METHODS, COMPUTER-READABLE MEDIA, AND DATA STRUCTURES FOR BUILDING AN AUTHORITATIVE DATABASE OF DIGITAL AUDIO IDENTIFIER ELEMENTS AND IDENTIFYING MEDIA ITEMS

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to the field of identifying media items. In particular, embodiments of this invention relate to methods, computer-readable media, and data structures capable of building an authoritative database of digital audio identifier elements for identifying media items accessed by users.

BACKGROUND OF THE INVENTION

[0002] Due to recent advances in technology, computer users are now able to enjoy many features that provide an improved user experience, such as playing various media and multimedia content on personal, laptop, or handheld computers, as well as cellular phones and other portable media devices. For example, most computers today are able to play compact discs (CDs) and have an internet connection capable of streaming and downloading audio and video so users can enjoy media while working on their computers. Many computers are also equipped with digital versatile disc (DVD) drives enabling users to watch movies.

[0003] Such users are naturally desirous of metadata information identifying the media accessible via their computing device. Data providers are therefore interested in providing a metadata experience that accurately and quickly identifies a selected media item accessed by a user. As such, conventional systems attempt to identify media items in any number of ways, using data tangential to the media item, rather than the media item itself. For example, identification codes associated with media items or groups of media items, metadata associated with the accessed media item, or other previously identified media items stored near the media item of interest, may all be employed in an attempt to identify an accessed media item. These methods are fraught with error, however, because identification is not based upon the media item itself, but rather tangential data associated with the media item. Moreover, because many media items are stored in different formats, conventional systems have had difficulty identifying media stored in an unfamiliar format. In addition, metadata associated with media items is error prone. Much of this metadata is user-entered, and may misidentify the media item or include incorrect, misspelled, or out-of-date information. In addition, the conventional practice of utilizing identifiers associated with a media collection, such as a compact disc (CD), to provide matching may

also introduce error through misidentification of similar or incorrectly matching identifiers. Moreover, such systems have difficulty identifying solitary media items not downloaded to a user device as part of an album.

[0004] Unfortunately, these issues are not addressed by any conventional system. Conventional techniques provide identification only through tangential data, such as metadata matching or identification number matching. Such conventional techniques provide no assistance for individual media items having no metadata, incorrect metadata, or missing identifiers. Such conventional techniques also fail to perform well where media items are stored in a foreign format. Accordingly, a solution that enables identification of a media item identically in each case, irrespective of the format of the media item or the metadata associated with the media item is desired. There is a need, therefore, for a method or system whereby any media item may be identified based upon the actual content of the media item itself, rather than tangential data associated with the media item. A solution that enables identification of any media item, in any format, with no other identification or metadata is desired.

SUMMARY OF THE INVENTION

[0005] Accordingly, a method (or a computer-readable media or a data structure) for building an authoritative database of digital audio identifier elements from digital media accessed by clients and for correctly identifying metadata associated with a media item accessed by a client is desired to address one or more of these and other disadvantages. The method comprises uploading a candidate base digital audio identifier for each media item on multiple copies of digital media accessed by one or more clients, processing the uploaded candidate base digital audio identifiers to create an authoritative base digital audio identifier for each media item from the digital media, and adding the authoritative base digital audio identifiers to an authoritative database of authoritative base digital audio identifiers associated with other digital media. For example, embodiments of the invention may be well-suited for preparing an authoritative database that may be shared with multiple users to quickly and correctly identify a media item based upon its content.

[0006] In one aspect of the invention, a method of building an authoritative database of digital audio identifier elements from digital media accessed by clients is disclosed. The digital media includes one or more media items. The method comprises uploading a candidate base digital audio identifier for each media item on multiple copies

of digital media accessed by one or more clients. The uploaded candidate base digital audio identifiers are processed to create an authoritative base digital audio identifier for each media item from the digital media. The method also comprises adding the authoritative base digital audio identifiers to an authoritative database of authoritative base digital audio identifiers associated with other digital media.

[0007] In another aspect of the invention, a computer-readable medium having stored thereon a data structure representing a digital audio identifier element for identifying an audio CD of audio media items is disclosed. The data structure comprises a unique album identifier associated with the audio CD and at least one track element. The track element corresponds to an audio media item on the audio CD. The track element comprises a candidate base digital audio identifier and a candidate confirmation digital audio identifier.

[0008] In still another aspect of the invention, a method of identifying metadata associated with a media item accessed by a client is disclosed. The method comprises receiving at least one specimen digital audio identifier associated with a media item. The specimen digital audio identifier is uploaded from a client accessing the media item. The method further matches the specimen digital audio identifier with an authoritative base digital audio identifier, retrieves metadata associated with the authoritative base digital audio identifier; and returns the metadata to the client.

[0009] In yet another aspect of the invention, a computer-readable medium having computer-executable instructions for identifying metadata associated with a media item accessed by a client is disclosed. The computer-executable instructions for performing steps comprises receiving instructions for receiving at least one specimen digital audio identifier associated with a media item. The specimen digital audio identifier being uploaded from a client accessing the media item. The computer-executable instructions for performing steps also comprises matching instructions for matching the specimen digital audio identifier with an authoritative base digital audio identifier. The computer-executable instructions for performing steps comprises retrieving instructions for retrieving metadata associated with the authoritative base digital audio identifier and returning instructions for returning the metadata to the client.

[0010] Alternatively, the invention may comprise various other methods, computer-readable media, and data structures.

