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(54) **AUTOMATIC DIGITAL MUSIC LIBRARY BUILDER**

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(58) **Field of Classification Search**

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See application file for complete search history.

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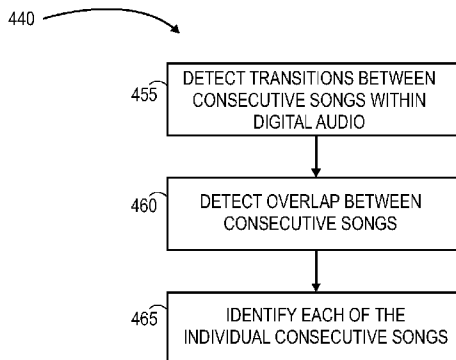
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(57) **ABSTRACT**

A digital music library builder including a casing, a receiver socket on the casing through which analog audio is received, an analog-to-digital converter housed within the casing for converting analog audio into digital audio, a meta-data identifier housed within the casing for identifying meta-data for a song, and a database manager housed within the casing for associating the identified meta-data with the song, within a digital music library.

15 Claims, 22 Drawing Sheets



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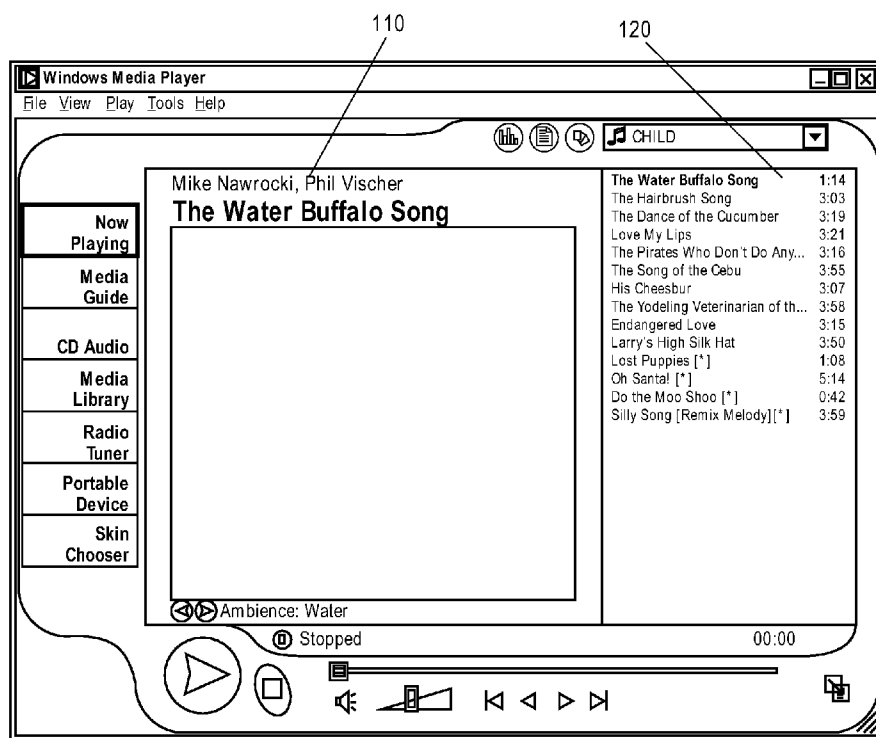


