Abstract: A method of adjusting audio characteristics of a mobile radio communications device, comprising an audiometric testing process, wherein tones at a selection of frequencies within the range of the audio bandwidth of the mobile radio communication device are presented to the user, the presentation of tones being such that the amplitude of the tone is altered until the user indicates by an input means that the user can barely perceive the tone, and a frequency dependent means of amplitude adjustment adjusting the audio characteristics of the mobile radio communications device, based on the user indicated amplitude, for any or all of the plurality of tones. A mobile radio communications device is also provided. The benefit of the present invention is in the provision of access to mobile telephony for those with impaired hearing, improving the intelligibility and apparent quality of the communication experience.
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Mobile Radio Communications Device and Method for Adjusting Audio Characteristics

Technical Field

The present invention relates to the field of mobile radio communications.

Background

Mobile radio communication devices commonly have a limited amplitude audio output, generally to maximise battery life. This applies to both mobile telephones, and portable- and mobile radios. Whilst a limited amplitude audio output is acceptable for the majority of users, it may make mobile radio communication devices less acceptable to the approximately 14% of the population who suffer from hearing impairment.

The majority of mobile radio communication devices are incompatible with hearing aids. Firstly, there is the comfort issue of holding a mobile device to the hearing aid. Additionally, there is a more fundamental problem that GSM and other digital transmission standards may cause electrical interference with hearing aids when the device is close to the hearing aid. This has been reported as varying from 'a very loud rasping sound', sometimes causing pain, to a 'quieter but audible hum'. The interference prevents simultaneous use of the hearing aid and mobile communication device in the normal manner.

The current provisions for the hard of hearing that seek to circumvent this problem are limited to induction-loops, used to couple the mobile radio communication device to
suitably enabled hearing aids at a distance from the device.

In addition to comfort and convenience issues, induction loops assume that the user will be wearing a hearing aid when they make, or - more unpredictably - answer a call. Similarly, this solution assumes that the user will be wearing or be able to quickly don the induction loop when a call occurs.

The induction loop also does not address additional aspects of hearing impairment:

1. The induction loop amplifies the signal uniformly via the hearing aid, making the signal appear distorted from the perspective of the user whilst not making best use of the user’s residual hearing.

2. Only a relative minority of people with poor hearing wear hearing aids all the time. Moreover, many people have reduced hearing, but do not want the expense or any perceived stigma associated with hearing aids.

Thus the inventor has recognised a need for a discrete solution providing an improvement in perceived audibility for any user with hearing difficulties.

Summary of the Invention

In accordance with a first aspect of the present invention, there is provided a method of adjusting audio characteristics, as claimed in claim 1.
In accordance with a second aspect of the present invention, there is provided a mobile radio communications device, as claimed in claim 11.

Further aspects of the present invention are defined in the dependent claims. The mobile radio communications device may be a mobile telephone, or a portable- or a mobile two-way radio.

Brief description of the drawings

Exemplary embodiments of the present invention will now be described, with reference to the accompanying drawings, in which:

FIG. 1 shows an example screen providing information about a test tone frequency;

FIG. 2 shows an example screen providing information about a test tone amplitude; and

FIG. 3 shows an example screen providing information about any deviation of test results from a norm.

Detailed description of the preferred embodiment

In summary, in a preferred embodiment of the present invention, a method is proposed to provide a specialised audiometric analysis and compensation means within a mobile communication device equipped with a frequency dependent amplitude control mechanism. The frequency dependent amplitude control mechanism may be, e.g. a 'graphic equaliser'.
In a preferred embodiment of the present invention, an audiometric test is used to determine the degree of hearing loss of the user over specific frequency bands. That information is then used to drive the frequency dependent amplitude control mechanism during normal use of the radio communications device, such that it compensates for loss of hearing sensitivity in each frequency band.

GSM and other transmission standards provide a narrowband voice channel. Consequently the audiometric test should preferably be tailored to the narrowband audio frequency range available to the mobile communications device.

In a preferred embodiment of the present invention, the narrowband signal limits the requirements of the audiometric test to frequencies between typically 300 and 3,500 Hz. Consequently a reasonable set of test frequencies are provided by the following twelve 1/3rd octave band centre frequencies:

315Hz, 400Hz, 500Hz, 630Hz, 800Hz, 1000Hz, 1250Hz, 1600Hz, 2000Hz, 2500Hz, 3150Hz and 4000Hz.