[0011] Other features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Fig. 1 is a flow diagram depicting a workflow of the present invention for building an authoritative database of digital audio identifier elements and for identifying media items accessed by clients;

[0013] Fig. 2 is a flow diagram depicting a further workflow of the present invention for building an authoritative database of digital audio identifier elements;

[0014] Fig. 3 is a graph illustrating the present invention ignoring any candidate base digital audio identifier whose difference from the other candidate base digital audio identifiers exceeds a threshold;

[0015] Fig. 4 is a diagram of a data structure of a digital audio identifier element of the present invention;

[0016] Figs. 5 and 6 are diagrams of computer-readable mediums of the present invention; and

[0017] Fig. 7 is a block diagram illustrating one example of a suitable computing system environment in which the invention may be implemented.

[0018] Corresponding reference characters indicate corresponding parts throughout the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Referring now to Fig. 1, a flow diagram depicting a workflow of methods of the present invention for building an authoritative database of digital audio identifier elements and for identifying media items accessed by clients utilizing a media player is shown. The details of this flow diagram are discussed in detail herein, and will be referred to throughout the following discussion.

Method of Building an Authoritative Database

[0020] In general, a user, or client, 21 may utilize a media player 23 on a computing device (e.g., a computer 130, *see* Fig. 7) to access media items stored in the memory (e.g. a hard disk drive 154 of Fig. 7) of the computer. An example of such a media player 23 is the Windows® Media Player by Microsoft Corporation of Redmond, Washington. Other media players or means for accessing media items are also contemplated as within the scope of the present invention. The term computer or computing device may comprise any number of devices, including but not limited to personal, laptop, or handheld computers, as well as cellular phones and other portable media devices, among others. To begin, the user 21 typically accesses a media item with

the media player 23. Accessing such a media item can occur in many ways, including opening a media item stored in the memory 154 of the computer 130 or saving (i.e., ripping) the contents of an audio compact disc (CD) to the computer, among others. Once accessed by the media player 23, the user 21 may desire additional metadata relating to the contents of the accessed media item. The following method facilitates matching of appropriate metadata with media items accessed by such a user 21.

[0021] First, an authoritative database of metadata matching media items must be built at 25 on a server 29 serving the metadata associated with the media items. In one example depicted in Fig. 1, such a server 29 of metadata is supported by Windows Media Internet Services (WMIS). As used herein, the term server 29 can mean one or more servers working together. In any event, to begin this construction, the method for building an authoritative database 25 of digital audio identifier (DAI) elements comprises uploading a candidate base DAI 31 for each media item from multiple copies of digital media (e.g., compact discs (CDs)) accessed by one or more clients 21.

[0022] As used herein, the term "DAI" connotes an identifier of digital audio. In one example, such a DAI comprises sixty-four dimensional vectors of single-precision floating point numbers for identifying digital audio based upon multiple physical characteristics of the actual audio (e.g., music) contained in the media item. An example of a DAI is shown below as an array of sixty-four 4-byte single-precision floating point numbers:

-6.946318, 2.086578, 0.361108, 1.221748, 2.837087, 1.386783, 1.966391,
0.448375, -20.897249, -0.975747, 5.043533,-8.346107, 4.418811,
9.238695, 2.234773, -4.468442, -2.617096, 5.547550, -0.960682, -
8.863153, 1.365220, 3.736820, -8.263194, -8.704166, -0.915178, -
3.908056, -4.839724, 3.292097, 0.295364, -6.583572, 2.353827, -
6.329947, 6.788795, 1.948128, 1.455992,
-1.238343, 0.969089, -7.560797, -0.127568, -3.596416, -4.641246,
2.757606,
-3.432780, -13.090852, -11.206924, -5.684618, 8.277532, 5.793239,
4.531317,
-3.000287, -1.782439, -0.747263, -2.504754, -5.246303, -1.231380,
0.044564, 4.611495, -1.274044, -1.393486, 3.086715, 0.428811, 5.493120,
-8.295065, 3.107833

In particular, the following publications describe how to identify a media item by the contents of the item itself: U.S. Patent Application No. US 2004/0260682 A1, entitled System and method for identifying content and managing information corresponding to objects in a signal, assigned to Microsoft Corporation of Redmond, Washington, U.S.A. and *Distortion Discriminant Analysis for Audio Fingerprinting*, by Burges et al., published in IEEE TRANSACTIONS ON SPEECH AND AUDIO PROCESSING, Vol. 11, No. 3, pp. 165-174 (2003). Such systems and methods may be utilized herein to compare candidate and specimen DAIs with authoritative DAIs, as discussed in greater detail below. The details of such systems and methods would be readily understood by one skilled in the art and will not be discussed in greater detail here. As used herein, the term "candidate" emphasizes that such DAIs are not considered confirmed, or authoritative, but rather are collected to facilitate determination of an authoritative base DAI that may be used as the basis for metadata matching, as discussed in detail below.

[0023] In any event, the method exemplified in Fig. 1 uploads DAIs at 31 from multiple users 21 and collects the candidate base DAIs at 35 from each media item ripped by the user to collect information about the content of each of the accessed media items. In one example of the present invention, the digital media comprises a CD and the uploading 31 occurs when a client 21 rips a CD or inserts a CD into a CD-ROM drive (e.g., optical disk drive 160 of Fig. 7). For example, a client 21 may rip the CD to his personal computer (e.g., 130 of Fig. 7) for use with a media player 23. Because a great number of CDs are ripped each day by the many users 21 of media players 23, such as the Windows Media Player. Thus, the present method can utilize this data to its advantage, utilizing media items provided by users to construct its database of metadata and mapping of metadata identifiers. Rather than obtaining a copy of every single media item for which it has metadata to manually create the authoritative DAI and map it to the correct metadata, the present invention utilizes data uploaded by users 21.