FIG. 1

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**Music
Choice '80s**



Song:
LIKE A VIRGIN
Artist:
MADONNA
Album:
LIKE A VIRGIN

HELLO
my name is

Madonna was
born Madonna
Louise Ciccone

Check out the Showcase channel for

STYX&REO

SPEEDWAGON



FIG. 2

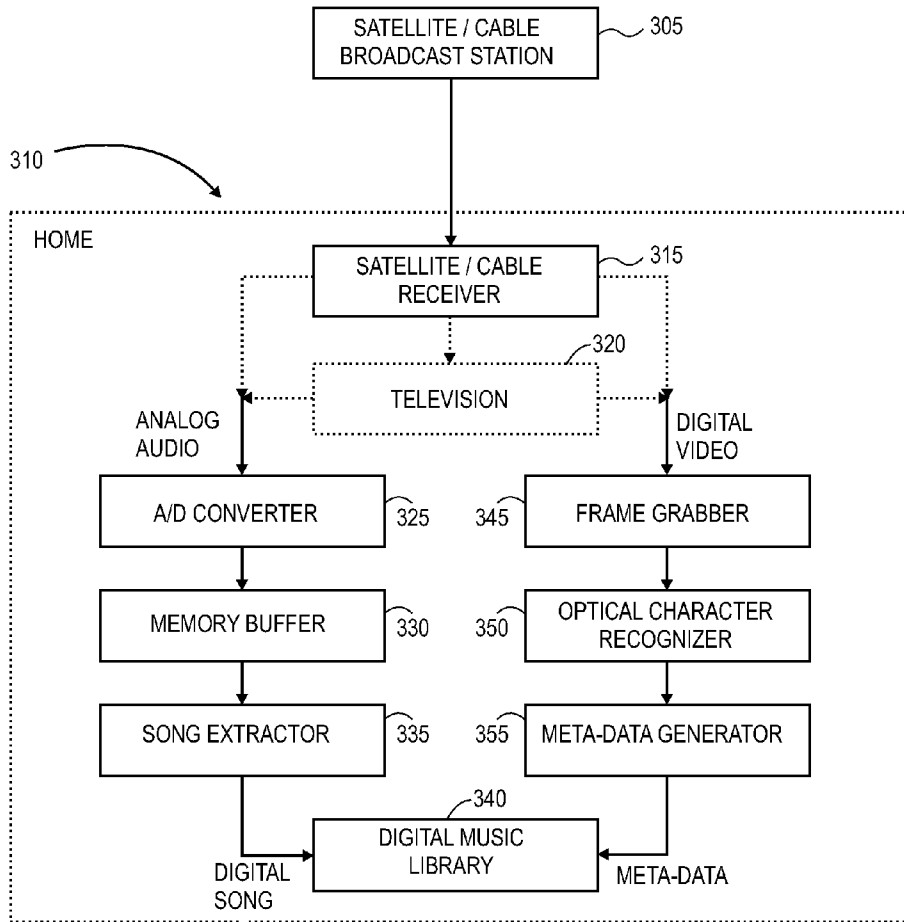


FIG. 3

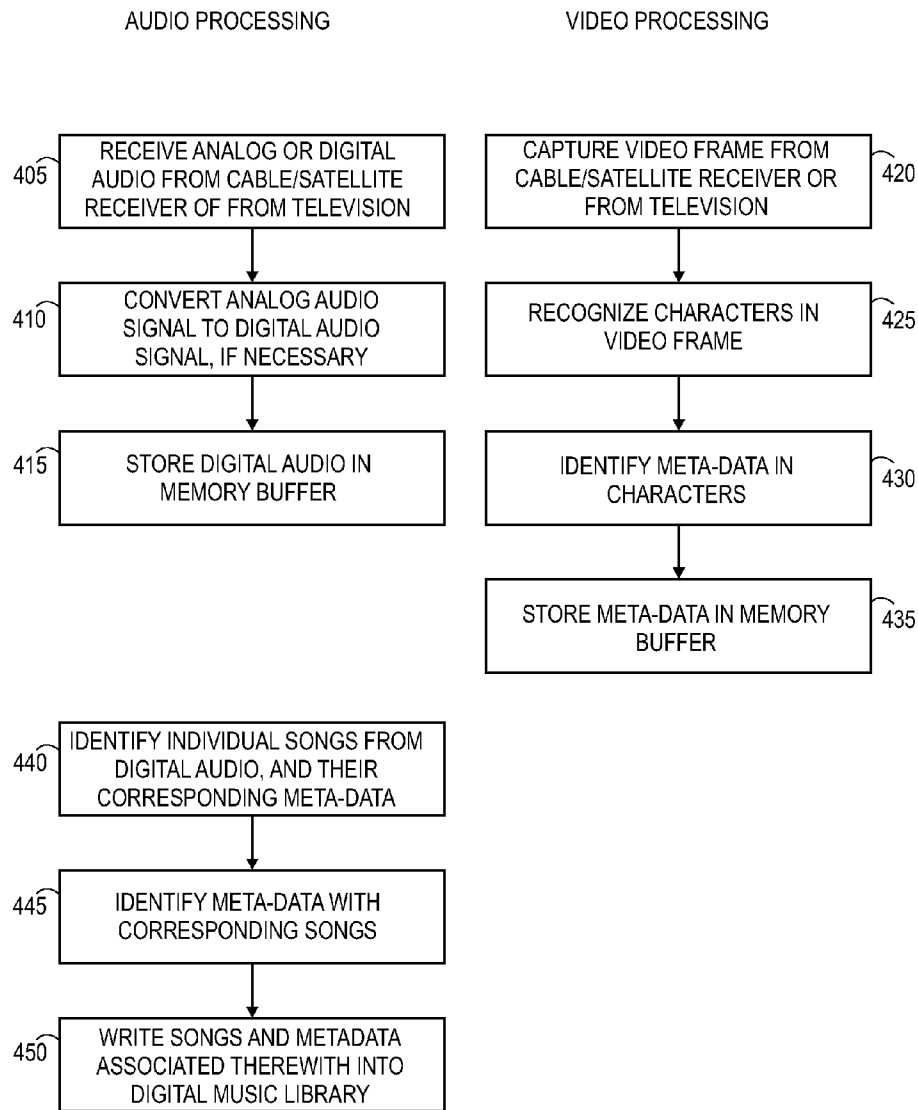


FIG. 4A

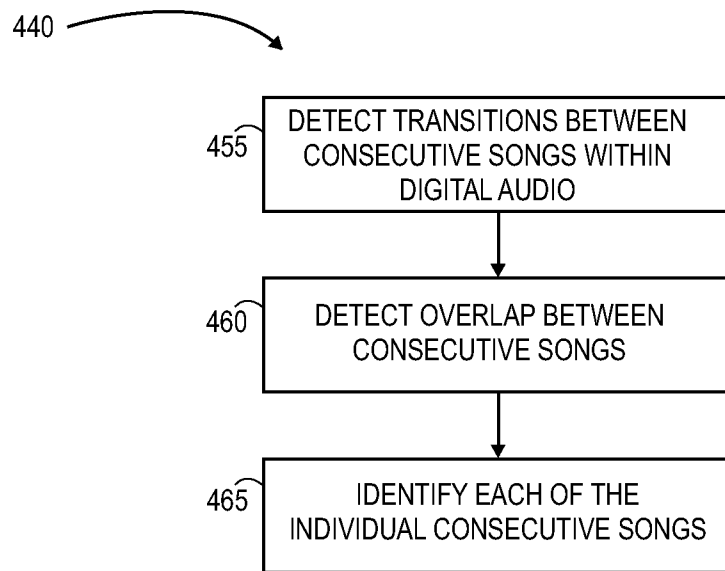


FIG. 4B

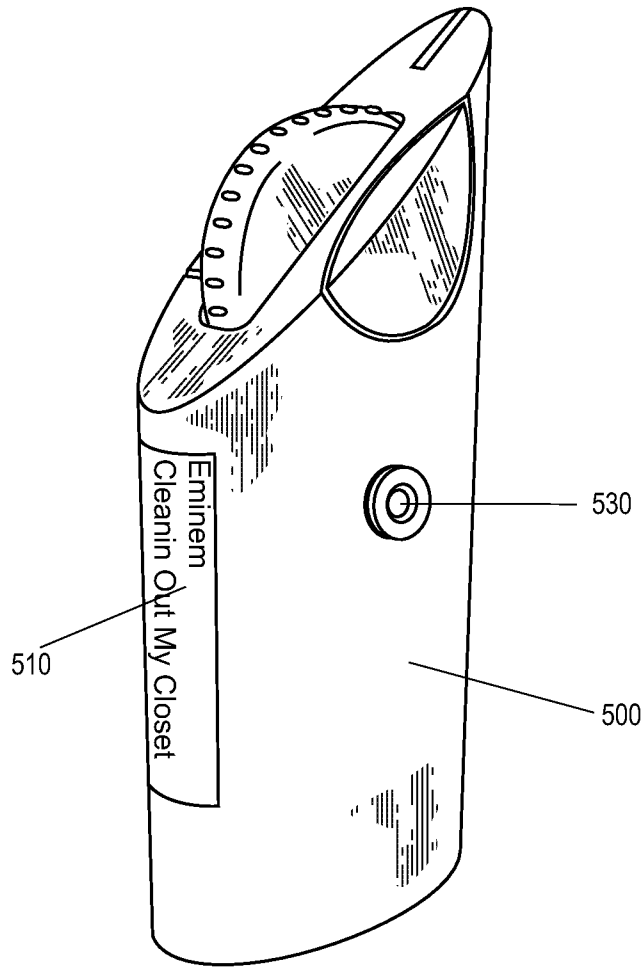


FIG. 5

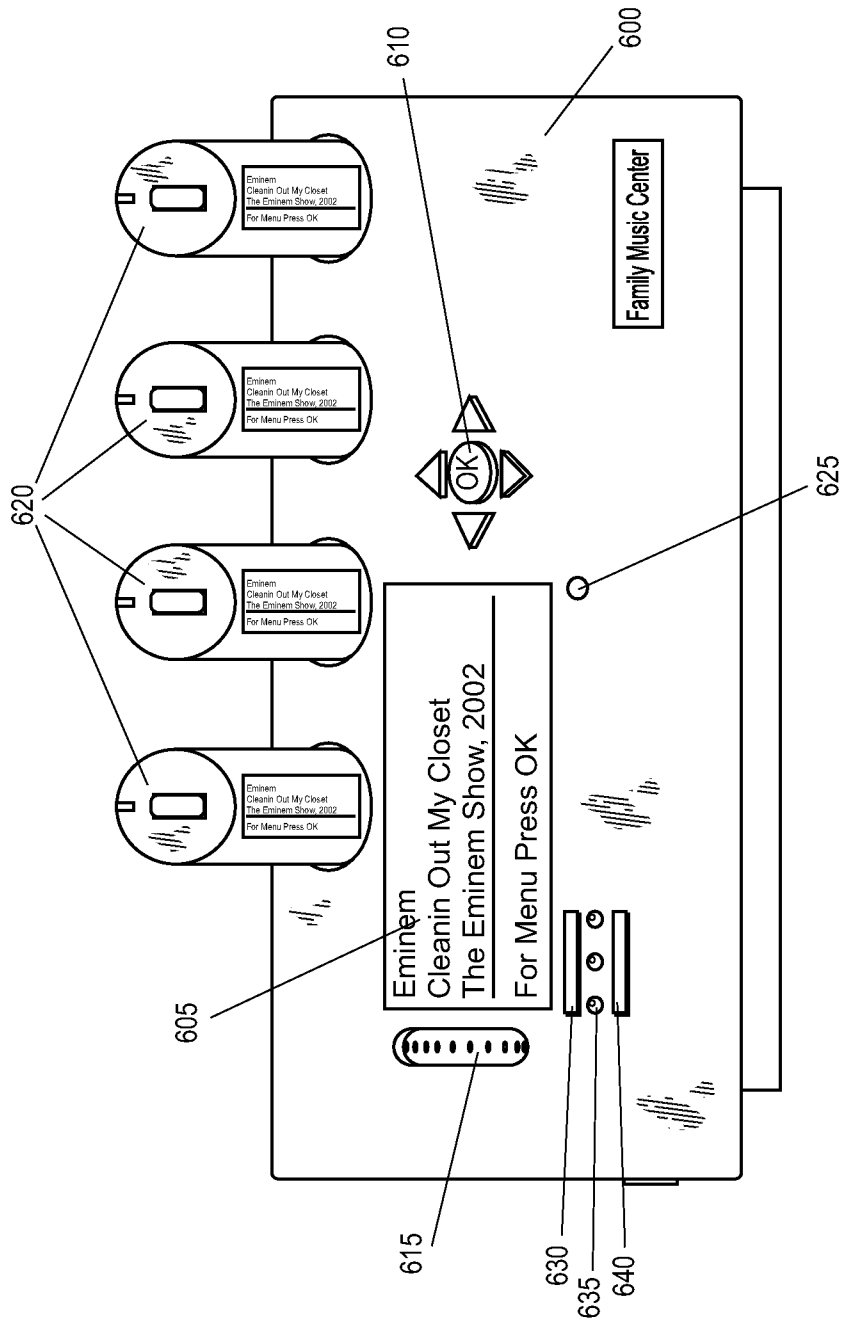


FIG. 6A

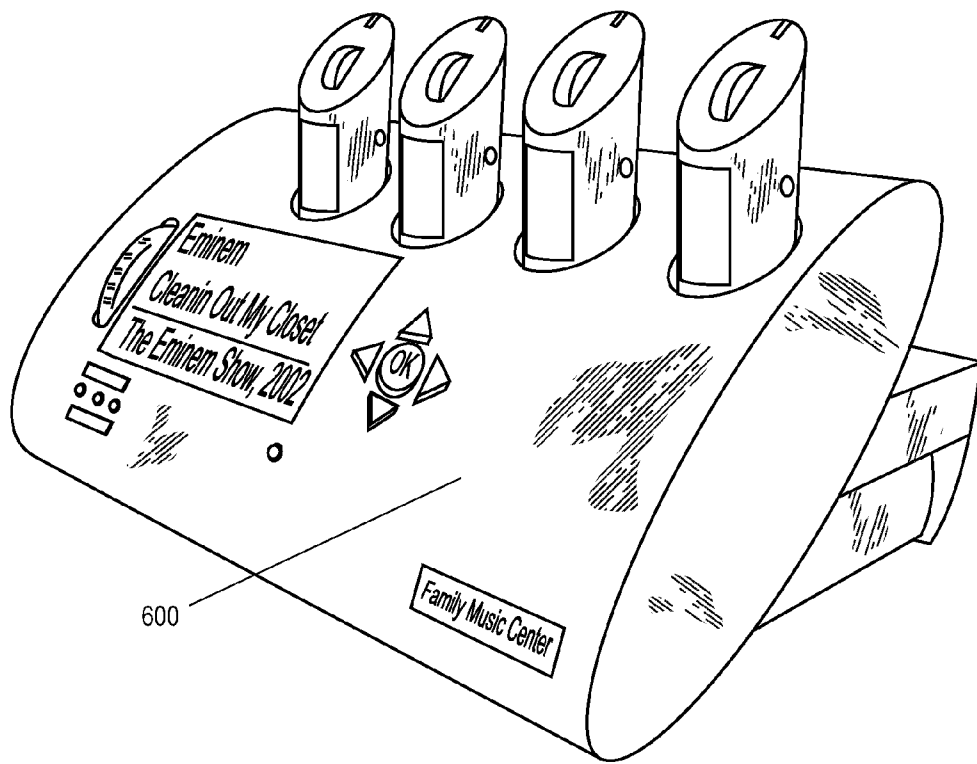


FIG. 6B

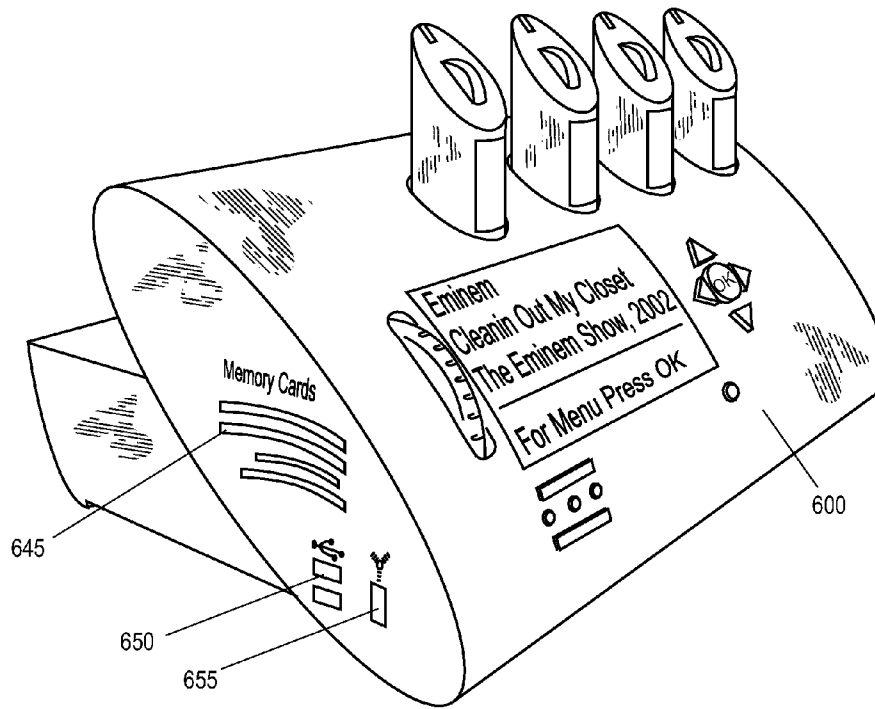


FIG. 6C

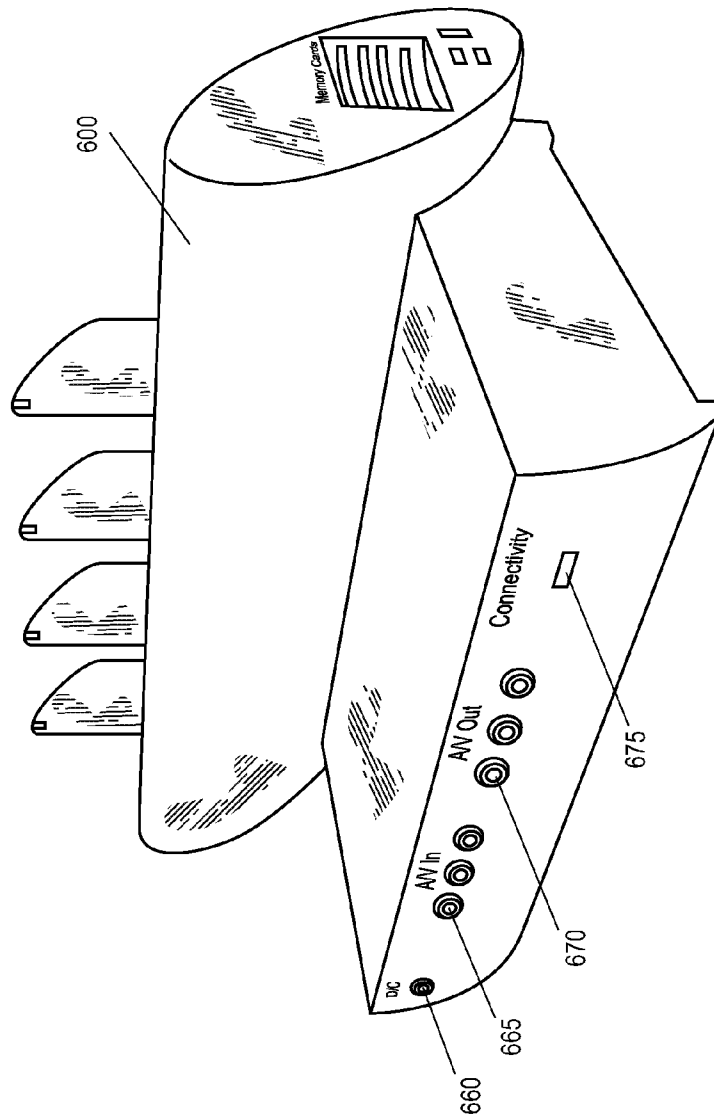


FIG. 6D

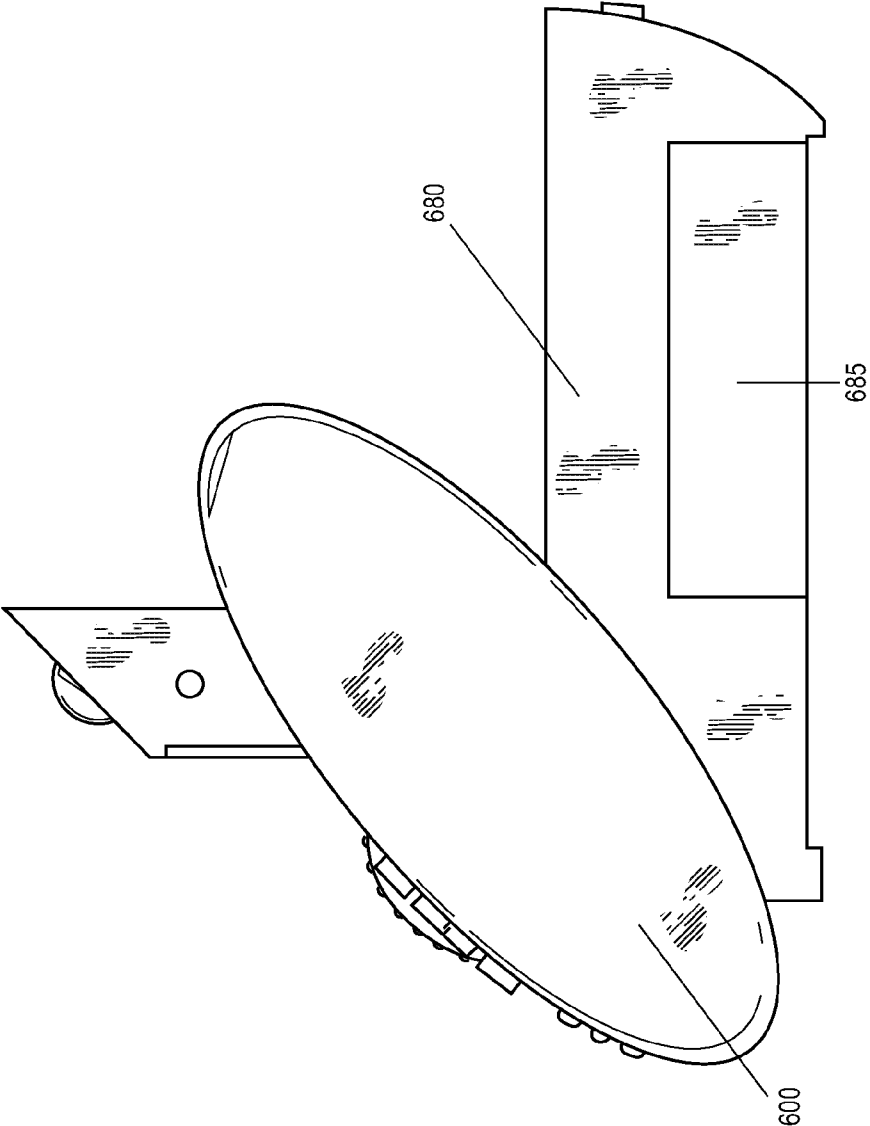


FIG. 6E

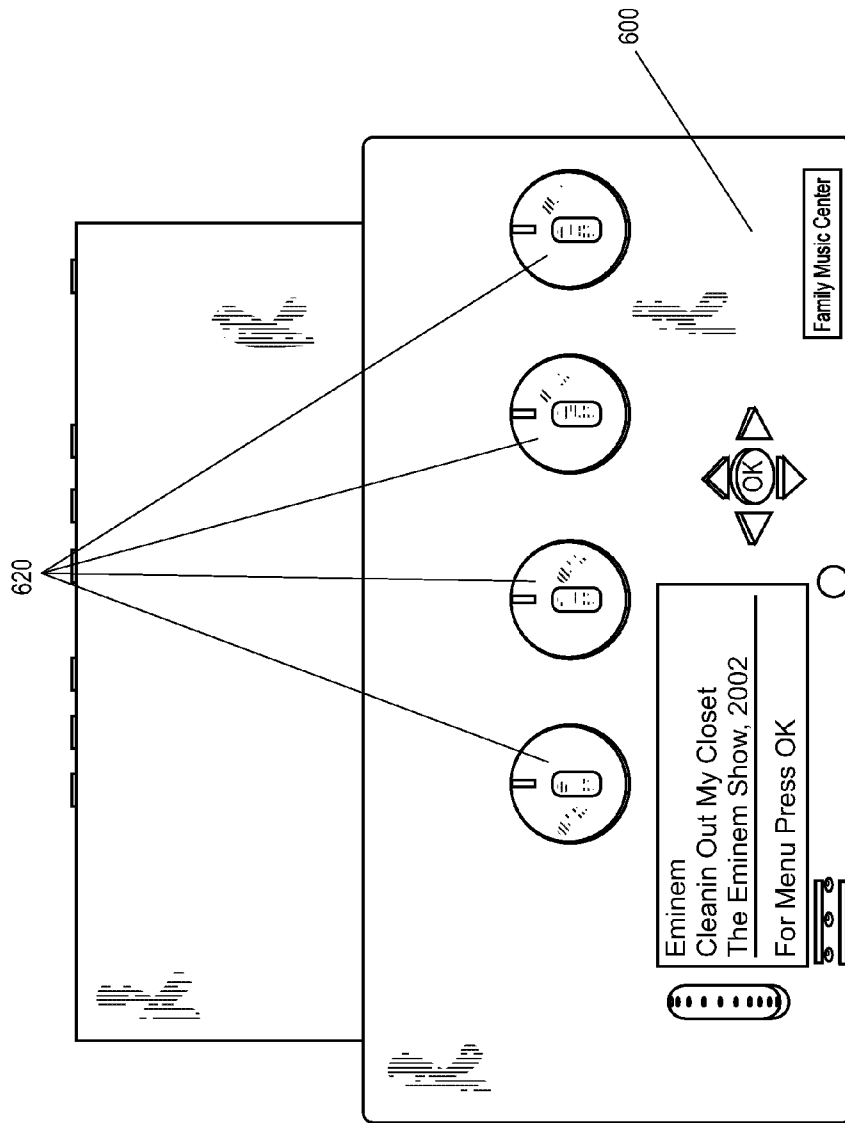


FIG. 6F

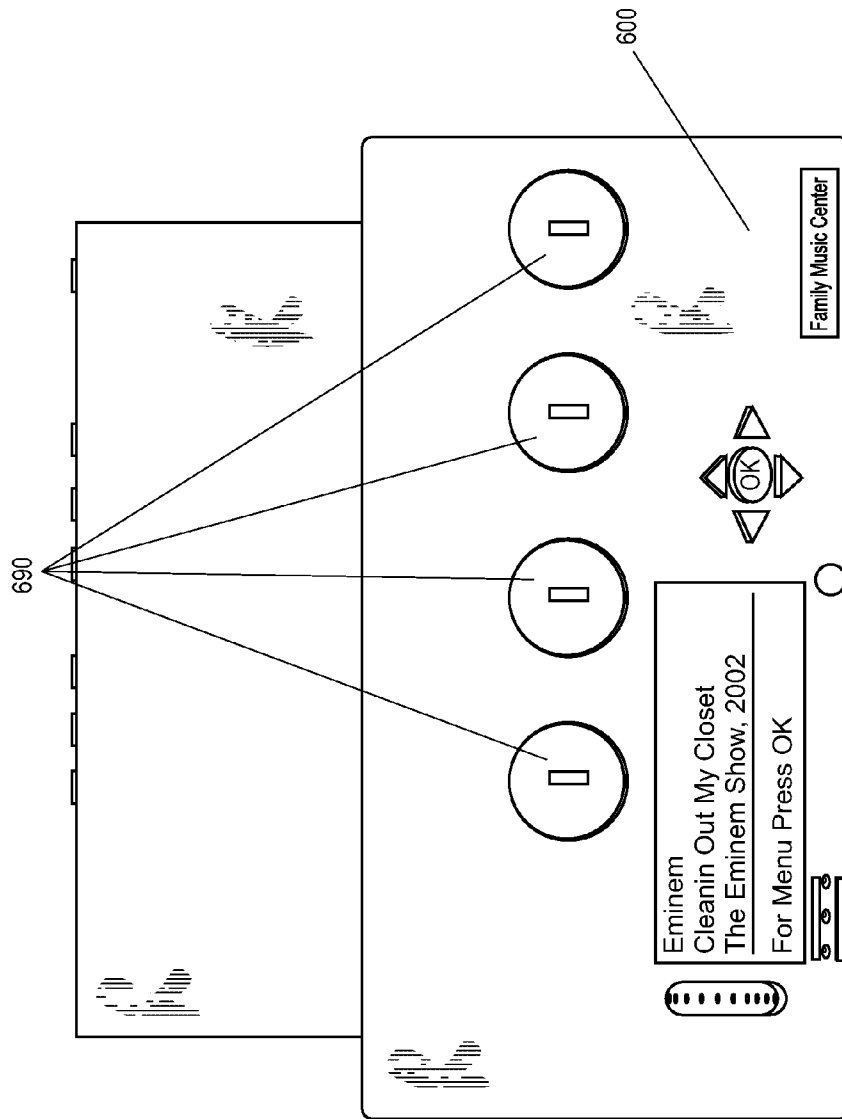


FIG. 6G

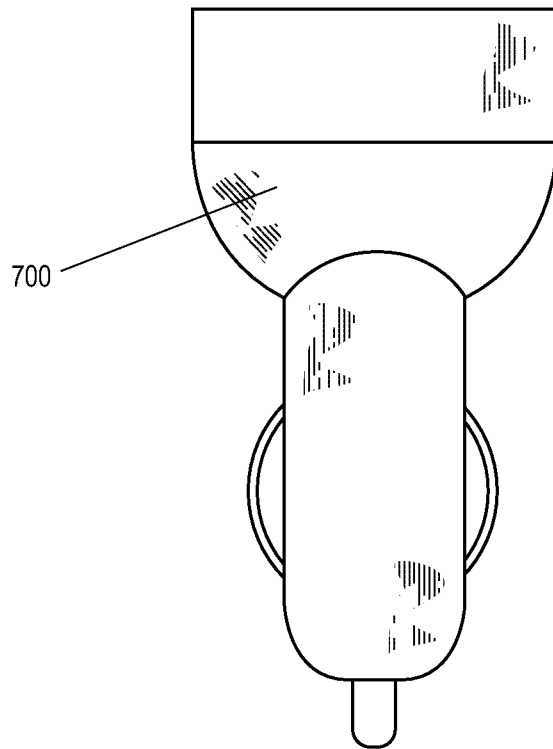


FIG. 7A

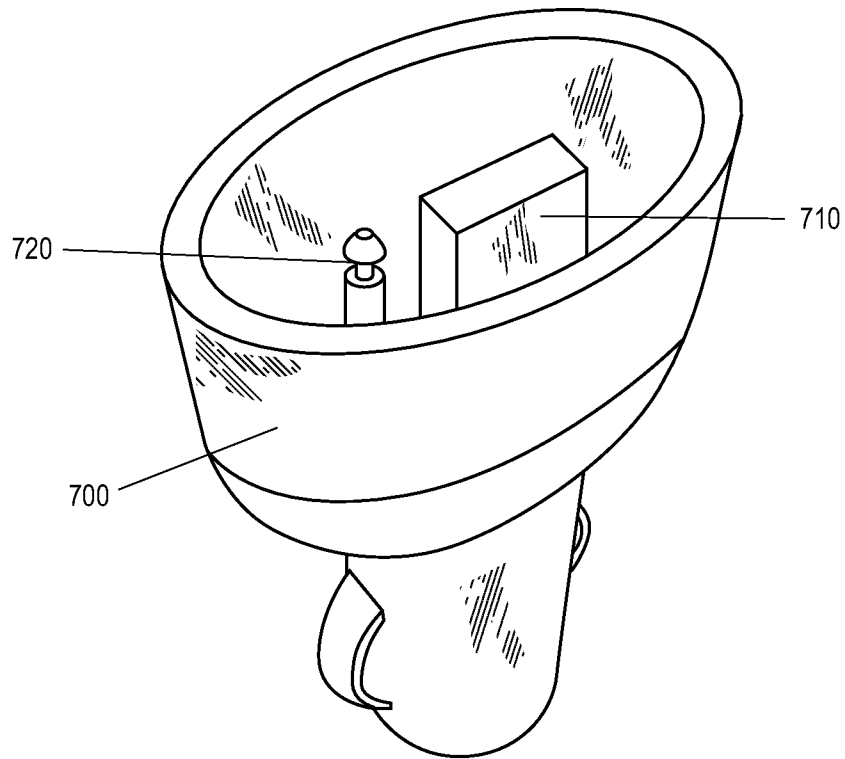


FIG. 7B

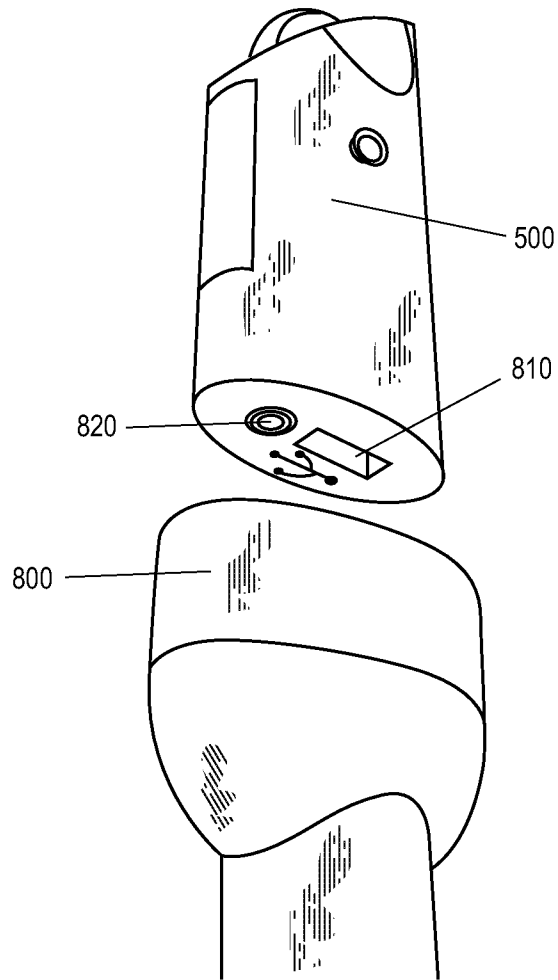


FIG. 8A

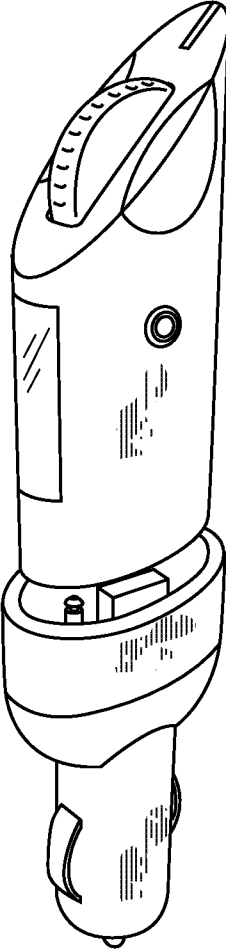


FIG. 8B

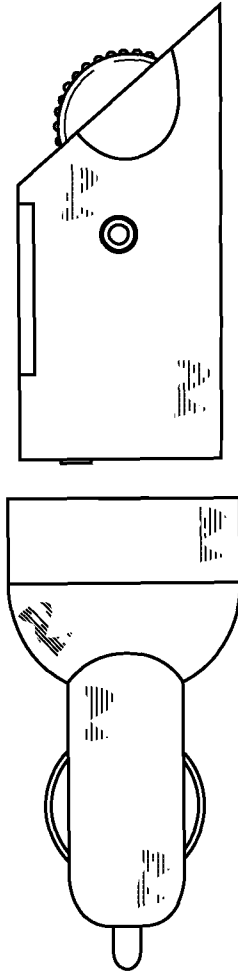


FIG. 8C

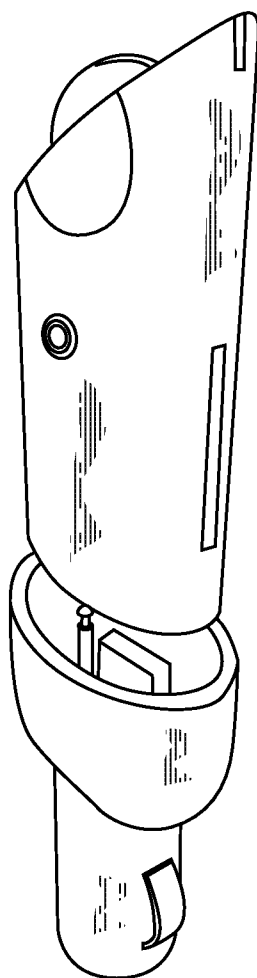


FIG. 8D

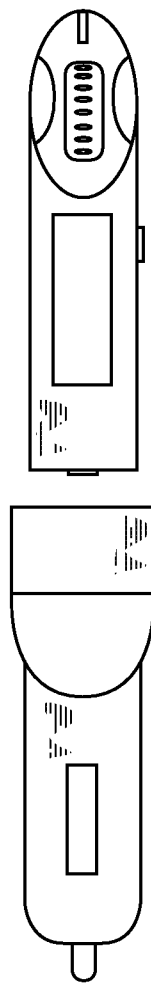


FIG. 8E

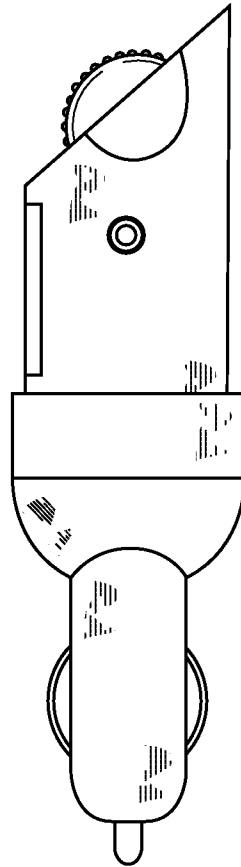


FIG. 8F

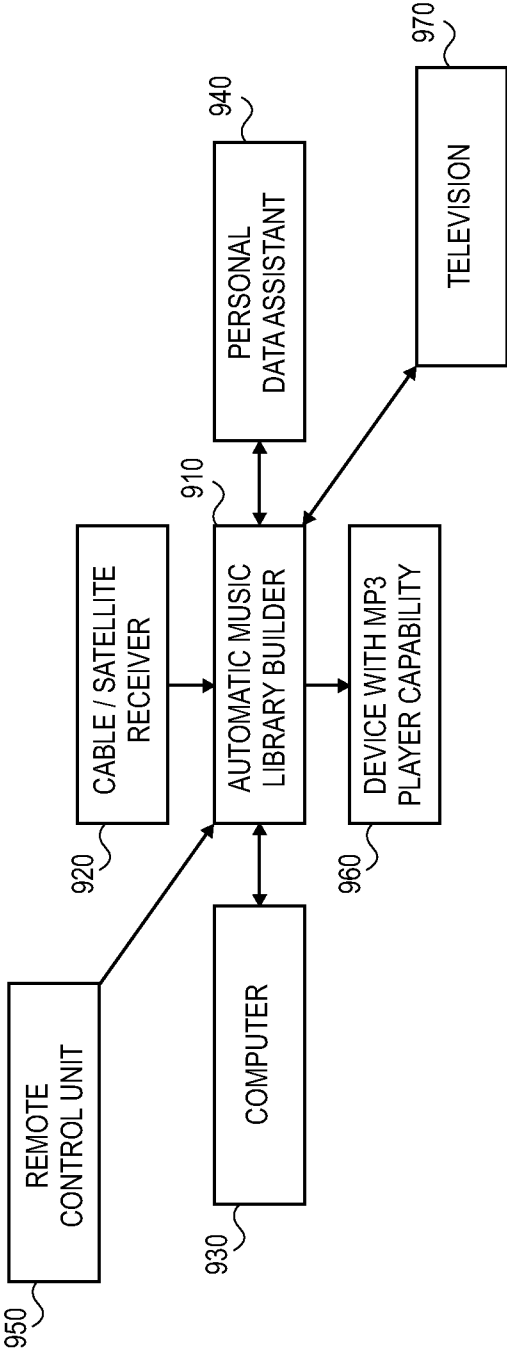


FIG. 9

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AUTOMATIC DIGITAL MUSIC LIBRARY BUILDER

CROSS REFERENCE TO RELATED APPLICATION

The present application claims priority from and is a divisional application of U.S. patent application Ser. No. 10/829, 581, filed on Apr. 21, 2004, published as U.S. Patent Publication No. 2004/0267390, entitled "Portable Music Player and Transmitter," which is a continuation-in-part of U.S. patent application Ser. No. 10/336,443, filed on Jan. 2, 2003, now U.S. Pat. No. 7,191,193, entitled "Automatic Digital Music Library Builder."

FIELD

