[0041] In operation, the audio-to-vibrotactile converter **40** responds to the aforementioned telecommunications signal, and provides an audio-to-vibrotactile converter signal containing information about a vibration modulation of the incoming speech from the called/calling party **11**.

[0042] The vibrotactile actuator **42** responds to the audio-to-vibrotactile converter signal, and provides the audio-modulated vibrotactile module force in the form of a vibrotactile actuator force that contains the information about the incoming speech from the called/calling party **11** to vibrate a user's fingers, facial skin, wrist, cheek or other suitable location.

[0043] The audio-to-vibrotactile converter **40** may be implemented in hardware or software, as discussed below. The scope of the invention is not intended to be limited to any particular implementation thereof.

[0044] The vibrotactile actuator **42** may be an electromechanical actuator **70** (**FIG. 9**) arranged in a housing generally indicated in **FIG. 1** as **10***a* of the mobile phone **10** (**FIG. 1**) for providing a vibration to a user's fingers, wrist or facial skin. Vibrotactile actuators are known in the art, and the scope of the invention is not intended to be limited to any particular type or kind thereof.

FIGS. **3-6**: Hardware-Based Vibration Modulation

[0045] **FIG. 3** shows a hardware-based signal processor **50** for performing a vibration modulation in the audio-to-vibrotactile converter **40**. In the hardware-based signal processor **50**, the vibration modulation may be performed using a frequency domain filtering or equalization module **52** shown in **FIG. 4, a** linear/non-linear amplification module **54** shown in **FIG. 5**, or a speech mixing module **56** shown in **FIG. 6** for mixing speech signals with other signals.

[0046] The hardware-based signal processor **50** may be implemented to perform any one of the aforementioned functions using a microcontroller-based design. As a person skilled in the art would appreciate, the microcontroller-based design would typically include an inexpensive microcontroller, ROM, RAM, input/output devices and data and address lines for coupling the same. The scope of the invention is not intended to be limited to any particular hardware implementation of the signal processor **50**.

FIGS. **7-8**: Software-Based Vibration Modulation

[0047] **FIG. 7** shows a software-based signal processor **60** for performing vibration modulation in the audio-to-vibrotactile converter **40**.

[0048] In the software-based signal processor **60**, the vibration modulation may be performed using a speech encoding algorithm module **62** shown in **FIG. 8**.

[0049] The software-based signal processor **60** may be implemented to perform any one of the speech encoded algorithm using a microprocessor-based design. As a person skilled in the art would appreciate, the microprocessor-based design would typically include a more expensive processor, ROM, RAM, input/output and data and address lines for coupling the same. The scope of the invention is not intended to be limited to any particular software implementation of the signal processor **60**.

[0050] Moreover, the software-based signal processor **60** may respond to user adjustable vibration defining parameters received from the user of the mobile phone **10** (**FIG. 1**), including direct numerical parameters or a pre-set list of parameters, as discussed above.

FIGS. **9-10**: Vibrotactile Actuator

[0051] The vibrotactile actuator **42** (**FIG. 2**) may be suitably arranged in different portions of the housing **10***a* (**FIG. 1**) for providing different vibrations on the different portions of the user of the mobile phone (**FIG. 1**).

[0052] For example, the electromechanical actuator **70** shown in **FIG. 9** may be suitably arranged as follows:

[0053] (1) in a lower portion of a housing **10***a* of the mobile phone **10** for providing vibration on the user's fingers,

[0054] (2) in a lower or intermediate portion of a housing **10***a* of the mobile phone **10** for providing vibration on the user's facial skin,

[0055] (3) in a lower or intermediate portion of a housing **10***a* of the mobile phone **10** for providing vibration on the user's wrist, or

[0056] (4) in an intermediate portion of a housing **10***a* of the mobile phone **10** for providing vibration on the user's cheek.

[0057] The scope of the invention is not intended to be limited to the arrangement of the vibrotactile actuator **42** (**FIG. 2**) in the housing **10***a* of the mobile phone **10**.

[0058] Moreover, the vibrotactile actuator **42** (**FIG. 2**) may also be an acoustic actuator **80** shown in **FIG. 10** suitably sized for fitting into a user's ear.

FIG. **11**: Telecommunications Network **100**

[0059] **FIG. 11** shows another embodiment of the present invention, wherein the telecommunications system generally indicated as **100** comprises an audio-to-vibrotactile converter **102**. Consistent with that discussed above, the audio-to-vibrotactile converter **102** may be implemented in hardware or software, and the scope of the invention is not intended to be limited to any particular implementation thereof.

[0060] In operation, the audio-to-vibrotactile converter **102** responds to an incoming speech signal from a called/calling party **111**, for providing the telecommunications signal in the form of an audio-to-vibrotactile converter signal containing information about a vibration modulation of the incoming speech from the called/calling party **111**.

[0061] In this embodiment, the mobile phone **110** has an audio-modulated vibrotactile module **130** that only includes a vibrotactile actuator **142**. The vibrotactile actuator **142** responds to the audio-to-vibrotactile converter signal from the audio-to-vibrotactile converter **102**, for providing the audio-modulated vibrotactile module force in the form of a vibrotactile actuator force.

[0062] The telecommunications network **100** may be a separately-priced vibrotactile service network.

[0063] The audio-to-vibrotactile converter **102** may include a personalized hearing parameters module **150**