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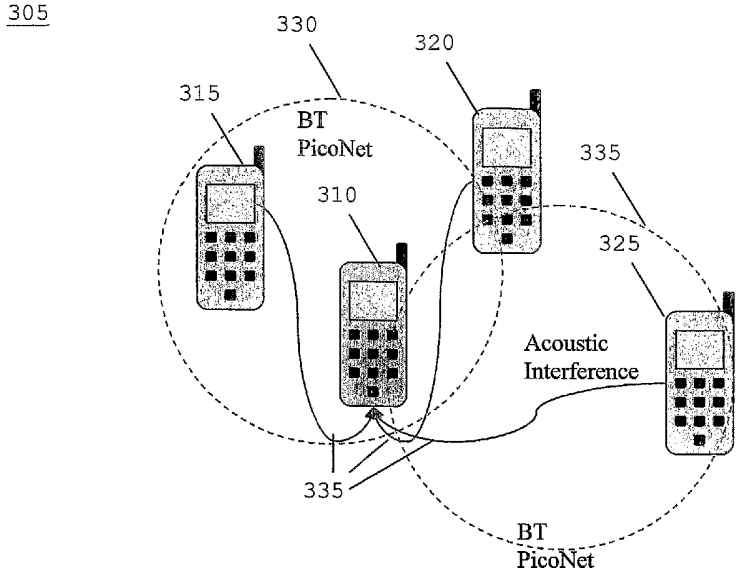
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(54) **Title:** LOCAL AREA NETWORK, COMMUNICATION UNIT AND METHOD FOR CANCELLING NOISE THEREIN



(57) **Abstract:** A speech communication unit (100) comprises a receiver for receiving a speech and noise signal, a signal processing function (108) operably coupled to the receiver and a noise cancellation function (142) operably oupled to the signal processing function (108). The speech communication unit (100) receives noise information from a proximal communication unit (315, 320, 325) and processes the noise information in the signal processing function. The speech communication unit (100) utilises the processed noise information in the noise cancellation function (142) to cancel out noise from the received speech and noise signal.

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LOCAL AREA NETWORK, COMMUNICATION UNIT AND METHOD FOR CANCELLING NOISE THEREIN

Field of the Invention

This invention relates to cancellation of interference in wireless communication units. The invention is applicable to, but not limited to, cancellation of background noise or interfering speech in a wireless communication unit using a local area network.

Background of the Invention

By their very nature, wireless communication units, such as mobile phones, will typically be used in a variety of 'noisy' environments. Noise in this context may include background audio noise or radio frequency interference noise. For example, one typical scenario is the use of a mobile phone in a public place in which many other mobile phone users are also using their mobile phones, for example in a train station or shopping precinct. Thus, noise exhibits itself in a mobile phone based on both radio frequency interference from neighbouring transmitting phones as well as background audio noise from neighbouring speakers, where the speech from neighbouring mobile phone users effectively act as further noise sources, i.e. as acoustic interference, entering the phone through its microphone. The background acoustic interference degrades the audio performance of the mobile phone.

Thus, it is known that noise reduction (suppression) of a noisy speech signal is a pre-requisite of current speech

communication, for example in the area of wireless speech communication or for improved speech recognition. One known noise suppression technique involves the estimation and subtraction of an interfering signal, through time-series or power spectrum techniques, where the acoustic interference is treated as random noise. However, as the acoustic interference cannot be relied upon to be random, and typically will not be random, this technique has limited applicability and provides only limited success in noise suppression in the area of mobile phones.

Another known noise suppression technique involves the use of multiple microphones to provide additional information on the content of the interfering signal, thereby allowing improved subtraction of the interfering signal from a combined speech and interference signal. Typically, one microphone will be physically located so as to receive the local speaker's voice with the second microphone arranged to receive any interfering signal, such as background noise. However, in practice, the practical separation that can be achieved on a mobile phone is very limited. Thus, the ability to readily differentiate desired from undesired signals is difficult, if not impossible, in practice.

Furthermore, the effectiveness of this method is also decreased if multiple interfering sources are present and located in different orientations with respect to the mobile phone. Consequently, this technique is not commonly used on mobile phones due to the increased cost and size of the additional microphone(s) and associated reception and conversion circuits.

In the field of microphones, it is known that null beamforming microphone arrays have been used to form noise estimates for direct spectral subtraction. In this regard an array formed from two or more microphones is used to place a null on the speaker. In this context, a null is a point, or a direction, in space where the microphone array has a zero response, i.e. sounds originating from this position will be severely attenuated in the array output.

In this manner, when a null is positioned on the talker, the output of the array provides a good estimate of the ambient noise. A second, noisy speech signal is also obtained from one or more of the microphones used by the user. Both signals are then transformed into the frequency domain, where non-linear spectral subtraction is applied, to remove the noise from the speech. Notably, the array is located within the speech communication unit and the nulling of particular signals is performed based solely on the ambient noise entering the array.

However, in practice, it is again difficult to incorporate complex techniques such as microphone arrays into a mobile phone, as well as differentiate desired from undesired signals.

Thus, improving a noisy speech signal by more accurately estimating and removing background noise is a critical area of providing effective speech communication in a wireless environment. A need therefore exists for an

improved arrangement wherein the abovementioned disadvantages may be alleviated.

Statement of Invention

In accordance with the preferred embodiment of the present invention, there is provided a communication unit, communication system and method of cancelling noise in a wireless environment, as defined in the accompanying Claims.

Brief Description of the Drawings

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 illustrates a simplified block diagram of a speech communication unit adapted in accordance with a preferred embodiment of the present invention;

FIG. 2 illustrates a noise cancellation block diagram used in the speech processing function of FIG. 1, and adapted in accordance with the preferred embodiment of the present invention;

FIG. 3 illustrates a speech communication system adapted in accordance with the preferred embodiment of the present invention; and

FIG. 4 is a flowchart illustrating a process of cancelling noise in a speech communication unit/system in

accordance with a preferred embodiment of the present invention.