Embodiments of the invention relate to mobile digital music players, such as MP3 players, and to mobile digital music transmitters.

BACKGROUND

Digital music players are proliferating as stand-alone consumer electronic devices (such as MP3 players), as bundled components within portable devices such as personal digital assistants and cell-phones, and as home network appliances. Listeners typically build up their own personal libraries of digital songs, which are stored on memory units such as hard disk drives and removable memory cards. Digital songs are typically acquired through the Internet via subscription services and peer-to-peer exchanges, or by converting songs from a compact disc ("CD") and importing them into an MP3 library.

Digital songs typically include audio data and peripheral data, referred to as meta-data, used to index the songs within the listener's library. For example, within an MP3 file, meta-data is accessed through an ID3Tag. By indexing the songs, a listener can search his library and access individual songs therein. Typically audio players provide a user interface through which users view meta-data.

Reference is now made to FIG. 1, which is an illustration of a prior art user interface for a Windows media player, indicating meta-data displayed within a window frame 110, and an index for accessing individual songs, displayed within a window frame 120.

Building up a digital music library requires a lot of work. Typically, the listener first searches the Internet for one or more songs of interest, identifies locations of the songs, and downloads them into a database associated with a media player. Songs are typically stored as digital files, formatted in compliance with a standard format, such as MP3 or WMA. Once the songs are downloaded, the listener typically uses software such as Windows Media player ("WMP") or Winamp to play the songs on a computer, or alternatively he uses a hardware device, such as an Ipod™ or an MP3 player, to play the songs. WMA files embed meta-data within the files, and also within the file names themselves.

Often individuals spend numerous nights downloading their favorite songs and building their own personal music libraries. Downloading music files from the Internet may infringe copyrights unless the files are obtained through a service that pays royalties to the recording industry.

A shortcoming in the digital music world is the great effort required to build custom music libraries. An alternative is to purchase libraries that have been prepared by others. But

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often someone else's library does not match a listener's taste, and the listener prefers to collect his own favorite songs.

Popular sources for listeners to hear their favorite songs are music stations. Cable, satellite broadcast and the Internet provide music channels for almost every genre of music—classical music, rock and roll, jazz, music of the 80's, etc. A listener can enjoy music according to his taste by subscribing to such broadcast services.

Ideally, a listener building up his personal digital music library would like to be able to record his favorite songs from such broadcast services. Raw audio recording from a music station, however, does not provide the meta-data necessary to identify such songs and incorporate them into a digital music library. Using today's technology, a listener has no choice but to painstakingly label each such song recorded from a music station with appropriate meta-data—a process that can last hours in order to build even a modest library with a few hundred songs.

Moreover, in addition to identifying each song, the listener has to manually separate each song from the next, because the songs are played sequentially on the music station.

