PCT/US05/05254

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/US 05/05254

18 FEB 05 (18.02.05)
International Filing Date

PCT INTERNATIONAL APPLICATION
RO/US
Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 04-103PCT

Box No. I TITLE OF INVENTION
Method and Apparatus for Identification of Broadcast Source

Box No. II APPLICANT ☐ This person is also inventor

Name and address: ***(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)***

Shazam Entertainment, Ltd.
2925 Ross Road
Palo Alto, CA 94303
United States of America

Telephone No.

Facsimile No

Teleprinter No.

Applicant's registration No. with the Office

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: ***(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)***

WANG, Avery Li-Chun
2925 Ross Road
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United States of America

This person is:
☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No with the Office

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name, for a legal entity, full official designation. The address must include postal code and name of country.)*

Joseph A. Herndon
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United States of America

Telephone No. 312-913-0001

Facsimile No. 312-913-0002

Teleprinter No.

Agent's registration No. with the Office 50,469

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Roku EX1008
IPR2024-01058
U.S. Patent No. 10,719,849

Box No.V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a), the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

☐ KR Republic of Korea **is not designated** for any kind of national protection

☐ RU Russian Federation **is not designated** for any kind of national protection

(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earler application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member	regional application:* regional Office	international application: receiving Office
item (1) 19 February 2004 (19.02.04)	60/545,879	US		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☒ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

** Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)). . . .*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/US

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*:

			Number of declarations
☐	Box No. VIII (i)	Declaration as to the identity of the inventor :	
☐	Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent :	
☐	Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application :	
☐	Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America) :	
☐	Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty :	

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Sheet No. ...3...

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application **contains:**

(a) in **paper form**, the following number of sheets:

request (including declaration sheets)	: 3
description (excluding sequence listing and/or tables related thereto)	: 26
claims	: 7
abstract	: 1
drawings	: 5
Sub-total number of sheets	42
sequence listing	:
tables related thereto	:
(for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c)	
Total number of sheets	: 42

(b) ☐ **only in computer readable form** (Section 801(a)(i))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

(c) ☐ **also in computer readable form** (Section 801(a)(ii))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the
- ☐ sequence listing: .....
- ☐ tables related thereto: .....

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*: — Number of items

1. ☒ fee calculation sheet : 1
2. ☐ original separate power of attorney :
3. ☐ original general power of attorney :
4. ☐ copy of general power of attorney; reference number, if any: ..... :
5. ☐ statement explaining lack of signature :
6. ☐ priority document(s) identified in Box No. VI as item(s): ..... :
7. ☐ translation of international application into *(language)*: ..... :
8. ☐ separate indications concerning deposited microorganism or other biological material :
9. ☐ sequence listing in computer readable form *(indicate type and number of carriers)*
   - (i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application) :
   - (ii) ☐ *(only where check-box (b)(i) or (c)(i) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter* :
   - (iii) ☐ together with relevant statement as to the identity of the copy or copies with the sequence listing mentioned in left column :
10. ☐ tables in computer readable form related to sequence listing *(indicate type and number of carriers)*
    - (i) ☐ copy submitted for the purposes of international search under Section 802(b-*quater*) only (and not as part of the international application) :
    - (ii) ☐ *(only where check-box (b)(ii) or (c)(ii) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Section 802(b-*quater*) :
    - (iii) ☐ together with relevant statement as to the identity of the copy or copies with the tables mentioned in left column :
11. ☐ other *(specify)*: ..... :

Figure of the drawings which should accompany the abstract:

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request)

Joseph A. Herndon
Reg. No. 50,469

(18.02.05)

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1. Date of actual receipt of the purported international application: DT03 Rec'd PCT/PTO 18 FEB 2005
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/ US
6. ☐ Transmittal of search copy delayed until search fee is paid

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Date of receipt of the record copy by the International Bureau:

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This sheet is not part of and does not count as a sheet of the international application.

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FEE CALCULATION SHEET

Annex to the Request

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International Application No. PCT/US 05/05254

Date stamp of the receiving Office 18.02.05

Applicant's or agent's file reference **04-103PCT**

Applicant

Shazam Entertainment, Ltd

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . 300.00 [T] — 300

2. SEARCH FEE . . . . . 1,000.00 [S] — 1000

International search to be carried out by US

(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FILING FEE

Where item (b) and/or (c) of Box No. IX apply, enter **Sub-total number of sheets**
Where item (b) and (c) of Box No. IX do not apply, enter **Total number of sheets** } 42

[i1] first 30 sheets . . . . . 1,134.00 [i1] — 1134

[i2] 12 (number of sheets in excess of 30) x 12.00 (fee per sheet) = 144.00 [i2] — 144

[i3] additional component (only if sequence listing and/or tables related thereto are filed in computer readable form under Section 801(a)(i), or both in that form and on paper, under Section 801(a)(ii)):

400 x _____ (fee per sheet) = _____ [i3] — 0

Add amounts entered at i1, i2 and i3 and enter total at I . . . . 1,278.00 [I] — 1278

(Applicants from certain States are entitled to a reduction of 75% of the international filing fee. Where the applicant is (or all applicants are) so entitled,

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* . . . . . 20.00 [P] — 20

5. TOTAL FEES PAYABLE . . . . . 2,598.00 TOTAL — 2598

Add amounts entered at T, S, I and P, and enter total in the TOTAL box

MODE OF PAYMENT

- [x] authorization to charge deposit account (see below)
- [ ] postal money order
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- [ ] revenue stamps
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AUTHORIZATION TO CHARGE (OR CREDIT) DEPOSIT ACCOUNT

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- [x] Authorization to charge the total fees indicated above.
- [x] *(This check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit)* Authorization to charge any deficiency or credit any overpayment in the total fees indicated above.
- [x] Authorization to charge the fee for priority document.

Receiving Office: US

Deposit Account No.: 13-2490

Date: 18 February 2005

Name: Joseph A. Herndon

Signature:

Form PCT/RO/101 (Annex) (January 2004)
LegalStar 2004, Form PCTREQ

See Notes to the fee calculation sheet

MBHB Case No. 04-103-PCT

TITLE: Method and Apparatus for Identification of Broadcast Source

CROSS-REFERENCE TO RELATED APPLICATIONS

The present patent application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Serial No. 60/545,879, filed on February 19, 2004, the entirety of which is herein incorporated by reference.

FIELD OF INVENTION

The present invention generally relates to identifying a source of transmitted content, and more particularly, to matching audio or media file samples to a broadcast source from which the sample was transmitted.

BACKGROUND

As industries move toward multimedia rich working environments, usage of all forms of audio and visual content representations (radio broadcast transmissions, streaming video, audio canvas, visual summarization, etc.) becomes more frequent. Whether a user, content provider, or both, everybody searches for ways to optimally utilize such content. For example, one method that has much potential for creative uses is content identification. Enabling a user to identify content that the user is listening to or watching offers a content provider new possibilities for success.