Description of Preferred Embodiments

In summary, the preferred embodiment of the present invention provides a number of mechanisms whereby one or more neighbouring wireless communication unit(s) provide audio (background) noise information (or interfering speech signals) to other wireless communication units in its/their local vicinity. This enables these proximal wireless communication units to better cancel out their perceived acoustic (audio) interference from received noisy speech signals, as they receive an indication of the noise direct from its source, or distal from (and therefore unaffected by) the desired speech signal.

A first mechanism is where the wireless communication unit(s) transmit(s) their respective raw speech signals to neighbouring wireless communication units. In this manner, a wireless communication unit is able to use the raw speech signal, received from the acoustic interferer (of the neighbouring unit(s)), to cancel out audio interference/noise from a noisy speech signal input to its microphone.

A second mechanism is where the wireless communication monitors background noise and then transmits the monitored background noise to neighbouring wireless communication units. Preferably, the communication unit operates an 'open' microphone to monitor background noise

in its/their vicinity when it is not heavily or actively involved in a speech communication. The neighbouring wireless communication units are thus provided with the ability to utilise this 'local' background noise or remote interfering raw speech information in the cancellation of noise from desired voice signals entering the microphone of their respective communication unit. This allows, for example, a wireless communication unit to record noise from, say, a passing train, communicate this 'noise' signal to neighbouring or proximal wireless communication units, such that the noise from the passing train can be cancelled from the desired speech/audio signal received through its microphone.

A primary advantage of the above mechanisms is to allow a received representation of a neighbouring mobile phone user's speech, or other acoustic noise, to be used for the cancellation of the noisy audio component entering a neighbouring mobile phone user's microphone. In this manner, acoustic cancellation can be performed based upon a more accurate representation of the noise/speech causing the acoustic interference at the respective wireless communication unit.

Referring now to FIG. 1, there is shown a block diagram of a wireless subscriber speech communication unit, adapted to support the inventive concepts of the preferred embodiments of the present invention. It is within the contemplation of the invention that the inventive concepts can be equally applied to any speech-based device.

As known in the art, the speech communication unit 100 contains an antenna 102 preferably coupled to a duplex filter or antenna switch 104 that provides isolation between a receiver chain and a transmitter chain within the speech communication unit 100. As also known in the art, the receiver chain typically includes receiver front-end circuitry 106 (effectively providing reception, filtering and intermediate or base-band frequency conversion). The front-end circuit is serially coupled to a signal processing function 108. An output from the signal processing function is provided to a suitable output device 110, such as a speaker via a speech-processing unit 130.

The speech-processing unit 130 includes a speech encoding function 134 to encode a user's speech signals into a format suitable for transmitting over the transmission medium. The speech-processing unit 130 also includes a speech decoding function 132 to decode received speech signals into a format suitable for outputting via the output device (speaker) 110.

In accordance with the preferred embodiment of the present invention, the speech-processing unit 130 further comprises an interference cancellation function 142 that has been adapted to implement the preferred embodiment of the present invention, as described below with respect to FIG. 2. In practice, it is envisaged that this feature may be implemented as a wireless link rather than a microphone, as shown. The interference cancellation function 142 is arranged to receive audio/acoustic information from proximal wireless communication units,

and use this information to clean up speech communications received from a microphone.

The speech-processing unit 130 is operably coupled to a memory unit 116, via link 136, and a timer 118 via a controller 114.

In particular, the operation of the speech-processing unit 130 incorporates a manipulation function 138 that has been adapted to support the inventive concepts of the preferred embodiments of the present invention. The speech manipulation function 138 is further described with regard to FIG. 2.

For completeness, the receiver chain also includes received signal strength indicator (RSSI) circuitry 112 (shown coupled to the receiver front-end 106, although the RSSI circuitry 112 could be located elsewhere within the receiver chain). The RSSI circuitry 112 is coupled to a controller 114 for maintaining overall subscriber unit control. The controller 114 is also coupled to the receiver front-end circuitry 106 and the signal processing function 108 (generally realised by a digital signal processor (DSP)).

The controller 114 may therefore receive bit error rate (BER) or frame error rate (FER) data from recovered information. The controller 114 is coupled to the memory device 116 for storing operating regimes, such as decoding/encoding functions and the like. A timer 118 is typically coupled to the controller 114 to control the timing of operations (transmission or reception of time-dependent signals) within the speech communication unit

100. In the context of the present invention, the timer 118 dictates the timing of speech signals, in the transmit (encoding) path and/or the receive (decoding) path.

As regards the transmit chain, this essentially includes an input device 144, such as a microphone transducer coupled in series via speech encoder 134 to a transmitter/modulation circuit 122. Thereafter, any transmit signal is passed through a power amplifier 124 to be radiated from the antenna 102. The transmitter/modulation circuit 122 and the power amplifier 124 are operationally responsive to the controller, with an output from the power amplifier coupled to the duplex filter or antenna switch 104. The transmitter/modulation circuitry 122 and receiver front-end circuitry 106 comprise frequency up-conversion and frequency down-conversion functions (not shown).

In the preferred embodiment of the present invention, the wireless communication unit is also provided with a Bluetooth™ (BT) interface 140, which is configured to work in conjunction with the existing transmitter and receiver circuitry. A skilled artisan will appreciate that such an additional wireless communication technology may, in some instances, be configured as comprising parallel circuits to complement the primary speech communication technology employed by the wireless communication unit. Alternatively, one or more components or circuits of the primary communication may be re-used in the secondary BT communication, thereby supporting communication in both technologies.

Thus, in one embodiment, the wireless communication unit 100 receives neighbouring raw speech information and/or remote acoustic interference information from a neighbouring wireless communication unit over a BT communication link. The wireless communication unit 100 then processes this information in the normal manner via the receiver chain, until the speech processing function. At this point, the speech manipulation function recognises that this is, in effect, a representation of a noise source, and uses the processed signal for noise cancellation purposes , as described below.