SUMMARY

Embodiments of the invention enable a listener to easily build a digital library of music that is cataloged and easily accessible for personal playback. Embodiments of the present invention provide a solution for the tens of millions of households in the U.S. and around the world that receive, either through digital cable or over Direct Broadcast Satellite ("DBS") transmissions, music channels such as Music Choice, DMX, and other commercial-free music services. Such music channels are currently broadcast as video and audio channels in which the audio feed includes a song being played, and typically the simultaneous video feed has information about the song, its artists, and the label whose song is being broadcast.

For one embodiment, a device referred to hereinafter as a "Nest" is connected to a digital cable box or digital satellite receiver in the same fashion that a video cassette recorder ("VCR") or personal video recorder ("PVR") is connected thereto—namely, by connecting the video output and the left and right audio outputs of the receiver to the device. For one embodiment, the Nest has the ability to record and to playback by category, much like a PVR. Whereas a PVR relies on data received through an electronic program guide to identify what it is recording, and to name the recorded shows, one embodiment of the Nest uses information in the video portion of the broadcast to identify the song that is being recorded. Alternatively, the Nest uses information from an audio wave-print database to identify the song that is being recorded.

For one embodiment, the Nest allows a listener to record in either a "record all" mode or a "selective mode." In "record all" mode, the listener sets his receiver to a music channel broadcasting a genre of music that he enjoys, and he presses a record button on the Nest. The Nest then records and categorizes all songs played during the recording period, until the listener either stops the recording process by pressing "stop" on the Nest, or changes the channel on his receiver. Alternatively, the Nest can be programmed to stop recording at the end of a preset time period set by the listener.

For one embodiment of the present invention, the Nest records each song once, and, if a song is broadcast more than once, the Nest marks the song as being virtually recorded an additional time, each time the song is re-broadcast, for managing digital rights.

In this fashion the Nest builds a personal digital music library for the listener. Assuming that an average song lasts approximately three minutes and assuming a 25% re-broadcast rate, the Nest records approximately 360 songs during a typical 24 hour day of operation. Thus in approximately a one week period of recording day and night, the Nest builds a library of over 2,500 songs, if left on one specific genre channel. In many cases a listener records only at night when he is asleep. This is because the recording process requires the receiver to be set to a music channel while recording, and if the listener wants to watch television, he will inherently change the viewing channel from the music channel. Thus, in a household with average daily television viewing, a library of over 2,500 songs for a specific genre is built by the Nest within two weeks of night recording.

In "selective mode" the Nest is set to record a specific artist or song, and then when that artist or song is broadcast, the Nest records the music. The "selective mode" is most useful if the desired song or artist is played frequently on one of the genre channels. If the desired song or artist is less frequently played, however, there is no guarantee that the Nest will record the requested music.

Songs recorded on the Nest can be heard in a number of different fashions. A convenient way to listen to songs on the Nest in a listener's living room is to connect audio out of the Nest to an amplifier and stereo system, and to connect video out to a television. The listener can then choose, either through a front panel interface, or by remote control through a television interface, songs that he would like to listen to. The listener can create play lists or choose to listen to songs in the order they were played by the broadcast music channel.

In addition to listening to the songs on the Nest, for one embodiment of the invention, the listener can "check out" a set of songs to a hand-held digital music player, referred to as an "Egg," which can be plugged into one or more docking ports on the Nest. When the listener has finished listening to songs on his Egg, he plugs his Egg back into a cradle on the Nest in order to check-in songs that are no longer being listened to on that specific player, and check out new songs for new listening.

For one embodiment of the invention, the Nest incorporates digital rights management with songs recorded, thereby preventing a listener from freely making unlimited copies of the recorded songs. For one embodiment, a listener is limited to check out of a specific song to the total number of times that that song was broadcast to the Nest. Additionally, an Egg is registered to a single Nest, and the Egg can only check out songs from the Nest to which the Egg is registered.

One embodiment of the invention also includes a device, referred to as a "Shell," which is used for playback of songs in the Egg on a radio, such as an audio deck within an automobile. The Shell includes a radio transmitter that transmits analog audio coming out of the Egg to a radio at a specified broadcast frequency. For one embodiment, the Shell also transmits meta-data using a Radio Data System ("RDS") sub-frequency, thus enabling meta-data to be displayed on the radio liquid crystal display ("LCD").

For one embodiment of the invention, the Nest includes a unit having a hard disk for storage of songs, an audio/video encoding and decoding platform, an on-screen display component, optional front panel navigation buttons and scroll wheel, an LCD panel, and various external interfaces including audio/video jacks, USB, Firewire, and power jacks. In addition, the main Nest unit includes four sockets that comprise a docking station for four Eggs. For one embodiment, the sockets have leads to both re-charge the Eggs and to transfer songs to and from the Eggs. The Nest receives analog

audio and video from the listener's receiver, and encodes both the audio and video signal in real-time. The video portion of the signal is analyzed in order to extract artist name, song name, and label and year from the video broadcast for categorization purposes. For one embodiment, the analog audio is encoded separately from the video.

Thus, a hand-held music player is described for use in conjunction with radios. The hand-held music player includes a casing, a receiver socket on the casing through which digital audio data is received, a digital-to-analog audio converter housed within the casing, a first transfer socket on the casing through which a song is transferred to a radio transmitter, a second transfer socket on the casing through which meta-data for the song is transferred to the radio transmitter, and a dial on the casing for selecting a song for playback.

Another hand-held music player for use in conjunction with radios is described. The hand-held music player includes a casing, a receiver socket on the casing through which digital audio data is received, a digital-to-analog audio converter housed within the casing, a radio transmitter for transmitting a song, an RDS transmitter for transmitting meta-data for the song, and a dial on the casing for selecting a song for playback.

A hand-held video player for use in conjunction with televisions is described. The hand-held music player includes a casing, a receiver socket on the casing through which digital video data is received, a digital-to-analog video converter housed within the casing, a first transfer socket on the casing through which a video is transferred to a television transmitter, a second transfer socket on the casing through which meta-data for the video is transferred to the television transmitter, and a dial on the casing for selecting a video for playback.

A further hand-held video player for use in conjunction with televisions is described. The hand-held video player includes a casing, a receiver socket on the casing through which digital video data is received, a digital-to-analog video converter housed within the casing, a television transmitter for transmitting a video and meta-data for the video, and a dial on the casing for selecting a video for playback.

A hand-held container for audio with associated meta-data is described. The hand-held container includes a casing, a memory housed within the casing storing digital audio with associated meta-data, a digital-to-analog audio converter housed within the casing, and a transfer socket on the casing through which a song and meta-data associated therewith is transferred to a radio transmitter.

A hand-held container for video with associated meta-data is described. The hand-held container for video includes a casing, a memory housed within the casing storing digital video with associated meta-data, a digital-to-analog video converter housed within the casing, and a transfer socket on the casing through which a video and meta-data associated therewith is transferred to a television transmitter.

A digital music library builder is described that includes a casing, a receiver socket on the casing through which analog audio is received, an analog-to-digital converter housed within the casing for converting analog audio into digital audio, a meta-data identifier housed within the casing for identifying meta-data for a song, and a database manager housed within the casing for associating the identified meta-data with the song within a digital music library.

A method is described for transferring audio with associated meta-data. The method includes converting digital audio to analog audio, and transferring an analog song and meta-data associated therewith to a radio transmitter.

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A method is described for building a digital music library builder. The method includes receiving analog audio, converting the analog audio to digital audio, identifying meta-data for a song, and associating the identified meta-data with the song within a digital music library.

A computer-readable storage medium is described storing program code for causing a device to perform the steps of converting digital audio to analog audio, and transmitting an analog song and meta-data associated therewith to a radio transmitter.

A computer-readable storage medium is described storing program code for causing a device to perform the steps of receiving analog audio, converting the analog audio to digital audio, identifying meta-data for a song, and associating the identified meta-data with the song, within a digital music library.

A device is described for transferring audio to a radio transmitter. The device includes a mini-jack through which an analog song is transferred to an FM radio transmitter for broadcast at a specific FM frequency, and a USB socket through which digital meta-data for the song is transferred to a radio data system (RDS), which is a sub-carrier of the specific FM frequency.

A method is described for transferring audio to a radio transmitter. The method includes transferring an analog song to an FM radio transmitter for broadcast at a specific FM frequency, and transferring digital meta-data for the song to a radio data system (RDS), which is a sub-carrier of the specific FM frequency.

A computer-readable storage medium is described storing program code for causing a device to perform the steps of transferring an analog song to an FM radio transmitter for broadcast at a specific FM frequency, and transferring digital meta-data for the song to a radio data system (RDS), which is a sub-carrier of the specific FM frequency.

Other features and advantages of embodiments of the invention will be apparent from the accompanying drawings and from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are illustrated by way of example and not limitation in the figures for the accompanying drawings, in which like references indicate similar elements and in which:

FIG. 1 is an illustration of a prior art user interface for a Windows media player, indicating meta data and an index for accessing individual songs displayed;

FIG. 2 is a sample video frame displaying meta-data for a song for processing in accordance with an embodiment of the present invention.

FIG. 3 is a simplified block diagram of a digital music library builder, or "Nest," in accordance with an embodiment of the present invention;

FIG. 4A is a simplified operational flow chart for building a digital music library in accordance with an embodiment of the present invention;

FIG. 4B is a simplified flowchart of a signal processing method for identifying individual songs from within a digital audio segment of music recorded from a cable or satellite receiver, or from a television, in accordance with an embodiment of the present invention;

FIG. 5 is a simplified perspective view of a music player, or "Egg," in accordance with an embodiment of the present invention;

FIGS. 6A-6G are simplified perspective views of a Nest in accordance with an embodiment of the present invention;

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FIGS. 7A and 7B are simplified perspective views of an adaptor, or "Shell," in accordance with an embodiment of the present invention;

FIGS. 8A-8F are simplified perspective views of an Egg and Shell combination in accordance with an embodiment of the present invention; and

FIG. 9 is a simplified block diagram illustrating interconnectivity of a Nest with other devices in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention enable a listener to automatically import songs recorded from a broadcast music station into his digital music library, along with the songs' meta-data required for indexing his library. A listener, with practically no effort, can automatically build a large digital music library with tens of thousands of his choice of songs, all properly indexed for search and retrieval.

Moreover, an additional feature of an embodiment of the present invention enables the listener to select which songs from among those broadcast on the music stations are to be imported into his library, based on one or more of genre, song title, artist, album, length of song, and other criteria.

Embodiments of the present invention concern a method and system for automatically building digital music libraries, from music channels broadcast through cable and satellite stations. For one embodiment, broadcast songs are recorded into a digital music library along with meta-data necessary for indexing and accessing each individual song, and for display while the songs are being played. The digital music library generated from the broadcast music serves as a large library of individual songs with full search and access capability.

Reference is now made to FIG. 2, which is a sample video frame **210** displaying meta-data for a song, for processing in accordance with an embodiment of the present invention. Video frame **210** is broadcast by satellite to listeners of the "Music Choice" station. Video frame **210** is typically displayed on a listener's television while live music is being broadcast. As shown in FIG. 2, the listener has selected a genre for songs of the 80's, and is currently listening to a song entitled "Like a Virgin" by the artist "Madonna," from an album entitled "Like a Virgin." The various descriptive data associated with a song is referred to as "meta-data;" i.e., descriptive data about the digital audio data itself.

Embodiments of the present invention provide a system that enables the listener to automatically digitally record each broadcast song into a digital music library and index each song according to genre, song title, artist and album title, as described below. Additionally, embodiments of the present invention enable the listener to filter songs to be automatically recorded by specifying, inter alia, a genre, song title, or artist, instead of recording all of the broadcast songs. The listener need not be present while the system is in operation. Embodiments of the present invention enable automatic generation of large libraries of songs.