As a specific example, suppose a user hears a song or piece of music broadcast over the radio that the user would like to purchase, but the user cannot identify the song.

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A content provider could enable a fingerprint of the song to be captured via a telephone handset and then identify the content. After recognition, the content provider could send identifying information (e.g., title, artist(s) and record label) to the user, with e-commerce options, such as to order the music or a corresponding ring tone, for example.

Furthermore, if the user could identify a broadcast source of desired content, more commerce possibilities become available to the content provider, such as advertisement and promotional plans, for example.

Existing methods for identifying the broadcast source of desired content have some drawbacks. For example, watermarks have been used by broadcast stations for identification purposes. Each broadcast station would embed a watermark into an audio stream that identifies the respective station. Thus, each broadcast station would need to actively embed a watermark into the audio stream, increasing data processing complexity, and furthermore each broadcast station would need to use a watermarking technique that follows an agreed-upon standard used by a source identification system. Any station that does not follow such standards would not be identified by these means. Furthermore, a watermark signal needs to be robust enough to withstand distortion, which can occur if audio is sampled within a noisy room with reverberation or if the audio is subject to lossy compression such as GSM, AMR, EVRC, QCP, etc., for example.

Another method for identifying the broadcast source of desired content includes performing a cross-correlation analysis between an audio sample and audio feeds captured from broadcast stations (e.g., from a monitoring station). A matching station would show a strong spike in the cross correlation. However, a difficulty with cross-correlation analysis is that where a lossy compression means is employed, signals are

weak and strong correlations may be difficult to achieve. In many voice codecs, phase information can be destroyed and a cross-correlation analysis would not yield a peak even if the audio sample and correct matching broadcast feed were cross-correlated, for example.

New methods for identifying broadcast sources or content providers of desired content are desirable.

SUMMARY

Within embodiments disclosed herein, a method for identifying a broadcast source of an audio sample is disclosed. The method includes recording an audio sample and a time at which the audio sample was recorded, and then identifying characteristics of the audio sample and an estimated time offset of the audio sample. The estimated time offset defines a time difference between a start time of the audio sample and the time at which the audio sample was recorded. The method further includes comparing the characteristics and the estimated time offset of the audio sample with characteristics and time offsets of samples taken from broadcast stations and taken at approximately the time at which the audio sample was recorded, and based on the comparison, identifying a broadcast station from which the audio sample was broadcast.

In another embodiment, the method for identifying a broadcast source of content includes comparing an identity of an audio sample with identities of broadcast audio samples taken from broadcast channels being monitored, and comparing a time offset of the audio sample with time offsets of the broadcast audio samples. The time offsets define an elapsed time between when a sample was taken and when the time offset

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comparison occurs plus a relative time offset, which defines a time difference between a start time of a sample and a time when a sample was recorded. The method further includes based on substantially matching identities and substantially matching time offsets, identifying a broadcast channel from which the audio sample was recorded.

In still another embodiment, a monitoring station is disclosed that includes broadcast channel samplers, an audio recognition engine and a processor. The broadcast channel samplers sample audio from respective broadcast stations and the audio recognition engine determines characteristics of the audio sampled from the respective broadcast stations and an estimated time offset of the audio that defines a time between a beginning of an original recording from which the audio sample was taken and a time at which the sample was taken. The processor receives a user audio sample, compares the characteristics and the estimated time offset of the audio sampled from the respective broadcast stations and taken at approximately the time at which the user audio sample was recorded with characteristics and a time offset of the user audio sample, and based on the comparisons, identifies a broadcast station from which the user audio sample was broadcast.

These as well as other features, advantages and alternatives will become apparent to those of ordinary skill in the art by reading the following detailed description, with appropriate reference to the accompanying drawings.

BRIEF DESCRIPTION OF FIGURES

Figure 1 illustrates one example of a system for identifying a broadcast source of desired content.

Figure 2 is a flowchart depicting one embodiment of a method of identifying a broadcast source.

Figure 3 illustrates another example of a system to identify a broadcast source of an audio sample.

Figure 4 is a flowchart depicting another embodiment of a method of identifying a broadcast source.

Figure 5 illustrates another example of a system for identifying a broadcast source of an audio sample.

DETAILED DESCRIPTION

In the field of content identification, it may be desirable to identify not only content, but also a source (e.g., channel, stream, or station) of a broadcast transmission. For example, it may be desirable to detect from a free-field audio sample of a radio broadcast which radio station a user is listening to, as well as to what song the user is listening.

Exemplary embodiments described below illustrate a method and apparatus for identifying a broadcast source of desired content. In one embodiment, a user can utilize an audio sampling device including a microphone and optional data transmission means to identify broadcast sources. The user may hear an audio program being broadcast from some broadcast means, such as radio or television, and can record a sample of the audio using the audio sampling device. The sample is then conveyed to an analyzing means to determine to which broadcast station the user is listening. The broadcast information may then be reported back to the user, combined with an advertisement of a promotion, prize

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notification, discount offers, and other information specific for a certain radio station, for example. The information may also be reported to a consumer tracking agency, or otherwise aggregated for statistical purposes, for example. Thus, not only can an audio sample be analyzed to identify its content using a free-field content identification technique, the audio sample may also be analyzed to determine its broadcast source.

Referring now to the figures, Figure 1 illustrates one example of a system for identifying a broadcast source of desired content. The system includes an audio sampling device 102, which a user utilizes to record an audio sample broadcast or transmitted by a broadcaster 104, such as a radio or television content provider for example. The user can then cause the audio sampling device 102 to send the audio sample to a sample analyzer 106 via a wireless or wired means. As such, the audio sampling device 102 may be a mobile cellular telephone, a PDA, or any device with processing means. Using the audio sample, the sample analyzer 106 can identify information pertaining to the broadcast, such as by accessing a database 108 containing audio sample and broadcast information, for example. The information may include content identification and/or broadcast identification. The broadcast information may then be reported back to the user by sending the information to the audio sampling device 102. Additional information may also be sent with the broadcast information, such as promotional advertisements, discount offers, and other information specific for a certain broadcaster, for example. The broadcast information may also be reported to a data store 110, which may be a consumer tracking agency, or other statistical center, for example.

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Source Identification via Relative Time Comparison

In one embodiment, a broadcast source is identified by performing a time-stamped recording of an audio sample and recordings from broadcast channels, and then identifying characteristics of the recordings for comparison. For example, "fingerprints" of recordings taken at similar times can be compared, and such a comparison allows for a direct identification of the broadcast channel from which the audio sample was recorded. Using this method, spectrogram peaks or other characteristics of the signal rather than the direct signals are compared. Further, the correct broadcast channel can be identified without any content identification being required, for example.

