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Head Mounted Displays That Detect User Presence Using Sound Pattern Recognition

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Head Mounted Displays That Detect User Presence Using Sound Pattern Recognition

ABSTRACT

Determining if a head mounted display (HMD) is being worn by a user is important in determining whether to turn on or to turn off the device; to enable certain features that are available when the HMD is in use; to disable features that consume too much power when turned on during periods of non-use; etc. This disclosure describes sound pattern recognition techniques to determine the presence or absence of the user's head inside the HMD. Per the techniques, sound patterns are generated by speakers and received by microphones within the HMD. The difference in received sound patterns between the head-present and head-absent states of the HMD is used to determine whether or not a user is wearing the HMD.

KEYWORDS

- Head mounted display (HMD)
- Augmented reality
- AR glasses
- User detection
- Presence detection
- Sound pattern
- Sound recognition
- Audio recognition

BACKGROUND

Determining if a head mounted display (HMD) is being worn by a user is important in determining whether to turn on or to turn off the device; to enable certain features that are available when the HMD is in use; to disable features that consume too much power when turned on during periods of non-use; etc. Current techniques to identify if an HMD is being worn by the user include mechanical switches, capacitive sensors, pressure sensors, etc., which determine if the HMD is worn or if it is sitting on a surface, e.g., a desk. Other sensors, e.g., inertial measurement units, accelerometers, etc., can also be used for turning on a HMD when the user

picks it up from a resting position. These techniques can trigger false activations under certain conditions. For example, in the case of the accelerometer, a false activation may result when the HMD is picked up by a user without intent to use.