Of course, the various components within the speech communication unit 100 can be arranged in any suitable functional topology able to utilise the inventive concepts of the present invention. Furthermore, the various components within the speech communication unit 100 can be realised in discrete or integrated component form, with an ultimate structure therefore being merely an application-specific selection.

It is within the contemplation of the present invention that the preferred use of speech processing and speech storing can be implemented in software, firmware or hardware, with the function being implemented in a software processor (or indeed a digital signal processor (DSP)), performing the speech processing function, merely a preferred option.

More generally, it is envisaged that any re-programming or adaptation of the speech processing function 130, according to the preferred embodiment of the present invention, may be implemented in any suitable manner.

For example, a new speech processor or memory device 116 may be added to a conventional wireless communication unit 100. Alternatively, existing parts of a conventional wireless communication unit may be adapted, for example, by reprogramming one or more processors therein. As such the required adaptation may be implemented in the form of processor-implementable instructions stored on a storage medium, such as a floppy disk, hard disk, programmable read-only memory (PROM), random access memory (RAM) or any combination of these or other storage media.

Referring now to FIG. 2, the speech manipulation function 138 of the speech communication unit of FIG. 1, adapted in accordance with the preferred embodiment of the present invention, is illustrated in greater detail. The speech manipulation function 138 is operably coupled to the receiver chain via the signal processing function 108, which processes and extracts the audio content of received (noise and/or speech) interference signals. Notably, an extracted, desired speech signal 205 is supplemented with a second audio signal that predominantly comprises background audio noise 210 sent from one or more remote wireless communication units. Advantageously, the background audio noise 210 may comprise speech signals uttered from proximal users and/or monitored background audio/acoustic noise prevalent in the vicinity of the proximal wireless communication unit.

The desired speech signal (that includes background noise/speech also received) can be defined by equation (1):

$$u(k) + i_1(k)*h_1(k) \quad (1)$$

Where:

$u(k)$ is the desired speech content;

$i_1(k)$ is the background audio/noise content; and

$h_1(k)$ is a gain factor associated with the background audio/noise content.

The audio content of the background (acoustic) noise ($i_1(k)$) or speech is preferably received as an acoustic interference signal received by the wireless communication unit from a number (one or more) remote wireless communication units. In this context, the acoustic interference signal provides an electronic representation of the acoustic interference of the reference source 210, filtered by adaptive filter 215, i.e. the adaptive filter 201 creates an estimate of the channel associated with the interfering signal.

Notably, the filter taps are set by a feedback representation of the desired audio signal. The output of the summing node, which in the absence of the speech of the user of the first mobile phone forms a digital representation of the error signal, is fed back to the input of the adaptive filter to control adaptation of the digital filter coefficients. The filtered acoustic interference output 225 of the adaptive filter 215 is subtracted from the desired audio signal 205, in summing junction 230, thereby performing acoustic cancellation.

The output of summing junction 230 is therefore substantially u(k) 235.

Referring now to FIG. 3, a wireless communication system is illustrated that is adapted in accordance with the preferred embodiment of the present invention. The preferred embodiment is based upon the use of, say, four mobile phones operating in relatively close proximity. Preferably, the four mobile phones are configured such that they are able to form a dynamic co-operating (short-range or local area network (LAN)) network. For example, in accordance with the preferred embodiment of the present invention, the four mobile phones are preferably arranged to dynamically set up a BT (or WLAN) network, e.g. a PicoNet.

In accordance with the preferred embodiment of the present invention, a number of proximal wireless communication units dynamically form a local network, e.g. a BT PicoNet. The selection of those units that should be allowed to participate in the BT PicoNet may, for example, be based upon received signal strength information between the respective units.

In operation a first mobile phone 310 supporting, for example Bluetooth standard technology, is configured to search for other participating Bluetooth supported communication devices. If the Bluetooth capabilities of these other devices are enabled, and are detected by the first mobile phone 310 (e.g. using the challenge/accept process that forms part of the Bluetooth standard), the

first mobile phone 310 and second mobile phone 315 establish a Bluetooth PicoNet to allow data to be transferred therebetween.

As shown, once the Bluetooth™ PicoNet has been established, a wireless communication unit 310 may suffer from audio (acoustic) interference, either from background noise or one or more neighbouring user's speech. A skilled artisan will appreciate that three proximal wireless communication units are shown for clarity purposes only.

A second mobile phone 315 is arranged to transmit over the BT PicoNet an electronic representation of any audio signals received or monitored by a microphone of the second mobile phone 315, for example an audio signal spoken by an user of the second mobile phone 315. The transmitted signal will typically be coded in continuously variable slope delta-modulation CVSD. However, a skilled artisan will appreciate that many other coding schemes could be used.

Thus, once a local co-operating network has been formed, a first mobile phone 310 is able to receive audio interference and/or proximal speech signals 335 from a number of proximal second mobile phones 315, 320, 325. Notably, the number of proximal second mobile phones 315, 320, 325 send background audio interference signals 335, as monitored at their respective locations, or raw speech signals entering their respective microphone, to the first mobile phone. This transmission is preferably

performed via the local BT network or via a wireless local network such as a PicoNet.

In this manner, an electronic representation of the background audio signals (noise and/or speech) at the respective second mobile phones' locations within the dynamic local communication network(s) is collated at the first mobile phone. A processing function in the first mobile phone uses the information received in this BT signal to perform acoustic cancellation of any unwanted signal received at the first mobile phone's microphone. For the purposes of this embodiment the acoustic cancellation is preferably performed by an adaptive filter incorporated within the processing module, as previously described with reference to FIG. 2. However, it will be appreciated by a skilled artisan that any form of acoustic cancellation technique could be used.

Thus, the first mobile phone is able to cancel audio/acoustic noise from its user's desired voice signal, based on a separate representation of the acoustic interference in the vicinity of the first mobile phone as received over the BT PicoNet. A skilled artisan will appreciate that an adjustment of the levels of acoustic/audio interference may be required, to effectively cancel out substantially the same level of acoustic/audio interference received in the first mobile phone's microphone.