Reference is now made to FIG. 3, which is a simplified block diagram of a digital music library builder in accordance with an embodiment of the present invention. Shown in FIG. 3 is a broadcast station **305** broadcasting cable or satellite entertainment to a home **310**. The broadcast entertainment is received within home **310** by a satellite or cable receiver **315** and played to a home viewer through his television **320** or other display device.

The audio output of satellite or cable receiver **315** is converted from analog to digital by an A/D converter **325**. The converted digital audio is written to a memory buffer **330**. If

cable or satellite receiver **315** includes an optical or coaxial connection for audio out, then digital audio can be extracted directly without the need for A/D converter **325**.

A song extractor **335** analyzes the digital audio and marks the beginnings and ends of individual songs. For one embodiment, song extractor **335** filters out non-musical portions from the digital audio, such as pure speech, and compensates for overlapping the end of one song with the beginning of a next song. Each such song marked by song extractor **335** is written to a digital music library **340**, which is a storage device such as a hard drive, and subsequently flushed from memory buffer **330**.

A video frame grabber **345** captures a video frame being displayed on television **320**, such as video frame **210** illustrated in FIG. 2. An optical character recognizer **350** extracts characters from the video frame, such as the characters in video frame **210**. A meta-data generator **355** identifies meta-data associated with a current song, within the extracted characters, such as a genre, song title, artist name, and album title within video frame **210**. The meta-data identified by meta-data generator **355** is then written to digital music library **340** and linked to the corresponding song.

The overall process through which meta-data is extracted from the video portion of the audio/video broadcast is as follows. A number of frames are captured from the video broadcast by station **305**—for one embodiment, between 10 and 20 frames per song. The captured frames are processed using image processing algorithms so as to create a clear image of a desired region of the screen. The clarified image is cropped according to a pre-determined template, which specifies the location of relevant data on the screen. For one embodiment, such template is generated by analyzing screens from multiple songs so as to recognize a pattern. For one embodiment, the resulting cropped image is transformed into a two-tone black and white image. The black and white image is processed through optical character recognizer **350** and relevant meta-data is extracted by meta-data extractor **355**.

For one embodiment, extracted meta-data is verified with an internal CD database, such as the Gracenote® database, to ensure accuracy. Such an internal CD database is also used for an embodiment to determine meta-data, in circumstances where the extracted meta-data is incomplete or inaccurate, by matching the extracted meta-data to entries in the database that are close matches.

As indicated in FIG. 3 by use of dashed lines, the audio signal and video frame may be extracted from television **320** instead of from cable or satellite receiver **315**.

Songs broadcast by station **305** can be selectively imported into digital music library **340**, filtered according to meta-data. Criteria based on one or more meta-data including, inter alia, genre, song title, artist name, album title, and length of song, can be used to filter songs to be imported from among all of the broadcast songs. For one embodiment, a memory buffer is used to record a song while a determination is being made whether or not to filter the song.

For one embodiment, songs already included within digital music library **340** are not overwritten unless the listener expressly instructs the system to overwrite.

Reference is now made to FIG. 4A, which is a simplified operational flow chart for building a digital music library in accordance with an embodiment of the present invention. At operation **405** an analog audio signal or a digital audio signal is received from a cable receiver, a satellite receiver, or from a television. At operation **410**, the analog signal is converted to digital audio if an analog signal was received at operation **405**. The digital audio is stored in a memory buffer at operation **415**.

At operation **420**, a video frame is captured from a cable receiver, a satellite receiver, or from a television. At operation **425**, character recognition is applied to recognize characters in the captured video frame. At operation **430** meta-data is identified from the recognized characters. For one embodiment, a template for the captured video frame is used as an aid in operations **425** and **430**. For example, a template corresponding to video frame **210** from FIG. 2 may indicate an area of the image in which relevant meta-data typically appears. At operation **435** the identified meta-data is stored in a memory buffer.

At operation **440** the digital audio stored in the memory buffer is analyzed to identify individual songs, as described in more detail with reference to FIG. 4B. At operation **445** meta-data stored in the memory buffer is identified as being associated with corresponding individual songs. At operation **450** individual songs and their associated meta-data are written to a digital music library.

Due to interlacing on the television screen, it may be necessary to capture more than one video frame at operation **420** in order to be able to extract the meta-data for the song being broadcast. Multiple frames are preferably averaged in order to enhance the appearance of characters prior to recognition operation **425**.

Alternatively, to enhance characters prior to recognition operation **425**, the luminance component of the one or more color video frames can be extracted. Extraction of luminance serves to remove color burst noise that degrades performance of optical character recognition.

The operations in FIG. 4 may be performed in a different order than as numbered in FIG. 4A. For example, operations **405**, **410**, and **415** for the audio processing may be performed before or after or simultaneous with operations **420**, **425**, **430**, and **435** for the video processing.

Reference is now made to FIG. 4B, which is a simplified flowchart of a signal processing method for identifying individual songs from within a digital audio segment of music recorded from a cable receiver, a satellite receiver, or from a television, corresponding to operation **440** in FIG. 4A. The recorded digital audio includes a signal of samples, $s(n)$, corresponding to a sequence of songs. At operation **455**, transitions are detected between a first song, $s_1(n)$, and a second song, $s_2(n)$, within the recorded signal $s(n)$. The songs broadcast from the cable receiver, the satellite receiver, or from the television generally overlap and fade in and out, thus making it difficult to separate them. If the broadcast songs do not overlap, then transitions are identified by short intervals of quiet, or background noise. But when the songs overlap, such quiet intervals may not exist. Thus automatic detection of transitions within broadcast songs, as at operation **455**, is challenging.

When the data stream $s(n)$ exhibits significant energy reduction between songs, such as is typical for fade in and fade out, a characteristic measurement such as

$$x(n) = \sum_{k=0}^{N-1} |s(n-k)|$$

is minimized during song transitions. Thus song separation can be based on a threshold value for $x(n)$. Such a threshold can be fine tuned by adjusting it dynamically based on the values of $x(n)$.

For data streams where energy reduction between songs is not significant, an alternate approach is to use a characteristic measurement such as

$$x(n) = \max_{0 \leq i < M} C(v_i(n), v_i(n-1)),$$

where $C(v,w)$ is a measure of correlation between two vectors v and w ; and where $v_i(n)$ is a vector that captures frequency-based properties of the samples $s(n), s(n-1), \dots, s(n-N+1)$, for frequencies within an i^{th} band, or range, of frequencies. As above, song separation can be based on a threshold value for $x(n)$. The motivation for this alternate approach is that each song generally has its own characteristic resonances in its rhythm and melody. Thus during a single song the vectors $v_i(n)$ tend to be correlated, and after a transition they tend to change significantly.

The two algorithms described above for performing operation 455 represent two different approaches to identifying transitions between songs, and other viable algorithms may also be used.

At operation 460 an interval of overlap between two songs is detected. An algorithm for detecting transitions may be used to detect start and stop of overlap. As above, other viable signal processing algorithms may also be used for performing operation 460.

At operation 465 individual songs $s_1(n)$ and $s_2(n)$ are recovered from the combined signal $s(n)$, using the overlap detected at operation 460 for one embodiment. An algorithm for recovering $s_1(n)$ is to use the values of $s_1(n)$ prior to the overlap interval, namely $s(n)$, to predict the values of $s_1(n)$ during the overlap interval. Denoting the predictor of $s_1(n)$ by $\hat{S}_1(n)$, the difference $s_1(n) - \hat{S}_1(n)$ is used as a predictor $\hat{S}_2(n)$ to estimate the values of $s_2(n)$ during the overlap interval. The value of $s_2(n)$ after the overlap interval, namely $s(n)$, is used to correct the estimator $\hat{S}_2(n)$, which in turn feeds back to correct the estimator $\hat{S}_1(n)$. By iterating prediction and feedback, converged estimators $\hat{S}_1(n)$ and $\hat{S}_2(n)$ are generally obtained. As above, other viable signal processing algorithms may also be used for performing operation 465.

For an alternative embodiment of the present invention, meta-data for a song is determined directly from the digital audio data by looking up the song using a database of "fingerprints" for known songs. A fingerprint of a song is a relatively small pattern of bits that captures perceptual qualities of the song. The fingerprint of a song can be computed from digital audio samples of the song. For one embodiment, a comprehensive database is generated, including fingerprints of a large number of known songs, together with the known meta-data associated with them. Then, to determine meta-data associated with an unknown song, the fingerprint of the unknown song is computed and compared with the fingerprints within the database to find a best match. The entry in the database whose fingerprint best matches that of the unknown song generally contains the sought for meta-data associated with the unknown song.

For this alternative embodiment, operations 425, 430, and 435 in FIG. 4A are not required. For another embodiment, operations 425, 430, and 435 are performed, and a database of fingerprints is used to correct possible errors that may occur in automatic recognition of meta-data from video frames.

The present invention is embodied in a programmable device, referred to herein as a "Nest," that can interface with computers, with MP3 players and other digital music players, and with other electronic devices that include MP3 players or

other digital music players therewithin, including, inter alia, cell phones, PDAs, home network appliances, and Internet appliances. For a first embodiment, the Nest is coupled to satellite/cable receiver 315 (FIG. 3). For a second embodiment, the Nest is coupled to television 320. For a third embodiment, the Nest is coupled to various external components via a USB and a Firewire connection.

For all embodiments, the memory storing digital music library 340 can be either a large hard disk situated within the Nest itself, or one or more smaller removable memory units such as compact disks and memory cards, or a combination of hard disk and removable memory. The advantage of a large hard disk is that the listener's music library is consolidated into a single library that can be searched and accessed in its entirety. The advantage of removable memory units, such as compact disks, is that the listener can insert the disks into portable players such as MP3 players. Assuming that 40 songs on average require 128 MB of data and include one and a half hour's worth of listening, a large 80 GB hard disk can hold a library of approximately 25,600 songs. A 640 MB compact disk can hold approximately 200 songs, or about 7½ hours worth of listening.

For one embodiment of the present invention, a Nest includes one or more exchange ports, also referred to herein as "cradles," through which one or more hand-held digital music players, referred to herein as "Eggs," can be connected to the Nest, for loading songs from a digital music library stored on the Nest thereto. Such exchange ports may be circular or oval ports into which Eggs in the shape of film canisters are inserted. Eggs may be "charged up" with songs while they are "plugged into" the Nest.

For one embodiment of the present invention, an Egg can be connected to an adaptor, referred to herein as a "Shell," that includes an FM/RF transmitter. Using the Shell, songs stored in an Egg can be played on a radio, such as an audio deck within an automobile. The shell receives analog audio out from the Egg and broadcasts the audio to an FM radio at a user-selectable frequency from among a list of frequencies. In addition, the Shell transmits meta-data concurrently with a song through a Radio Data System (RDS) transmission. Alternatively, instead of using a user-selectable frequency, the Egg may transmit to the Shell a list of one or more free FM frequencies.

Reference is now made to FIG. 5, which is a simplified perspective view of a music player, or "Egg," in accordance with an embodiment of the present invention. Shown in FIG. 5 is a hand-held Egg 500 including a display 510 for viewing meta-data for a song being played. Egg 500 is loaded with songs from a Nest and serves as a player. Also shown in FIG. 5 is a jog dial 520 and a mini-jack 530 for inserting a headphone.

Reference is now made to FIGS. 6A-6G, which are simplified perspective views of a Nest in accordance with an embodiment of the present invention. FIG. 6A is a front view of a Nest 600, including a user interface display 605 with buttons 610 and scroll wheel 615 for navigation, and including slots for four Eggs 620. Also shown in FIG. 6A is a mini-jack 625 for inserting a headphone, an on/off button 630, green and yellow LEDs 635 and a record button 640. FIGS. 6B, 6C, and 6D are side views of Nest 600. FIG. 6C shows a side of Nest 600 having slots 645 for memory cards, USB sockets 650 for connecting foreign MP3 players to the Nest, and an IEEE 1394 socket 655 for connecting IEEE 1394 devices to the Nest. FIG. 6D shows the back of Nest 600 with a slot 660 for a DC power supply, slots 665 for audio and video in, slots 670 for audio and video out, and a connectivity slot 675. Connectivity slot 675 is preferably used for Ethernet

support, Bluetooth support, and 802.11 based connectivity. FIG. 6E is a view from the right of Nest 600, indicating a base support 680 for the Nest and a removable disk drive 685. FIGS. 6F and 6G are views from the top of Nest 600 with and without Eggs 620 inserted into slots 690, respectively.