In an alternative embodiment of the present invention, the set of test frequencies may be calculated from frequency/intelligibility relationships known in the art.

It should be clear to a person skilled in the art that any set of test frequencies that reasonably populate the narrowband acoustic frequency range of the mobile device may be adopted, such as a linear distribution.

A preferred process for conducting the test is as follows:
Step 1: The user selects the audiometric test from an appropriate menu on the mobile communication device, for example 'tools' or 'settings'.

Step 2: The test is initialised with the first test frequency. The user starts the first test by pressing an appropriate key, or speaking a keyword. An optional progress indicator can be provided (see Figure 1).

Step 3: A tone at the current frequency is played for a short period, typically 1-2 seconds, while the user is listening. The tone is repeated with rising increments in volume. The user presses an appropriate key upon barely hearing the tone. In an alternative embodiment, the tone decreases in volume until no longer perceivable by the user. An optional visual feedback can be included to provide assurance that the phone is operating (see Figure 2). After the user detects the tone, the level is recorded and the test progresses to the next frequency.

Step 4: After all test tone sequences have been completed, the user has the option to adopt or discard the new equalisation profile. To assist in this judgement, the phone may play before vs. after compensation segments of speech for the user. An optional visual feedback can be included to inform the user of the test results (see Figure 3).

In the preferred embodiment there should be options to select/discard/reacquire the test results in subsequent use.

Within the preferred embodiment, there are four strategies for applying the user's indications from an audiometric test (the 'test results') to generate the compensating
gains within the frequency dependent amplitude control mechanism that may be applied for each or all frequency bands:

1. If the user appears to be only slightly hard of hearing, the test results can be used to determine gains in selected frequency bands that restore the perceived signal to some reference level for those frequency bands.

2. If the user appears to be moderately hard of hearing, the test results can be used to determine in which frequency bands the user has least sensitivity and boost a selection of those bands to improve apparent quality.

3. If the user appears to be more significantly hard of hearing, the test results can be used to determine in which frequency bands the user has most sensitivity and boost a selection of those bands to improve intelligibility.

4. If the user appears to be profoundly hard of hearing in a given frequency band, then instead of boosting that frequency band to maximum, the phone could optionally cut the frequency out. This has the benefit of reducing power consumption and improving call privacy.

Selection of strategy could be an automatic choice, or the user could audition the methods using a test speech sample.

Whilst strategy 1 above is preferable, strategies 2, 3 and 4 provide lower power solutions for situations that require significant amplification.

In the preferred embodiment it may be preferable to have several equalisation profiles, selected either manually, or automatically depending on the mode of use of the mobile
communication device. For example use directly at the ear, via a hands-free kit or with an induction loop will all result in different profiles due to proximity of and response variations in the respective transducers. In the case of the induction loop, the benefit is primarily the introduction of a frequency-based amplitude gain.

In the preferred embodiment, the use of a hands-free kit may enable the selection of a 'hearing aid' option, wherein the mobile communication device uses the microphone of the hands-free kit as a signal source and applies a compensating equalisation to it that is sent to the earpiece, thus making the combined mobile communication device and hands-free kit act as a frequency-dependent hearing aid.

The benefit of the present invention is in the provision of access to mobile telephony for those with impaired hearing, improving the intelligibility and apparent quality of the communication experience and optionally providing hearing assistance in a more general context.
Claims

1. A method of adjusting audio characteristics of a mobile radio communications device, the mobile radio communications device comprising a frequency dependent means of audio output amplitude adjustment, comprising:
   (i) an audiometric testing process, wherein tones at a selection of frequencies within the range of the audio bandwidth of the mobile radio communication device are each presented to the user;
   (ii) the presentation of each of the plurality of tones is such that the amplitude of the tone is altered until the user indicates by an input means that the user can barely or no longer perceive the tone; and
   (iii) the frequency dependent means of amplitude adjustment adjusts the audio characteristics of the mobile radio communications device based on the user-indicated amplitude for any or all of the plurality of tones; and
   (iv) the user indications provided during the audiometric test are analysed to characterise the severity of hearing sensitivity impairment for any or all test frequencies within four groups of increasing severity.