[0024] As noted above, the method of the present invention makes use of users 21 because they collectively have a complete collection of the media items required for identification. When the user 21 rips a CD to a computer 130, the media player 23 will upload several candidate base DAIs at 31 for each track, or media item, of the CD to the server 29, along with a known identifier such as a table of contents identifier (TOC) from the ripped CD. The TOC of the CD is an identifier that, in this instance, the server 29 already has in a repository that is mapped to the album metadata, which is in turn mapped

to the track metadata of the album. With the TOC and the candidate base DAIs collected at 35 by the server 29, the server can generate and map an authoritative base DAI for each track of the ripped CD. As shown in Fig. 2, a set of candidate base DAIs, generally indicated 41, are uploaded during ripping of a CD accessed by a client 21 via a media player 23. Each candidate base DAI 43 is associated with its respective track, along with the TOC 45 for the entire CD. The TOC 45 is used to map to the corresponding TOC record 47 in a metadata repository 51. The metadata repository in turn maps to a CD 53 which has an associated collection of track placeholders 57, each differentiated by track number. These track placeholders 57 may then be mapped to the candidate base DAIs uploaded by the user 31 to the corresponding track in the metadata repository.

[0025] For example, ripping a CD of media items to the user device triggers the uploading 31 of the candidate base DAIs from each of the media items. The candidate base DAIs are determined from small portions, or traces, of each media item taken at a particular time interval from the beginning of each media item. These portions of the media items may be of any desired length (e.g., 6 seconds) and may be utilized to identify particular media items. In other words, a DAI will identify a user's media item independent of format (e.g., Windows Media Audio (WMA), MPEG Audio Layer-3 (MP3), Transform-domain Weighted Interleave Vector Quantization (VQF), waveform (WAV), Real Audio (RA), Advanced Audio Coding (AAC), etc.) using an identifier that is generated from the media item itself, rather than from metadata associated with the media item. Using this identifier, a method embodying aspects of the invention can return the relevant metadata (such as track title, artist, etc.) corresponding to the media item. In one example, the candidate base DAIs are collected at a first time interval of 30 seconds from the beginning of each media item. By collecting the DAIs at the same time interval for each track, the method ensures a consistent comparison between the media item as accessed by different users.

[0026] The uploading the candidate base DAIs at 31 further comprises uploading a TOC associated with each of one or more compact discs accessed by the clients 21. A TOC is included with many CDs for identifying the contents of the CD. TOCs, however, are imperfect identifiers because some CDs do not have TOCs, and other CDs having similar media content may have different TOCs. In addition to uploading candidate base DAIs and TOCs at 31 from a CD of a single user, the method may further comprise uploading a candidate base DAI for each media item from another N copies of the CD

accessed by respective N distinct clients. The method may also comprise uploading a TOC 45 associated with each of the N copies of the CD accessed by respective N distinct clients. In this manner, the method of the present invention can upload data from multiple clients with respect to the same CD. This data may then be analyzed, as discussed below, to determine which of the candidate base DAIs is most representative of a particular media item.

[0027] In addition to the uploading 31 of candidate base DAIs, the method also comprises uploading a candidate confirmation DAI for each media item on the multiple copies of the digital media accessed by the users 21. The candidate confirmation DAI differs from the candidate base DAI in that the candidate confirmation DAI can be used to verify the accuracy of any match provided by the candidate base DAI, as discussed below. In such instances, uploading the candidate base DAIs at 31 comprises uploading at a first time interval of each media item on the digital media, while the uploading the candidate confirmation DAIs comprises uploading at a second time interval, different from the first time interval, of each media item on the digital media. In one example, the candidate confirmation DAIs are uploaded at a second time interval about 20 seconds later than the first time interval for uploading the candidate base DAIs. In another example, the candidate base DAIs are uploaded at a time interval of 30 seconds, while the candidate confirmation DAIs are uploaded at a time interval of 50 seconds. In such an example, DAIs are only collected from those media items of at least about 60 seconds in length, because otherwise the candidate confirmation DAIs cannot be collected for a particular media item. The time interval between the collection of the candidate base DAI and the candidate confirmation DAI may be of any duration without departing from the scope of the claimed invention. In particular, the time interval may be reduced or the collection times moved closer to the beginning of a media item so that media items of shorter duration may also be harvested for candidate base DAIs and confirmation base DAIs.

[0028] An exemplary XML disclosed in Appendix A shows one implementation of how such an upload of a TOC for a CD, a candidate base DAI for each track of the CD, and a candidate confirmation DAI for each track of the CD can occur. In this example, a single TOC associated with a CD is identified. In addition, each of four tracks from the CD numbered one to four includes a candidate base DAI and a candidate confirmation DAI.

[0029] Again referring to Fig. 1, once the DAIs and TOC are uploaded at 31 to the server 29, the method further comprises processing the uploaded candidate base DAIs at 61 to create an authoritative base DAI for each media item associated with the digital media. This portion of the process takes the several candidate base DAIs for a particular media item and processes them into a single authoritative base DAI, thereby establishing a DAI that will be used as the benchmark for a particular media item. This processing to create an authoritative base DAI may include a number of different techniques without departing from the scope of the present invention. In one example, processing the uploading 61 of candidate base DAIs comprises comparing each of the uploaded candidate base DAIs associated with a respective media item with one another. By comparing the candidate base DAIs from different users, but with respect to the same media item, the method can determine if there are differences in the candidate base DAIs as uploaded from different users and process the authoritative base DAI in an effort to minimize those differences. This processing helps overcome the problem of how to obtain an authoritative base DAI associated with a particular media item when the candidate base DAI for any given track can vary from one client to the next. The solution utilized herein comprises uploading candidate base DAIs at 31 from multiple clients and then aggregating those candidate base DAIs to form the authoritative base DAI. Once the server 29 has received some required number of candidate base DAIs for each of the tracks on a CD (e.g., seven candidate base DAIs per track), the method will then proceed to generate the authoritative base DAI, as discussed in greater detail below.

