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Sony Corporation,
Petitioner,

v.

One-E-Way, Inc.
Patent Owner.

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Title: Wireless Digital Audio System

EXHIBIT 1010

COMPARISON OF 2003 APPLICATION SPECIFICATION AS ORIGINALLY FILED AND ISSUED U.S. PATENT NO. 7,412,294

No. IPR2016-01638

On the following pages, the as-filed specification of U.S. App. No. 10/648,012, filed on Aug. 26, 2003 ("the 2003 specification") is compared to the U.S. Patent No. 7,412,294 ("the '294 patent") issued from that application. Blue text in square brackets appears in the '294 patent but not in the 2003 specification. Red text in strikeout appears in the 2003 specification but not in the '294 patent.

~~FUZZY AUDIO~~ WIRELESS ~~MUSIC~~
[DIGITAL AUDIO] SYSTEM

This [utility patent application] is a continuation-in-part of [U.S. patent] application Serial No. [10/027,391] ~~10/027,739~~ ~~which patent application is pending~~ [filed Dec. 21, 2001, now abandoned for "Wireless Digital Audio System," published under US 2003/0118196/A1 on Jun. 26, 2003, now abandoned, which is incorporated herein in its entirety by reference].

BACKGROUND OF THE INVENTION

[0001] This invention relates to [music]audio player devices and more particularly to systems that include headphone listening devices. The new audio [music] system uses [an] existing ~~audio player device~~ headphone ~~jacks~~ [jack (i.e., this is the standard analog headphone jack that connects to wired headphones) of a music audio player (i.e., portable CD player, portable cassette player, portable A.M./F.M. radio, laptop/desktop computer, portable MP3 player, and the like)] to connect a battery ~~10~~ powered transmitter for [digital] wireless transmission of a signal to a [set of] battery powered [receiver] ~~receiving~~ headphone[s].

[0002] Use of [music] audio headphones with [music] audio player devices such as ~~radio, tape players~~, [portable] CD players, [portable cassette players, portable A.M./F.M. radios, laptop/desktop computer, portable MP3 players] ~~and the computers, television audio~~ and the like, have been in use for [many] ~~may~~ years. These systems ~~usually~~ incorporate an audio source having ~~a~~ [an analog] headphone jack to which ~~a~~ headphone[s] may be connected by wire~~. and connector.~~

[0003] There are also known wireless headphones that may receive A.M.

and F.M. radio transmissions. However, [they] ~~these systems~~ do not allow use of a simple plug in [(i.e. plug in to the existing analog audio headphone jack)] battery powered transmitter for connection to any [music] audio player device jack, such as [the above mentioned music audio player devices, for coded] ~~laptop and desktop computers, portable compact disc players, portable MP3 players, portable cassette players and the like, for~~ wireless transmission and reception [by headphones] of audio music for private listening [without interference where] ~~to~~ multiple users occupying the same space [are operating wireless transmission devices]. Existing audio systems make use of electrical wire connections between the audio source and the headphones to accomplish private listening to multiple users.

[0004] There is a need for a battery powered simple connection system for existing [music] audio player devices [(i.e., the previously mentioned music devices)], to allow [coded digital]wireless transmission [(using a battery powered

transmitter)] to a headphone receiver [(using battery powered receiver headphones)] that accomplishes private listening to multiple users occupying the same space [without the use of wires].

SUMMARY OF THE INVENTION

[0005] The present invention is [generally] directed to [a wireless] ~~FAWM (Fuzzy Audio Wireless Music) systems for coded~~ digital [audio system for coded digital] transmission of an audio signal from any audio player [with an analog] ~~device with a~~ headphone jack to a receiver headphone [located away from the audio player. Fuzzy logic technology may be utilized by the system to enhance bit detection.]. ~~using fuzzy logic technology.~~ A battery-powered digital transmitter may include a headphone plug in communication with any [suitable music]~~of the previously mentioned~~ audio source.~~s, laptop and desktop computers, portable compact disc players, portable MP3 players, portable cassette players and the like.~~ [For reception, a battery-powered headphone receiver may use embedded fuzzy logic to enhance user code bit detection. Fuzzy logic detection may be used to enhance user code bit detection during decoding of the transmitted audio signal.] The [wireless digital] ~~FAWM system converts the~~ audio music signal [provides] ~~that may be supplied by the source, into a digital signal. This conversion takes place in the small battery powered transmitter that connects to the headphone jack of the source. The transmitter then adds a unique user code and transmits it to the battery powered receiver headphones where the fuzzy logic detector decodes only the unique user code to allow~~ private listening without interference from other users [or wireless devices and without the use of conventional cable connections.]

