

# Chapter 37

## Preservation and Reproduction of Human Motion Based on a Motion–Copying System

Seiichiro Katsura  
Keio University, Japan

### ABSTRACT

*In this chapter, a novel method for preserving and reproducing human motion based on haptic technology is described. Haptic technology makes it possible to preserve and reproduce human motion using a paired master and slave system. Because it is possible to preserve motion information based on position trajectory and force input, future human support technology that will facilitate skill acquisition, physical rehabilitation will be developed and will facilitate personal adaptation, tele-communication, et cetera. Once human motions are preserved, it will be possible to process them for various applications. For example, being able to reproduce the speed and trajectory of motion will allow for adjustments that fit the desired function. As a result, the temporal and spatial coupling of perception and action can be attained. This type of physical extension technology based on haptics will be important for the future of human support in society.*

### INTRODUCTION

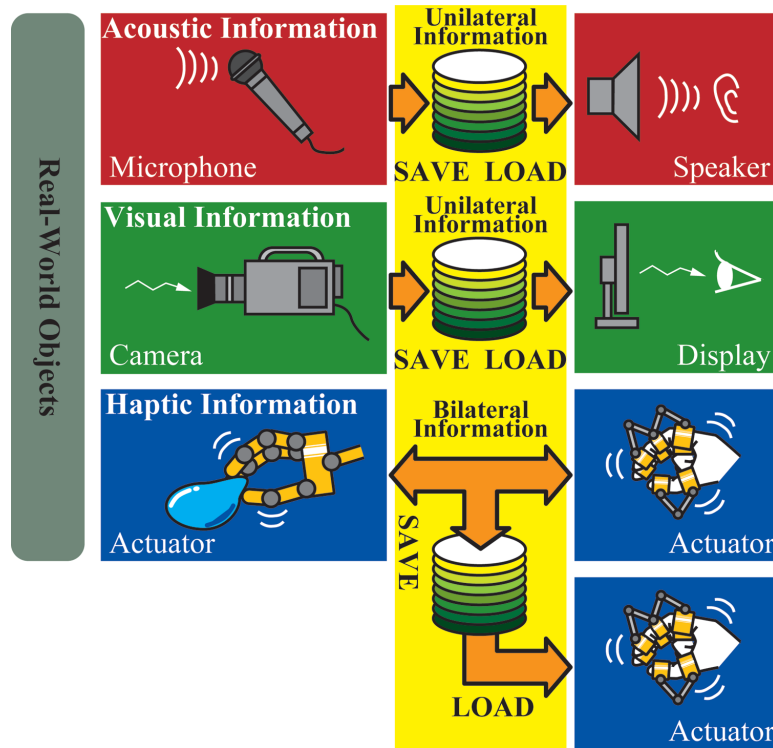
Multimedia technology has been the basis for human communication and industry applications. Auditory and visual information is obtained through human ears and eyes, respectively. Artificial acquisition and reproduction of auditory and visual sensations are basic technologies in communication engineering and have been commercialized in various forms. Auditory information is obtained by a microphone, and a speaker

reproduces it by artificial means. A video camera and a display make it possible to transmit visual sensation through television broadcasting. Multimedia technologies such as these can connect a human with another human located at a remote site. Furthermore, it is possible to preserve, process, and analyze information through the development of digital signal processing technology.

Haptic information has received attention as a third type of multimedia information. The directional properties of human sensations are shown in Figure 1.

DOI: 10.4018/978-1-4666-2196-1.ch037

Figure 1. Directional properties of human sensations



A touching motion is inherently bilateral, as an action of this sort is always accompanied by a reaction. Furthermore, the recognition of the contact environment is attained only after touching it. This means that the artificial realization of touching requires a very fast controller to keep the time-delay as small as possible. Thus, conventional model-based environmental recognition will not always be suitable for future applications. Environmental recognition in the real world should be based on action, and it is necessary for future modes of communication to have force feedback ability. As a result, real-world haptics is the key technology that will enable future haptic communication engineering.

## BACKGROUND

It is possible to extend human sensation through remote environments by bilateral tele-operation.

There has been extensive research on how bilateral tele-operation can attain force feedback from a remote environment. One of the major objectives in designing bilateral control systems is achieving transparency, which is defined as a correspondence of positions and forces between a master and a slave (Yokokohji, 1994) or a match between the impedance perceived by an operator and an environmental impedance (Lawrence, 1993). To attain bilateral force feedback between a master and slave system, it is important to control their forces and positions simultaneously. As both controllers are represented by oppositely controlled stiffness, it is difficult to attain them using a conventional minor-loop-based servo system. In addition, the frequency range of the force signal is also important for the vivid sensation needed to achieve higher transparency (Katsura, 2006a; 2007). An acceleration controller brings a wide-band controller, which satisfies the above requirements (Katsura, 2005a; 2008).

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