A Wearable Communication Modulator

Soichiro Matsushita
Department of Computational Science and Engineering, Toyo University
gmatsu@ieee.org

Abstract

This paper introduces a peripheral device that supports communication especially in terms of expressive power in mobile environments. As people can speak and hear while doing something else without losing concentration very much, sound has been chosen as a communicating medium not to prevent the daily use of the device. Referring to the conditions recognized by an electronic sensory system, the device modifies both incoming and outgoing communicating sound from and to somebody else and the user's self. An implementation of headset computer with variety of sensors and experimental results are also described in this paper.

1. Motivation

As the proverb says "seeing is believing," a visual presentation using such as figures and photos is one of the best way to communicate with somebody else. In mobile environments, however, it tends to be inappropriate to use visual objects for communication in terms of safety, latency for preparing them, and so on. On the other hand, a verbal communication is widely used in mobile environments because it has rather strong expressive power especially under the requirement of dynamic interactivity. If there are additional ways of expression in the form of sound to a verbal communicating channel, it would make the communication rather more rich, diversified, and interesting, as seen in sound effects in the cinema.

2. Communication Modulator

Figure 1 describes the basic configuration of the communication modulator. The natural sound from the microphone is "modulated" by referring the recognized symbols from the sensory system. The inputs for the sensory system can be voices, sounds, motions, visions, ambient conditions such as temperature, and so on. A memory bank stores sound clips to be used as sound effects. By storing a set of sounds specific to the user, the communication modulator can have an ability of personal identity expression. If some vital signs such as heartbeat rate are interpreted into the changes in background sounds, it would add rather strange but funny communicating way to the communication. The sound set related to specific combination of the wearer's

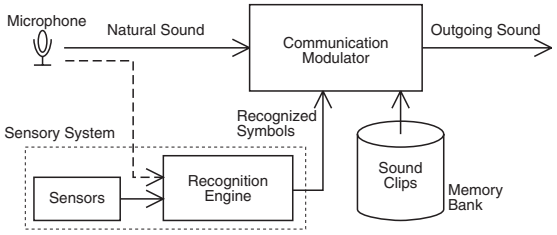

Figure 1. Wearable communication modulator

motion can make the communication modulator behave as some musical instruments. As well as the addition of sound effects, a modulation over the incoming natural sounds might bring some useful functionalities. For example, if the frequency response characteristics of sound amplifier for the incoming voice change by the signals from the sensory system, an adjustment for some noisy environment in terms of the quality of voice sound can be realized. Emphasizing higher frequency components might make some users feel easier to hear foreign language.

Although it seems to be very interesting to use the communication modulator, however, it would be hard to expect what happens if the device is used in realistic situations. Therefore, an experimental implementation was designed and the happenings were examined.

3. Headset Computer Implementation

Figure 2 shows the configuration of a headset-based wearable communication modulator. A 2-axis accelerometer, a 1-axis gyro sensor, a thermometer, and a photosensor were utilized with an 8-bit single-chip microcontroller having

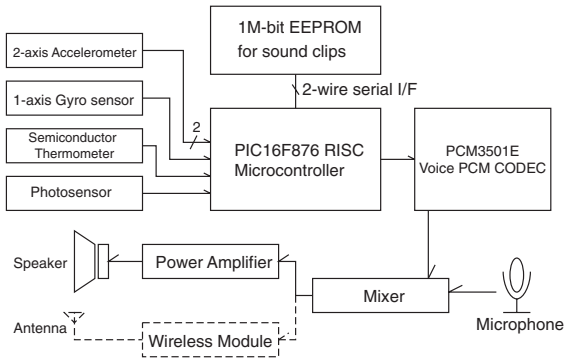

Figure 2. Implementation of the WCM

Proceedings of the 6th International Symposium on Wearable Computers (ISWC'02)
0-7695-1816-8/02 $17.00 © 2002 IEEE

IEEE COMPUTER SOCIETY

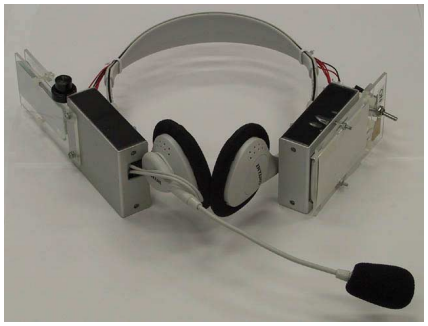

Figure 3. Headset implementation of the WCM

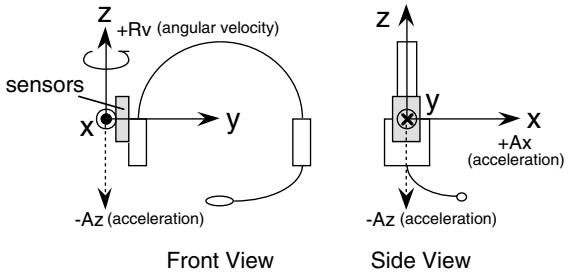

Figure 4. Definitions of motion detection

analog signal input ports. Figure 3 shows the photograph of the prototype device. The microcontroller performs primitive signal recognition tasks concerning existence of footsteps, rotating motion of the user's head, ambient temperature, sudden change in brightness, and so on. Some context-recognition algorithms are described in [1].

The definitions of motion measurements with both the accelerometer and gyro sensor are shown in Fig. 4. In addition, a memory bank for sound clips was realized by a flash memory chip in which the clips can be altered in mobile environments without opening or even touching to the device. To make the device enjoyable all the time in mobile environments, I have paid attention especially to the weight and power consumption of the device. Thanks to the nature of sound in terms of required processing power as compared to vision-based system, the device consumed less than 150mW. If a wireless connection is required, a low-power communication module can be attached to the device as seen in the early prototype of the headset-based computer, which consumes only 224mW with almost all capability as the communication modulator [1]. Figure 5 shows an example of wearable communication modulator system configuration. If sufficient loudness of sound is required, a power-consuming power amplifier should be used to drive a loudspeaker. Therefore, the amplifier and loudspeaker with additional batteries are separated from the headset computer.

4. Experimental Results

First of all, it was found to be interesting that the sound effects from the wearable communication modulator made me feel as if I had become to be another personality. In the

Figure 5. Setup example of the WCM system

experiment, a set of some cute sounds was assigned to the walking motion. I thought that it would be a kind of psychotherapy in the form of communication to myself. Listening to the music may cause similar effects. However, it was another kind of feeling maybe because the sounds from the device were synchronized to my motion.

Secondly, I tried to interpret some body language into sound effects. By using motion sensors, a nodding motion corresponding to the sign of 'YES' and a wondering motion to the sign of 'Huh?' were interpreted into specific sounds. It was found that rather unintentional motion that causes sound effects made the communication much interesting. If the wearable communication modulator is connected to a cellular phone, the separated users can add such a funny nonverbal way to their 'ordinary' conversation channel.

5. Future Work

From the early stage of experimental results, the following issues arose to make the wearable communication modulator attractive to a wide range of users.

(1) Programmability of sound effects

An easy way to configure the wearable communication modulator should be prepared. At this moment, the sound clips and the relation ship between them and results from the recognition engine are static, and it would make the user get bored sooner or later.

(2) Variety of context-awareness realization

The key to keep the proposed device interesting to the user is to realize a wide variety of context recognition. By using and combining image sensors and some other sensors, context recognition methods to make communication much more interesting should be explored.

References

[1] S.Matsushita, "A Headset-Based Minimized Wearable Computer," IEEE Intelligent Systems, Vol. 16, No.3, pp.28-32 (2001).

IEEE COMPUTER SOCIETY