SteganoSonic:
A Locally Information Overlay System Using Parametric Speakers

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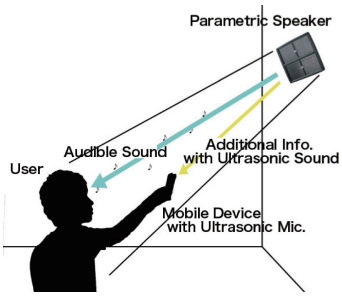

Figure 1: *SteganoSonic*

Figure 2: *Prototype System.*

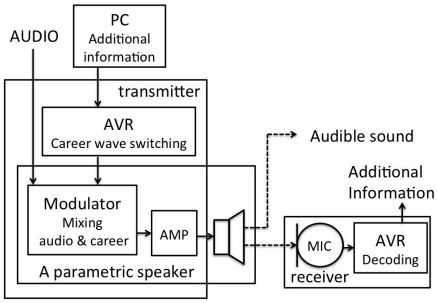

Figure 3: *Basic System Design.*

1 Introduction

To construct information environment that augments the real world, there is an important theme that is realization of embedding information into a certain area and receiving it naturally. To develop these systems, it is necessary to announce the existence of additional information and intuitive connection of real world and them. Approaches that use marker-type indicators like AR marker [Kato and Billinghurst 1999] which is significant for the camera recognition but insignificant for human have exiguous intuitiveness. On the other hand, when applying wireless communication technologies like RFID or infrared light [Nishimura et al. 2004], which we cannot sense the existence of the information, we need another sign that indicates the existence of the information to embed information to certain areas. Toward these problems, we propose a novel system named SteganoSonic that embeds digital data into the sound outputted from parametric speakers. This system, with a speaker which has strong directivity, can send audible sound to certain area and embed additional information into the sound which is caught by a receiver. Users can find the existence of additional information by hearing the sound, receive additional information at the same time.

2 SteganoSonic

SteganoSonic embeds digital data into sound outputted from a parametric speaker. Users can receive embedded information by pointing a device. Technical contributions of this research are as follows.

The first is a development of the hardware that embeds additional information into sound. A parametric speaker outputs ultrasonic sound modulated by audible sound, to send sound to narrow area. Though output sound itself is inaudible for human, while the sound propagates in the air, the audible sound is demodulated. Therefore parametric speaker sends audible sound to narrow range that ultrasonic propagates. SteganoSonic provides two ultrasonic career wave of different frequency, and switches them. As this system implements the switching of the data by hardware, it can edit the data simultaneously, unlike the systems with software signal processing which need to process the sound in advance.

The second is receiving and decoding of information by devices with ultrasonic microphone. In the current implementation, our system provides data in the form of serial communication, and the communication speed is 75 bps. The receiver converts the data into various kinds of information and presents them to users with audible sound information.

The third is area-limited information presentation utilizing audio directivity. In this system, as digital data and audible sound reaches at the same area, it can augment specific range in the real world by additional information without calibrations. By setting multiple speakers, the SteganoSonic transmitters can present different information to each location. Additionally, when the sound from a parametric speaker hits an object, the sound reflects as if the object sounds. With this feature, there can be an intuitive arrangement that indicates the interaction between objects and additional information.

We developed the prototype of the system, and applications using it. As an example, in a museum or other exhibitions, a parametric speaker can send audio explanation of the displayed item only to audience in front of the item. With our system, additionally, by holding the receiver to the sound, audience can reach the additional data for example a video or links to web sites relative to the displayed item. Furthermore we developed a multi-channel information overlaying depending on the locations of audience by setting several SteganoSonic speakers from different directions. It can realize applications, for example, the multi-lingual information presentation, or giving specific information according to audiences viewpoint.

In the future, we are going to develop other applications of not only converting received data to visual information, but also operation of robots or control of devises behaviors.

References

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NISHIMURA, T., ITOH, H., NAKAMURA, Y., YAMAMOTO, Y., AND NAKASHIMA, H. 2004. A compact battery-less information terminal for real world interaction. In *Springer LNCS 3001*, 124–139.

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