[0030] Processing the uploaded candidate base DAIs at 61 comprises generating an authoritative base DAI element associated with each respective media item uploaded from the CD for identifying each media item of the CD and generating a unique album identifier identifying the CD. In one example, to generate the unique album identifier identifying the CD, a method such as illustrated in Fig. 1 may select the most common TOC of the various TOCs associated with a particular CD as an authoritative TOC. Other ways of generating the unique album identifier are also contemplated as within the scope of the claimed invention.

[0031] The processing of the candidate base DAIs at 61 may further comprise aggregating each of the uploaded candidate base DAIs associated with a respective media item to combine the DAIs into a single measure. In one example, the aggregation is a simple aggregation per dimension using all candidate base DAIs in that dimension. In

particular, the aggregating of the uploaded candidate base DAIs may comprise averaging together all of the uploaded candidate base DAIs associated with a respective media item, excluding any outlier candidate base DAIs. This average candidate base DAI may be utilized as the authoritative base DAI.

[0032] Referring now to Fig. 3 and as would be appreciated by one skilled in the art, each DAI 65 can be thought of as a point in space, its location based upon the sixty-four dimensional vectors of single-precision floating point numbers introduced above. None of the candidate base DAIs 65, although similarly located in the x-y plane of Fig. 3, is necessarily identical to the other candidate base DAIs. These differences in the candidate base DAIs can be caused by hardware (e.g., CD drive differences) or physical damage to the compact disc (e.g., a scratch), among other things. In some cases, it is possible that these differences can cause one or more of the candidate base DAIs 65 to be significantly different from the majority uploaded for a particular media item. For example, an outlier candidate base DAI 65' is depicted in Fig. 3, having a significantly different location than the other DAIs 65. These location differences are analogous to the outlier being distanced from the others, and such distances may be measured in any number of ways (e.g., Euclidean distance).

[0033] Candidate base DAIs fitting this category are considered outliers and are not included in the calculation of the authoritative base DAI. There are multiple methods of determining which, if any, of the candidate base DAIs are outliers. In one example, the processing may comprise ignoring any candidate base DAI wherein the difference between the ignored candidate base DAI and the other candidate base digital audio identifiers exceeds a particular threshold. Such a threshold may be set to remove outlying candidate base DAIs that should not be included in the processing calculations. In one example, a statistical calculation first determines the mean, or average, of all candidate base DAIs. This mean 65'' of each of the candidate base DAIs is depicted in Fig. 3. From this mean 65'', the method calculates the standard deviation of the candidate base DAIs 65, 65'. In one example, any calculated difference between a candidate base DAI and the mean 65'' of the uploaded candidate base DAIs that is greater than some multiple of the standard deviation is considered an outlier and is ignored (i.e., removed) from the averaging calculation. For the example of Fig. 3, the multiple is 1.5 times the standard deviation, as depicted by the circular threshold 67. Because the difference between the outlier candidate base DAI 65' and the mean 65'' of the uploaded candidate base DAIs is greater than the

threshold 67, the outlier may be ignored for purposes of the average calculation. After removal, the average 65'' of the remaining candidate base DAIs may change slightly, due to the removal of the outlier 65'. This revised mean candidate base DAI may be utilized as the authoritative base DAI. Other standard deviation multiples and methods for setting the threshold are also contemplated as within the scope of the present invention.

[0034] Once the authoritative base DAI 65'' associated with a particular media item is determined according to the process at 61 noted above, these values will be added to an authoritative database, to build the database at 25 and add to the store of authoritative base DAIs associated with other digital media. At this point, uploading 31 of additional candidate base DAIs pertaining to this particular digital media item may be terminated, because the authoritative base DAI has been determined. The method now readily utilizes the authoritative base DAI to identify this media item. Uploading of other candidate base DAIs relating to other digital media continues until authoritative base DAIs associated with those media items are added to the authoritative database. As each new media item is accessed by users 21, additional candidate base DAIs are uploaded at 31 from multiple users, collected at 35 by the server 29, and processed at 61 to generate an authoritative base DAI. For previously generated authoritative base DAIs, no candidate base DAIs need be uploaded, unless the method determines that the authoritative base DAI is in error, as is discussed in greater detail below.

[0035] After at least a portion of the authoritative database is built at 25, the method embodying aspects of the invention extracts the authoritative base DAIs from the authoritative database at 71 and performs an index generation that facilitates retrieval of the authoritative base DAIs. The details of such an extraction and indexing would be readily apparent to one skilled in the art and will not be discussed in detail here. The generated index is then processed according to an optimized DAI lookup scheme at 73 and matched to a database of metadata at 75 for matching with the authoritative base DAIs. For example, an album identifier may be assigned to each authoritative base DAI, whereby metadata associated with that album may be readily matched to the appropriate media item. The foregoing process is ongoing as new media items are built into the authoritative database based upon users 21 accessing new media items. In the meantime, however, the method may also identify and present metadata to users associated with previously authenticated media items, as will now be described in detail.

Identification of Metadata Associated with a Media Item

[0036] Referring again to Fig. 1, once the authoritative database contains authoritative base DAIs for each of the previously accessed media items, a method for identifying metadata associated with a media item accessed by a client 21' may be employed. In particular, this method comprises receiving at least one specimen DAI associated with a media item uploaded at 81 from a user 21'. In one example, the method requires receiving at least X number of specimen DAIs from the client 21' associated with the particular media item accessed by the client. Obtaining the at least X number of specimen DAIs associated with a particular media item comprises bundling the identifiers into a metadata query (MDQ) 83 uploaded to the server 29 for matching with the authoritative DAI database.

