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Remote ranging using vibrations and ultrasonic transmission

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ABSTRACT

This disclosure addresses the problem of ranging or imaging a remote environment, e.g., a remote conference room, using audio equipment present at the remote location. Ultrasonic waves are transmitted, e.g., via standard telecommunication channels, from the near end to the remote location, and their reflections off objects at the remote location are received at the near end. The reflections are used to reconstruct the remote environment and form an ultrasonic signature. The techniques of this disclosure can be used to secure a phone call, e.g., to verify the identity of the remote party; verify the remote location; differentiate humans from bots at the remote location; verify the number of individuals present at the remote location; verify the identity of the devices being used at the remote location; etc. In addition to ultrasonic waves, devices are remotely vibrated to characterize the surface on which the device rests.

KEYWORDS

Remote ranging; ultrasonic imaging; secure phone call; ultrasonic signature; haptic feedback; acoustic reflection; acoustic characterization; stereo channel; voice call

BACKGROUND

Parties to a phone call often want to verify each other's identities. In particular, they may want to verify that the remote party is who they claim to be; if the remote party is a human or a bot; if the remote party is near or far from the microphone; if remote location has a single individual or multiple individuals; if the make and model of the remote phone match a known device; if the remote party is at an expected or claimed location; etc. There is often no channel other than the standard voice-mode telecommunication channel available to perform such verification.

DESCRIPTION

The techniques of this disclosure leverage the wide voice bandwidth, e.g., 20 kHz, available in telecommunication channels, and the observation that telephone audio generally occupies only a fraction, e.g., 8 kHz or less, of that bandwidth. For example, AMR-WB+ supports encoding of signals up to 20 kHz, some of which is beyond the range of most human hearing.

