Imitation-Based Motion Programming for Robotic Manipulators

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Abstract

In this paper, based on original idea, the authors propose a new strategy to robot programming using imitation paradigm. To program the desired motion sequence for the physical robot, one captures the motion reference paths from her virtual robot model and maps these to the joint settings of the physical robot. Motion imitation requires transfer of a dynamical signature of a movement of the virtual robot to the physical robot, i.e. the robots should be able to encode and reproduce a particular path as one with a specific velocity and/or an acceleration profile. Furthermore, the virtual robot must cover all possible contexts in which the physical robot will need to generate similar motions in unseen context.

We present a description of the theoretical aspects of the programming from a simulated virtual model and of the strategy which is at foundation of this approach. The advantages of such programming approach as an alternative to the classical methods (e.g. vision guided trajectory imitation) are on-line adaptation to the motion of the virtual prototype.

A solution to the above problem is to construct a virtual prototype model and transfer the virtual trajectory by interacting with the physical model. Designing a model would be an option; however, the behavior of the robots is very difficult to model. Moreover, the use of system knowledge is contrary to our research aim. Therefore we focus on creating a virtual prototype model from experimental data obtained from the physical robot model.

Thus, we will prove that our method guarantees the motion optimization for each robotics tasks. The planning package communicates primarily with simulation environment. A planning module can send messages to the simulation system such as computed plans for the robots. The planning module can further send trajectory and planning structure information to visualization so users can see the results of an algorithm.

The planning module also receives control signals from the simulation module, such as when to start planning joint trajectories.

Figure 1 shows our experiment involving the imitation learning for a physical robotic arm with 3 degrees-of-freedom (DOFs) for performing the manipulate tasks. We demonstrated the imitation of elbow, shoulder and wrist movements. Importantly, these tasks required the coordination of 3 DOFs, which was easily accomplished in our approach.

Figure 1 also displays (left image) the user interface of a virtual robotic manipulator arm, which has been created which a dynamical simulator.

To generate the motion sequence for the real robot, one captures the motions from a virtual robot model and maps these to the joint settings of the physical robot.

References