[0037] More particularly, obtaining the at least X number of specimen DAIs comprises collecting one of the X number of specimen DAIs at a first time interval from the beginning of the media item and collecting each of the remaining X specimen DAIs at a multiple of an offset from the first specimen DAI. This requirement of additional collection of specimen DAIs offset from the first specimen DAI is undertaken to combat the inherent problem relating to the collection of the DAIs as a function of the audio stream. In particular, any variation in the audio stream from user to user results in a slightly different specimen DAI. For example, if one media player 23 begins data collection slightly earlier or later than another, the specimen DAIs associated with each of the players will be slightly offset from one another. As discussed above, the authoritative base DAI stored in the authoritative database should be generated such that it will match as many small variations of the specimen DAIs as possible. The DAI matching process does not require an exact match, but rather is a proximity calculation comparing the specimen DAI to the authoritative base DAI, based upon the sixty-four dimensional vectors of single-precision floating point numbers associated with each DAI. In one example, a first specimen DAI may be taken at a time interval of 30 seconds from the beginning of the media item, the same as the authoritative base DAI, while the additional specimen DAIs are taken at an offset multiple from the first DAI. For example, if five specimen DAIs are taken and the offset is 186 milliseconds, the DAIs are taken at 30 seconds, 30.186 seconds, 29.814 seconds, 30.372 seconds, and 29.628 seconds, respectively. A different time interval from the beginning of the media item, other offsets, and collecting different numbers of specimen DAIs are also contemplated as within the scope of the claimed invention. The time interval from the beginning of the media item, the length of the offset,

and the number of specimen DAIs collected may be altered to tune the method to enhance the likelihood of a proper match.

[0038] In addition, the method contemplates obtaining multiple specimen DAIs associated with multiple media items, or tracks, from a single CD. Here, the method according to an embodiment of the invention receives a plurality of specimen DAIs collected at a first time interval from the beginning of each track of a CD and subsequently thereafter at an offset from each respective first time interval, as described above.

[0039] Once the specimen DAIs associated with a particular media item are uploaded, the method may attempt to match the several traces of the specimen DAI with an appropriate authoritative base DAI of the authoritative database. The several traces are packaged into the MDQ 83 and sent to the server 29. The server looks for matches by comparing the several specimen DAIs of the MDQ 83 with the authoritative base DAIs of the authoritative database. If only one match is found, the metadata associated with that match is determined to be the appropriate metadata. If no matches are found, the method may default to utilizing another matching method, namely matching based upon a TOC or other metadata associated with the media item on the client's computer. If more than one match is found, the method attempts to determine the best match, utilizing whatever information is available, including album TOC, other media items grouped with this media item that may form part of a common album, or other metadata associated with the media item on the client's computer.

[0040] Once the specimen DAI is matched with an authoritative base DAI, the method retrieves metadata associated with the authoritative base DAI and returns the metadata to the client at 87, as shown in Fig. 1. In another example, the method may prioritize the identifiers, for example making the specimen identifiers the default and utilizing other metadata associated with the media item on the client's computer only as a backup identifier.

[0041] When returning the metadata to the client 21' at 87, the method additionally returns an authoritative confirmation DAI to the client at 91. In one embodiment, the authoritative confirmation DAI, which is associated with the media item, verifies the accuracy of the match. The method then utilizes the media player 23 on the client's device to determine if the authoritative confirmation DAI matches a specimen confirmation DAI of the media item. If the client media player 23 determines that the authoritative confirmation DAI does not match a specimen confirmation DAI of the media item, the

client sends, and the server receives, a failure notification at 93. The failure notification comprises a unique track identifier (e.g., WMContentId) and the amount of the confirmation failure discrepancy. Upon receipt of the failure notification at 93, the server 29 logs the received failure notification associated with the authoritative base DAI. A database at the server 29 stores, for example, a counter for each WMContentId created. This counter may be incremented each time a confirmation failure occurs. Once a counter has exceeded a predetermined count (e.g., logging at least X number of failure notifications for a given media item) the method of the present invention determines that the authoritative base DAI is inaccurately matched. At this point, the method will begin the process of uploading and collecting additional candidate base DAIs at 31 from multiple clients 21 for regenerating the authoritative base DAI for this media item and updating the authoritative database at 97. Because the specimen DAI is not accurately matched to the authoritative base DAI, the authoritative base DAI is determined again to ensure the accuracy of the metadata match.

[0042] In another example, the method may further comprise comparing the retrieved metadata related to the authoritative base DAI with metadata associated with the media item uploaded from the client. Such a comparison is another method of determining the accuracy of the retrieved metadata. Other methods of confirming the accuracy of the match are also contemplated as within the scope of the present invention.

Data Structure

[0043] Referring now to Fig. 4, an exemplary computer-readable medium having stored thereon a data structure, generally indicated 101, representing a digital audio identifier element (DAIE) for identifying an audio CD of audio media items is shown. In general, the data structure 101 comprises a unique album identifier associated with the audio CD, generally indicated 103, and at least one track element 105. In the example depicted in Fig. 4, track elements one, two, and three 105 are shown with a Nth track element, demonstrating that the data structure may include any number of track elements. For a standard Redbook CD, for example, up to 99 tracks may be included. Each of the track elements 105 corresponds to an audio media item on the audio CD. Each track element 105 comprises a different candidate base DAI (CBDAI) and a different candidate confirmation DAI (CCDAI), generally as set forth above. In particular, the candidate base

DAI comprises a sample of the media item taken at a first time interval, and the candidate confirmation DAI comprises a sample of the media item taken at a second time interval. In one example, the first time interval is about 30 seconds from the beginning of the media item, and the second time interval is about 50 seconds from the beginning of the media item.

