A MOTION CAPTURE AND IMITATION LEARNING-BASED APPROACH TO ROBOT CONTROL

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ABSTRACT

Imitation Learning is a discipline of Machine Learning primarily concerned with replicating observed behavior of agents known to perform well on a given task, collected in demonstration data sets. In an industrial robotics context this presents the opportunity to replace explicit programming of behavior with demonstrations of the task to be performed. Motion capture is one of the methods for recording such data. It enables lesser model complexity compared to more indirect observation modalities such as visual data, yet requires additional data pre-processing if signals beyond a time series of effector positions and orientations are relevant to the task at hand. In this paper, an approach for motion capture-based imitation learning and implicit control signal estimation is introduced and evaluated on an object throwing task.

Keywords Imitation Learning · Motion capture · Robotics · Artificial neural networks · RNN

1 Introduction

Manipulator arms and other types of robots have become ubiquitous in modern industry and their use has been proliferating for decades, yet even now the primary method for programming these devices remains procedural code, hand-crafted by specially trained technicians and engineers. This significantly increases the cost and complexity of commissioning process nodes that utilize industrial robots. Therefore, it is not surprising that attempts to reduce the skill requirements and complexity of robot programming stretch back decades – with Imitation Learning (IL), or, as it has been otherwise referred to, programming by demonstration, having been proposed and reexamined many times in various technical implementations [Muench et al., 1994, Attia and Dayan, 2018].

As a means of collecting demonstration data, motion capture also has a long history of being studied

Traditionally, theoretical literature in IL has operated on state-action pairs in the context of a Markov Decision Process (MDP)

Motivating use case asgasgasgags asgasgasgags

2 Related Work

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3 Preliminaries

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4 Materials and Methods

The overall approach proposed in this paper can be broken down into three main sections – the collection of observations in the physical environment (4.1), a pipeline for turning raw observation data into structured demonstrations (4.2) and neural network model implementations (4.3). Two general approaches to system evaluation and design feedback were employed. First, qualitative observations of the generated trajectories were made using spatial visualization in a virtual environment, followed by execution on simulated and real robots (4.4). Additionally, a series of quantitative metrics have been computed comparing system outputs with training and validation datasets (4.5).

4.1 Data collection

4.2 Pre-processing, extraction of implicit control signals

bla bla bla

4.3 Models

bla bla bla

4.4 Visualization and execution

bla bla bla

4.5 Evaluation metrics

bla bla bla

5 Results

bla bla bla

6 Discussion

bla bla bla

7 Examples of citations, figures, tables, references

7.1 Citations

Citations use `natbib`. The documentation may be found at

`http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf`

Here is an example usage of the two main commands (`citet` and `citep`): Some people thought a thing [Kour and Saabne, 2014a, Hadash et al., 2018] but other people thought something else [Kour and Saabne, 2014b]. Many people have speculated that if we knew exactly why Kour and Saabne [2014b] thought this...

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