[0006] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[Some aspects of the present invention are generally shown by way of reference to the accompanying drawings in which:]

[FIG.] ~~Figure~~ 1 [schematically] illustrates a [wireless digital audio system in accordance with the present invention;] ~~schematic diagram representation of the FAWM system;~~

[FIG.] ~~Figure~~ 2 [is a block diagram of an audio transmitter portion of the wireless digital audio system of FIG. 1;] ~~illustrates a graph of the high and low bit fuzzy logic if-then part fuzzy set according to an embodiment of the invention.~~

[FIG. 3 is a block diagram of an audio receiver portion of the wireless digital audio system of FIG. 1; and

FIG. 4 is an exemplary graph showing the utilization of an embedded fuzzy logic coding algorithm according to one embodiment of the present invention.]

DETAILED DESCRIPTION

[0008] The following detailed description is the best currently contemplated modes for carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention.

[0009] Referring to [FIGS. 1 through 3, a wireless digital audio music] ~~Figure 1, a FAWM~~ system 10 may include a battery powered transmitter 20 connected to a portable [music] audio player or [music] audio source 80. The battery powered [wireless digital audio music] transmitter 20 [utilizes an analog to digital converter or ADC 32] and may be connected to the [music] audio source 80 [analog] headphone jack 82 using a headphone plug 22. The battery powered transmitter 20 may have a transmitting antenna 24 that may be omni-directional for transmitting [a spread spectrum]~~a coded digital~~ modulated signal to a receiving antenna 52 of a battery powered [headphone] receiver 50. ~~that may be a headphone receiver.~~ The battery powered receiver 50 may have headphone speakers [75]~~54~~ in headphones 55 for listening to the [spread spectrum] demodulated and decoded [communication]~~digital~~ signal. [In the headphone receiver 50, fuzzy logic detection may be used to optimize reception of the received user code.] The ~~FAWM~~ transmitter 20 may digitize the audio signal [using ADC 32]. ~~This digital~~ [The digitized] signal ~~has a throughput of approximately 1.4 Mbps, which~~ may be [processed downstream by an encoder 36. After digital conversion, the digital signal may be processed by a digital low pass filter.]~~determined by the analog to digital AID converter sampling rate of 44.1kHz multiplied by 16 bit quantization.~~ To reduce the effects of channel noise, the battery powered transmitter 20 may use [a channel encoder 38]. [A modulator 42 modulates the digital signal to be transmitted.]For further noise immunity, [a] spread spectrum [DPSK (differential phase shift key) transmitter or module 48 is] ~~modulation may be~~ utilized. The battery powered transmitter 20 may contain a ~~shift register~~ [code] generator [44](~~SRG~~) that may be used to create a unique user code. The unique user code generated is specifically associated with one [wireless digital audio system] ~~FAWM~~ user, and it is the only code recognized by the battery powered ~~FAWM~~ headphone receiver 50 [operated by a]~~of that~~ particular user. The radio frequency (RF) spectrum utilized (as taken from the Industrial, Scientific and Medical (ISM) band), may be approximately 2.4 GHz. ~~And~~ The power radiated by the transmitter adheres to the ISM standard.

[0010] [Particularly, the received spread spectrum signal may be communicated to a 2.4 GHz direct conversion receiver or module 56.] Referring to ~~Figure 1,~~ [FIGS 1 through 4,]the ~~digital~~ [spread spectrum]modulated signal from transmit antenna 24 may be received by receiving antenna 52 and then [processed by spread