2. A method according claim 1, wherein the four groups of increasing severity of hearing sensitivity impairment are:
   A) Slightly Impaired;
   B) Moderately Impaired;
   C) Severely Impaired; and
   D) Profoundly Impaired.

3. A method of adjusting the audio characteristics of a mobile radio communications device according claim 1 or claim 2, wherein the presentation of each of the plurality of tones is further characterised by:
each tone being presented such that the amplitude of the tone increases until the user indicates by an input means that they can perceive the tone, or a maximum amplitude is reached.

4. A method of adjusting the audio characteristics of a mobile radio communications device according claim 1 or claim 2, wherein the presentation of each of the plurality of tones is further characterised by:
  each tone being presented such that the amplitude of the tone decreases until the user indicates by an input means that they can no longer perceive the tone, or a minimum amplitude is reached.

5. A method of adjusting the audio characteristics of a mobile radio communications device according to any of claims 1-4, wherein respectively each tone substantially matches one of the plurality of 1/3 octave band centre frequencies spanning the audio range of the mobile communications device.

6. A method of adjusting the audio characteristics of a mobile radio communications device according to any one of claims 2-5, wherein for any or all frequency bands in which the user is characterised as slightly hearing impaired, the frequency dependent means of amplitude adjustment alters the gain of the aforesaid frequency bands proportionate to the degree of sensitivity loss of the user, as compared with a reference sensitivity.

7. A method of adjusting the audio characteristics of a mobile radio communications device according to any one of claims 2-5, wherein for any or all frequency bands in which the user is characterised as moderately hearing impaired, the frequency dependent means of amplitude adjustment
alters the gain of the user's n least sensitive frequency bands proportionate to the degree of sensitivity loss of the user, as compared with a reference sensitivity, where n is some value between 1 and the number of aforesaid frequency bands.

8. A method of adjusting the audio characteristics of a mobile radio communications device according to any one of claims 2-5, wherein for any or all frequency bands in which the user is characterised as severely hearing impaired, the frequency dependent means of amplitude adjustment alters the gain of the user's m most sensitive aforesaid frequency bands proportionate to the degree of sensitivity loss of the user, as compared with a reference sensitivity, where m is some value between 1 and the number of aforesaid frequency bands.

9. A method of adjusting the audio characteristics of a mobile radio communications device according to any one of claims 2-5, wherein for any or all frequency bands in which the user is characterised as profoundly hearing impaired, the frequency dependent means of amplitude adjustment alters the gain of the aforesaid frequency bands substantially to zero.

10. A method of adjusting the audio characteristics of a mobile radio communications device according to any of the above claims, wherein the user indications from multiple audiometric tests may be stored, and subsequently selected either manually or by automatic detection of operating mode or other connected equipment.

11. A mobile radio communications device comprising a frequency dependent means of audio output amplitude adjustment, comprising:
(i) a means for audiometric testing, wherein tones at a selection of frequencies within the range of the audio bandwidth of the mobile communication device are each presented to the user;

(ii) the presentation of each of the plurality of tones being such that the amplitude of the tone is altered until the user indicates by an input means that they can barely or no longer perceive the tone;

(iii) the frequency dependent means of amplitude adjustment is adapted to adjust the audio characteristics of the mobile communications device based on the user-indicated amplitude for any or all of the plurality of tones; and

(iv) the user indications provided during the audiometric test are analysed to characterise the severity of hearing sensitivity impairment for any or all test frequencies within four groups of increasing severity.

12. A mobile radio communications device according to claim 11, wherein the four groups of increasing severity of hearing sensitivity impairment are:

A) Slightly Impaired;
B) Moderately Impaired;
C) Severely Impaired; and
D) Profoundly Impaired.

13. A mobile radio communications device according to claim 11 or claim 12, wherein the user indications from multiple audiometric tests may be stored and subsequently selected either manually or by automatic detection of operating mode or other connected equipment.

14. A mobile radio communications device according to any one of claims 11 to 13, wherein microphone signals from a hands-free kit operably coupled to the mobile communications device are processed by the frequency
dependent means of amplitude adjustment, the frequency
dependent means of amplitude adjustment being responsive to
stored user-indications from an audiometric test, before
being sent to the audio output of the hands free kit.

15. A mobile radio communications device according to any
one of claims 11-14, wherein the device is a mobile
telephone, or a portable- or a mobile two-way radio.