Chapter 1
Humanoid Robots:
Future Avatars for Humans through BCI

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ABSTRACT

This paper provides a review of humanoid robots and mind control humanoid robots. Information was obtained mainly from journals and conference proceedings on robotics and mind control technology. We primarily focus on providing an overview of commercially available robots and prototype research-stage humanoid robots in addition to mind control humanoid robot systems. First, a history and overview of the humanoid robot is presented. Then, typical mind control humanoid robot systems are described, including the relevant brain-computer interface and the whole control framework. Finally, the remaining research challenges in the field of humanoid robot safety are summarized.

INTRODUCTION

A humanoid robot is a robot with human appearance and behavior. These qualities provide this kind of robot with a more human-friendly appearance that is more acceptable to individuals. Human robots are used as a research tool to promote the development of scientific areas such as biomechanics, biomechanical controls, sensors, and mechanisms, computer science, and artificial intelligence. A human shape and appearance also make it possible for humanoid robots to adapt to surroundings similar to those of humans (including a normal environment and some dangerous or dirty environments) and to utilize tools designed for humans (Sakamoto 2005; Behnke, 2008). These advantages make humanoid robots the best choice for serve humans in daily life or for improving the lives of the elderly or physically disabled people.

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Brain Computer Interfaces (BCIs) are communication systems that allow external devices, including computers and robots, to be controlled by brain activity. Humanoid robot surrogates controlled using BCI can help users, especially the elderly and physical disabled, to regain autonomy. The user can meld his/her own mind and movements with a robot surrogate or avatar. The development of robotics and BCI currently make the idea of avatars a possibility. Compared to other types of robots, humanoid robots, with their human size and appearance, are more suitable for use as special avatars for individuals.

This paper presents a review of the recent literature in the field of humanoid robots. The review is divided into three inter-related sections:

1. An overview of humanoid robots,
2. Mind control humanoid robots, and
3. Safety for humanoid robots.

More specifically, the first section presents a history and overview of humanoid robots. The second section describes the mind actuated humanoid robot system, which is a new trend in the application of humanoid robots. Finally, the last section addresses key research into the safety of humanoid robots, including a discussion of safety issues for both robots and humans.

BACKGROUND

Researchers have made substantial progress in the field of humanoid robots since the first such robot, WABOT-1 (Kato,1973), was developed in 1973. The field of humanoid robots can be divided into two broad classes, fully actuated and passive robots, according to the mode of control.

Inspired by the work of McGeer (1990), passive walking humanoid robots forgo full actuation and allow gravity and natural dynamics to play a large part in the generation of their motions. They may be completely passive or partially actuated. Research into this type of humanoid robot is mainly focused on the generation of human-like and highly efficient motions (Manoj, 2006; Steve, 2005) and not on serving in human surroundings. The widely used humanoid robots that were developed for undertaking these types (human environment) of tasks are fully actuated robots, which consist of position control and force/torque control robots.

Position Control Humanoid Robots

Position control robots are driven by motors that connect joints with reducers. The control parameters in these robots are joint angle and angular velocity.

ASIMO, which was developed by Honda in 1997, is a representative of joint position controlled biped robots. ASIMO (Cleland, 2002) initially possessed the ability to walk and manipulate objects under certain circumstances, such as serving tea, carting and walking on rough terrain (Hirose, 2007). Later, these robots were constructed with decision-making and real-time planning capabilities that functioned under uncertain circumstances. It can also run at a speed of 9 km/h.

Waseda University, a pioneer in biped robots, has developed multiple generations of biped robots. In 2006, the new generation biped robot WABIAN-2R achieved human-like walking with knee stretching