spectrum direct conversion receiver or module 56 with a receiver code generator 60 that contains the same transmitted unique code, in the battery powered receiver 50 headphones. The transmitted signal from antenna 24 may be received by receiving antenna 52 and communicated to a wideband bandpass filter (BPF).] ~~demodulated, decoded and deinterleaved in the battery powered receiver 50 headphones.~~ The battery powered receiver 50 may utilize [embedded] fuzzy logic [61 (as graphically depicted in FIGS. 1, 4)] to optimize the [bit] detection of the received user code. [The down converted output signal of direct conversion receiver or module 56 may be summed by receiver summing element 58 with a receiver code generator 60 signal. The receiver code generator 60 may contain the same unique wireless transmission of a signal code word that was transmitted by audio transmitter 20 specific to a particular user. Other code words from wireless digital audio systems 10 may appear as noise to audio receiver 50. This may also be true for other device transmitted wireless signals operating in the wireless digital audio spectrum of digital audio system 10. This code division multiple access (CDMA) may be used to provide each user independent audible enjoyment. The resulting summed digital signal from receiving summary element 58 and direct conversion receiver or module 56 may be processed by a 64-Ary demodulator 62 to demodulate the signal elements modulated in the audio transmitter 20. A block de-interleaver 64 may then decode the bits of the digital signal encoded in the block interleaver 40. Following such, a Viterbi decoder 66 may be used to decode the bits encoded by the channel encoder 38 in audio transmitter 20. A source decoder 68 may further decode the coding applied by encoder 36.]

[0011] Each receiver [headphone] 50 user may be able to listen (privately) to high fidelity audio music, using any of the audio devices listed previously, without the use of wires, and without interference from any other receiver [headphone] 50 user [, even when operated with a shared space]. ~~Because of the~~ [The] fuzzy logic detection technique [61]used in the [receiver 50 could provide greater] ~~wireless digital audio system,~~ user separation through [optimizing] code division [in the headphone receiver.] ~~may be achieved.~~

[0012] The battery powered transmitter 20 sends the audio [music]information to the battery powered receiver 50 in digital packet format. ~~Each packet may consist of, at minimum, a start bit to indicate the beginning of a packet, the unique user code, the digitized audio information and a stop bit to indicate the end of a packet.~~ These packets may flow to create a digital bit stream rate of less than or equal to ~~1~~ [1.0]Mb/s.

[0013] The user code bits in each packet may [also] be received and detected by a fuzzy logic [detection sub-system 61 (as an option) embedded in headphone receiver 50 to optimize audio receiver performance.] ~~detector~~ For each consecutive packet received, ~~the~~ fuzzy logic ~~detector~~ [detection sub-system 61] may compute a conditional density with respect to the context and fuzziness of the user code vector, i.e., the received ~~user~~ code bits in each packet. [Fuzziness may describe the ambiguity of the high bit (1)/low bit (0 or −1) event in the received user code within the packet.] The fuzzy logic [detection sub-system 61 may measure the degree to which a high/low bit occurs in the user code vector, which produces a low probability of bit error in the presence of noise.] ~~detector is the key component to the FAWM system 10. Because the fuzzy logic detector enables the battery~~

~~powered FAWM receiver 50 to accurately detect the assigned user code in the presence of noise, which includes other FAWM users. Fuzziness may describe the ambiguity of the high (1)/low (0) bit event in the noisy received packet. Note that the fuzzy detector may measure the degree to which a high/low bit occurs in the user code vector, which produces a low probability of bit error in the presence of noise.~~ The fuzzy [logic detection sub-system 61] ~~detector~~ may use a set of if-then rules to map the user code bit inputs to validation outputs. These rules may be developed as if- then statements.

[0014] ~~The~~ Fuzzy logic [detection sub-system 61]~~detector~~ in ~~the~~ battery-powered [headphone] receiver 50 utilizes the if-then fuzzy set to map the received user code bits into two values; a low ~~(0)~~ [(0 or −1)] and a high (1). Thus, as the user code bits are received, the "if" rules map the signal bit energy to the fuzzy set low value to some degree and to the fuzzy set high value to some degree. ~~See Figure 2.~~ [FIG. 4 graphically shows that x-value -1 equals the maximum low bit energy representation and x-value 1 equals the maximum high bit energy representation.] Due to additive noise, ~~each~~ [the] user code bit ~~(bit~~ energy ~~x)~~ may have some membership to ~~a~~ low and high as represented in [FIG. 4]. ~~Figure 2. Therefore, the~~ [The] if-part fuzzy set may determine if each bit in the user code, for every received packet, has a greater membership to a high bit representation or a low bit representation. The more a user code bit energy~~, x~~ fits into the high or low representation, the closer its subsethood, i.e., a measure of the [membership] degree to which a set may be a subset of another set, may be to one. ~~Note that Figure 2 shows that -1 equals the maximum low bit energy representation and 1 equals the maximum high bit energy representation to illustrate that this design may utilize Manchester encoding/decoding schemes.~~