Computer Readable Media

[0044] The present invention further comprises one or more computer-readable media, generally indicated 111 in Fig. 5, having computer-executable instructions for performing a method of building an authoritative database of digital audio identifier elements from digital media accessed by clients, the digital media including one or more media items. In particular, the computer-executable instructions comprise uploading instructions for uploading a candidate base DAI for each media item on multiple copies of digital media accessed by one or more clients. The computer-executable instructions further comprise processing instructions for processing the uploaded candidate base DAIs to create an authoritative base DAI for each media item from the digital media. The computer-executable instructions further comprise adding instructions for adding the authoritative base DAIs to an authoritative database of authoritative base DAIs associated with other digital media.

[0045] The present invention additionally comprises one or more computer-readable media, generally indicated 113 in Fig. 6, having computer-executable instructions for identifying metadata associated with a media item accessed by a client. In particular, the computer-executable instructions comprise receiving instructions for receiving at least one specimen DAI associated with a media item. The specimen DAI may be uploaded from a client accessing the media item. The computer-executable instructions further comprise matching instructions for matching the specimen DAI with an authoritative base DAI. The computer-executable instructions further comprise retrieving instructions for retrieving metadata associated with the authoritative base DAI. The computer-executable instructions additionally comprise returning instructions for returning the metadata to the client.

[0046] In another example also depicted in Fig. 6, the computer-readable media may further comprise computer-executable instructions comprising obtaining instructions for obtaining at least X number of specimen digital audio identifiers associated with the media item from the client. The obtaining instructions may further comprise collecting

instructions for collecting one of the at least X number of specimen digital audio identifiers at a first time interval from the beginning of the media item and collecting each of the remaining X identifiers at an offset from the other identifiers. In another example, the obtaining instructions may further comprise bundling instructions for bundling the identifiers into a metadata query uploaded to an authoritative digital audio identifier database. In still another example, the computer-readable media may further comprise computer-executable instructions comprising returning instructions for returning an authoritative confirmation digital audio identifier associated with the media item to the client to verify the accuracy of the matching. The computer-readable media may further comprise computer-executable instructions comprising receiving instructions for receiving a failure notification from the client when the client determines that the authoritative confirmation digital audio identifier does not match a specimen confirmation digital audio identifier of the media item. The computer-readable media may further comprise computer-executable instructions comprising logging instructions for logging the received failure notification associated with the authoritative base digital audio identifier and determining instructions for determining that the authoritative base digital audio identifier is inaccurately matched when the logging logs at least X number of failure notifications. The computer-readable media may further comprise computer-executable instructions comprising uploading instructions for uploading additional candidate base digital audio identifiers for the media item from multiple users for creating a new authoritative base digital audio identifier when the specimen digital audio identifier is not accurately matched to the authoritative base digital audio identifier. In addition, the computer-readable media may further comprise computer-executable instructions comprising comparing instructions for comparing the retrieved metadata related to the authoritative base digital audio identifier with metadata associated with the media item uploaded from the client to determine the accuracy of the retrieved metadata.

General Purpose Computing Device

[0047] Fig. 7 shows one example of a general purpose computing device in the form of a computer 130. In one embodiment of the invention, a computer such as the computer 130 is suitable for use in the other figures illustrated and described herein. In one example, the client computer or device discussed above may be embodied by computer 130. Computer 130 additionally has one or more processors or processing units 132 and a system memory 134. In the illustrated embodiment, a system bus 136 couples

various system components including the system memory 134 to the processors 132. The bus 136 represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnect (PCI) bus also known as Mezzanine bus.

[0048] The computer 130 typically has at least some form of computer readable media. Computer readable media, which include both volatile and nonvolatile media, removable and non-removable media, may be any available medium that can be accessed by computer 130. By way of example and not limitation, computer readable media comprise computer storage media and communication media. Computer storage media include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions, data structures, program modules or other data. In one example, computer storage media include RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store the desired information and that can be accessed by computer 130. Communication media typically embody computer readable instructions, data structures, program modules, or other data in a modulated data signal such as a carrier wave or other transport mechanism and include any information delivery media. Those skilled in the art are familiar with the modulated data signal, which has one or more of its characteristics set or changed in such a manner as to encode information in the signal. Wired media, such as a wired network or direct-wired connection, and wireless media, such as acoustic, RF, infrared, and other wireless media, are examples of communication media. Combinations of the any of the above are also included within the scope of computer readable media.

[0049] The system memory 134 includes computer storage media in the form of removable and/or non-removable, volatile and/or nonvolatile memory. In the illustrated embodiment, system memory 134 includes read only memory (ROM) 138 and random access memory (RAM) 140. A basic input/output system 142 (BIOS), containing the basic routines that help to transfer information between elements within computer 130, such as

during start-up, is typically stored in ROM 138. RAM 140 typically contains data and/or program modules that are immediately accessible to and/or presently being operated on by processing unit 132. By way of example, and not limitation, Fig. 7 illustrates operating system 144, application programs 146, other program modules 148, and program data 150.

[0050] The computer 130 may also include other removable/non-removable, volatile/nonvolatile computer storage media. In one example, Fig. 7 illustrates a hard disk drive 154 that reads from or writes to non-removable, nonvolatile magnetic media. Fig. 7 also shows a magnetic disk drive 156 that reads from or writes to a removable, nonvolatile magnetic disk 158, and an optical disk drive 160 that reads from or writes to a removable, nonvolatile optical disk 162 such as a CD-ROM or other optical media. Other removable/non-removable, volatile/nonvolatile computer storage media that can be used in the exemplary operating environment include, but are not limited to, magnetic tape cassettes, flash memory cards, digital versatile disks, digital video tape, solid state RAM, solid state ROM, and the like. The hard disk drive 154, and magnetic disk drive 156 and optical disk drive 160 are typically connected to the system bus 136 by a non-volatile memory interface, such as interface 166.

