An Open-Source Simulator for Cognitive Robotics Research: The Prototype of the iCub Humanoid Robot Simulator

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ABSTRACT

This paper presents the prototype of a new computer simulator for the humanoid robot iCub. The iCub is a new open-source humanoid robot developed as a result of the "RobotCub" project, a collaborative European project aiming at developing a new open-source cognitive robotics platform. The iCub simulator has been developed as part of a joint effort with the European project "ITALK" on the integration and transfer of action and language knowledge in cognitive robots. This is available open-source to all researchers interested in cognitive robotics experiments with the iCub humanoid platform.

Keywords

Open-Source, Simulator, iCub humanoid robot, cognitive robotics.

1. INTRODUCTION

Computer simulations play an important role in robotics research. Despite the fact that the use of a simulation might not provide a full model of the complexity present in the real environment and might not assume a fully reliable transferability of the controller from the simulation environment to the real one, robotic simulations are of great interest for cognitive scientists [18]. There are several advantages of robotics simulations for researchers in cognitive sciences. The first is that simulating robots with realistic physical interactions permit to study the behavior of several types of embodied agents without facing the problem of building in advance, and maintaining, a complex hardware device. The computer simulator can be used as a tool for testing algorithms in order to quickly check for any major problems prior to use of the physical robot. Moreover, simulators also allow researchers to experiment with robots with varying morphological characteristics without the need to necessarily

develop the corresponding features in hardware [1]. This advantage, in turn, permits the discovery of properties of the behavior of an agent that emerges from the interaction between the robot's controller, its body and the environment. Another advantage is that robotic simulations make it possible to apply particular algorithms for creating robots' controllers, such as evolutionary or reinforcement learning algorithms [12]. The use of robotics simulation permits to drastically reduce the time of the experiments such as in evolutionary robotics. In addition, it makes it possible to explore research topics like the co-evolution of the morphology and the control system [1]. A simulator for the iCub robot magnifies the value a research group can extract from the physical robot, by making it more practical to share a single robot between several researchers. The fact that the simulator is free and open makes it a simple way for people interested in the robot to begin learning about its capabilities and design, with an easy "upgrade" path to the actual robot due to the protocol-level compatibility of the simulator and the physical robot. And for those without the means to purchase or build a humanoid robot, such small laboratories or hobbyists, the simulator at least opens a door to participation in this area of research.

The iCub simulator is currently being used by both the RobotCub and the ITALK project partners for preliminary experiments on the simulator robot, and subsequent testing with the physical robots.

2. ICUB SIMULATOR DEVELOPMENT

The iCub simulator has been designed to reproduce, as accurately as possible, the physics and the dynamics of the robot and its environment. The simulated iCub robot is composed of multiple rigid bodies connected via joint structures. It has been constructed collecting data directly from the robot design specifications in order to achieve an exact replication (e.g. height, mass, Degrees of Freedom) of the first iCub prototype developed at the Italian Institute of Technology in Genoa. The environment parameters on gravity, objects mass, friction and joints are based on known environment conditions.

2.1 Open-Source Approach

The iCub simulator presented here has been created using open source libraries in order to make it possible to distribute the

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