~~**(0015]** The received user code input bit in each packet may be:~~

~~x(i), where i = 1,2, ..., n is the set of all bits that make up the user code vector.~~

~~X(c), where c = 1, 2, ..., m represents each user assigned a unique user code.~~

~~So user X(1) has bit code [x(1) x (2) .....x(n)] and user X(m) has bit code [x(1) x (2) ....x(n)] which is different from user X(1).~~

~~**(0016]** Each x in X may activate a fuzzy "if" rule. The if-part sets may be conditional densities, so the fuzzy "if" rule activates to the degree p[x(i)IX(c)] p[X(c)]. which is the probability of the user code bits x given the user vector X multiplied by the probability of X.~~

~~**(0017]** The then-part fuzzy rule set may be indirectly dependent on the input bits x in X. The then-part set may be a weighted sum equal to p[x(i)] p[ylx(i), i = 1, 2, ...,n.~~

~~**[0018]** Which is the probability of the user bit vector x multiplied by the probability of y given the user bit vector x. Where y may be a number representation to define the correct user headset battery powered receiver 50~~

~~given the input bit set x(i), I = 1, 2, ...,n.~~

[0019] The if-then rule parts that make up the fuzzy logic [detection sub-system 61] ~~detector~~ must be followed by a defuzzifying operation. This operation reduces the [aforementioned] ~~output~~ fuzzy set to a [bit energy representation (i.e., −1 or 1) that is received by the transmitted packet. Fuzzy logic detection sub-system 61 may be used in battery-powered headphone receiver 50 to enhance overall system performance.] ~~single number that determines if the correct received user code bits within the transmitted packet have been detected. The defuzzifying operation may be implemented with the modal method, i.e., calculation of the value that has the highest membership in the fuzzy set. With the modal method a strategy of clarity may be applied in the event that some user code energy bit values have equally high membership. The clarity of a fuzzy set may be considered by weighting the conditional densities discussed previously. The weighting determines relative fuzziness of the user code energy bit (x) that gives a measure of the uncertainty of the unique user code vector. As a result, the fuzzy logic detector used in the battery powered headset receiver 50 greatly reduces the unique user code bit error probability. The fuzzy logic detector technique, combined with convolutional error detection and correction techniques, may enable the FAWM system 10 to operate in most any environment.~~

[The next step may process the digital signal to return the signal to analog or base band format for use in powering sneaker(s) 75. A digital-to-analog converter 70 (DAC) may be used to transform the digital signal to an analog audio signal. An analog low pass filter 72 may be used to filter the analog audio music signal to pass a signal in the approximate 20 Hz to 20 kHz frequency range and filter other frequencies. The analog audio music signal may then be processed by a power amplifier 74 that may be optimized for powering headphone speakers 75 to provide a high quality, low distortion audio music signal for audible enjoyment by a user wearing headphones 55. A person skilled in the art would appreciate that some of the embodiments described hereinabove are merely illustrative of the general principles of the present invention. Other modifications or variations may be employed that are within the scope of the invention. Thus, by way of example, but not of limitation, alternative configurations may be utilized in accordance with the teachings herein. Accordingly, the drawings and description are illustrative and not meant to be a limitation thereof.

Moreover, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms “comprises” and “comprising” should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Thus, it is intended that the invention cover all embodiments and variations thereof as long as such embodiments and variations come within the scope of the appended claims and their equivalents.]

[0020] ~~While the invention has been particularly shown and described with respect to the illustrated and preferred embodiments thereof, it will be understood~~

~~by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.~~

CLAIMS

I claim:

1. A ~~fuzzy audio~~ wireless [digital audio] ~~music~~ system ~~for wireless transmission of a signal from an audio source to a battery powered headphone receiver~~ comprising:

~~a headphone jack from an~~ [at least one] audio source [to produce an audio output]; ~~in communication with a connectable battery powered transmitter;~~

[at least one digital portable audio transmitter operatively coupled to said at least one audio source, said at least one portable audio transmitter comprising:]

[a first analog low pass filter receiving audio output from said at least one audio source;]

[a digital low pass filter;]

[an analog-to-digital converter (ADC) operatively coupled between said first analog and digital low pass filters;]

[a first encoder receiving output from said digital low pass filter and being configured to reduce intersymbol interference (ISI);]