DESCRIPTION

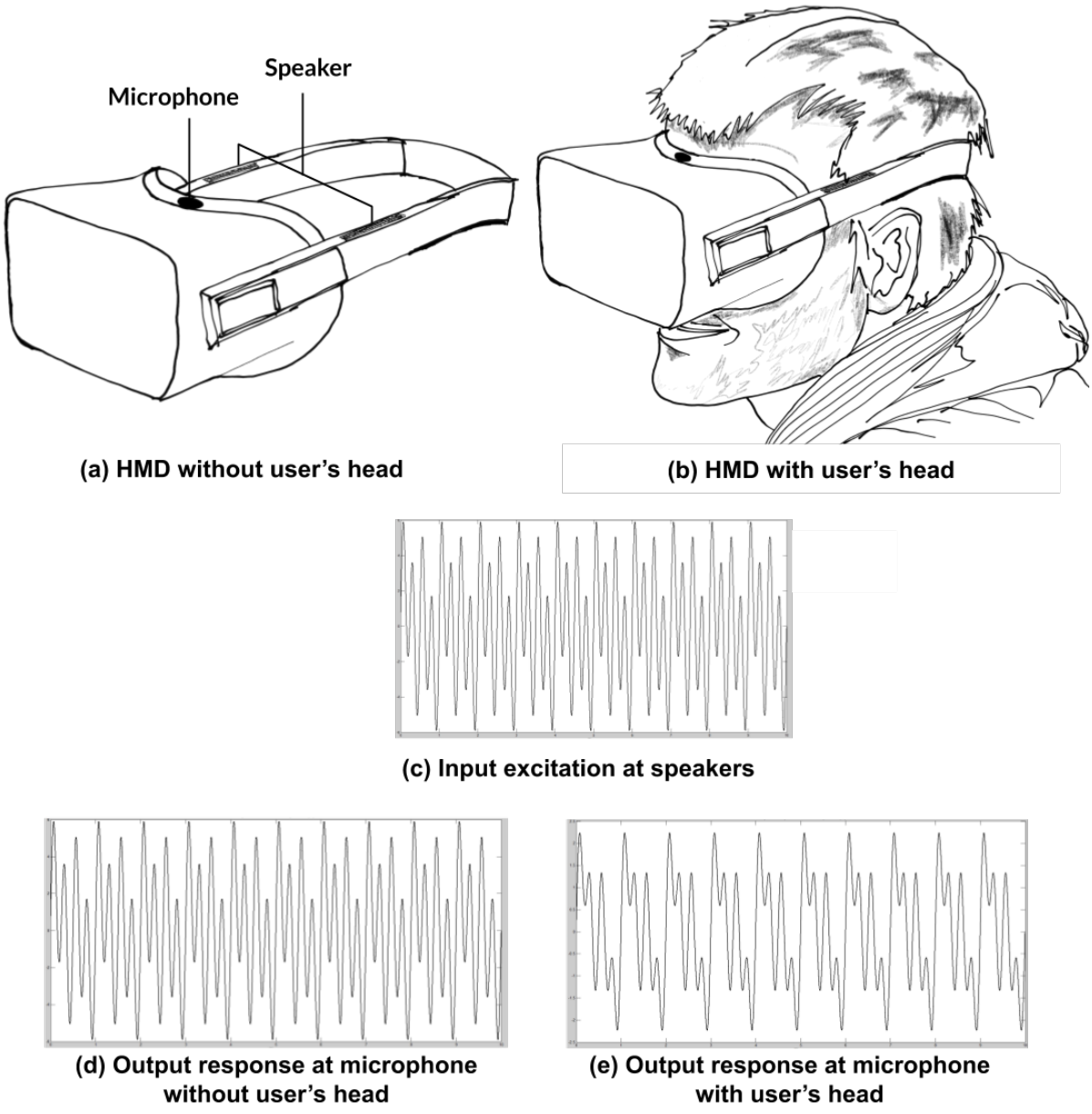

Fig. 1: (a) HMD without user's head; (b) HMD with user's head; (c) Sound excitation at speakers; (d) Response at microphone without user's head; (e) Response at microphone with user's head

This disclosure describes sound pattern recognition techniques to determine the presence or absence of a user's head inside the HMD. As illustrated in Fig. 1, speakers and microphones, which are ordinarily part of HMDs (Fig. 1a), are activated such that sound patterns of various amplitudes and frequencies are generated by the speakers (Fig. 1c) and received by the microphones. The sound patterns can be selected such that these are not in the audible spectrum, e.g., above twenty kHz, such that they are imperceptible to the user.

A sound pattern generated by a speaker in the presence of the human head (Fig. 1b) are received by a microphone after undergoing attenuation or spectral modification due to the presence of the human head (Fig. 1e). The same sound pattern is received differently in the absence of the human head, since the modifications to the sound through the transmission medium between speaker and microphone are similar to open-space (devoid of multipath) propagation (Fig. 1d). The difference in the received sound patterns between the two states of the HMD - head-present and head-absent - is used to determine whether or not a user is wearing the HMD.

In an example configuration, the microphone(s) and speaker(s) can be located on the left and right side of the mounting structure. For instance, a semi-rigid strap can accommodate these devices. The number of speakers and microphones can vary. For example, an array of one or more speakers and an array of one or more microphones can be used. The position of the speakers and the microphones can be optimized to enable triangulation of transmitting (speakers) and receiving (microphones) sensors.

Calibration of the device when not in use (head absent) can be performed as part of the manufacturing process such that accurate parameters that are specific to each manufactured device can be determined. Calibration of the device when in use (head present) can be done

without user intervention during normal usage of the device. Device calibration with head present can enable better identification of the sound patterns and how they are altered when the HMD is worn by the user versus, for example, when the HMD is carried in a backpack, possibly with other objects in close proximity.

In this manner, the techniques of this disclosure leverage the presence of existing sound devices in an HMD, e.g., microphones and speakers, which are otherwise used during normal operation to provide audio functionality, to robustly determine the presence or absence of the user's head inside the HMD.

CONCLUSION

This disclosure describes sound pattern recognition techniques to determine the presence or absence of the user's head inside the HMD. Per the techniques, sound patterns are generated by speakers and received by microphones within the HMD. The difference in received sound patterns between the head-present and head-absent states of the HMD is used to determine whether or not a user is wearing the HMD.