UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

Sony Corporation,
Petitioner,

v.

One-E-Way, Inc.
Patent Owner.

Patent No. 9,282,396

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Title: Wireless Digital Audio System

EXHIBIT 1008

COMPARISON OF 2001 APPLICATION SPECIFICATION AND 2003 APPLICATION SPECIFICATION AS ORIGINALLY FILED

No. IPR2016-01638

On the following pages, the as-filed specification of U.S. App. No. 10/027,391, filed on Dec. 21, 2001 ("the 2001 specification") is compared to the as-filed specification of U.S. App. No. 10/648,012, filed on Aug. 26, 2003 ("the 2003 specification"). Blue text in square brackets appears in the 2003 specification but not in the 2001 specification. Red text in strikeout appears in the 2001 specification but not in the 2003 specification.

FUZZY AUDIO WIRELESS ~~DIGITAL AUDIO~~ MUSIC SYSTEM

This is a continuation-in-part of application Serial No. 10/027,739 which patent application is pending

BACKGROUND OF THE INVENTION

[0001] This invention relates to audio player devices and more particularly to systems that include headphone listening devices. The new audio system uses existing audio player device headphone jacks to connect a [battery powered] transmitter for wireless transmission of a signal to a [battery powered] receiving headphone.

[0002] Use of audio headphones with audio player devices such as radio, tape players, CD players, computers, television audio and the like have been in use for many years. ~~Such use includes the portable player systems such as cassette tape players that may be used during exercising as for example running.~~ These systems usually incorporate an audio source having a headphone jack to which a headphone ~~is~~ [may be] connected by wire and connector.

[0003] There are also known wireless headphones that may receive [A.M. and F.M.] radio transmissions. ~~Also, audio player devices have been modified to allow wireless communication with a headphone receiver.~~ However, these systems do not allow use of a simple plug in [battery powered] transmitter for connection to ~~the~~ [any] audio player device jack [such as, laptop and desktop computers, portable compact disc players, portable MP3 players, portable cassette players and the like] for wireless transmission [and reception of audio music for private listening to multiple users occupying the same space. Existing audio systems make use of electrical wire connections between the audio source and the headphones to accomplish private listening to multiple users] ~~between space separated devices~~.

[0004] ~~As can be seen,~~ There is a need for a [battery powered] simple connection system for existing audio player devices, to allow wireless transmission to a headphone receiver [that accomplishes private listening to multiple users occupying the same space].

SUMMARY OF THE INVENTION

[0005] The present invention is directed to ~~wireless digital audio~~ [FAWM (Fuzzy Audio Wireless Music)] systems for [coded digital] transmission of ~~a~~ [an audio] signal from ~~any~~ audio player device [with a] headphone [jack] to a [receiver] headphone~~. An audio~~ [using fuzzy logic technology.] ~~An audio~~ [A battery powered digital] transmitter may include a headphone plug in

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communication with ~~an analog low pass filter wherein the headphone plug may be connectable to a headphone jack of an audio source. The low pass filter output signal may be in communication with an A/D converter whose output may be in communication with a digital low pass filter that outputs a signal to an encoder. The encoder output may be in communication with a channel encoder the output of which may be in communication with a block interleaver. The block interleaver output may be in communication with a modulator the output of which may be summed with a transmitter code generator output in a summating element. The modulator may be a 64 Ary modulator. The summating element output may be in communication with a differential phase shift key transmitter the output of which may be in communication with a transmit antenna for wireless transmission of a signal. The transmitted signal may be transmitted to an audio receiver for processing to power a headphone speaker.~~ [any of the previously mentioned audio sources, laptop and desktop computers, portable compact disc players, portable MP3 players, portable cassette players and the like. The FAWM system converts the audio music signal 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 inference from other users.]

[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

[0007] Figure 1 illustrates a schematic diagram representation of the ~~wireless digital audio~~ [FAWM] system;

[0008] Figure 2 illustrates a ~~functional block diagram of the audio transmitter~~ [graph of the high and low bit fuzzy logic if-then part fuzzy set] according to an embodiment of the invention;

[0009] ~~Figure 3 illustrates a functional block diagram of the audio receiver according to an embodiment of the invention~~.

DETAILED DESCRIPTION

[0010] 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.

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[0011] Referring to Figure 1, a ~~wireless digital audio~~ [FAWM] system 10 may include ~~an audio~~ [a battery powered] transmitter 20 connected to ~~an~~ [a portable] audio player or audio source 80. The ~~audio~~ [battery powered] transmitter 20 may be connected to the audio source 80 headphone jack 82 using a headphone plug 22. The ~~audio~~ [battery powered] transmitter 20 may have a transmitting antenna 24 that may be omni-directional for transmitting ~~an electromagnetic~~ [a coded digital modulated] signal to a receiving antenna 52 of ~~an audio~~ [a battery powered] receiver 50 that may be a headphone receiver. The ~~audio~~ [battery powered] receiver 50 may have headphone speakers 54 in headphones 55 for listening to the ~~audio~~ [demodulated and decoded digital] signal. The ~~audio system 10~~ [FAWM transmitter 20] may digitize the audio signal ~~and may transmit an electromagnetic signal at 2.4 GHz using approximately 100 milliwatts or less of power.~~ [This digital signal has a throughput of approximately 1.4 Mbps, which may be determined by the analog to digital A/D 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 convolutional encoding and interleaving. For further noise immunity, spread spectrum modulation may be utilized. The battery powered transmitter 20 may contain a shift register generator (SRG) that may be used to create a unique user code. The unique user code generated is specifically associated with one FAWM user, and it is the only code recognized by the battery powered FAWM headphone receiver 50 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.]