[a second channel encoder operatively coupled to said first encoder and adapted to reduce transmission errors;]

[a digital modulator operatively coupled to said second channel encoder; and]

[a differential phase shift key (DPSK) module receiving output from said digital modulator and a unique user code bit sequence and being configured for direct sequence spread spectrum (DSSS) communication, said DPSK module transmitting a corresponding DSSS signal having said audio output and the unique user code bit sequence;]

[at least one portable audio receiver configured for digital wireless communication with said at least one portable audio transmitter and utilizing an embedded fuzzy logic detector wherein the fuzzy logic detector activates fuzzy logic rules and performs a defuzzification operation in response to a received user code to optimize digital signal processing, said at least one portable audio receiver comprising;]

[a band pass filter (BPF) configured to process said transmitted DSSS signal;]

[a direct conversion module receiving output from said BPF and being configured to capture the correct unique user code bit sequence embedded in said processed DSSS signal;]

[a digital demodulator adapted to process output from said direct conversion module;]

[a Viterbi decoder operatively coupled to said digital demodulator and generating a corresponding digital output;]

[a source decoder processing said digital output from said Viterbi decoder and being configured to decode the digital signal encoded by said first encoder;]

[a second analog low pass filter; and]

[a digital-to-analog converter (DAC) operatively coupled between said source decoder and said second analog low pass filter, said second analog low pass filter generating an audio output corresponding to the decoded and converted digital signal; and]

[at least one module adapted to reproduce said generated audio output, if the unique user code bit sequence is recognized, said audio output having been wirelessly transmitted from said at least one audio source without interference from other users or wireless devices when operated within a shared space containing multiple users of wireless devices utilizing code division multiple access (CDMA) communication.]

~~said connectable battery powered transmitter contains an AID converter wherein said AID converter converts an analog music audio signal to a digital signal at a signal rate of approximately 1.4 Mbps;~~

~~said AID converter in communication with a shift register generator, a convolutional encoder and an interleaver;~~

~~said interleaver in communication with a spread spectrum modulator;~~

~~said spread spectrum modulator in communication with a transmit antenna for wireless transmission of a coded digital signal to a receiving antenna at a radio frequency of approximately 2.4 GHz;~~

~~said receiving antenna in communication with a spread spectrum demodulator, a convolutional deinterleaver and a decoder; and~~

~~said decoder in communication with a fuzzy logic detector~~.

2. The ~~fuzzy audio~~ wireless [digital audio] ~~music~~ system ~~as in~~ [of] claim 1 wherein said [BPF is a wideband BPF.] ~~battery powered headphone receiver having said fuzzy logic detector with a detection method, comprising the steps of:~~

~~a) receiving a user code having:~~

~~x(i) where i = 1, 2, ..., n is the set of all bits that make up the user code vector;~~

~~X(c), where c = 1, 2, ..., m represents each user assigned unique user code;~~

~~Wherein user X(1) has bit code [x(1) x (2).... X(n)] and user X(m) has bit code [x(1) x(2) ... x(n)] which is different form X(1);~~

~~b) activating a fuzzy if rule based on each x in X wherein the if part sets are conditional densities to activate the if rule to the degree p[x(i)IX(c)] p[X(c)];~~

~~c) activating a fuzzy then rule indirectly dependent on each x in X wherein the then part sets are a weighted sum equal to p[x(i)]p[ylx(i)], i = 1,2, ..., n; and~~

~~d) performing a defuzzifying operation of modal type.~~

3. [The wireless digital audio system of claim 1, wherein said modulator is a 64-Ary modulator.] ~~A battery powered headphone receiver having a fuzzy logic detector method, comprising the steps of:~~

~~a) receiving a user code having:~~

~~x(i) where i = 1, 2, ..., n is the set of all bits that make up the user code vector;~~

~~X(c), where c = 1, 2, ..., m represents each user assigned unique user code;~~

~~wherein user X(1) has bit code [x(1) x (2).... X(n)] and user X(m) has bit code [x(1) x(2) ... x(n)] which is different form X(1);~~

~~b) activating a fuzzy if rule based on each x in X wherein the if part sets are conditional densities to activate the if rule to the degree p[x(i)IX(c)] p[X(c)];~~

~~c) activating a fuzzy then rule indirectly dependent on each x in X wherein the then part sets are a weighted sum equal to p[x(i)]p[ylx(i)], i = 1,2, ..., n; and~~

d) performing a defuzzifying operation of modal type.