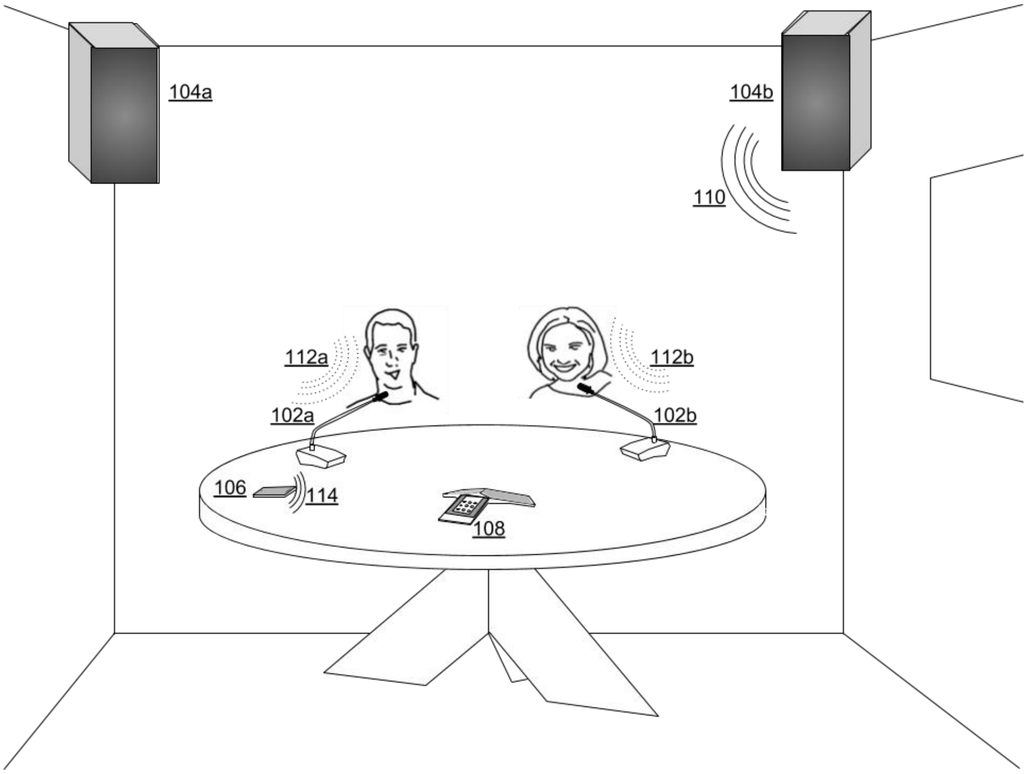

Fig. 1: Ranging a remote environment using audio communication channels

Fig. 1 illustrates a remote environment from where participants are engaged in a voice call. In the example of Fig. 1, the remote environment is a conference room with audio equipment, e.g., microphones (102a-b), speakers (104a-b), conference phone (108), smartphone (106), etc. While Fig. 1 shows a conference room, the techniques described in this disclosure are applicable for any type of remote environment, e.g., a smartphone or other device in various indoor and outdoor environments.

The near end (not shown) transmits an ultrasonic wave, e.g., a strong, short-duration 19 kHz pulse, overlaid over ordinary conversation between the parties in a voice call (e.g., a telephone call, an Internet Protocol based call, etc.) The ultrasonic wave (110) is played through the appropriate channel at the remote location. The wave is captured by use of left and right microphones (112a-b) and is transmitted back to near end (not shown). At the near end, the delay between transmitted and received ultrasonic pulses is used to determine the distances between the right channel speaker and the microphones. The exercise is repeated with the left channel speaker.

Alternatively or in addition, ultrasonic waves transmitted by the near end and reflected off objects or surfaces at the remote location are used to produce at the near end an image, or signature, of the remote location. The image or signature of the remote location is compared with known images or signatures to confirm the identity of the remote location. A signature of the remote location includes, e.g., an ultrasonic fingerprint of the individuals comprising the remote party; an ultrasonic fingerprint of objects at the remote location; etc. Similarly, acoustic reflections off the side of a user’s head, or conduction of ultrasonic audio through the user’s head, can be measured in order to verify the identity of the remote party. The techniques can also reveal if there is no human at the remote end, e.g., if the remote party is a bot.

Sampling at different ultrasonic frequencies enables a more nuanced sounding of the remote environment. Observation of frequency (Doppler) shifting of reflected waveforms enables information to be obtained about the motion of objects surrounding the remote telephony device.

Another implementation includes triggering vibrations on a remote mobile device (114), and using the resulting waveforms sensed by the microphone and on-board inertial measurement units (e.g., gyroscope, accelerometer, etc.) to remotely characterize and verify the type of surface (e.g., wood, metal, etc.) on which the mobile device is resting. Vibrations can also be used to characterize and verify the mechanical or resonant properties of the device. The verification of the phone via vibrations can be done at the time of call setup, e.g., as part of WebRTC for a call over IP. Vibrations can also be triggered using haptic feedback APIs available in some mobile devices, which are triggered by permitted applications or websites, or by sending a text message during an ongoing conversation.

In this manner, available wideband audio communication channels, e.g., stereo channels, high fidelity channels, etc., are used as a side channel to infer information about the remote device and environment. While the foregoing description refers to verification of the far-end, the techniques can be implemented at either or both ends of a call. Further, the techniques may be implemented prior to users speaking on the call, or at any suitable time during the call. The techniques can be utilized to verify the presence of a human user at either end of a call, for improved call security, etc. The techniques are deployed with permission of the participants in a call and/or location/organization-specific policies. Individual techniques (e.g. vibration triggering, ultrasound transmission, reflection measurement, etc.) are deployed as permitted, and one or more of the techniques are turned off when permission has not been provided. Any combination of the described techniques can be utilized to verify remote environments.

CONCLUSION

This disclosure addresses the problem of ranging or imaging a remote environment, e.g., a remote conference room, using audio equipment present at the remote location. Ultrasonic waves are transmitted, e.g., via standard telecommunication channels, from the near end to the remote location, and their reflections off objects at the remote location are received at the near end. The reflections are used to reconstruct the remote environment and form an ultrasonic signature. The techniques of this disclosure can be used to secure a phone call, e.g., to verify the identity of the remote party; verify the remote location; differentiate humans from bots at the remote location; verify the number of individuals present at the remote location; verify the identity of the devices being used at the remote location; etc. In addition to ultrasonic waves, devices are remotely vibrated to characterize the surface on which the device rests.