Audio signals received by microphones of second mobile phones will typically include an audio signal generated

by the user of the second mobile phones, i.e. speech of the user of the second mobile phone, in addition to acoustic interference.

In an enhanced embodiment of the present invention, a number of neighbouring wireless communication units may be arranged to 'broadcast' audio/acoustic (noise) information to other wireless communication units within the local network.

Furthermore, it is envisaged that the dynamically formed BT PicoNet may dynamically change the respective mobile phones participating in the PicoNet. In this regard, it is envisaged that neighbouring mobile phones that are not being used for speech communication, or that are not in a noisy background area, may not transmit/broadcast acoustic information from its locality. In addition, when a mobile phone moves outside of the local area network (i.e. the BT PicoNet coverage area), the particular mobile phone is removed from an 'active' user list. In this manner, there is a dynamic introduction, as well as dropping, of mobile phones within the local area network that are able to assist (or not) in the acoustic cancellation process.

Although the preferred embodiment of the present invention is described with reference to the first mobile phone 310 establishing one piconet or WLAN communication with other mobile phones, it is envisaged that the first mobile phone 310 may establish either one piconet or network with other devices. In addition, it is envisaged

that it can also establish one, two or more local wireless networks/BT piconets with other devices, and this is transparent from a macroscopic perspective. Also, it is noteworthy that the first mobile phone 310 may establish a BT piconet with 325 and a WLAN local network with 315, so the simultaneous networks can utilise various transport mechanisms (e.g. BT, WLAN...).

In a further preferred embodiment of the present invention, the first mobile phone and/or one or more of the second mobile phone(s), may be configured to perform an audio test/monitoring operation of its surroundings prior to establishing a call. Typically the audio test would be performed by a signal processing function 108 or controller 114 (of FIG. 1) utilising signals received from one or more microphones.

Advantageously, if the audio test establishes that there is no, or low, ambient noise it may be assumed that acoustic cancellation is not required and the acoustic cancellation function, including for example its Bluetooth capability, is not switched on (i.e. the transmitting of an electronic representation of an audio signal and/or the processing of any received electronic representation is not performed). By utilising audio testing procedures to identify audio signals in its surroundings, a mobile phone is able increase its security/privacy whilst also reducing power consumption.

It is envisaged that the remote (second) mobile phones may employ mechanisms to determine whether their units

are detecting speech or background noise. Such remote mobile phones may then transmit this information to the first mobile phone, to assist in the cancellation process. In this regard, methods for detection or absence of speech of a user of a mobile phone are well known to a person skilled in the art, and may be used in this context. Hence, such methods will not be described in any further detail.

In an enhanced embodiment of the present invention, the signal manipulation function is preferably arranged to establish a local wireless network, for example a Bluetooth PicoNet or wireless local area network (WLAN) (for example the 802.11, 802.16e and UWB standards) or other similar network type. It is also envisaged that combinations of multiple networks may be established, where several users' noise inputs may be received over different networks. It is envisaged that other participating mobile phones may also be arranged to perform acoustic cancellation using data received from other proximal mobile phones over the local network, in a similar manner as described above. Optionally, the mobile phones may be arranged to perform acoustic cancellation using data received over any local synchronised network, as described below.

Referring now to FIG. 4, a flowchart 400 of the preferred process for audio/acoustic interference cancellation in a wireless communication unit is illustrated. The process of audio/acoustic interference cancellation first comprises the step of a number of proximal mobile phones dynamically setting up a local area network, as shown in

step 405. Preferably, the LAN is set up as a local area BT PicoNet. The proximal mobile phones preferably determine whether they are sufficiently proximal to other mobile phones using a received signal strength indication. Alternatively, it is envisaged that any other means for determining the proximity can be used, such as absolute location information, say from global positioning satellite (GPS) information.

For the mobile phones that are operational and identified as being able to participate in the local area BT PicoNet, the phones monitor the background noise at their location by opening their respective microphones, as in step 410. In this manner, they are able to obtain raw information on localised acoustic noise. In addition, or in the alternative, the respective microphones receive raw speech data, as enunciated by the mobile phone user, as in step 410. The raw speech data and/or localised acoustic noise are then transmit, in step 415, to other mobile phones within the local BT PicoNet.

In the context of the present invention, a first mobile phone then receives these transmissions over the local BT PicoNet, and processes this data, as shown in step 420. The first mobile phone then uses the received information to cancel noise received from a combined desired speech and undesired noise signal received through its microphone, as shown in step 425. It is envisaged that any known multi-input echo cancellation technique can be used to cancel out such undesired acoustic noise.

Thus, a mechanism has been described that enables the cancellation of acoustic interference, with the 'noise'

information received from neighbouring mobile handset users. Furthermore, the inventive concept allows implementation of acoustic cancellation techniques that were previously impractical from a wireless handset perspective.

In this manner, improved acoustic performance of handsets is achieved. Furthermore, the BT local area network enables handsets to broadcast copies of their local speech input to be utilised for acoustic cancellation by all other handsets in their locality. This is particularly advantageous in scenarios where there are many proximal users, each generating speech that interferes with other users, such as in an 'emergency' situation, or when a number of users are travelling in a small area such as a train carriage.

Although the preferred embodiment of the present invention has been described with reference to a BT PicoNet, it is envisaged that the inventive concept is equally applicable to any wireless local area network (WLAN).

Advantageously, it is envisaged that the preferred feature of utilising acoustic information from neighbouring handsets may be only initiated as and when required. That is, it is envisaged that such an acoustic 'sniffing' technique may be put into 'sleep mode' and only activated when needed. In this manner, a reduction in transmit power, particularly with respect to BT operation, can be achieved.