Figure 2 is a flowchart depicting the method of identifying a broadcast source. Initially, in the field, a user may collect an audio sample with a sampling device, as shown at block 202. The sampling device will further time stamp the sample in terms of a "real-time" offset from a common time base. Using the technique of Wang and Smith (described more fully below), described within U.S. Patent Application Publication US 2002/0083060, entitled System and Methods for Recognizing Sound and Music Signals in High Noise and Distortion, the entire disclosure of which is herein incorporated by reference as if fully set forth in this description, characteristics of the sample and an estimated time offset of the audio sample within the "original" recording are determined, as shown at blocks 204 and 206 (e.g., to determine the point in a song when the sample was recorded).

At the same time, samples from broadcast channels being monitored are recorded, as shown at block 208. Similar to user samples, each broadcast sample is also time stamped in terms of a "real-time" offset from a common time base. Further, using the

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technique of Wang and Smith, described below, characteristics and an estimated time offset of the broadcast sample within the "original" recording are determined, as shown at blocks 210 and 212 (e.g., to determine the point in a song when the sample was recorded).

Then the user sample characteristics are compared with characteristics from broadcast samples that were taken at or near the time the user sample was recorded, as shown at block 214. The user audio sample time stamp is used to identify broadcast samples for comparison. Further, the time offset of the user audio sample is compared to the time offset of the broadcast sample to identify a match, as shown at block 216. If the real-time offsets are within a certain tolerance, e.g., one second, then the user audio sample is considered to be originating from the same source as the broadcast sample, since the probability that a random performance of the same audio content (such as a hit song) is synchronized to less than one second in time is low.

The user audio sample is compared with samples from all broadcast channels until a match is found, as shown at blocks 218 and 220. Once a match is found, the broadcast source of the user sample is identified, as shown at block 222.

Figure 3 illustrates one example of a system to identify a broadcast source of an audio sample according to the method shown in Figure 2. The audio sample may originate from any of radio station 1, radio station 2, radio station 3, ..., or radio station k 302. A user may record the audio sample being broadcast from an individual receiver 304 on an audio sampling device 306 (e.g., a mobile telephone), along with a sample time (e.g., time according to standard reference clock at which the sample is recorded).

The user may then dial a service to identify broadcast information pertaining to the audio sample, such as an IVR answering system 308, for example. Based on system

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setup and user constraints, the audio sample is provided to the IVR system 308 from any number of analog or digital sources, such as a stereo system, television, radio broadcast, Internet streaming broadcast, or any other suitable means of transmitting such recorded material. Depending on the source, the sample can be in the form of acoustic waves, radio waves, a digital audio PCM stream, a compressed digital audio stream (such as Dolby Digital or MP3), or an Internet streaming broadcast. A user interacts with the IVR system 308 through a standard interface such as a telephone, mobile telephone, web browser, or email.

The system 308 will initially receive the audio sample from the sampling device 306 and then identify or compute characteristics or fingerprints of the sample. The particular locations within the sample at which fingerprints are computed depend on reproducible points in the sample. Such reproducibly computable locations are referred to as "landmarks." The location within the sample of the landmarks can be determined by the sample itself, i.e., is dependent upon sample qualities, and is reproducible. That is, the same landmarks are computed for the same signal each time the process is repeated. A landmarking scheme may mark about 5-10 landmarks per second of sound recording; of course, landmarking density depends on the amount of activity within the sound recording.

One landmarking technique, known as Power Norm, is to calculate the instantaneous power at every possible timepoint in the recording and to select local maxima. One way of doing this is to calculate the envelope by rectifying and filtering the waveform directly. Another way is to calculate the Hilbert transform (quadrature) of the

signal and use the sum of the magnitudes squared of the Hilbert transform and the original signal. Other methods for calculating landmarks may also be used.

Once the landmarks have been computed, a fingerprint is computed at or near each landmark timepoint in the recording. The nearness of a feature to a landmark is defined by the fingerprinting method used. In some cases, a feature is considered near a landmark if it clearly corresponds to the landmark and not to a previous or subsequent landmark. In other cases, features correspond to multiple adjacent landmarks. The fingerprint is generally a value or set of values that summarizes a set of features in the recording at or near the timepoint. In one embodiment, each fingerprint is a single numerical value that is a hashed function of multiple features. Other examples of fingerprints include spectral slice fingerprints, multi-slice fingerprints, LPC coefficients, cepstral coefficients, and frequency components of spectrogram peaks.

Fingerprints can be computed by any type of digital signal processing or frequency analysis of the signal. In one example, to generate spectral slice fingerprints, a frequency analysis is performed in the neighborhood of each landmark timepoint to extract the top several spectral peaks. A fingerprint value is just the single frequency value of the strongest spectral peak.

To take advantage of the time evolution of many sounds, a set of timeslices is determined by adding a set of time offsets to a landmark timepoint. At each resulting timeslice, a spectral slice fingerprint is calculated. The resulting set of fingerprint information is then combined to form one multitone or multi-slice fingerprint. Each multi-slice fingerprint is more unique than the single spectral slice fingerprint, because it tracks temporal evolution, resulting in fewer false matches in a database index search.

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For more information on calculating characteristics or fingerprints of audio samples, the reader is referred to U.S. Patent Application Publication US 2002/0083060, to Wang and Smith, entitled System and Methods for Recognizing Sound and Music Signals in High Noise and Distortion, the entire disclosure of which is herein incorporated by reference as if fully set forth in this description.

Thus, the system 308 will receive the audio sample from the sampling device 306 and compute fingerprints of the sample. The system 308 may compute the fingerprints by contacting additional recognition engines, such as a fingerprint extractor 310. The system 308 will thus have timestamped fingerprint tokens of the audio sample that can be used to compare with broadcast samples.

A broadcast monitoring station 312 monitors each broadcast channel of the radio stations 302 to obtain the broadcast samples. The monitoring station 312 includes a multi-channel radio receiver 314 to receive broadcast information from the radio stations 302. The broadcast information is sent to channel samplers 1 ... k 316. Each channel sampler 316 has a channel fingerprint extractor 318 for calculating fingerprints of the broadcast samples, as described above, and as described within Wang and Smith.

The monitoring station 312 can then sort and store fingerprints for each broadcast sample for a certain amount of time within a fingerprint block sorter 320. The monitoring station 312 can continually monitor audio streams from the broadcasters while noting the times corresponding to the data recording. After a predetermined amount of time, the monitoring station 312 can write over stored broadcast sample fingerprints to refresh the information to coordinate to audio samples currently being broadcast, for example. A rolling buffer of a predetermined length can be used to hold recent fingerprint history.