4. [The wireless digital audio system of claim 1, wherein said demodulator is a 64-Ary demodulator.] A method for battery powered digital wireless transmission and reception of high fidelity audio music between a battery operated transmitter and a battery operated receiver comprising the step of:

connecting a headphone plug attached to said battery operated transmitter to a headphone jack of an audio source;

converting an music audio signal to a digital signal using an AID converter having a sampling rate of approximately 44.1 kHz multiplied by 16 bit quantization to produce a signal rate of approximately 1.4 Mbps;

encoding the digital signal using a convolutional encoding and interleaving method;

creating a spread spectrum signal using a shift register generator to modulate a unique user code;

transmitting said spread spectrum signal at a radio frequency of approximately 2.4 GHz at a power level that adheres to the ISM standard for reception at a distance of up to approximately 10 feet from said battery operated transmitter;

receiving said spread spectrum signal at said battery operated receiver headphones;

demodulating said spread spectrum signal and optimal bit detecting of said unique user code using fuzzy logic technology;

convolutional decoding and deinterleaving to receive said digital signal;

converting said digital signal to said analog music audio signal; and

communication said analog music audio signal to a headphone speaker.

5. [The wireless digital audio system of claim 1, wherein said generated audio output is in the approximate range of 20 Hz to 20 kHz.] The battery powered receiver headphone as in claim 4 wherein said receiver having a fuzzy logic detector method comprising the steps of:

~~a) receiving a user code having:~~

~~x(i) where I = 1, 2, ..., n is the set of all bits that make up the user code vector;~~

~~X(c), where c = 1, 2, ..., m represents each user assigned uniue user code~~

~~Wherein user X(1) has bit code [x(1) x (2).... X(n)] and user X(m) has bit code [x(1) x(2) ... x(n)] which is different form X(i);~~

~~b) activating a fuzzy if rule based on each x in X wherein the if part sets are conditional densities to activate the if rule to the degree p[x(i)IX(c)] p[X(c)];~~

~~c) activating a fuzzy then rule indirectly dependent on each x in X wherein the then part sets are a weighted sum equal to p[x(i)]p[ylx(i)], i = 1,2, ..., n; and~~

~~d) performing a defuzzifying operation of modal type.~~

[6. The wireless digital audio system of claim 1, wherein said spread spectrum signal is transmitted at about 2.4 GHz via an omni-directional antenna.]

[7. The wireless digital audio system of claim 6, wherein said spread spectrum signal is transmitted at a power of about 100 milliwatts or less.]

[8. The wireless digital audio system of claim 1, wherein said ADC is a 4-bit analog-to-digital converter.]

[9. The wireless digital audio system of claim 1, wherein said BPF is operatively coupled to at least one antenna configured to receive said transmitted DSSS signal.]

[10. A wireless digital audio system, comprising:

at least one audio source;

at least one portable digital audio transmitter operatively coupled to said at least one audio source, said at least one portable digital audio transmitter comprising;

a first analog low pass filter receiving audio output from said at least one audio source;

a digital low pass filter;

an analog-to-digital converter (ADC) operatively coupled between said first analog and digital low pass filters;

a first encoder receiving output from said digital low pass filter and being configured to reduce intersymbol interference (ISI);

a second channel encoder operatively coupled to said first encoder and adapted to reduce transmission errors;

a digital modulator operatively coupled to said second channel encoder; and

a differential phase shift key (DPSK) module receiving output from said digital modulator and a unique user code and being configured for direct sequence spread spectrum (DSSS) communication, said DPSK module transmitting a corresponding DSSS signal;

at least one audio receiver configured for digital wireless communication with said at least one portable digital audio transmitter and utilizing embedded fuzzy logic detector wherein the fuzzy logic detector activates fuzzy logic rules and performs a defuzzification operation in response to a received unique user code to enhance detection of the unique user code in said transmitted DSSS signal, said at least one audio receiver comprising:

a band pass filter (BPF) configured to process said transmitted DSSS signal;

a direct conversion module receiving output from said BPF and being configured to capture the correct bit sequence embedded in the received DSSS signal;

a digital demodulator adapted to process output from said direct conversion module;

a Viterbi decoder operatively coupled to said digital demodulator and generating a corresponding digital output;

a source decoder processing said digital output from said Viterbi decoder and being configured to decode the digital signal encoded by said first encoder;

a second analog low pass filter; and

a digital-to-analog converter (DAC) operatively coupled between said source decoder and said second analog low pass filter, said second analog low pass filter generating the audio output;

at least one module adapted to reproduce said amplified audio output, if the unique user code is recognized, said audio output having been wirelessly transmitted from said at least one audio source to a user privately without interference from other users or wireless devices when operated in a shared space containing multiple users of wireless devices utilizing code division multiple access (CDMA) communication.]