It is also envisaged that there may be occasions when users may not wish their speech to be broadcast locally and made available to other participating users e.g. behind closed door business calls. This is supported by providing a privacy mechanism that prevents the user's speech from being broadcast to other users. This may be achieved through either of two mechanisms. First, a switch may be implemented either as software or hardware, and may be used to disable the noise cancellation functionality. Secondly, when the previously described 'acoustic sniffing' detects no adjacent users, then the noise cancellation functionality may be disabled. This provides an automatic mechanism ensuring that the users speech may only be broadcast if the function has been enabled and other participating users are adjacent.

Advantageously, the aforementioned method is network independent, e.g. the handset can be configured to support any wireless technology such as GSM, CDMA, and W-CDMA. Also, the inventive concept does not require any additional network resources or capacity from the primary communication system.

Whilst specific, and preferred, implementations of the present invention are described above, it is clear that one skilled in the art could readily apply variations and modifications of such inventive concepts.

Thus, an improved speech communication unit has been described wherein the abovementioned disadvantages associated with prior art speech communication units have been substantially alleviated.

Claims

1. A speech communication unit (100) comprising a receiver for receiving a speech and noise signal, a signal processing function (108) operably coupled to the receiver and a noise cancellation function (142) operably coupled to the signal processing function (108), wherein the speech communication unit (100) receives noise information from a proximal communication unit (315, 320, 325) and processes the noise information in the signal processing function and utilises the processed noise information in the noise cancellation function (142) to cancel out noise from the received speech and noise signal.

2. The speech communication unit (100) according to Claim 1 further characterised in that the received noise information comprises raw speech data and/or localised acoustic noise information from the proximal wireless communication unit.

3. The speech communication unit (100) according to Claim 1 or Claim 2 further characterised by a local area network interface (140), operably coupled to the noise cancellation function (142), such that the received noise information is received over the local area network.

4. The speech communication unit (100) according to Claim 3 further characterised in that the local area network interface (140) is a Bluetooth™ interface configured to work in conjunction with existing transmitter and/or receiver circuitry of the speech communication unit (100).

5. The speech communication unit (100) according to any preceding Claim further characterised by a transmitter and an audio monitoring function for monitoring background noise (410) at the speech communication unit and transmitting monitored background noise (410) to one or more proximal wireless communication unit(s).

6. The speech communication unit (100) according to any preceding Claim further characterised by a transmitter and a speech input function for receiving raw speech data (410), as enunciated by a user of the speech communication unit and transmitting raw speech data (410) to one or more proximal wireless communication unit(s).

7. The speech communication unit (100) according to any preceding Claim further characterised by a processor configured to dynamically join or set up a local area network (405) between a number of proximal wireless communication units to transfer raw speech data and/or localised acoustic noise information therebetween.

8. The speech communication unit (100) according to any preceding Claim further characterised by a privacy mechanism operably coupled to the signal processing function (108) and arranged to prevent a user's speech from being broadcast to other users.

9. An integrated circuit adapted for use in the speech communication unit according to Claim 1 and arranged to cancel noise (400) received from proximal

wireless communication units from a received noisy speech signal.

10. A wireless local area network (100) comprising a plurality of wireless communication units, wherein one or more of the wireless communication units are arranged to monitor background noise (410) at their location and or receive raw speech data (410), as enunciated by a user of the respective wireless communication unit and transmit;

the local area network characterised in that a number of the plurality of wireless communication units are configured to transmit (415) raw speech data and/or localised acoustic noise information to proximal wireless communication units within the local area network.

11. A wireless local area network (100) according to Claim 10, further characterised in that one or more of the plurality of wireless communication units is arranged to receive and process (420) the raw speech data and/or localised acoustic noise information at the first wireless communication unit and cancel noise (425) from a noisy speech signal using the processed raw speech data and/or localised acoustic noise information signal to provide a noise cancelled speech signal.

12. A method for cancelling noise (400) in a speech communication unit, the method comprising the step of:

receiving noisy speech (405) uttered by a speaker of a first wireless communication unit;

wherein the method is characterised by the steps of:

monitoring background noise (410) at a remote wireless communication unit's location and or receiving raw speech data (410), as enunciated by a user of the remote wireless communication unit;

transmitting (415) raw speech data and/or localised acoustic noise information from the remote wireless communication unit to the first wireless communication unit;

receiving and processing (420) the raw speech data and/or localised acoustic noise information at the first wireless communication unit; and

cancelling noise (425) from the noisy speech signal using the processed raw speech data and/or localised acoustic noise information signal to provide a noise cancelled speech signal.

13. A method for cancelling noise (400) in a speech communication unit according to Claim 12 further characterised by the step of dynamically setting up a local area network between a number of proximal wireless communication units, such that the step of transmitting (415) raw speech data and/or localised acoustic noise information is performed through the local area network.

14. A method for cancelling noise (400) in a speech communication unit according to Claim 12 or Claim 13 further characterised by the step of determining, by a number of proximal wireless communication units as to

whether they are sufficiently proximal to other wireless communication units to form the local area network.

15. A method for cancelling noise (400) in a speech communication unit according to any of preceding Claims 12 to 14further characterised in that the step of dynamically setting up a local area network comprises setting up a local area Bluetooth PicoNet.

16. A method for cancelling noise (400) in a speech communication unit according to any of preceding Claims 12 to 15 further characterised in that the step of cancelling noise comprises cancelling audio/acoustic interference.

17. A method for cancelling noise (400) in a speech communication unit according to any of preceding Claims 12 to 16 further characterised by the step of initiating a privacy mechanism to prevent a user's speech from being broadcast to other users.

18. An integrated circuit adapted to cancel noise according to the steps of Claim 12.

AMENDED CLAIMS

[received by the International Bureau on 25 July 2005 (25.07.2005);
original claims 1-18 replaced by amended claims 1-17]

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STATEMENT

1. A speech communication unit (100) comprising a receiver for receiving a speech and noise signal, a signal processing function (108) operably coupled to the receiver and a noise cancellation function (142) operably coupled to the signal processing function (108), wherein the speech communication unit (100) receives noise information from a proximal communication unit (315, 320, 325) and processes the noise information in the signal processing function and utilises the processed noise information in the noise cancellation function (142) to cancel out noise from the received speech and noise signal, wherein the speech communication unit (100) is characterised by a privacy mechanism operably coupled to the signal processing function (108) and arranged to be activated by the signal processing function (108) to prevent a user's speech from being broadcast to other users when the receiver detects no proximal communication unit (315, 320, 325).