[0012] ~~Referring to Figure 2, an audio transmitter 20 may receive an audio signal from an audio source 80. The audio transmitter 20 may be a compact device that may be connected to the audio source 80 to remain therewith for transmitting a signal to an audio receiver. An audio source 80 normally provides an analog output signal in the approximate range of 20 Hz to 20 kHz. This signal may then be processed through an analog low pass filter 30 to then be digitized by a 4 bit analog-to-digital (A/D) converter 32. After digital conversion of the analog audio signal, the digital signal may be processed by a digital low pass filter 34 to reduce unwanted out of band noise that may have been produced by the A/D converter 32.~~

[0013] ~~An encoder 36 may be used to reduce intersymbol interference (ISI) by using a transform code to encode the digital signal. The reduction of ISI may lower the probability of a signal detection error in the audio receiver. The digital signal may next be processed by a channel~~

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~~encoder 38 and a block interleaver 40 to produce encoded redundancies in the transmitted signal to reduce errors that may occur during transmission~~.

[0014] ~~Modulation of the digital signal may be performed using direct sequence spread spectrum communication technology. A 64-Ary modulator.42 may be used for summation at summation element 46 with a transmitter code generator 44 signal to produce a high symbol rate, and a unique codeword that spreads the signal spectrum. The output of the summation element 46 may then be communicated to a differential phase shift key (DPSK) transmitter 48 that modulates the digital signal to be transmitted by an omni-directional transmitting antenna 24 at approximately 2.4 GHz. The transmit power may be limited to 100 milliwatts.~~

[0015] ~~The transmitted~~ [Referring to Figure 1, the digital modulated] signal from transmit antenna 24 may be received by receiving antenna 52 and [then demodulated, decoded and deinterleavered in the battery powered receiver 50 headphones. The battery powered receiver 50 may utilize fuzzy logic to optimize the detection of the received user code]~~. communicated to a wideband band pass filter (BPF) 54. The received spread spectrum signal may then be communicated to a 2.4 GHz direct conversion receiver 56. The direct conversion receiver 56 may provide a method for down converting the received signal while utilizing timing and synchronization to capture the correct bit sequence embedded in the received spread spectrum signal. The audio receiver 50 may utilize fuzzy logic (or continuous logic) to optimize performance of the audio receiver 50.~~

[Each receiver 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 50 user. Because of the fuzzy logic detection technique used in the wireless digital audio system, user separation through code division may be achieved.]

[The battery powered transmitter 20 sends the audio 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 less than or equal to 1 Mb/s.]

[The user code bits in each packet may be received and detected by a fuzzy logic detector in the headset receiver 50. For each consecutive packet received, the fuzzy logic detector may compute a conditional density with respect to the context and fuzziness of the user code vector,

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i.e., the received user code bits in each packet. The fuzzy logic 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 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.]

[The fuzzy logic detector in the battery powered receiver 50 utilizes the if-then fuzzy set to map the received user code bits into two values; a low (0) 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. Due to additive noise each user code bit (bit energy x) may have some membership to a low and high as represented in Figure 2. Therefore, 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 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.]

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).]

[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.]

[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[y1x(i), i = 1, 2, ….,n.]

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[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), l = 1, 2, …..,n.]

[The if-then rule parts that make up the fuzzy logic detector must be followed by a defuzzifying operation. This operation reduces the output fuzzy set to a 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.]

[0016~~] The down converted output signal of the direct conversion receiver 56 may be summed in receiver summing element 58 with a receiver code generator 60 signal. The receiver code generator 60 may contain the same unique code word that was transmitted by the audio transmitter 20 specific to a particular a user. Other code words from wireless digital audio systems 10 may appear as noise to a particular audio receiver 50. This may also be true for other device transmitted signals operating in the wireless digital audio system 10 spectrum. This code division multiple access (CDMA) may be used to provide each user independent operation.~~

~~[0017] The resulting summed digital signal from receiving summary element 58 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 the audio transmitter 20. A source decoder 68 may further decode the coding applied by the encoder 36. The resultant processed digital signal may~~

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~~thereby be condition to represent the original signal processed and transmitted by the audio transmitter 20.~~

~~[0018] The next step may process the digital signal to return the signal to analog or base band format for use in powering a speaker 54. 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 signal to pass a signal in the approximate 20 Hz to 20kHz frequency range and filter other frequencies. The analog audio signal may then be processed by a power amplifier 74 that may be optimized for powering a headphone speaker 54 to optimize a high quality, low distortion signal for hearing by a user wearing the headphones 55.~~

[0019] 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.

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

ABSTRACT OF THE DISCLOSURE

[0020] [The fuzzy] ~~The present invention is directed to wireless digital~~ audio [wireless music] system~~s~~ [may utilize a battery powered] ~~for transmission of a signal from an audio player device to a headphone. An audio~~ transmitter [to transmit a coded digital signal from an audio player device or source to a battery powered] ~~may include a~~ 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.] ~~plug in communication with an analog low pass filter wherein the headphone plug may be connectable to a headphone jack of an audio source. The low pass filter output signal may be in communication with an A/D converter whose output may be in communication with a digital low pass filter that outputs a signal to an encoder. The encoder output may be in communication with a channel encoder the output of which . may be in communication with a block interleaver. The block interleaver output may be in communication with a modulator the output of which may be summed with a transmitter code generator output in a summating element. The modulator may be a 64 Ary modulator. The summating element output may be in communication with a differential phase shift key transmitter the output of which may be in communication with a transmit antenna for wireless transmission of a signal. The transmitted signal may be transmitted to an audio receiver for processing to power a headphone speaker. It is emphasized that this abstract is provided to comply with the rules requiring an abstract that will allow a searcher, or other reader to quickly ascertain the subject matter of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.~~

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