Since the fingerprints within the rolling buffer will be compared against fingerprints generated from the incoming sample, fingerprints older than a certain cutoff time can be ignored, as they will be considered to be representing audio collected too far in the past. The length of the buffer is determined by a maximum permissible delay plausible for a real-time simultaneous recording of audio signals originating from a real-time broadcast program, such as network latencies of Voice-over-IP networks, internet streaming, and other buffered content. The delays can range from a few milliseconds to a few minutes.

A rolling buffer may be generated using batches of time blocks, e.g., perhaps M=10 seconds long each: every 10 seconds blocks of new [hash + channel ID + timestamp] are dumped into a big bucket and sorted by hash. Then each block ages, and parallel searches are done for each of N blocks to collect matching hashes, where N*M is the longest history length, and (N-1)*M is the shortest. The hash blocks can be retired in a conveyor-belt fashion.

Upon receiving an inquiry from the user sampling device 306 to determine broadcast information corresponding to a given audio sample, the monitoring station 312 searches for linearly corresponding fingerprint hashes within the broadcast sample fingerprints. In particular, a processor 322 in the monitoring station 312 first selects a given broadcast channel (using selector 320) to determine if a broadcast sample identity of a broadcast sample recorded at or near the user sample time matches the user audio sample fingerprints. If not, the selector 320 selects the next broadcast channel and continues searching for a match.

Fingerprints of the broadcast samples and the user audio sample are matched by generating correspondences between equivalent fingerprints, and the file that has the

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largest number of linearly related correspondences or whose relative locations of characteristic fingerprints most closely match the relative locations of the same fingerprints of the audio sample is deemed the matching media file.

In particular, the user audio sample fingerprints are used to retrieve sets of matching fingerprints stored in the sorter 320. The set of retrieved fingerprints are then used to generate correspondence pairs containing sample landmarks and retrieved file landmarks at which the same fingerprints were computed. The resulting correspondence pairs are then sorted by media file identifiers, generating sets of correspondences between sample landmarks and file landmarks for each applicable file. Each set is scanned for alignment between the file landmarks and sample landmarks. That is, linear correspondences in the pairs of landmarks are identified, and the set is scored according to the number of pairs that are linearly related. A linear correspondence occurs when a large number of corresponding sample locations and file locations can be described with substantially the same linear equation, within an allowed tolerance. The file of the set with the highest score, i.e., with the largest number of linearly related correspondences, is the winning file.

Furthermore, fingerprint streams of combinatorial hashes from multiple channels may be grouped into sets of [hash + channel ID + timestamp], and these data structures may be placed into a rolling buffer ordered by time. The contents of the rolling buffer may further be sorted by hash values for a faster search for matching fingerprints with the audio sample, e.g., the number of matching temporally-aligned hashes is the score.

A further step of verification may be used in which spectrogram peaks may be aligned. Because the Wang and Smith technique generates a relative time offset, it is

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possible to temporally align the spectrogram peak records within about 10 ms in the time axis, for example. Then, the number of matching time and frequency peaks can be determined, and that is the score that can be used for comparison.

While it may be possible for two distinct signals to contain a number of identical fingerprints, it is unlikely that these fingerprints have the same relative time evolutions. For example, if the relative offset is near zero then it is likely that the streams are being monitored from the same source. Longer and random time delays could mean that the user is listening to an independent but coincident copy of the same audio program. The requirement for linear correspondences is a key feature, and provides better recognition than techniques that simply count the total number of features in common or measure the similarity between features.

Once the correct audio sound has been identified, the result is reported to the user or a system 324 by any suitable method. For example, the result can be reported by a computer printout, email, web search result page, SMS (short messaging service) text messaging to a mobile phone, computer-generated voice annotation over a telephone, or posting of the result to a web site or Internet account that the user can access later. The reported results can include identifying information of the source of the sound such as the name of the broadcaster, broadcast recording attributes (e.g., performers, conductor, venue); the company and product of an advertisement; or any other suitable identifiers. Additionally, biographical information, information about concerts in the vicinity, and other information of interest to fans can be provided; hyperlinks to such data may be provided. Reported results can also include the absolute score of the sound file or its score in comparison to the next highest scored file.

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For more information regarding fingerprint calculation and comparison, the reader is referred to U.S. Patent Application Publication US 2002/0083060, to Wang and Smith, entitled System and Methods for Recognizing Sound and Music Signals in High Noise and Distortion, the entire disclosure of which is herein incorporated by reference as if fully set forth in this description.

Within the embodiment described above for broadcast source identification, it was assumed that the user sampling device 306 would record a sample, and then send the sample to the monitoring station 312 for comparison. Alternatively, the user sampling device 306 could contact the monitoring station 312, and send a sample to the monitoring station 312 instantaneously (e.g., in the case where the sampling device 306 is a phone, the user can call into the monitoring station 312 and stream a sample to the monitoring station 312 as a phone call conversation). In yet another example, the user sampling device 306 could record a sample, identify fingerprints of the sample, and just send the fingerprints to the monitoring station 312 for comparison. Other examples are possible as well.

Source Identification via Time-Stamped Identity

In another embodiment, a broadcast source can be identified by performing a timestamped identification. Figure 4 illustrates one example of a flowchart depicting functional steps for performing the timestamped broadcast identification. Initially, a user audio sample collected by the user is identified using a content identification means, as shown at block 402, such as the one described above by Wang and Smith (e.g., identifying an audio sample out of a database of audio content files). While the user

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audio sample is collected, a user sample timestamp (UST) is taken to mark the beginning time of the audio sample based on a standard reference clock, as shown at block 404. Using the identification method disclosed by Wang and Smith, as discussed above, produces an accurate relative time offset between a beginning of the identified content file from the database and a beginning of the audio sample being analyzed, e.g., a user may record a ten second sample of a song that was 67 seconds into a song. Hence, a user sample relative time offset (USRTO) and a user sample identity are noted as a result of identifying the user audio sample, as shown at block 406.

Alternatively, it is noted that the user audio sample may be transmitted to a central identification server, or partially or fully analyzed on the user audio sampling device in order to produce the user sample identity, user sample timestamp (UST) and user sample relative time offset (USRTO), for example.

At the same time, broadcast audio samples are taken periodically taken from each of at least one broadcast channel being monitored by a monitoring station; and similarly, a content identification step is performed for each broadcast channel, as shown at block 408. The broadcast samples should be taken frequently enough so that at least one sample is taken per audio program (i.e., per song) in each broadcast channel. For example, if the monitoring station records 10 second samples, after a content identification, the monitoring station would know the length of the song, and also how much longer before the song is over. The monitoring station could thus calculate the next time to sample a broadcast channel based on the remaining length of time of the song, for example.

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For each broadcast sample, a broadcast sample timestamp (BST) is also taken to mark the beginning of each sample based on the standard reference clock, as shown at block 410. Further, a relative time offset between the beginning of the identified content file from the database and the beginning of the broadcast sample being analyzed is computed. Hence, a broadcast sample relative time offset (BSRTO) and a broadcast sample identity is noted as a result of identifying each broadcast audio sample, as shown at block 412.