2. The speech communication unit (100) according to Claim 1 further characterised in that the received noise information comprises raw speech data and localised acoustic noise information from the proximal wireless communication unit.

3. The speech communication unit (100) according to Claim 1 or Claim 2 further characterised by a local area network interface (140), operably coupled to the noise cancellation function (142), such that the received noise information is received over the local area network.

4. The speech communication unit (100) according to Claim 3 further characterised in that the local area network interface (140) is a Bluetooth™ interface configured to work in conjunction with existing transmitter and/or receiver circuitry of the speech communication unit (100).

5. The speech communication unit (100) according to any preceding Claim further characterised by a transmitter and an audio monitoring function for monitoring background noise (410) at the speech communication unit and transmitting monitored background noise (410) to one or more proximal wireless communication unit(s).

6. The speech communication unit (100) according to any preceding Claim further characterised by a transmitter and a speech input function for receiving raw speech data (410), as enunciated by a user of the speech communication unit and transmitting raw speech data (410) to one or more proximal wireless communication unit(s).

7. The speech communication unit (100) according to any preceding Claim further characterised by a processor configured to dynamically join or set up a local area network (405) between a number of proximal wireless communication units to transfer raw speech data and localised acoustic noise information therebetween.

8. The speech communication unit (100) according to any preceding Claim further characterised in that the privacy mechanism disables the noise cancellation

function (142) upon detecting no proximal communication unit (315, 320, 325) .

9. An integrated circuit adapted for use in the speech communication unit according to Claim 1 and arranged to cancel noise (400) received from proximal wireless communication units from a received noisy speech signal.

10. A wireless local area network (100) comprising a plurality of wireless communication units, wherein one or more of the wireless communication units are arranged to monitor background noise (410) at their location and receive raw speech data (410), as enunciated by a user of the respective wireless communication unit and transmit;

the local area network characterised in that a number of the plurality of wireless communication units are configured to transmit (415) raw speech data and localised acoustic noise information to proximal wireless communication units within the local area network, wherein one or more of the proximal wireless communication units is arranged to receive and process (420) the transmit raw speech data and localised acoustic noise information and cancel noise (425) from a noisy speech signal using the processed raw speech data and localised acoustic noise information signal to provide a noise cancelled speech signal.

11. A wireless local area network (100) according to Claim 10 wherein the one or more of the proximal wireless communication units comprises a privacy mechanism arranged to prevent a user's speech from being broadcast to other users when the a receiver of the one or more of

the proximal wireless communication units detects no proximal communication unit (315, 320, 325).

12. A method for cancelling noise (400) in a speech communication unit, the method comprising the step of:

receiving noisy speech (405) uttered by a speaker of a first wireless communication unit;

wherein the method is characterised by the steps of:

monitoring background noise (410) at a remote wireless communication unit's location and receiving raw speech data (410), as enunciated by a user of the remote wireless communication unit;

transmitting (415) raw speech data and localised acoustic noise information from the remote wireless communication unit to the first wireless communication unit;

receiving and processing (420) the raw speech data and localised acoustic noise information at the first wireless communication unit;

cancelling noise (425) from the noisy speech signal using the processed raw speech data and localised acoustic noise information signal to provide a noise cancelled speech signal;

detecting, by the first wireless communication unit, whether there is an adjacent user; and

disabling a cancellation function of the first wireless communication unit when no proximal communication unit (315, 320, 325) is detected.

13. A method for cancelling noise (400) in a speech communication unit according to Claim 12 further characterised by the step of dynamically setting up a local area network between a number of proximal wireless

communication units, such that the step of transmitting (415) raw speech data and localised acoustic noise information is performed through the local area network.

14. A method for cancelling noise (400) in a speech communication unit according to Claim 12 or Claim 13 further characterised by the step of determining, by a number of proximal wireless communication units as to whether they are sufficiently proximal to other wireless communication units to form the local area network.

15. A method for cancelling noise (400) in a speech communication unit according to any of preceding Claims 12 to 14 further characterised in that the step of dynamically setting up a local area network comprises setting up a local area Bluetooth PicoNet.

16. A method for cancelling noise (400) in a speech communication unit according to any of preceding Claims 12 to 15 further characterised in that the step of cancelling noise comprises cancelling audio/acoustic interference.

17. An integrated circuit adapted to cancel noise according to the steps of Claim 12.

Statement under Article 19(1) PCT

Re: Patent Application PCT/EP2004/014907 in the name of Freescale Semiconductor, Inc.

Amendments and support therefor:

Claim 1 and Claim 12 have been amended to include the feature of the privacy mechanism and the activation thereof in response to a determination of a proximal communication unit. Support for this feature can be found throughout the Specification as originally filed, not least page 20, line 24 to page 21 line 15 and Claim 8.

Similarly, new Claim 11 has been amended to encompass the aforementioned feature.

The alternative aspect of Claims 2, 7, 10, 12 and 13 has been deleted.

Claim 8 has been amended to the feature that the cancellation function is disabled upon detecting no proximal communication unit. Support for this feature can be found on page 21, lines 10 to 12 as originally filed.

The features of original Claim 11have been incorporated into Claim 10.

Claim 17 has been deleted without prejudice. Subsequent Claim 18 has been re-numbered as Claim 17 accordingly.

