Entertainment Robots

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Abstract

Recent entertainment robots created by Sarcos Research Corporation and the Center for Engineering Design at the University of Utah are presented. Categories include humanoid and non-humanoid display robots that replay programmed motions, interactive robots that are teleoperated, and humanoid robots for research.

1 Introduction

The field of robotics has been expanding well beyond its initial concentration on industrial robotics, and entertainment robotics represents one such interesting expansion. The creation of entertainment robots has been a specialty of Sarcos Research Corporation, a commercial spinoff of the Center for Engineering Design at the University of Utah, both led by Prof. Steve Jacobsen.

2 Humanoid Robots

Development of entertainment robots began in 1984 with a contract with Walt Disney Enterprises to increase compliance in the Lincoln figure at Disneyland. Since that time, advanced figures (both hydraulic and pneumatic) with up to 52 degrees of freedom have been developed, including moving arms, legs, torsos, necks, eyes and mouths (Figure 1). Details of the head mechanism to allow facial expressions are shown on the right. Over 100 robots subsequently were manufactured for the Disney organization, mostly for European Disneyland. These robots can be programmed to recreate smooth, graceful, and fast human actions so effectively that they are frequently mistaken for human actors.

The next generation in entertainment robots beyond the Disney robots is represented by the Ford robot, which has been used to introduce new Ford cars at various expositions. One of the main differences is the presence of knee motion in the Ford robot. Whereas the

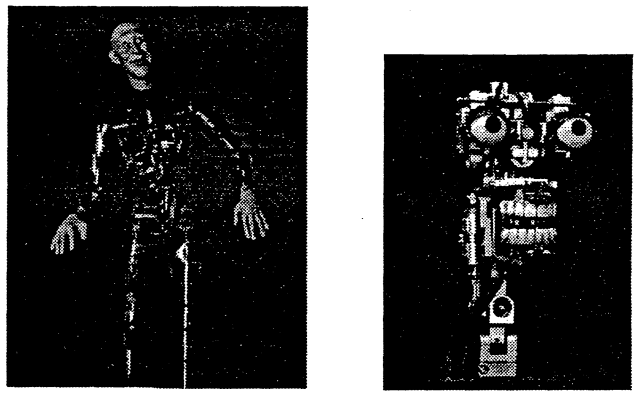

Figure 1: Disney robot.

Disney robots were programmed manually through individual joint control knobs by animation experts, the Ford robot is controlled by an operator wearing a sensor suit (Figure 2). Another version of a similar robot has been delivered to a theme park in Jakarta and to the Carnegie Museum in Pittsburgh.

Active dioramas with life-size humanoid and animatronic figures depicting 15 scenes from the Wild West were created for Bally's Casino in Atlantic City. Example scenes are a group of musicians, a group of tavern ladies, and a prospector with mule. In each diorama the figures perform some skit.

In February, 1999, a humanoid robot for research based on the Ford figure was delivered to Dr. Matsuo Kawato of ATR [3]. In collaboration with Profs. Stefan Schaal [5] of USC and Chris Atkeson of Georgia Tech, Dr. Kawato is investigating computational and biological theories of perceptuo-motor control utilizing this humanoid robot (Figure 3). The Ford and Disney robots are anchored to the ground through their legs, through which pass hydraulic, pneumatic, and control lines. By contrast, the ATR robot is anchored from the back of the torso, so that the legs are free to move. An additional linkage at the base allows the torso to be raised and low-

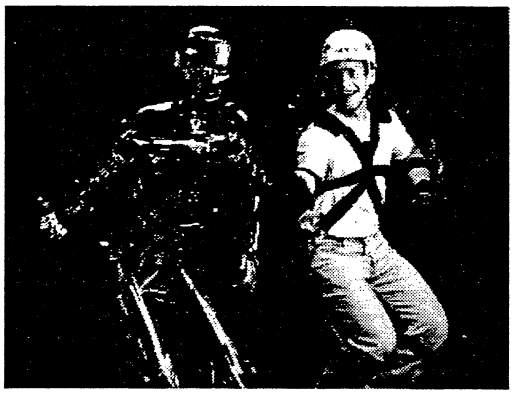

Figure 2: Ford robot teleoperated by the Sensor Suit.

ered. Each leg has three degrees of freedom (hip, knee, ankle). The arms have 7 degrees of freedom (shoulder, elbow, wrist), but there are no active hands. The torso and the head are each three degrees of freedom.

3 Non-Humanoid Robots

An initial contract with Universal Studios involved the redesign of the torso of the King Kong figure. Based on this success, Sarcos was chosen to build the robotic dinosaurs of Jurassic Park the Ride, at Universal Studios in Hollywood. Myriad dinosaurs, including Tyrannasaurus Rex, Stegasaurus, and Ultrasaurus, were created in greater-than-life proportions. They differed in degrees of freedom and mobility platform. One of the most significant difficulties was the development of the dinosaur skin, which had to be realistic and wear well. A design difficulty was the size: massive weights have to be hurtled in short time spans safely. The dinosaurs were classified as buildings, and had to pass stringent earthquake codes.

In November, 1998, a programmable water fountain display was opened at the Bellagio Hotel in Las Vegas. Sarcos created individually programmable fountain heads, called Oarsmen, with pan-tilt degrees of freedom and a linear motion to raise each assembly out of the water. Over 200 Oarsmen are arranged in linear and circular patterns over a large pond area. Individual water jets can be controlled for height and waved in graceful patterns. Choreographed water patterns set to music and light produce a stunning impression.

4 Discussion

Nearly all of these entertainment robots employ hydraulic actuation for their main degrees of freedom. It wouldn't be possible to achieve a compact design with similar performance had electric drives been employed [1]. In many cases, a special electrohydraulic servo-

Figure 3: ATR humanoid robot.

valve designed by Sarcos [6] was employed, which has a unique suspension jet pipe design. Principles of low moving mass, direct drive, and collocated force sensors are employed throughout to achieve high-performance joints. These hydraulic servovavles are also employed in the Sarcos Dextrous Arm telemanipulator [2]. More recent robots employed an all-digital controller. In many ways, these entertainment robots are more sophisticated than industrial robots.

Sarcos is continuing with a variety of new entertainment robot projects. A difficulty in this specialty field is the high pressures in the entertainment industry.

References

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