To identify a broadcast source, the user audio sample and broadcast audio samples are compared to first identify matching sample identities, as shown at block 414, and then to identify matching "relative times" as shown at block 416. If no matches are found, another broadcast channel is selected for comparison, as shown at blocks 418 and 420. If a match is found, the corresponding broadcast information is reported back to the user, as shown at block 422.

The comparisons of the user and broadcast samples are performed as shown below:

(User sample identity) = (Broadcast sample identity) Equation (1)

USRTO + (ref. time – UST) = BSRTO + (ref. time – BST) + delay Equation (2)

where the ref. time is a common reference clock time, and (ref. time – UST) and (ref. time – UST) take into account the possibility for different sampling times by the user audio sampling device and the monitoring station (e.g., (ref. time – BST) = elapsed time since last broadcast sample and now). For example, if broadcast stations are sampled once per minute, and since user samples can occur at any time, to find an exact match, a measure of elapsed time since last sample for each of the broadcast and user sample may

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be needed. In Equation (2), the delay is a small systematic tolerance that depends on the time difference due to propagation delay of the extra path taken by the user audio sample, such as for example, latency through a digital mobile phone network. Furthermore, any algebraic permutation of Equation (2) is within the scope of the present application.

Thus, matching the sample identities ensures that the same song, for example, is being compared. Then, matching the relative times translates the samples into equivalent time frames, and enables an exact match to be made.

As a specific example, suppose the monitoring station samples songs from broadcasters every three minutes, so that at 2:02pm the station begins recording a 10 second interval of a 4 minute long song from a broadcaster, which began playing the song at 2:00pm. Thus, BST = 2:02pm, and BSTRO = 2 minutes. Suppose a user began recording the same song at 2:03pm. Thus, UST = 2:03, and USRTO = 3 minutes. If the user contacts the monitoring station now at 2:04pm to identify a broadcast source of the song, Equation (2) above will be as follows (assuming a negligible delay):

$$\text{USRTO} + (\text{ref. time} - \text{UST}) = \text{BSRTO} + (\text{ref. time} - \text{BST}) + \text{delay} \rightarrow$$

$$3 + (2{:}04 - 2{:}03) = 2 + (2{:}04 - 2{:}02) = 4$$

Thus, the monitoring station will know that it has made an exact match of songs, and the monitoring station also knows the origin of the song. As a result, the monitoring station can inform the user of the broadcast source.

The probability of misidentification is low, since the probability that a user sample is taken from the wrong broadcast channel or non-monitored audio source (such as a CD player) and happens to satisfy Equations (1) and (2) is fairly small.

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A decision is thus made as to whether the user audio sample originated from a given broadcast source by noting whether Equations (1) and (2) hold. If a broadcast channel is found for which this holds then this broadcast channel is determined to be the channel to which the user is listening. This information is noted and relayed to the user or a reporting means, which uses the information for some follow-on action.

Figure 5 illustrates one example of a system for identifying a broadcast source of an audio sample according to the method illustrated in Figure 4. The audio sample may originate from any of radio station 1, radio station 2, radio station 3, ..., or radio station k 502. A user may record the audio sample being broadcast from an individual receiver 504 on an audio sampling device 506 (e.g., a mobile telephone), along with a sample time (e.g., time according to standard reference clock at which the sample is recorded). The user may then dial a service to identify broadcast information pertaining to the audio sample using an IVR system 508, for example. The system 508 will initially identify the audio sample by contacting an audio recognition engine 510. In the case of a mobile telephone sampling device, the IVR system 508 may utilize a cellular communication network to contact the audio recognition engine 510, for example.

The audio recognition engine 510 will then identify the audio sample by performing a lookup within an audio program database 512 using the technique described within Wang and Smith, as described above, for example. In particular, the audio sample may be a segment of media data of any size obtained from a variety of sources. To perform data recognition, the sample should be a rendition of part of a media file indexed in a database. The indexed media file can be thought of as an original recording, and the sample as a distorted and/or abridged version or rendition of the original recording.

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Typically, the sample corresponds to only a small portion of the indexed file. For example, recognition can be performed on a ten-second segment of a five-minute song indexed in the database.

The database index contains fingerprints representing features at particular locations of the indexed media files. The unknown media sample is identified with a media file in the database (e.g., a winning media file) whose relative locations of fingerprints most closely match the relative locations of fingerprints of the sample. In the case of audio files, the time evolution of fingerprints of the winning file matches the time evolution of fingerprints in the sample.

Each recording in the database has a unique identifier, e.g., sound_ID. The sound database itself does not necessarily need to store the audio files for each recording, since the sound_IDs can be used to retrieve the audio files from elsewhere. The sound database index is expected to be very large, containing indices for millions or even billions of files. New recordings are preferably added incrementally to the database index.

Using the database of files, a relative time offset of sample can be determined. For example, the fingerprints of the audio sample can be compared with fingerprints of original files. Each fingerprint occurs at a given time, so after matching fingerprints to identify the audio sample, a difference in time between a first fingerprint of the audio sample and a first fingerprint of the stored original file will be a time offset of the audio sample, e.g., amount of time into a song. Thus, a relative time offset (e.g., 67 seconds into a song) at which the user began recording the song can be determined.

For more information on determining relative time offsets, the reader is referred to U.S. Patent Application Publication US 2002/0083060, to Wang and Smith, entitled

System and Methods for Recognizing Sound and Music Signals in High Noise and Distortion, the entire disclosure of which is herein incorporated by reference as if fully set forth in this description.

In addition, an audio sample can be analyzed to identify its content using a localized matching technique. For example, generally, a relationship between two audio samples can be characterized by first matching certain fingerprint objects derived from the respective samples. A set of fingerprint objects, each occurring at a particular location, is generated for each audio sample. Each location is determined in dependence upon the content of respective audio sample and each fingerprint object characterizes one or more local features at or near the respective particular location. A relative value is next determined for each pair of matched fingerprint objects. A histogram of the relative values is then generated. If a statistically significant peak is found, the two audio samples can be characterized as substantially matching. For a more detailed explanation, the reader is referred to published PCT patent application WO 03/091990, to Wang and Culbert, entitled Robust and Invariant Audio Pattern Matching, the entire disclosure of which is herein incorporated by reference as if fully set forth in this description.

The two methods described above for identifying content of an audio sample (e.g., Wang and Smith, and Wang and Culbert) are examples only, since many other systems and methods exist that can be used for identifying content.

The audio recognition engine 510 will return the identity of the audio sample to the sampling device 506, along with a relative time offset of the audio sample as determined using the Wang and Smith technique, for example. The sampling device 506 may contact the monitoring station 514 and using the audio sample identity, relative time

offset, and sample timestamp, the monitoring station 514 can identify the broadcast source of the audio sample.

