Project VeryHuman

Learning and Verifying Complex Behaviours for Humanoid Robots

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH

In this project, we want to understand how robots with a human-like shape learn to walk, and then prove that they can.

The Problem

The correct control of upright walking humanoid (in the shape of a humanoid) robots is a complex task that scientists and engineers have been working on for a very long time. Biologically inspired control algorithms have proven to be very promising. These algorithms are based on AI techniques such as deep learning, in which the system learns the desired behavior based on a large amount of training data. However, there are three main challenges:

- First, the mechanical and kinematic properties of the humanoid robot have a significant influence on the selection of suitable training data and learning methods. However, the introduction of appropriate physical models into the learning process is currently a task for which standard solution approaches cannot yet be used.
- Secondly, the control programs learned in this way are difficult to check or verify. After completion of the training phase, a deep learning algorithm is quasi a black box, which only provides well-predictable results - i.e. control commands - for the trained input data. Beyond this data, however, the uncertainty increases as to whether the control will deliver the desired results.
- A further challenge is to formally specify the desired movement behavior - i.e. to describe mathematically exactly what constitutes an upright gait.

Our Answer

For these tasks, the project VeryHuman will develop solutions and methods and evaluate them by means of demonstrators for the humanoid walking of robots. Thereby answers to the following questions shall be found: How can properties for a control system be described and its correct functioning be demonstrated if its internal structure is not completely known? How can complex behaviors be learned efficiently, i.e. in a short time, by a robot without too many restrictive specifications? How can known, mathematically exactly describable relationships (e.g. physical properties and laws) be used as prior knowledge for the formulation of reward functions for training? How can the developed approaches be used to create a methodology for the development of AI-based control algorithms that also takes into account the kinematic properties of the robot to be designed?

The humanoid robot RH5 developed at DFKI Bremen serves as a consistent application study for the project.

Usage and Application

The problem of learning complex behaviors and their subsequent verification goes far beyond the application case at hand here, and arises wherever systems are controlled by deep learning techniques and used in a safety-oriented manner, for example in autonomous driving.

Humanoid Robot RH5