[11. The wireless digital audio system of claim 10, wherein said at least one audio amplifying module includes at least one power amplifier, said at least one power amplifier being configured to provide a low distortion audio signal output.]

[12. The wireless digital audio system of claim 11, wherein said at least one audio reproducing module includes at least one headphone speaker, said at least one headphone speaker receiving said low distortion audio signal output from said at least one power amplifier.]

[13. A wireless digital audio system, comprising:

at least one audio source;

at least one digital audio transmitter operatively coupled to said at

least one audio source, said at least one audio transmitter comprising:

a first analog low pass filter receiving audio output representative of music from said at least one audio source;

a digital low pass filter;

an analog-to-digital converter (ADC) operatively coupled between said first analog and digital low pass filters;

a first encoder receiving output from said digital low pass filter and being configured to reduce intersymbol interference (ISI);

a second channel encoder operatively coupled to said first encoder and adapted to reduce transmission errors;

a digital modulator operatively coupled to said second channel encoder; and

a differential phase shift key (DPSK) module receiving output from said digital modulator and a unique user code bit sequence and being configured for direct sequence spread spectrum (DSSS) communication, said DPSK module transmitting a corresponding DSSS signal;

at least one audio receiver configured for digital wireless communication with said at least one audio transmitter, said at least one audio receiver comprising:

an embedded fuzzy logic detector wherein the fuzzy logic detector activates fuzzy logic rules and performs a defuzzification operation in response to a received unique user code to enhance detection of the unique user code;

a band pass filter (BPF) configured to process said transmitted DSSS signal;

a direct conversion module receiving output from said BPF and being configured to capture the correct unique user code bit sequence embedded in the received DSSS signal;

a digital demodulator adapted to process output from said direct conversion module;

a Viterbi decoder operatively coupled to said digital demodulator and generating a corresponding digital output;

a source decoder processing said digital output from said Viterbi decoder and being configured to decode the digital signal encoded by said first encoder;

a second analog low pass filter; and

a digital-to-analog converter (DAC) operatively coupled between said source decoder and said second analog low pass filter, said second analog low pass filter generating an audio output corresponding to the decoded and converted digital signal; and

at least one module adapted to reproduce said generated audio output, if the unique user code bit sequence is recognized, said audio output having been wirelessly transmitted from said at least one audio source to a user privately without interference from other users or wireless devices when operated in a shared space containing multiple users of wireless transmission devices.]

[14. A wireless digital audio system, comprising:

a least one audio source;

at least one digital audio transmitter operatively coupled to said at least one audio source, said at least one audio transmitter comprising:

a first analog low pass filter receiving audio output from said at least one audio source;

a digital low pass filter;

an analog-to-digital converter (ADC) operatively coupled between said first analog and digital low pass filters;

a first encoder receiving output from said digital low pass filter and being configured to reduce intersymbol interference (ISI);

a second channel encoder operatively coupled to said first encoder and adapted to reduce transmission errors;

a digital modulator operatively coupled to said second channel encoder, and

a differential phase shift key (DPSK) module receiving output from said digital modulator and a unique user code and being configured for direct sequence spread spectrum (DSSS) communication, said DPSK module transmitting a corresponding DSSS signal;

at least one audio receiver configured for digital wireless communication with said at least one audio transmitter, said at least one audio receiver comprising;

an embedded fuzzy logic detector wherein the fuzzy logic detector activates fuzzy logic rules and performs a defuzzification operation in response to a received unique user code to enhance detection of the unique user code;

a band pass filter (BPF) configured to process said transmitted DSSS signal;

a direct conversion module receiving output from said BPF and being configured to capture the correct unique user code bit sequence embedded in the received DSSS signal;

a digital demodulator adapted to process output from said direct conversion module;

a Viterbi decoder operatively coupled to said digital demodulator and generating a corresponding digital output;

a source decoder processing said digital output from said Viterbi decoder and being configured to decode the digital signal encoded by said first encoder;

a second analog low pass filter; and

a digital-to-analog converter (DAC) operatively coupled between said source decoder and said second analog low pass filter, said second analog low pass filter generating an audio output corresponding to the decoded and converted digital signal;

at least one module adapted to amplify said generated audio output; and

at least one module adapted to reproduce said amplified audio output, if the unique user code is recognized, said audio output having been wirelessly transmitted from said at least one audio source to a user without interference from other users or wireless devices when operated in a shared space containing multiple users of wireless transmission devices.]