The broadcast monitoring station 514 monitors each broadcast channel of the radio stations 502. The monitoring station 514 includes a multi-channel radio receiver 516 to receive broadcast information from the radio stations 502. The broadcast information is sent to channel samplers 1 ... k 518, which identify content of the broadcast samples by contacting the audio recognition engine 510. Similar to the user sampling device 506, the monitoring station 514 may utilize a standard telephone network to contact the audio recognition engine 510. In addition, the monitoring station 514 may also include a form of an audio recognition engine to reduce delays in identifying the broadcast samples, for example.

The monitoring station 514 can then store the broadcast sample identities for each broadcast channel for a certain amount of time. After a predetermined amount of time, the monitoring station 514 can write over stored broadcast sample identities to refresh the information to coordinate to audio samples currently being broadcast, for example.

Upon receiving an inquiry from the user sampling device 506 to determine broadcast information corresponding to a given audio sample, the monitoring station 514 performs the tests according to Equations (1) and (2) above. In particular, a processor 522 in the monitoring station 514 first selects a given broadcast channel (using selector 520) to determine if a broadcast sample identity of a broadcast sample recorded at or near the user sample time matches the user audio sample identity. If not, the selector 520 selects the next broadcast channel and continues searching for an identity match.

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Once an identity match is found, the processor 522 then determines if the user sample relative time matches the broadcast sample relative time for this broadcast channel. If not, the selector 520 selects the next broadcast channel and continues searching for an identity match. If the relative times match (within an approximate error range) then the processor 522 considers the audio sample and the broadcast sample to be a match.

After finding a match, the processor 522 reports information pertaining to the broadcast channel to a reporting center 524. The processor 522 may also report the broadcast information to the user sampling device 506, for example. The broadcast information may include a radio channel identification, promotional material, advertisement material, discount offers, or other material relating to the particular broadcast station, for example.

Additional Correlation Factors

Additional factors may also be considered when attempting to find a match to the audio sample. For example, in one embodiment, when identifying music at high duty cycles of sample vs. non-sampled time, many, if not all broadcast stations, incorporate voice over or other non-music material that frequently is superimposed upon the music streams to be identified, e.g., DJ's talking over the beginning and end of records. Thus, the monitoring station 514 could use variations in recognition score (or non-recognition) as a "signature" of the performance of a track or audio sample on a station at a certain time and date, which can be used as a further correlation factor to determine station identity.

In another embodiment, to further verify that the user is actually listening to a given broadcast channel, and that it is not just a coincidence (such as a user taking a recording from a CD player), user samples can be taken over a longer period of time, e.g., longer than a typical audio program, such as over a transition between audio programs on the same channel. If a match that is considered to be correct is actually the correct channel, a content alignment should be continuously maintained between song transitions. An exception can occur when the user records an audio sample while changing broadcast channels. However, continuity of identity over a program transition may be an indicator that the correct broadcast channel is being tracked. Thus, sample identity (e.g., Equation (1)) can be tracked, and user sample identity changes can also be tracked. For example, sample identities at multiple time periods can be tracked (as shown below in Equations 3-5), and if a first sample identity does not equal a second sample identity from a second time period (as shown below in Equation 5), then the continuity or transition between songs has been tracked. This can provide further confidence that a correct match has been made (e.g., when both the user and the broadcast sources change synchronously).

$$\text{User sample identity}[n] = \text{Broadcast sample identity}[n] \qquad \text{Equation (3)}$$

$$\text{User sample identity}[n+1] = \text{Broadcast sample identity}[n+1] \qquad \text{Equation (4)}$$

$$\text{User sample identity}[n] \neq \text{User sample identity}[n+1] \qquad \text{Equation (5)}$$

where [n] is the nth sample in time.

If it is determined that a user has changed channels, the monitoring station 514 can then search for an identify match for the new identity of the audio sample to verify the new broadcast source to which the user is listening.

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In yet another embodiment, broadcast source identification may be performed by determining certain systematic distortions of audio as the audio is being played. As an example, often times a radio broadcaster will play an audio program slightly faster or slower than the original recording, owing to slight inaccuracies in a crystal oscillator or other time-base used to play back the program recording. A speed percentage stretch may be measured during the identification process, using the technique of Wang and Culbert described above, for example. If a time-base of a broadcast program is stretched and also substantially similar to a stretch factor measured in a user sample, then the user sample is highly likely to have originated from the same source, e.g., as shown below in Equation (6).

User sample stretch ratio = Broadcast sample stretch ratio Equation (6)

Furthermore, for the purposes of identification, a program may be intentionally stretched by a predetermined amount. The predetermined stretch amount could be used to encode a small amount of information. For example, a recording could be stretched to play 1.7% slower. Such a slowdown may not be noticeable to most people. However, if the recognition algorithm is capable of reporting stretch values with 0.05% tolerance, it may be possible to encode 10-20 different messages if playback speeds between –2.0% and +2.0% with 0.1% to 0.2% steps are used, for example.

Furthermore, a stream of information may be embedded in audio by varying a playback speed dynamically (but slowly) over a small range. For example, a frame size of 10 seconds could be used, and each 10 second segment may be sped up or slowed down by a small percentage. If the stretch factors are continually extracted, the values may define a message being sent by the broadcaster.

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Many embodiments have been described as being performed, individually or in combination with other embodiments, however, any of the embodiments described above may be used together or in any combination to enhance certainty of an opinion that a broadcast channel has been identified.

Note that while the present application has been described in the context of a fully functional recognition system and method, those skilled in the art will appreciate that the mechanism of the present application is capable of being distributed in the form of a computer-readable medium of instructions in a variety of forms, and that the present application applies equally regardless of the particular type of signal bearing media used to actually carry out the distribution. Examples of such computer-accessible devices include computer memory (RAM or ROM), floppy disks, and CD-ROMs, as well as transmission-type media such as digital and analog communication links.

While examples have been described in conjunction with present embodiments of the application, persons of skill in the art will appreciate that variations may be made without departure from the scope and spirit of the application. For example, the apparatus and methods described herein may be implemented in hardware, software, or a combination, such as a general purpose or dedicated processor running a software application through volatile or non-volatile memory. The true scope and spirit of the application is defined by the appended claims, which may be interpreted in light of the foregoing.

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CLAIMS

What is claimed is:

1. A method for identifying a broadcast source of content comprising:

recording an audio sample;

recording a time at which the audio sample was recorded;

identifying characteristics of the audio sample and an estimated time offset of the audio sample, the estimated time offset defining from a time difference between a start time of the audio sample and the time at which the audio sample was recorded;

comparing the characteristics and the estimated time offset of the audio sample with characteristics and time offsets of samples taken from broadcast stations and taken at approximately the time at which the audio sample was recorded; and

based on the comparison, identifying a broadcast station from which the audio sample was broadcast.

