Walking Humanoids for Robotics Research

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Abstract

We present three humanoid robots aimed as platforms for research in robotics, and cognitive development in robotics systems. The 'priscilla' robot is a 180cm full scale humanoid, and the mid-size prototype is called 'elvis' and is about 70cm tall. The smallest size humanoid is the 'elvina' type, about 28 cm tall. Two instances of 'elvina' have been built to enable experiments with cooperating humanoids. The underlying ideas and conceptual principles, such as anthropomorphism, embodiment, and mechanisms for learning and adaptivity are introduced as well.

1. Introduction

The applications of robots with human-like dimensions and motion capabilities, humanoid robots, are plentiful. Humanoid robots constitute both one of the largest potentials and one of the largest challenges in the fields of autonomous agents and intelligent robotic control. In a world where man is the standard for almost all interactions, humanoid robots have a very large potential acting in environments created for human beings.

In traditional robot control programming, an internal model of the system is derived and the inverse kinematics can thus be calculated. The trajectory for movement between given points in the working area of the robot is then calculated from the inverse kinematics. Conventional industrial robots are designed in such a way that a model can be easily derived, but for the development of so called bio-inspired robots, this is not a primary design principle. Thus, a model of the system is very hard to derive or to complex so that a model-based calculation of actuator commands requires to much time for reactive tasks. For a robot that is conceived to operate in an actual human living environment, it is impossible for the programmer to consider all eventualities in advance. The robot is therefore required to have an adaptation mechanism that is able to cope with unexpected situations.

2. Robot Platforms

In this paper we briefly introduce three humanoid robot prototypes.

Figure 1: 'elvis' (left) and 'priscilla' (right).

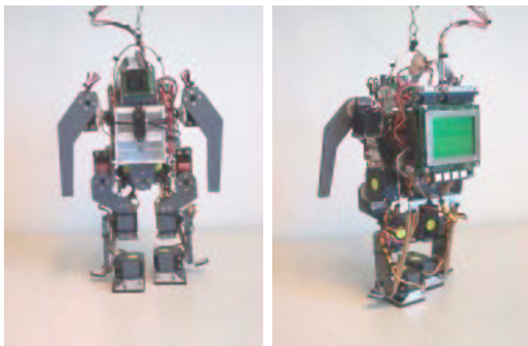

Figure 2: Front and back view of 'elvina' robot.

The 'priscilla' robot consists of a plastic skeleton with titanium reinforcements and linear electric actuators. The skeleton design guarantees anthropomorphic geometry and enables close correspondence in movement capabilities. The goal is to make the robot strong and fast enough to be able to walk with normal human walking speed.

The 'elvis' robot is a scale model of a full-size humanoid with a height of about 70cm, built with 42 standard servo motors giving a high degree of freedom in legs, arms and hands. Microphones, cameras and touch sensors guide the robot. The imminent goals are to walk upright and to navigate through vision serving a prototype for 'priscilla'. 'elvis' is autonomous, with onboard power supply and main processing unit, however many experiments are mainly performed with connection to a host computer (Langdon and Nordin, 2001).

'elvina' is a simplified, scaled model of a full-size humanoid with body dimensions that mirrors the dimensions of a human. The 'elvina' humanoid is a fully autonomous robot with onboard power supply and computer, however many experiments are performed with external power supply. It is 28cm tall and has a total of 14 degrees of freedom. However, a modified version of the previous used humanoid robot 'elvina' is underway. The number of degrees of freedom, dof, is increased to 24, the actuators are exchanged to a stronger type, and the main controller board is exchanged to a miniature single board PC running LINUX. These modifications, together with various other smaller changes in the construction result in a more robust and durable robot platform, however the basic mechanical design concept remains the same (Wolff and Nordin, 2001).

3. Anthropomorphic Principle

The anthropomorphic principle behind humanoids might be a stronger motivation factor then conventionally assumed. Consider for example the phenomenon of human left-handedness. Left-handed persons have been shown to have a shorter expected life length than right-handed persons. The standard explanation for the higher mortality rate is a higher accident frequency and the assumed explanation for this deviation is due to the fact that the world is built for right-handed people (Gazzaniga, 1999). If such a minute deviation in behavior could cause accident frequencies measurable in as statistically significant mortality biases, we could expect considerable difficulties for a robot working in a human environment. The differences between human and robot will always be bigger there, than the difference between a left-handed and right-handed person. We aim at exploring and evaluating the consequences of a strong anthropomorphic principle where humanoids are built with very close correspondence with humans in terms of size, weight, geometry and motion capabilities. We have therefore devised a full-sized autonomous humanoid[1] robot that is built around an accurate model of a human skeleton -the 'priscilla' robot.

[1]http://humanoid.fy.chalmers.se/

4. Embodiment and Adaptivity

From a methodological and developmental standpoint are the project guided by more than the anthropomorphic principle. Even though we have simulators for the 'priscilla' robot we strongly believe in the embodiment principle and we try to make most of our experiments on the full-size autonomous 'priscilla' robot. However, the over-all efficiency of our humanoid project has turned out to increase when using several smaller size prototypes.

A third guiding principle is the need for adaptivity when dealing with such a complex object as a humanoid in such a complex environment as everyday human life. We are furthermore using evolutionary algorithms and more specifically genetic programming as the adaptation method. Genetic programming is an efficient method for breeding symbolic structures such as computer programs and behavior definitions (Koza, 1992).

5. Summary and conclusions

Here, we have introduced our three humanoid robots 'priscilla', 'elvis' and 'elvina' and some of the underlying conceptual principles. The basis for our research is the anthropomorphic principles where humanoids are built with very close correspondence with humans in terms of size, weight, geometry and motion capabilities. We realize humanoids capable of cognitive (including behavioral and social) development. From a methodological and developmental standpoint are the project guided by the embodiment principle and mechanisms for real adaptivity and learning.

References

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