FIG. 1

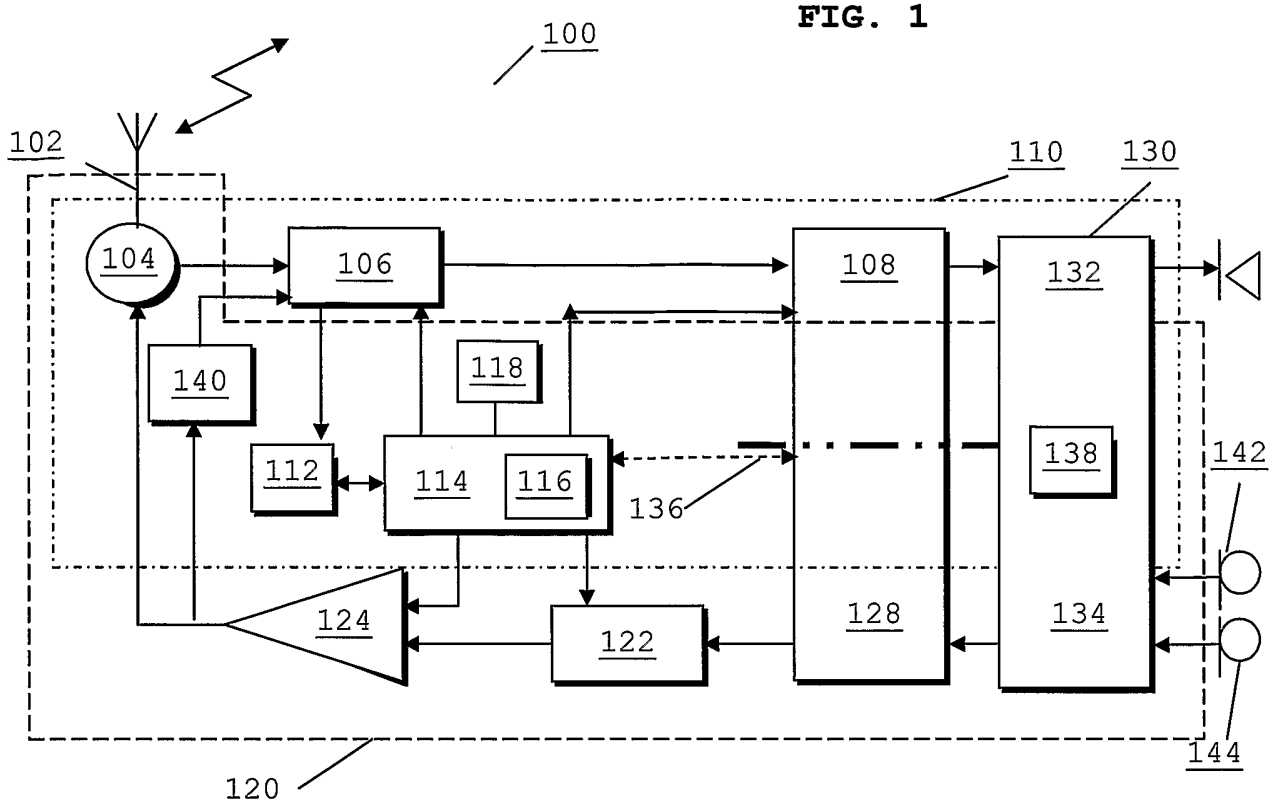
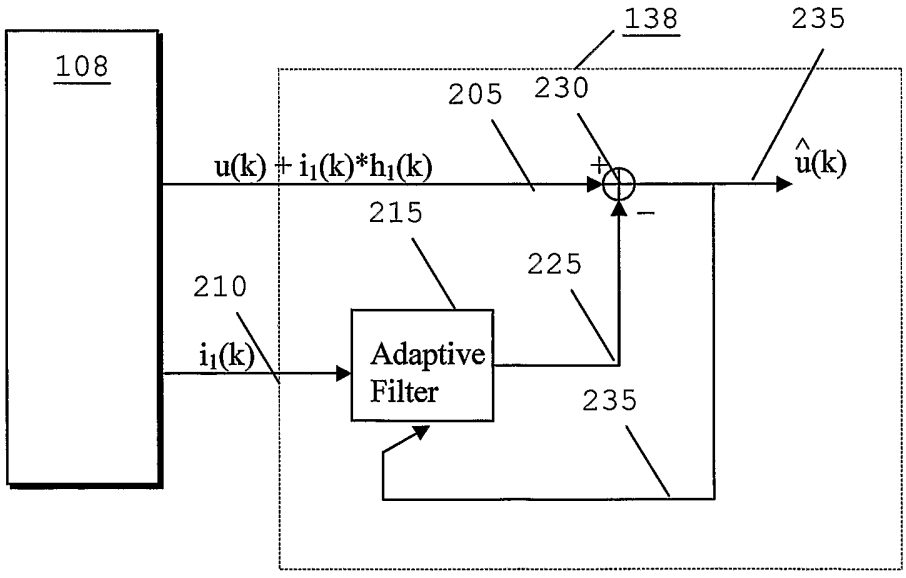

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114
116
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142
124
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128
134
120
144

FIG. 2


108
138
235
205
230
u(k) + i1(k)*h1(k)
+
−
û(k)
215
225
210
i1(k)
Adaptive Filter
235