[0051] The drives or other mass storage devices and their associated computer storage media discussed above and illustrated in Fig. 7, provide storage of computer readable instructions, data structures, program modules and other data for the computer 130. In Fig. 7, for example, hard disk drive 154 is illustrated as storing operating system 170, application programs 172, other program modules 174, and program data 176. Note that these components can either be the same as or different from operating system 144, application programs 146, other program modules 148, and program data 150. Operating system 170, application programs 172, other program modules 174, and program data 176 are given different numbers here to illustrate that, at a minimum, they are different copies.

[0052] A user may enter commands and information into computer 130 through input devices or user interface selection devices such as a keyboard 180 and a pointing device 182 (e.g., a mouse, trackball, pen, or touch pad). Other input devices (not shown) may include a microphone, joystick, game pad, camera, scanner, or the like. These and other input devices are connected to processing unit 132 through a user input interface 184 that is coupled to system bus 136, but may be connected by other interface and bus structures, such as a parallel port, game port, or a Universal Serial Bus (USB). A monitor 188 or other type of display device is also connected to system bus 136 via an interface,

such as a video interface 190. In addition to the monitor 188, computers often include other peripheral output devices (not shown) such as a printer and speakers, which may be connected through an output peripheral interface (not shown).

[0053] The computer 130 may operate in a networked environment using logical connections to one or more remote computers, such as a remote computer 194. The remote computer 194 may be a personal computer, a server, a router, a network PC, a peer device or other common network node, and typically includes many or all of the elements described above relative to computer 130. The logical connections depicted in Fig. 7 include a local area network (LAN) 196 and a wide area network (WAN) 198, but may also include other networks. LAN 136 and/or WAN 138 can be a wired network, a wireless network, a combination thereof, and so on. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets, and global computer networks (e.g., the Internet).

[0054] When used in a local area networking environment, computer 130 is connected to the LAN 196 through a network interface or adapter 186. When used in a wide area networking environment, computer 130 typically includes a modem 178 or other means for establishing communications over the WAN 198, such as the Internet. The modem 178, which may be internal or external, is connected to system bus 136 via the user input interface 184, or other appropriate mechanism. In a networked environment, program modules depicted relative to computer 130, or portions thereof, may be stored in a remote memory storage device (not shown). By way of example, and not limitation, Fig. 7 illustrates remote application programs 192 as residing on the memory device. It will be appreciated that the network connections shown are exemplary and other means of establishing a communications link between the computers may be used.

[0055] Generally, the data processors of computer 130 are programmed by means of instructions stored at different times in the various computer-readable storage media of the computer. Programs and operating systems are typically distributed, in one example, on floppy disks or CD-ROMs. From there, they are installed or loaded into the secondary memory of a computer. At execution, they are loaded at least partially into the computer's primary electronic memory. The invention described herein includes these and other various types of computer-readable storage media when such media contain instructions or programs for implementing the operations described below in conjunction with a microprocessor or other data processor.

[0056] For purposes of illustration, programs and other executable program components, such as the operating system, are illustrated herein as discrete blocks. It is recognized, however, that such programs and components reside at various times in different storage components of the computer, and are executed by the data processor(s) of the computer.

[0057] Although described in connection with an exemplary computing system environment, including computer 130, the invention is operational with numerous other general purpose or special purpose computing system environments or configurations. The computing system environment is not intended to suggest any limitation as to the scope of use or functionality of the invention. Moreover, the computing system environment should not be interpreted as having any dependency or requirement relating to any one or combination of components illustrated in the exemplary operating environment. Examples of well known computing systems, environments, and/or configurations that may be suitable for use with the invention include, but are not limited to, personal computers, server computers, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, mobile telephones, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

[0058] In operation, a computer 130 acting as the server 29 executes a method such as described above for building an authoritative database of DAI elements from digital media accessed by clients, wherein the digital media includes one or more media items. The computer 130 or its components uploading a candidate base DAI for each media item on multiple copies of digital media accessed by one or more clients. The computer or its components processing the uploaded candidate base DAIs to create an authoritative base DAI for each media item from the digital media. The computer or its components adding the authoritative base DAIs to an authoritative database of authoritative base DAIs associated with other digital media.

[0059] Also in operation, a computer 130 acting as a server 29 executes another method such as described above for identifying metadata associated with a media item accessed by a client. The computer 130 or its components receiving at least one specimen DAI associated with a media item, wherein the specimen DAI is uploaded from a client accessing the media item. The computer 130 or its components matching the specimen

DAI with an authoritative base DAI, retrieving metadata associated with the authoritative base DAI, and returning the metadata to the client.

[0060] Additionally in operation, a computer 130 acting as a server 29 executes another method such as described above for retrieving metadata associated with a media item accessed by a client. The computer 130 or its components receiving, if available, a TOC associated with a compact disc (CD) accessed by a client. The computer 130 or its components further receiving, if the TOC is not available, at least one specimen DAI associated with the CD, wherein the specimen DAI is uploaded from the client accessing the CD. The computer 130 or its components additionally matching the specimen DAI with an authoritative base DAI, retrieving metadata associated with retrieving metadata associated with the CD based on either the TOC or the authoritative base DAI, and returning the retrieved metadata to the client.

