Perch on My Arm!: A Haptic Device that Presents Weight and a Sense of Being Grabbed

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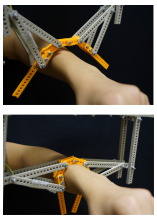

Figure 1: *Basic Mechanism*

Figure 2: *Perch on My Arm!*

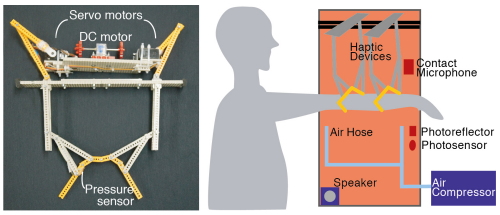

Figure 3: *System Design*

1 Introduction

Touching and felling physical objects has been an important method of understanding and communicating with others. Although most of the existing haptic devices are limited to the hand, arms are used in a daily basis to interact with other people and animals by linking, hugging or being grabbed. In attempt to realize interactions with a virtual character we propose a novel haptic device that can grab and provide pressure to the human arm. We have also created a system that utilizes two of these devices to virtually represent a bird perching on a person's arm. Unlike the approach of wearable devices [Sato et al. 2008], our system does not require attachment in advance, so as to make the experience intuitive. In addition, the users can feel different feedback according to their actions.

2 Mechanism of a Haptic Device for the Arm

We propose a novel device that presents weight and grabbing sensations to the human arm. It is made of a simple yet durable framework and does not require any attachment to the user. We have adopted an underactuated structure to this device which can be controlled to naturally grab objects with few motors. At the top of the device, two servomotors are installed to move the structure vertically by using a crank mechanism. This device passively grabs when it is pressed against an object (Figure 1). The section that grabs consists of 6 plastic joints and is adjustable to the size of the object it is pressed against. In the current implementation, it is designed for grasping an object with a diameter of 35 to 60 millimeters. This device is flexible enough to withstand user's movements such as twisting, shaking or pulling their arm. A DC motor is also attached at the top center of the device. While it is placed on the ladder it can move the device horizontally, enabling different approaches of presentation. In addition, by changing the movement of the device the structure can flexibly and gradually grab objects, providing a wider variety of haptic expressions that have yet to be achieved by the currently existing haptic devices.

3 Application: Perch on My Arm!

The haptic devices are implemented in the application called "Perch on My Arm!" in which users can virtually feel a bird perching on their arm (Figure 2). The tactile and audio feedback is produced from a box that has two holes on the facing sides. At first, the user puts his or her arm through the holes of the box. Then the bird comes flying from above and perches on the arm. In an attempt to keep its balance, it moves its feet and walks sideways. The user can also interact with the virtual bird. When the user shakes the inserted arm, the bird wildly flaps its wings in alarm and takes a firmer grip of the arm. When the user taps on the side of the box with the opposite hand, the bird jolts in surprise and chirps correspondingly. After interacting with the user for a while, the bird is satisfied and flies away.

Figure 3 shows the system overview. This system is managed by a program on the computer which controls the microcontrollers. The program runs according to the values obtained by the sensors that detect the user. Just below the hole of the box, a photosensor and photoreflector is set to detect the user's arm when it is completely inserted and when it is shaken. A pressure sensor is attached beneath the haptic device to detect whether it was able to firmly grab the user's arm and to monitor the amount of pressure it is applying to the user. A contact microphone is attached to the side of the box and is used to detect when the user taped the box. To represent the sense of flapping wind, air is generated by an air compressor and ejected by opening and closing the solenoid valve which is attached to hoses. The audio of the bird chirping and flapping is played from the computer through speakers that are placed inside the box.

This application was demonstrated in several exhibitions. Despite the absence of visual feedback, many users enjoyed the weight and movements of the virtual bird. As a result of the human arm being less sensitive than the hand and the haptic devices' flexible movements, many users who observed the haptic devices after the experience remarked that the bird's feet had felt softer than the plastic joints appeared and several commented that it felt similar to the texture of rubber or felt. In the future, we intend to present an extended variety of sensations by changing and improving the size, movements and grasping strength of the device in order to develop additional applications.

References

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