Reference is now made to FIGS. 7A and 7B, which are simplified perspective views of an adaptor, or “Shell” 700 in accordance with an embodiment of the present invention. Shell 700 is used to broadcast analog audio played by an Egg to a radio, such as an audio deck in an automobile. FIG. 7A is a front view of the Shell. FIG. 7B is a top view of Shell 700, indicating a male USB connector 710 and a male RCA audio connector 720.

Reference is now made to FIGS. 8A-8F, which are simplified perspective views of an Egg and Shell combination in accordance with an embodiment of the present invention. Shown in FIG. 8A is a Shell 800 and an Egg 500. Underneath Egg 500 is a female USB connector 810 and a female audio/video RCA connector 820.

A typical usage scenario for a Nest is as follows. A listener sets his cable or satellite receiver box to a specific music channel—for one embodiment, from a commercial-free radio station such as The Music Choice®—and activates the Nest to capture songs from the music channel. The Nest automatically creates a digital music library and imports the broadcast songs therein. Thereafter, the listener plugs an Egg into the Nest and loads selected songs from the music library onto the Egg. If the Nest is connected to the listener’s speaker system, then the listener may also pipe music from the Nest into speakers in various rooms. If the Nest is connected to a home network, the listener may stream audio to a computer that is authorized to work with the Nest.

For one embodiment of the present invention, Nest 600 supports two types of I/O interfaces; namely, those inherently supported by the Nest, and those supported when connected to a network. Specifically, the I/O interfaces include one or more of the following:

TABLE I

Nest Hardware I/O Interfaces	
Hardware Interface	Description
Four male USB 2.0 On-The-Go (OTG) connectors 690 (FIG. 6G)	Inside the Egg cradle, as illustrated in FIG. 6G. The USB 2.0 OTG connectors need not work simultaneously and, as such, they can be implemented in a hub or switch configuration. The connectors need not be OTG connectors, since the Nest can act as a USB 2.0 host, thus obviating the need for OTG support.
Four audio/video male connectors	(Optional) Adjacent to the USB 2.0 OTG connectors in the Egg cradles. The A/V connectors are used for connecting analog audio and analog video leads from the Eggs to the Nest. For one embodiment, Egg A/V connectors support multi-system video, including PAL, NTSC and SECAM.
Two sets of analog left and right audio in and analog video in, or s-video in connectors 665 (FIG. 6D)	One set located on the front of the Nest, and one set located on the rear of the Nest. For one embodiment, these connectors are high quality female RCA plug connectors. The front set of connectors is used to connect auxiliary audio devices, such as a CD player, in order to add content into the Nest. The rear set of connectors is used to connect analog audio and analog video outs from a digital cable or DBS box to the Nest for one embodiment.
Left and right analog audio out and analog video out, or s-video out connectors 670 (FIG. 6D)	Used to connect to a television set in order to provide both pass-through audio and video to the television set from the digital cable or DBS box. For one embodiment, these connectors are high quality female RCA plug connectors. For one embodiment, the Nest applies an overlay, over the incoming video, which has a menuing graphical user interface for enabling a consumer to interact with the Nest and perform on-screen menuing functions using a remote control.
Infrared receiver 625 (FIG. 6A)	Shown in FIG. 6A on the front of the Nest, used to receive commands from a remote control unit. For one embodiment, the infrared receiver controls both the on-screen menuing functions and the Nest itself.
Connectivity connector 675 (FIG. 6D)	Shown in FIG. 6D on the rear of the Nest, serving as a USB 2.0 socket for Ethernet (RJ45) support. Alternatively, Bluetooth support and 802.11 based connectivity may be built into the Nest.
Solid state memory socket(s) 645 (FIG. 6C)	(Optional) Shown in FIG. 6C on the left side of the unit. For one embodiment, there are four sockets supporting various media types, including inter alia a Sony memory stick, Panasonic SD, Smart Media and Compact Flash types 1 and 2. For one embodiment, these sockets are used for checking in and out songs located on the various media types.
USB 2.0 OTG socket(s) 650 (FIG. 6C)	Shown in FIG. 6C underneath the solid-state memory socket(s) on the left side of the Nest. For one embodiment, these sockets are used for connecting foreign MP3 players to the Nest. As above, if the Nest acts as a USB host to other devices, then a USB 2.0 host socket can be used in place of an OTG socket.

TABLE I-continued

Nest Hardware I/O Interfaces	
Hardware Interface	Description
IEEE 1394 socket 655 (FIG. 6C)	(Optional) Shown in FIG. 6C on the left side of the Nest, to the right of the USB 2.0 socket. For one embodiment, this socket is used for connecting IEEE 1394 devices to the Nest, for example, to create backups of the hard disk inside the Nest.
Mini-jack socket	On the front of the Nest, providing analog stereo audio out for hooking up headphones to the Nest.
Optical digital audio out	On the back of the Nest, used for playback of movies. For one embodiment, when movies with Dolby digital audio are played, the digital audio is sent out through this connector.
Optical digital audio in	On the back of the Nest, enabling connection of digital audio out from digital cable or DBS receivers that support digital audio out.

For one embodiment of the present invention, the Nest includes hardware components used as a front panel interface for interaction and viewing data from the Nest, and hardware

components necessary to provide Nest functionality. Specifically, the user interface components of the Nest include one or more of the following:

TABLE II

Nest Hardware User Interface Components	
Component	Description
Large jog dial 615 (FIG. 6A)	(Optional) Shown in FIG. 6A on the left front of the Nest, and used to scroll up and down and select items displayed on the Nest front display. In addition, for one embodiment, the jog dial enables a user to choose a menu item and select it. For one embodiment of the present invention, the jog dial is a rolling jog dial, pressable for selection. For an alternative embodiment of the present invention, the jog dial is a spring based jog dial that does not fully roll, but is used as a five function jog dial; namely, single click scroll up, single click scroll down, selection click toggle by pressing on the jog dial, and duration based scroll up and scroll down for two additional functions.
Navigation arrows and select buttons 610 (FIG. 6A)	(Optional) Shown in FIG. 6 on the front of the Nest, used to navigate through the Nest front display menu options, as well as to select and create play lists.
On/off button 630 (FIG. 6A)	(Optional) Shown in FIG. 6A on the left front of the Nest, used to turn the Nest on and off. For one embodiment, holding down the On/Off button resets the Nest, in case the Nest is stuck. For one embodiment, the Nest may also be reset by holding down the On/Off button during powering up of the Nest after plugging in the DC power.
Green and yellow LEDs 635 (FIG. 6A), or a single multi-colored LED	(Optional) Shown in FIG. 6A underneath the On/Off button on the left front of the Nest, used to give a user feedback when various actions occur, and to provide error codes based on the LED's behavior - lit, turned off, blinking or blinking quickly.
Red infrared receiver and LED 625 (FIG. 6A)	(Optional) Shown in FIG. 6A on the left front of the Nest, to the right of the green and yellow LEDs, for flashing when an infrared signal is being received from a remote control.
Record button 640 (FIG. 6A)	(Optional) Shown in FIG. 6A on the left front of the Nest. For one embodiment, the record button begins automatic song record from an audio and video source; namely, from one of the sets of analog left and right audio and analog video in connectors. For one embodiment, the record button is a toggle button to start and stop recording, and the red LED lights up while the Nest is recording.
LED display 605 (FIG. 6A)	(Optional) Shown in FIG. 6A on the front of the Nest, used to display information about the state the Nest is in. For one embodiment, the LCD is at least approximately four inches in width by three inches in height, and supports at least five lines of text. The LCD is used as an interface, together with the various navigation buttons and jog dial, for interaction with the Nest. Alternatively, an LED display may be used instead of an LCD display.

The functional components of the Nest include one or more of the following:

TABLE III

Nest Hardware Functional Components	
Component	Description
Power connector 660 (FIG. 6D)	Shown in FIG. 6D on the rear of the Nest, and used to supply DC power to the Nest, sufficient for powering the Nest, for charging the Eggs that can be placed in the Nest, and for peripherals connected to the Nest through the IEEE 1394 socket, the USB 2.0 OTG socket and the connectivity connector at the rear of the Nest.
Removable hard disk drive 685 (FIG. 6E)	Shown in FIG. 6E located on the right side of the Nest. Preferably, the removable hard disk drive is at least a 20 GB drive, situated within a bay, which can be removed so that the drive can be upgraded to a larger storage capacity. For one embodiment, the drive read and write rates are fast enough so that the Nest supports video reading and writing to and from the disk.
Optional battery compartment for backup power	For storing date and clock information when the Nest is not plugged in, so that the Nest does not lose its clock settings if it loses power.

For one embodiment of the present invention, the Nest includes software drivers, and appropriate infrastructure to allow additional driver support as later versions are released. Specifically, the Nest includes one or more of the following device drivers:

TABLE IV

Nest Software Drivers		
Driver		Description
USB Device Drivers	Digital audio player support	Including inter alia MP3 and WMA support, enabling import and export to and from digital audio players.
	USB based hard disk support	Including inter alia DiskOnKey type products.
	Ethernet dongle driver support	For supporting multiple brands and chipsets of USB ethernet dongles.
	802.11 dongle driver support	For supporting multiple brands and chipsets of USB 802.11.
	Bluetooth support	For supporting multiple brands and chipsets of Bluetooth hosting, connected through the USB connectivity socket. Alternatively, as mentioned hereinabove, the Nest may support Bluetooth

TABLE IV-continued

Nest Software Drivers		
Driver		Description
		internally.
30	USB based DVD RW/CDRW support	For supporting multiple brands of USB based DVD/RW and CDRW devices, for ripping and archiving purposes.
	IEEE 1394 Device Drivers	For supporting multiple brands of USB based DVD/RW and CDRW devices, for ripping and archiving purposes.
35	IEEE 1394 based hard disk support	For backing up the internal hard disk to an external hard disk, for archiving purposes and also for upgrading to a larger hard disk.
	Bluetooth Device Drivers	Keyboard support For inputting data via wireless keyboard.
40	Bluetooth 2.0 support	For data transfer from PDAs and for Bluetooth enabled MP3 players.

For one embodiment of the present invention, the Egg supports three I/O interfaces. Specifically, the I/O interfaces include:

TABLE V

Egg Hardware I/O Interfaces	
Interface	Description
Female audio/video connector 820 (FIG. 8A)	Shown in FIG. 8A on the bottom of the Egg, used to output analog audio and analog video from the Egg to the Nest, the Shell and to other peripheral devices. For one embodiment, the Egg audio/video connector supports multi-system video, including inter alia PAL, NTSC and SECAM. Connection of this connector triggers the Egg to switch to an "on" state, and disconnection puts the Egg in an "off" state.
Female USB 2.0 OTG connector 810 (FIG. 8A)	Shown in FIG. 8A on the bottom of the Egg next to the female A/V connector, used to transfer data between the Egg and the Nest, between the Egg and a "filling station" kiosk, and between the Egg and another Egg.
Stereo mini-jack 530 (FIG. 5)	(Optional) Shown in FIG. 5, located on the side of the Egg, used to attach headphones to listen to music on the Egg. For one embodiment, the stereo mini-jack acts as one of the on/off mechanisms of the Egg.

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For one embodiment, the user interface components of the Egg include:

TABLE VI

Egg Hardware User Interface Components	
Component	Description
Jog dial 520 (FIG. 5)	Shown in FIG. 5 on top of the Egg.
LCD display 510 (FIG. 5)	Shown in FIG. 5 on a side of the Egg.
SD memory slot	Not shown.
Left and right buttons at top of egg	Not shown.