[15. The wireless digital audio system of claim 13, wherein said at least one audio source provides analog output in the approximate range of 20 Hz to 20 kHz.]

[16. The wireless digital audio system of claim 14, wherein said at least one audio source provides analog output in the approximate range of 20 Hz to 20 kHz.]

[17. The wireless digital audio system of claim 13, wherein said at least one audio source is a portable music player.]

[18. The wireless digital audio system of claim 14, wherein said at least one audio source is a portable music player.]

[19. A wireless digital audio system, comprising: an audio source to provide an audio signal representative of music;

a portable digital audio transmitter operatively coupled to said audio source, said portable audio transmitter comprising;

a first analog low pass filter receiving audio output from said audio source; a digital low pass filter;

an analog-to-digital converter (ADC) operatively coupled between said first analog and digital low pass filters;

a first encoder receiving output from said digital low pass filter and being configured to reduce intersymbol interference (ISI);

a second channel encoder operatively coupled to said first encoder and adapted to reduced transmission errors;

a digital modulator operatively coupled to said second channel encoder; and

a differential phase shift key (DPSK) module receiving output from said digital modulator and being configured for code division multiple access (CDMA) communication, said DPSK module transmitting a corresponding CDMA signal with a unique user code;

an audio receiver configured for digital wireless communication with said portable digital audio transmitter and utilizing an embedded fuzzy logic detector wherein the fuzzy logic detector activates fuzzy logic rules and performs a defuzzification operation in response to a received unique user code to enhance detection of the unique user code, said audio receiver comprising;

a band pass filter (BPF) configured to process said transmitted CDMA signal;

a direct conversion module receiving output from said BPF and being configured to capture the correct bit sequence embedded in the received spread spectrum signal;

a digital demodulator adapted to process output from said direct

conversion module;

a Viterbi decoder operatively coupled to said digital demodulator and generating a corresponding digital output;

a source decoder processing said digital output from said Viterbi decoder and being configured to decode the digital signal encoded by said first encoder;

a second analog low pass filter; and

a digital-to-analog converter (DAC) operatively coupled between said source decoder and said second analog low pass filter, said second analog low pass filter generating an audio output corresponding to the decoded and converted digital signal; and at least one module adapted to reproduce said generated audio output, said audio having been wirelessly transmitted from said audio source free from interference from multiple CDMA transmission sources and other device transmitted signals operating in the wireless digital audio system spectrum to a user providing a particular said audio receiver headphone user with independent audio in a shared space with other wireless digital audio system users, wherein each of said wireless digital audio system users utilize an independent portable transmitter and headphone receiver.]

~~FUZZY AUDIO~~ WIRELESS [DIGITAL AUDIO] ~~MUSIC~~ SYSTEM

ABSTRACT OF THE DISCLOSURE

[0021] **[A]**~~The fuzzy audio~~ wireless [digital audio] ~~music~~ system [includes a portable audio source with a digital audio transmitter operatively coupled thereto and an audio receiver operatively coupled to a headphone set. The audio receiver is configured for digital wireless communication with the audio transmitter. The digital audio receiver utilizes fuzzy logic to optimize digital signal processing. Each of the digital audio transmitter and receiver is configured for code division multiple access (CDMA) communication. The wireless digital audio system allows private audio enjoyment without interference from other users of independent wireless digital transmitters and receivers sharing the same space.] ~~may utilize a battery powered transmitter to transmit a coded digital signal from an audio player device or source to a battery powered headphone receiver without the use of wires. A battery powered digital transmitter may include a headphone plug in communication with any audio source, such as, laptop and desktop computers, portable compact disc players, portable MP3 players, portable cassette players, etc. The battery powered transmitter adds a unique user code and transmits it to the battery powered receiver headphones where a fuzzy logic detector decodes only the unique user code to allow private listening without interference from other users.~~