-simulation pose estimation training.
- Look into domain randomization and adaptation techniques.
- Project Alpe with Nolan: On pause for right now.
- UR5e: Finish ROS Industrial tutorials.

6 2021 Goals and Target Journals/Conferences

- Submit a paper on pose estimation with uncertainty to ICIRS.
- Get comfortable with TensorFlow and related Python modules.
- Keep writing.

References

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