For one embodiment, the Egg includes the following software I/O drivers:

TABLE VII

Egg Software I/O Drivers	
Driver	Description
USB 2.0 OTG drivers	For peripheral transfer.

In accordance with one embodiment of the present invention, the Shell provides the capability to listen to songs and play lists that are being played on the Egg through a user's car deck. Specifically, the Shell includes one or more of the following I/O interfaces:

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TABLE VIII

Shell Hardware I/O Interfaces	
Interface	Description
Male USB 2.0 OTG connector 710 (FIG. 7B)	Shown in FIG. 7B, located on the top of the Shell, used primarily to supply power to the Egg and to recharge the Egg's rechargeable battery.
Male audio/video connector 720 (FIG. 7B)	User to receive analog audio and analog video and pass it to the FM/RF transmitter located in the Shell.

For one embodiment, the Shell includes the following hardware components:

TABLE IX

Shell Hardware Components	
Component	Description
Bluetooth transmitter	(Optional) On top of the Shell.
Bluetooth cassette recorder	(Optional) Inside the Shell.
FM transmitter	Selectable frequency is determined from among a plurality of frequencies displayed on the Egg display, by a setting on the Shell. For one embodiment, both even and odd frequencies are supported for international use. For one embodiment, the FM transmitter includes Radio Data System (RDS) functionality so that when an RDS FM deck receives a signal from the transmitter, it identifies an Egg name and ID#.
RF transmitter	(Optional) For video and audio transmission

For one embodiment of the present invention, the Nest includes at least one of the following functions:

TABLE X

Nest Functionality	
Function	Description
Automatic song record	A user tunes in a channel on a digital cable or DBS box, and activates the record function. The Nest begins to record and index songs played from that moment on. Recording continues until the channel is changed on the digital cable or DBS box, or until the user instructs the Nest to stop recording, for example, through a remote control unit.
Selective song record	A user chooses one or more artists, albums and song names from a list, or enters such data. The user tunes the digital cable or DMS box to a desired channel to selectively record from. The Nest waits for a song that matches the selected criteria, and records the song into the Nest.
Auxiliary song record	A user connects an auxiliary device, such as a CD player, to the Nest, by connecting audio out from the CD player mini-jack to the left and right RCA audio in on the front of the Nest. The Nest is set to record, and the CD is played on the CD player. The Nest begins to digitize ("rip") songs played on the CD player, and stores each song in a separate file. The Nest identifies the song and stores the identifying meta-data in the Nest library.
On screen play list creation	A user creates play lists from songs located on the Nest, using a remote control unit to make selections, from an on-screen menuing system displayed on a television.
Checking in and out songs and play lists	A user checks songs and play lists in and out from the Nest to one or more eggs located in the Nest cradles, using a remote control unit to make selections, from an on-screen menuing system displayed on a television. For one embodiment of the present invention, permission to check out a particular song or play list is subject to a flexible and configurable digital rights management system.

TABLE X-continued

Nest Functionality	
Function	Description
Backing up the Nest for archiving	A user creates a backup of the Nest hard drive for archiving and disk upgrade purposes. For one embodiment, backup is supported through an IEEE 1394 socket, or USB 2.0 sockets, or over TCP/IP connectivity. This function enables the user to upgrade seamlessly to a larger hard disk and not lose data.
DBS/Cable recording	A user records a video into MPEG-4 VHS quality.
Line input recording	A user records analog audio from a line input, and the Nest identifies the meta-data.
Nest front display	(Optional) For one embodiment, the Nest front display includes one or more of (i) album covers, (ii) play list organization, (iii) setup screens, (iv) meta-data confirmation, (v) meta-data entry, (vi) organization of songs, (vii) deletion of songs, (viii) one or more sorted views, (ix) statistics including number of songs recorded in a period of time, (x) data and time setup, (xi) connectivity setup, (xii) Nest registration and naming setup, and (xiii) Egg registration and naming setup.

For one embodiment of the present invention, the Nest and Egg devices support mechanisms to update software in the devices. Software updates are transported to the Nest by one or more of the following:

Placing software on the Egg via a kiosk, such as in a retail environment. When the Egg is subsequently placed in the Nest cradle, the software upgrade is passed to the Nest, and the Nest updates itself and also updates the Egg, as necessary.

Software is received over broadcast medium in the form of video transmission, for example, through the vertical blanking line, or through other video based or audio based data transfer mechanisms.

Software is received over the Internet through the Nest's connectivity connector.

For one embodiment of the present invention, Egg and Nest software updates have a recovery method so that if power is lost during a software update, for example, if an Egg is pulled out during a software update, a rollback can be applied to revert to the previous software version.

For one embodiment of the present invention, the Egg includes at least one of the following functions: (i) playing a song; (ii) selecting a play list and playing it; (iii) next and previous song; (iv) fast forward and rewind; (v) status checking; and (vi) transfer songs or play lists from one Egg to another.

The Egg may receive control commands through the USB connector. (Refer to Table V hereinabove.) Specifically,

when connected to a Nest, the Nest may issue control commands to the Egg, such as a command to advance to the next song;

when connected to the Shell, the Shell may issue control commands to the Egg, such as a command to search for a free FM frequency; and

when connected to a docking station, such as a docking station for the Egg in a room of a house, the docking station may receive infra red commands issued by a user, and translate them into control commands to the Egg over the USB connector.

Reference is now made to FIG. 9, which is a simplified block diagram illustrating interconnectivity of an automatic music library builder with other devices, in accordance with one embodiment of the present invention. Shown in FIG. 9 is an automatic music library builder 910, receiving audio and video feed from a cable or satellite receiver 920 that broadcasts music channels. Music library builder 910 generates an

MP3 music database in accordance with one embodiment of the present invention, optionally filtering broadcast songs according to pre-defined listener settings and preferences.

Optionally, music library builder 910 interconnects with a computer 930 and a personal data assistant (PDA) 940. Listener settings and preferences can be set on computer 930 or PDA 940, and loaded therefrom onto music library builder 910. Music library builder 910 can be programmed and controlled using computer 930 or PDA 940. Music library builder 910 can also be controlled using a remote control unit 950, using an infra-red (IR) or radio frequency (RF) signal.

After automatic music library builder 910 generates a digital music database such as an MP3 database, the database can be streamed to computer 930 or transferred to a PDA 940, with appropriate digital rights management (DRM) algorithms, for playback. Alternatively, the database can be transferred to a portable device 960 with MP3 player capability through a removable memory unit such as a compact disk or memory card.

For one embodiment, automatic music library builder 910 includes a user interface, albeit a limited user interface, that enables a listener to select and categorize songs that are automatically imported into his digital music library. For an alternative embodiment of the present invention, a listener can specify his settings on his computer or PDA, and then load them into the device of an embodiment of the present invention using a USB cable or memory medium.

For one embodiment, the user interface displays the current song, a yes/no indicator, and the cumulative number of songs already recorded. For one embodiment, the user interface also enables a user to view an index of all songs recorded on the current memory unit, and to view an index of all songs recorded on all memory units.

For an alternate embodiment of the present invention, automatic music library builder 910 uses a television 970 to display a user interface. For one embodiment, automatic music library builder 910 includes a video out connector that can be used to connect into television 970. Selections from menu screens displayed on television 970 are made using a control device, such as remote control unit 950, the control device having directional buttons for left-right-up-down and a button for select for one embodiment.

An enhanced embodiment of the present invention incorporates digital rights management. Specifically, meta-data for a song can also include the number of times the song was played on the broadcast music channel. Such number is used

to limit the number of times a listener can access the song from his music library by another digital music player.

In reading the above description, persons skilled in the art will realize that there are many apparent variations that can be applied to the methods and systems described. Thus, with reference to FIGS. 3 and 4, it may be appreciated that the analog audio and the video frame containing meta-data may be captured from different sources, instead of from a single source. Meta-data for broadcast songs may be available, for example, at a broadcaster's Internet site.

Alternatively, meta-data for broadcast songs may be extracted from a video or still image camera that photographs a display screen of a radio that includes meta-data. For example, XM and Sirius satellite radios display meta-data on their screens. Often broadcasters transmit meta-data in an encrypted form, and thus use of a camera enables determination of meta-data without the need to decrypt an encrypted data stream.

For an alternate embodiment of the present invention, meta-data may be included within a video broadcast, for example, as data within a vertical blanking channel. For such an embodiment, the present invention obtains meta-data by extraction from the vertical blanking channel.

It may be appreciated that the Eggs of the present invention may receive digital music from other devices, in addition to the Nest. Thus the Eggs may be compatible with kiosks, such as music kiosks located in music distribution stores used for listening to songs prior to purchase. For one embodiment, when an Egg is checked in with a Nest, the digital music received from other devices and stored within the Egg is archived on the Nest.

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made to the specific exemplary embodiments without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A song separator comprising:
 - a casing;
 - a receiver socket on said casing through which broadcast audio is received, the broadcast audio comprising:
 - a first portion comprising a beginning segment of a first song;
 - a second portion comprising overlap of an ending segment of the first song with a beginning segment of a second song; and
 - a third portion comprising an ending segment of the second song; and
 - a song separator for separating the ending segment of the first song from the beginning segment of the second song in the second portion, by predicting the ending segment of the first song based on the beginning segment of the first song, and by predicting the beginning segment of the second song based on the ending segment of the second song, the predictors being constrained so as to generate the second portion when combined.
2. The song separator of claim 1 further comprising a meta-data identifier housed within said casing for identifying meta-data for the first or second song by finding the first or second song within a database of song meta-data.
3. The song separator of claim 2 wherein said meta-data identifier uses a digital fingerprint of the first or second song to key into the database of meta-data for songs.

4. The song separator of claim 1 further comprising a meta-data identifier housed within said casing for identifying meta-data for the first or second song via manually entered input.

5. The digital music library builder song separator of claim 1 further comprising a meta-data identifier housed within said casing for identifying the meta-data for the first or second song from voice input.

6. The song separator of claim 1 further comprising a meta-data identifier housed within said casing for identifying the meta-data for the first or second song from video input.

7. The song separator of claim 1 further comprising a meta-data identifier housed within said casing for identifying the meta-data for the first or second song by extracting the meta-data from at least one Internet web page.

8. A method for song separation comprising:

- receiving broadcast audio, the broadcast audio comprising:
 - a first portion comprising a beginning segment of a first song;
 - a second portion comprising overlap of an ending segment of the first song with a beginning segment of a second song; and
 - a third portion comprising an ending segment of the second song; and

separating the ending segment of the first song from the beginning segment of the second song in the second portion, by predicting the ending segment of the first song based on the beginning segment of the first song, and by predicting the beginning segment of the second song based on the ending segment of the second song, the predictors being constrained so as to generate the second portion when combined.

9. The method of claim 8 further comprising identifying meta-data for the first or second song by finding the first or second song within a database of meta-data for songs.

10. The method of claim 9 wherein said identifying uses a digital fingerprint of the first or second song to key into the database of meta-data for songs.

11. The method of claim 8 further comprising identifying meta-data for the first or second song via manually entered input.

12. The method of claim 8 further comprising identifying meta-data for the first or second song from voice input.

13. The method of claim 8 further comprising identifying meta-data for the first or second song from video input.

14. The method of claim 8 further comprising identifying meta-data for the first or second song by extracting the meta-data from at least one Internet web page.

15. A non-transitory computer-readable storage medium storing program code for causing a device:

- to receive broadcast audio, the broadcast audio comprising:
 - a first portion comprising a beginning segment of a first song;
 - a second portion comprising overlap of an ending segment of the first song with a beginning segment of a second song; and
 - a third portion comprising an ending segment of the second song; and

- to separate the ending segment of the first song from the beginning segment of the second song in the second portion, by predicting the ending segment of the first song based on the beginning segment of the first song, and by predicting the beginning segment of the second song based on the ending segment of the second song, the predictors being constrained so as to generate the second portion when combined.

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