[0061] Those skilled in the art will note that the order of execution or performance of the methods illustrated and described herein is not essential, unless otherwise specified. That is, it is contemplated by the inventors that elements of the methods may be performed in any order, unless otherwise specified, and that the methods may include more or less elements than those disclosed herein.

[0062] When introducing elements of the present invention or the embodiment(s) thereof, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0063] In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

[0064] As various changes could be made in the above products and methods without departing from the scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

APPENDIX A

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WHAT IS CLAIMED IS:

1. A method of identifying metadata associated with a media item accessed by a client, said method comprising:

creating an authoritative base digital audio identifier corresponding to a media item from a plurality of candidate base digital audio identifiers, said candidate base digital audio identifiers being uploaded by multiple users, wherein each of said candidate base digital audio identifiers is uploaded with a known identifier corresponding to the media item;

receiving at least one specimen digital audio identifier associated with the media item, said specimen digital audio identifier being uploaded from a client accessing the media item;

matching said specimen digital audio identifier with the created authoritative base digital audio identifier;

retrieving metadata associated with said matched authoritative base digital audio identifier; and

returning said retrieved metadata to said client.

2. The method of claim 1 wherein receiving the specimen digital audio identifier comprises obtaining at least a predetermined number of specimen digital audio identifiers associated with said media item from the client.

3. The method of claim 2 wherein said obtaining the predetermined number of specimen digital audio identifiers comprises collecting one of said specimen digital audio identifiers at a first time interval from the beginning of the media item and collecting each of the remaining specimen digital audio identifiers at an offset from each other.

4. The method of claim 2 wherein obtaining the predetermined number of specimen digital audio identifiers associated with said media item comprises

bundling said specimen digital audio identifiers into a metadata query uploaded to an authoritative digital audio identifier database.

5. The method of claim 4 wherein receiving the specimen digital audio identifier comprises receiving multiple specimen digital audio identifiers associated with multiple media items from a single CD.

6. The method of claim 5 wherein said receiving multiple specimen digital audio identifiers associated with multiple media items from a single CD further comprises collecting said multiple specimen digital audio identifiers at a first time interval from the beginning of each media item of the CD and subsequently thereafter at an offset from the respective first time interval.

7. The method of claim 1 further comprising returning an authoritative confirmation digital audio identifier associated with said media item to said client to verify the accuracy of the matching.

8. The method of claim 7 further comprising receiving a failure notification from said client when said client determines that said authoritative confirmation digital audio identifier does not match a specimen confirmation digital audio identifier of said media item.

9. The method of claim 8 further comprising logging said received failure notification associated with said authoritative base digital audio identifier and determining that said authoritative base digital audio identifier is inaccurately matched when said logging logs at least a predetermined number of failure notifications.

10. The method of claim 9 further comprising uploading additional candidate base digital audio identifiers for said media item from multiple users for creating a new authoritative base digital audio identifier when the specimen digital audio identifier is not accurately matched to the authoritative base digital audio identifier.

11. The method of claim 1 further comprising comparing said retrieved metadata related to said authoritative base digital audio identifier with

metadata associated with the media item uploaded from said client to determine the accuracy of the retrieved metadata.

12. A computer-readable storage media having computer-executable instructions for identifying metadata associated with a media item accessed by a client, said computer-executable instructions for performing steps comprising:

uploading instructions for creating an authoritative base digital audio identifier corresponding to a media item from a plurality of candidate base digital audio identifiers, said candidate base digital audio identifiers being uploaded by multiple users, wherein each of said candidate base digital audio identifiers is uploaded with a known identifier corresponding to the media item;

receiving instructions for receiving at least one specimen digital audio identifier associated with the media item, said specimen digital audio identifier being uploaded from a client accessing the media item;

matching instructions for matching said specimen digital audio identifier with the created authoritative base digital audio identifier;

retrieving instructions for retrieving metadata associated with said authoritative base digital audio identifier; and

returning instructions for returning said retrieved metadata to said client.

13. The computer-readable storage media of claim 12 wherein said receiving instructions of said computer-executable instructions further comprise:

obtaining instructions for obtaining at least a predetermined number of specimen digital audio identifiers associated with said media item from the client.

14. The computer-readable storage media of claim 13 wherein said obtaining instructions of said computer-executable instructions further comprise:

collecting instructions for collecting one of said specimen digital audio identifiers at a first time interval from the beginning of the media item and collecting each of the remaining specimen digital audio identifiers at an offset from each other.

15. The computer-readable storage media of claim 13 wherein said obtaining instructions of said computer-executable instructions further comprise:

bundling instructions for bundling said identifiers into a metadata query uploaded to an authoritative digital audio identifier database.

16. The computer-readable storage media of claim 12 further comprising returning instructions for returning an authoritative confirmation digital audio identifier associated with said media item to said client to verify the accuracy of the matching.

17. The computer-readable storage media of claim 16 further comprising receiving instructions for receiving a failure notification from said client when said client determines that said authoritative confirmation digital audio identifier does not match a specimen confirmation digital audio identifier of said media item.

18. The computer-readable storage media of claim 17 further comprising:

logging instructions for logging said received failure notification associated with said authoritative base digital audio identifier; and

determining instructions for determining that said authoritative base digital audio identifier is inaccurately matched when said logging logs at least a predetermined number of failure notifications.

19. The computer-readable storage media of claim 18 wherein the uploading instructions are further for uploading additional candidate base digital audio identifiers for said media item from multiple users for creating a new authoritative base digital audio identifier when the specimen digital audio

identifier is not accurately matched to the authoritative base digital audio identifier.

20. The computer-readable storage media of claim 12 further comprising comparing instructions for comparing said retrieved metadata related to said authoritative base digital audio identifier with metadata associated with the media item uploaded from said client to determine the accuracy of the retrieved metadata.