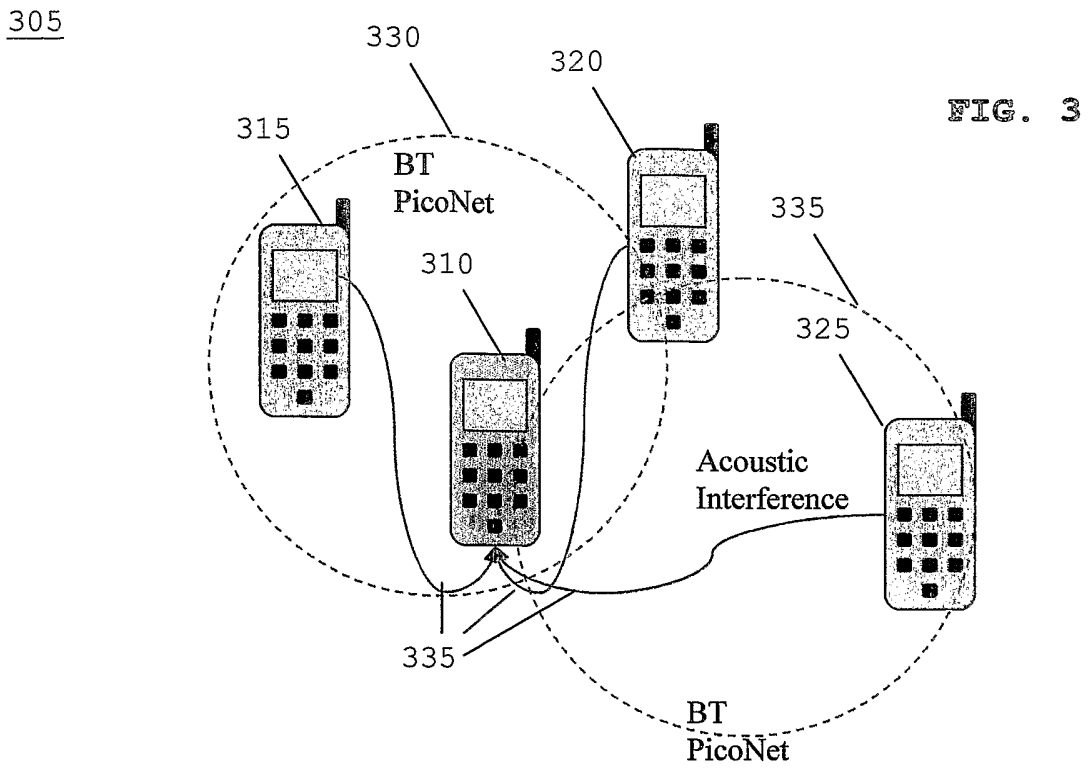
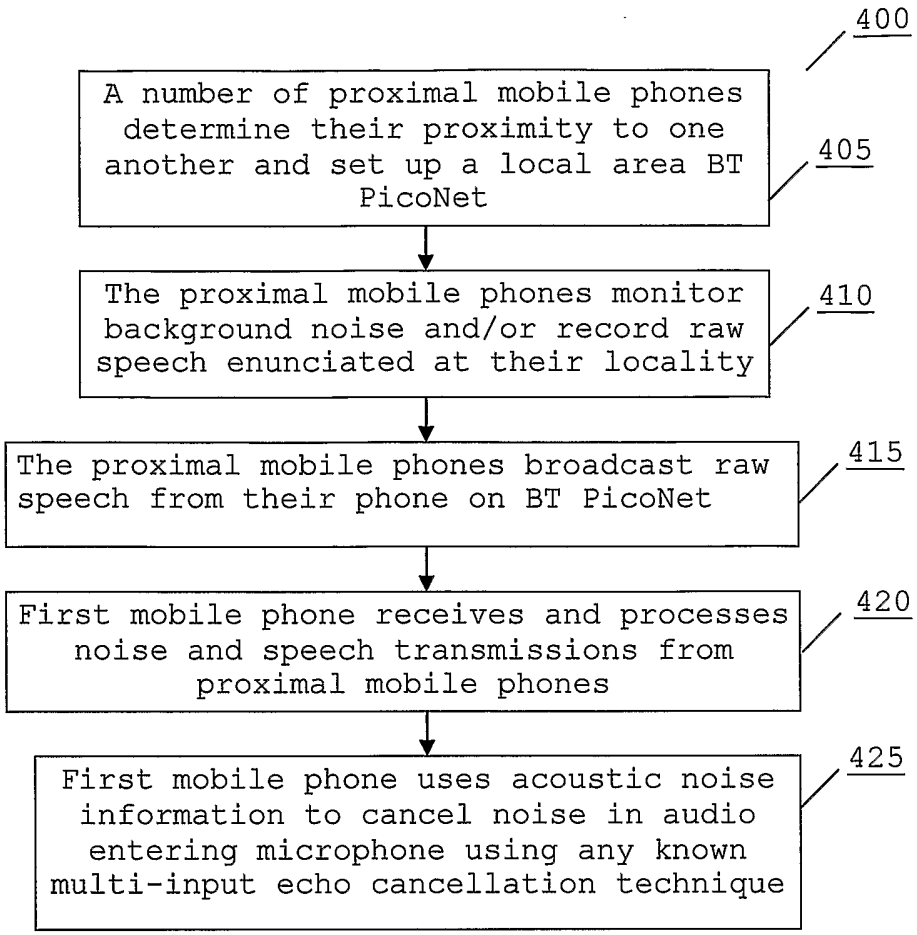

305
330
320
315
BT
PicoNet
335
310
325
Acoustic
Interference
335
BT
PicoNet

FIG. 3

FIG. 4


400
A number of proximal mobile phones determine their proximity to one another and set up a local area BT PicoNet
405
The proximal mobile phones monitor background noise and/or record raw speech enunciated at their locality
410
The proximal mobile phones broadcast raw speech from their phone on BT PicoNet
415
First mobile phone receives and processes noise and speech transmissions from proximal mobile phones
420
First mobile phone uses acoustic noise information to cancel noise in audio entering microphone using any known multi-input echo cancellation technique
425

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/014907

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G10L21/02 H04B1/12 H04M1/19

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G10L H04B H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ANONYMOUS: "Noise cancellation by source subscription" RESEARCH DISCLOSURE, KENNETH MASON PUBLICATIONS, HAMPSHIRE, GB, vol. 442, no. 98, February 2001 (2001-02), XP007127657 ISSN: 0374-4353 the whole document	1-18
A	US 2003/228023 A1 (BURNETT GREGORY C ET AL) 11 December 2003 (2003-12-11) abstract paragraph '0047! figure 1	1-18

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
27 April 2005	24/05/2005

Name and mailing address of the ISA	Authorized officer
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Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2004/014907

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 835 607 A (MARTIN ET AL) 10 November 1998 (1998-11-10) abstract column 3, lines 26-50 figures 1,2	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP2004/014907

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