

## MOBILE PHONE FEATURING AUDIO-MODULATED VIBROTACTILE MODULE

### BACKGROUND OF THE INVENTION

**[0001]** 1. Field Of Invention

**[0002]** The present invention relates to a telecommunications network; and, more particularly, to a mobile phone used therein.

**[0003]** 2. Description of Related Art

**[0004]** Many people are either hard of hearing or cannot hear at all. These people have a very hard time using a mobile phone, or cannot use it at all.

**[0005]** In the prior art, there are only a few products that address this problem, including a hearing aid or a mobile phone loop headset. However, the hearing aids normally cannot be used with mobile phones. The NMP loop headset is one solution, but this requires that a significant amount of hearing capability still exists, and only the user's ears are used as an input channel.

**[0006]** Moreover, vibrotactile representation of speech stimuli is known in the art. In medical science, the vibrotactile-phenomenon is commonly practiced in audiology. See "Vibrotactile Perception of Speech," by Stina Ojala, Phonetics, University of Turku, Finland, for a full explanation of the vibrotactile phenomenon itself. Many different vibrotactile device are known, including devices mounted on an ear mould, a ring, a bracelet or a watch. These devices convert speech into a vibration modulation that stimulates and assists the user.

### SUMMARY OF INVENTION

**[0007]** The present invention provides both a method and apparatus for assisting and improving hearing capability by feeding mechanical vibration to the fingers or other suitable location. This vibration is modulated by a received speech signal. This invention provides a way of applying the vibrotactile-phenomenon to use in mobile phones and a manner of implementing the same. The benefit of having this feature is to make hearing easier in case of reduced hearing capability or very loud background noise.

**[0008]** In its broadest sense, the present invention features a telecommunications network having a mobile phone with an audio-modulated vibrotactile module that responds to a telecommunications signal containing information about incoming speech from a called/calling party, for providing an audio-modulated vibrotactile module force containing information about the incoming speech from the called/calling party to vibrate a user's fingers, facial skin, wrist, cheek or other suitable location.

**[0009]** In one embodiment, the audio-modulated vibrotactile module comprises an audio-to-vibrotactile converter that responds to the telecommunications signal, for providing an audio-to-vibrotactile converter signal containing information about a vibration modulation of the incoming speech from the called/calling party. The audio-modulated vibrotactile module also has a vibrotactile actuator that responds to the audio-to-vibrotactile converter signal, for providing the audio-modulated vibrotactile module force in the form of a vibrotactile actuator force.

**[0010]** In another embodiment, the telecommunications system would comprise the audio-to-vibrotactile converter, and the audio-modulated vibrotactile module in the mobile phone would contain only the vibrotactile actuator.

**[0011]** The vibrotactile actuator may be an electromechanical actuator arranged in the housing of the mobile phone for providing vibration to a user's fingers, wrist or facial skin.

**[0012]** The present invention also includes a method comprising two steps, i.e. a converting step and a transforming step. First, a telecommunications signal containing information about incoming speech from a called/calling party is converted into an audio-to-vibrotactile converter signal containing information about a vibration modulation of the incoming speech from the called/calling party. Next, the audio-to-vibrotactile converter signal is transformed into an audio-modulated vibrotactile module force containing information about the incoming speech from the called/calling party to vibrate a user's fingers, facial skin, wrist, cheek or other suitable location.

**[0013]** The step of converting may include performing vibration modulation using frequency domain filtering or equalization, linear/non-linear amplification, mixing speech signals, or a speech encoding algorithm.

**[0014]** The step of transforming may include electromechanically or acoustically actuating the audio-modulated vibrotactile module force.

#### Implementation in a Mobile Phone

**[0015]** In particular, in the mobile phone an incoming voice information is used as a source for vibration modulation. Speech is fed directly or it can be modified by one or more known methods before it is sent to the transducer component that transforms electrical signals to mechanical vibration. The later modification can be done by hardware or by software, and it can perform a specific algorithm if so specified.

**[0016]** If a hardware approach is used, a relatively simple modification may be performed, such as frequency domain filtering or equalization, linear/non-linear amplification or mixing speech signal with other signal(s). A more complex modification may add considerable size, cost and component number within a device.

**[0017]** If a software approach is used, typically a calculation method or an algorithm can be used to modify the incoming speech signal. By using this signal as an input signal, a new output signal is determined according to the algorithm so that optimal vibration will be produced. An advantage of the software approach is that a known speech encoding algorithm can be utilized within the mobile phone to produce input parameters for the actual modification purpose for vibrotactile functionality. In the best case, only minor additions to the existing speech coding software would need to be made, and therefore the processing capacity requirement will not be significant, which makes this feature quite easy to include in existing phones from the software point of view. Another advantage is that, if needed, the vibration defining parameters can be adjusted by the user through a user interface, where the user may be the person him/herself, the doctor of the person, or where parameters such as either direct numerical parameters or a preset-list to select from may be used.