2. The method of claim 1, wherein identifying the broadcast station from which the audio sample was broadcast comprises:

identifying a sample from the samples taken from the broadcast stations that has characteristics which most closely match the characteristics of the audio sample; and

selecting the broadcast station from which the identified sample was taken to be the broadcast station from which the audio sample was broadcast.

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3. The method of claim 2, wherein the step of comparing comprises comparing characteristics and the estimated time offset of the audio sample with the characteristics and the time offsets of each sample taken from the broadcast stations and taken at approximately the time at which the audio sample was recorded.

4. The method of claim 1, wherein upon identifying a sample from the samples taken from the broadcast stations that has characteristics which substantially match the characteristics of the audio sample, the step of identifying comprises selecting the broadcast station from which the identified sample was taken to be the broadcast station from which the audio sample was broadcast.

5. The method of claim 1, further comprising comparing an identify of the audio sample with identities of the samples taken from the broadcast stations.

6. The method of claim 1, further comprising reporting information relating to the broadcast station to a user who recorded the audio sample.

7. The method of claim 6, wherein the broadcast information includes an advertisement.

8. The method of claim 1, further comprising:

continually recording samples from each of the broadcast stations;

recording a time at which each of the samples was recorded;

identifying characteristics of each of the samples; and

identifying estimated time offsets of each of the samples.

9. The method of claim 1, further comprising:

recording the audio sample over a transition between audio programs on the same broadcast station;

comparing the transition within the audio sample with transitions within the samples taken from the broadcast stations; and

identifying a content alignment between the transition within the audio sample and at least one transition within a sample taken from the broadcast stations.

10. A method for identifying a broadcast source of content comprising:

comparing an identity of an audio sample with identities of broadcast audio samples taken from broadcast channels being monitored;

comparing a time offset of the audio sample with time offsets of the broadcast audio samples, the time offsets defining an elapsed time between when a sample was taken and when the time offset comparison occurs plus a relative time offset, the relative time offset defining a time difference between a start time of a sample and a time when a sample was recorded; and

based on substantially matching identities and substantially matching time offsets, identifying a broadcast channel from which the audio sample was recorded.

11. The method of claim 10, further comprising:

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identifying variations in the audio sample, the variations including non-music material superimposed upon the audio sample; and

comparing the variations in the audio sample with variations in the broadcast audio samples.

12. The method of claim 10, further comprising:

identifying an identity change within the audio sample; and

comparing a first identify of the audio sample with identities of the broadcast audio samples, and comparing a second identity of the audio sample with identities of the broadcast audio samples.

13. The method of claim 10, further comprising:

determining a stretch factor of the audio sample, the stretch factor defining a difference between a speed at which the audio sample was broadcast and a speed of an original playback of the audio sample; and

comparing the stretch factor of the audio sample with stretch factors of the broadcast audio samples.

14. The method of claim 10, further comprising collecting broadcast audio samples from the broadcast channels at time intervals such that at least one audio sample is taken per audio program for each broadcast channel.

15. The method of claim 10, further comprising reporting the broadcast channel to a user.

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16. A monitoring station comprising:

broadcast channel samplers for sampling audio from respective broadcast stations;

an audio recognition engine for determining characteristics of the audio sampled from the respective broadcast stations, and for determining an estimated time offset of the audio between a beginning of an original recording from which the audio sample was taken and a time at which the audio sample was taken; and

a processor for (i) receiving a user audio sample, (ii) comparing the characteristics and the estimated time offset of the audio sampled from the respective broadcast stations and taken at approximately the time at which the user audio sample was recorded with characteristics and a time offset of the user audio sample, and (iii) based on the comparisons, identifying a broadcast station from which the user audio sample was broadcast.

17. The monitoring station of claim 16, wherein the broadcast channel samplers sample the audio from the respective broadcast stations on a continual basis.

18. The monitoring station of claim 16, wherein the broadcast channel samplers sample the audio from the respective broadcast stations at time intervals such that at least one audio sample is taken per audio program for each respective broadcast station.

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19. The monitoring station of claim 16, further comprising memory for storing the characteristics of the audio sampled from the respective broadcast stations and the estimated time offset of the audio sampled from the respective broadcast stations.

20. The monitoring station of claim 19, wherein after a predetermined amount of time, the monitoring station writes over stored information of the audio sampled from the respective broadcast stations to refresh the information so as to coordinate stored information with audio samples currently being broadcast.

21. The monitoring station of claim 16, wherein the processor receives a recording of the user audio sample.

22. The monitoring station of claim 16, wherein the processor receives the characteristics of the user audio sample.

23. The monitoring station of claim 22, wherein the processor is also operable to compare an identity of the user audio sample with identities of the audio sampled from the respective broadcast stations.

24. A method for identifying a broadcast source of content comprising:

recording an audio sample;

recording a time at which the audio sample was recorded;

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identifying characteristics of the audio sample and an estimated time offset of the audio sample, the estimated time offset defining a time difference between a start time of the audio sample and the time at which the audio sample was recorded;

recording audio samples from each of a plurality of broadcast stations;

recording a time at which each of the audio samples from each of the plurality of broadcast stations was sampled;

identifying characteristics and estimated time offsets of the audio samples from each of the plurality of broadcast stations;

comparing the characteristics and the estimated time offset of the audio sample with the characteristics and the estimated time offsets of the audio samples taken from the plurality of broadcast stations and taken at approximately the time at which the audio sample was recorded; and

based on the comparison, identifying a broadcast station from which the audio sample was broadcast.

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ABSTRACT OF THE DISCLOSURE

A method and apparatus for identification of a broadcast source is provided. A user may hear an audio program being broadcast from some broadcast means, and can record a sample of the audio. The sample is then conveyed to an analyzing means to determine to which broadcast station the user is listening. The analyzing means monitors many broadcast channels. Thus, characteristics of the audio sample and samples taken from the broadcast channels can be compared to find a match. Broadcast information pertaining to the broadcast channel from which the match was found may then be reported back to the user, combined with an advertisement of a promotion, prize notification, discount offers, and other information specific for a certain radio station, for example.

