Deep Reinforcement Learning for Robot Hand-Eye Coordination

A Data Management Plan created using DMPonline

Creator: Swagat Kumar

Affiliation: Edge Hill University

Funder: Edge Hill University

Template: DCC Template

ORCID iD: https://orcid.org/0000-0001-7405-3445

Grant number: REF/GRS/1KUMAR9

Project abstract:

Hand-eye coordination or visual servoing is about guiding robot motion (or arm motion) through visual feedback obtained from cameras. Traditional visual servoing methods have several limitations. The performance of these methods relies heavily on the accurate knowledge of robot and camera models which are not readily available for real systems and may undergo variation over time. Secondly, it is required to extract hand-crafted features amenable to analytical formulation of controller design. Many of these limitations can be overcome by using the deep reinforcement learning (DRL) paradigm which combines the capabilities of Deep Neural Networks (DNN) with that of Reinforcement Learning (RL). In this paradigm, the robotic agent learns optimal control policies through an iterative process where the random actions taken by the agent is either rewarded or penalized by the environment. The deep network obviates the need to extract hand-crafted features from the images and RL does not require any model information to learn the control policies. Hence, this new paradigm holds promise to revolutionize the field of hand-eye coordination which is at the core of automating industrial processes. However, there are several research challenges which needs to be solved before we can realize the true potential of this paradigm. One of the challenges is the requirement of a large amount of data needed for training the model. Obtaining this data from real world physical machines is very difficult, if not impossible. Secondly, models trained on simulated data do not work well in the real world which deviate significantly from the simulated environment. RL methods also suffer from poor generalization requiring re-training even with slight variation in work environment. This project aims at overcoming these limitations thereby increasing the applicability of DRL paradigms for effective hand-eye coordination. The applications of the proposed research will be demonstrated through real world experiment with existing robotic arm to automate pick & place tasks within a laboratory environment.

Last modified: 04-12-2019

Deep Reinforcement Learning for Robot Hand-Eye Coordination

Data Collection

In this project, the data pertains to robotic simulation and experiments comprising of model parameters, network weights, robot and environment states, observations made using sensors such as camera, range finders etc. These data will be generated by running simulations on computers.
Volume of data: 10-20 GB
Format of data: Text files containing numeric data and images in TIF or JPEG

The data will be generated by using open source physics-based simulators such as Gazebo, OpenAI GYM etc. These simulators will be run on computer to generate datasets necessary for running and testing various algorithms.

Documentation and Metadata

System models will be provided which will be able to reproduce datasets used for experimentation. The system models will be accompanied with necessary documentation regarding its use.

Ethics and Legal Compliance

There is no ethical issue involved in the data generation process as no personal, human-related or sensitive data is being collected. The data will be generated using computer simulations.

Since the data is being generated using existing opensource models and simulators, there is no IPR and copyright related issues arise in this case.

New knowledge created by using this data will be published at conferences and journals while the source code of computer programs will be made available for public use through GITHUB repositories.

Storage and Backup

University IT infrastructure will be utilized to store and back up data and programs during research.

The issue of data security does not arise in this case as we are not dealing with any personal or confidential data. The data will be generated using existing opensource simulation engines which are publicly available.

Selection and Preservation

The data has no long term value. However, the machine learning models developed based on this data will be published in conferences and journals for wider dissemination within the research community. IPR and Copyright (if any) will be held by the university.

No long term preservation is required for the dataset. The dataset could be reproduced by using the computational machine learning models developed as a part of this research.

Data Sharing

The code and data (if any) will be shared through GITHUB repositories under Opensource / Creative Commons licenses.

No restriction on data sharing required.

Responsibilities and Resources

Myself and the Research Assistant recruited to work on this project will be responsible for data management.

GPU computers will be required to developing algorithms and running simulations.