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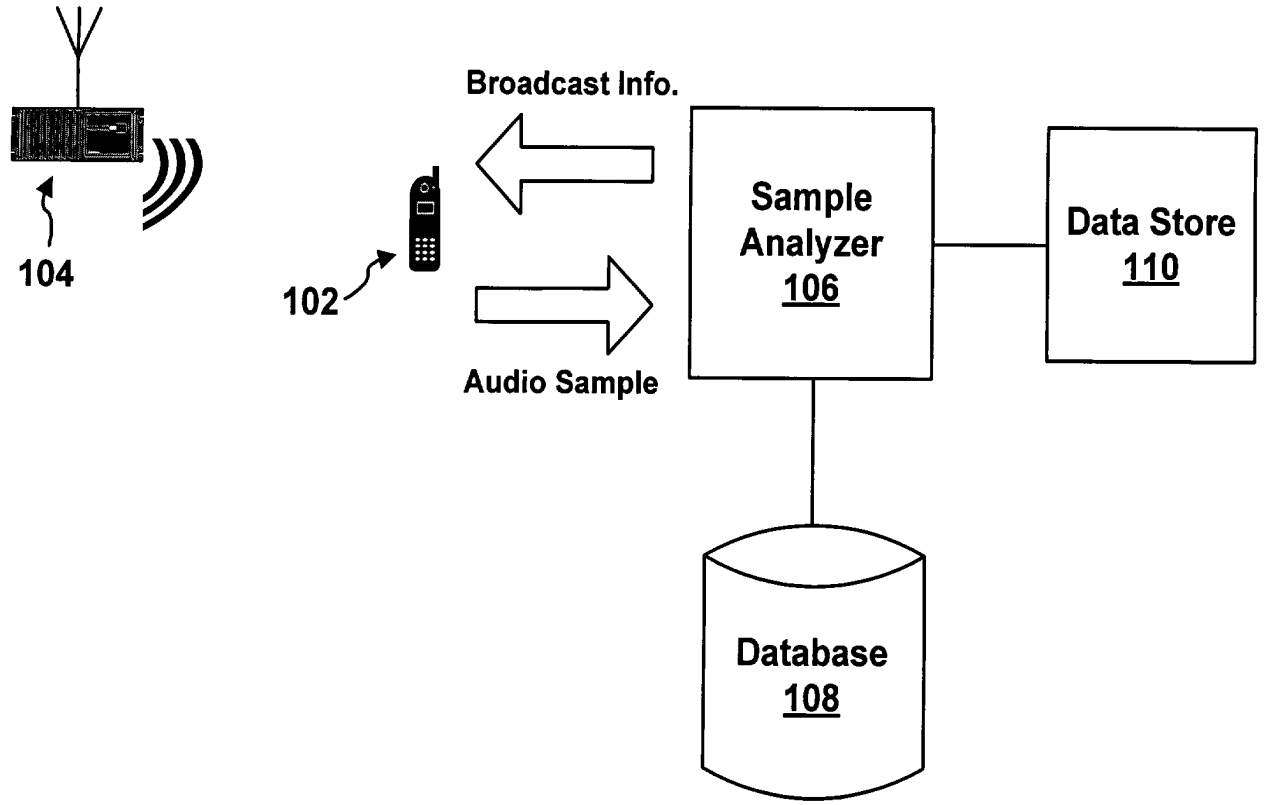

104
102
Broadcast Info.
Audio Sample
Sample Analyzer 106
Data Store 110
Database 108

Figure 1

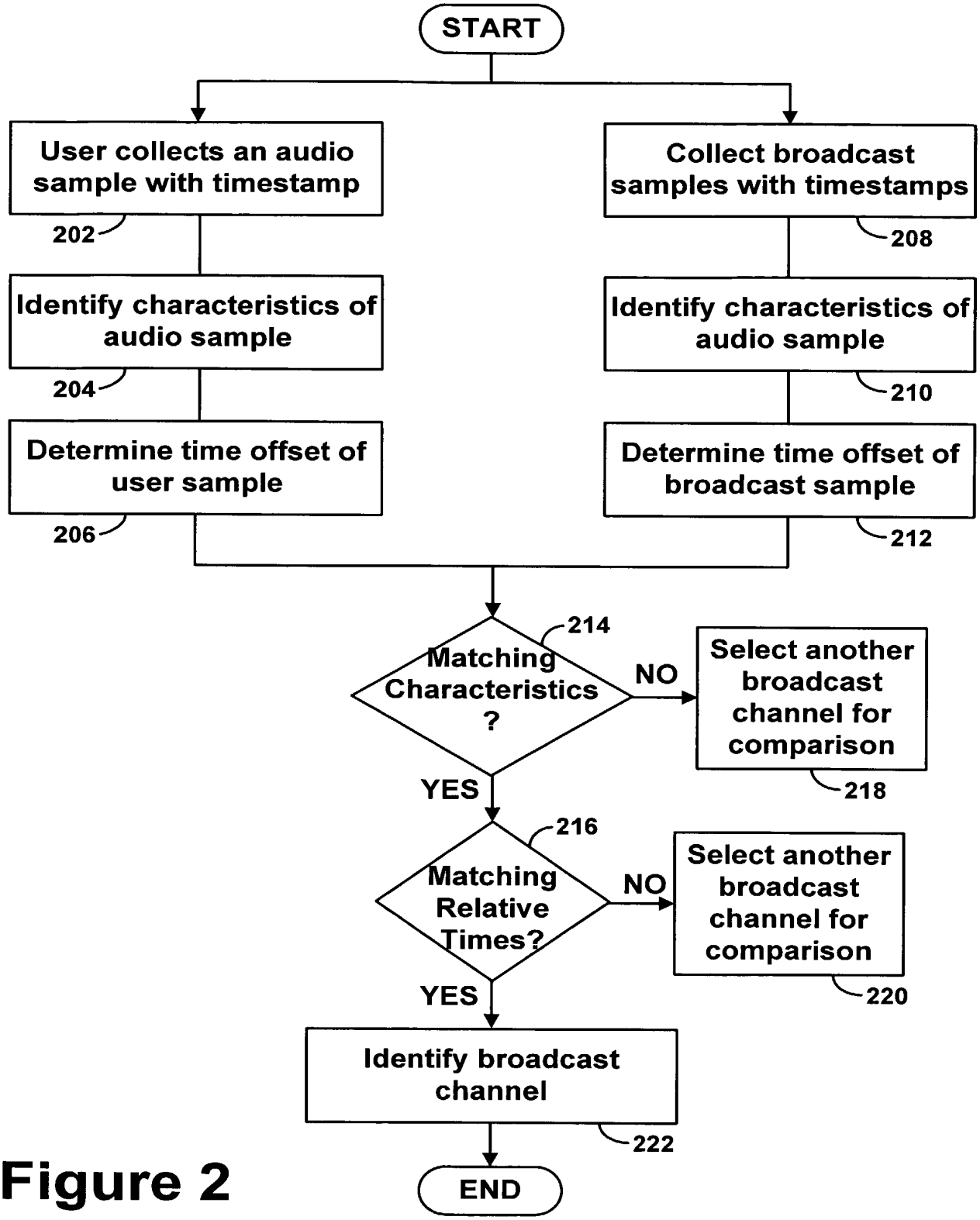
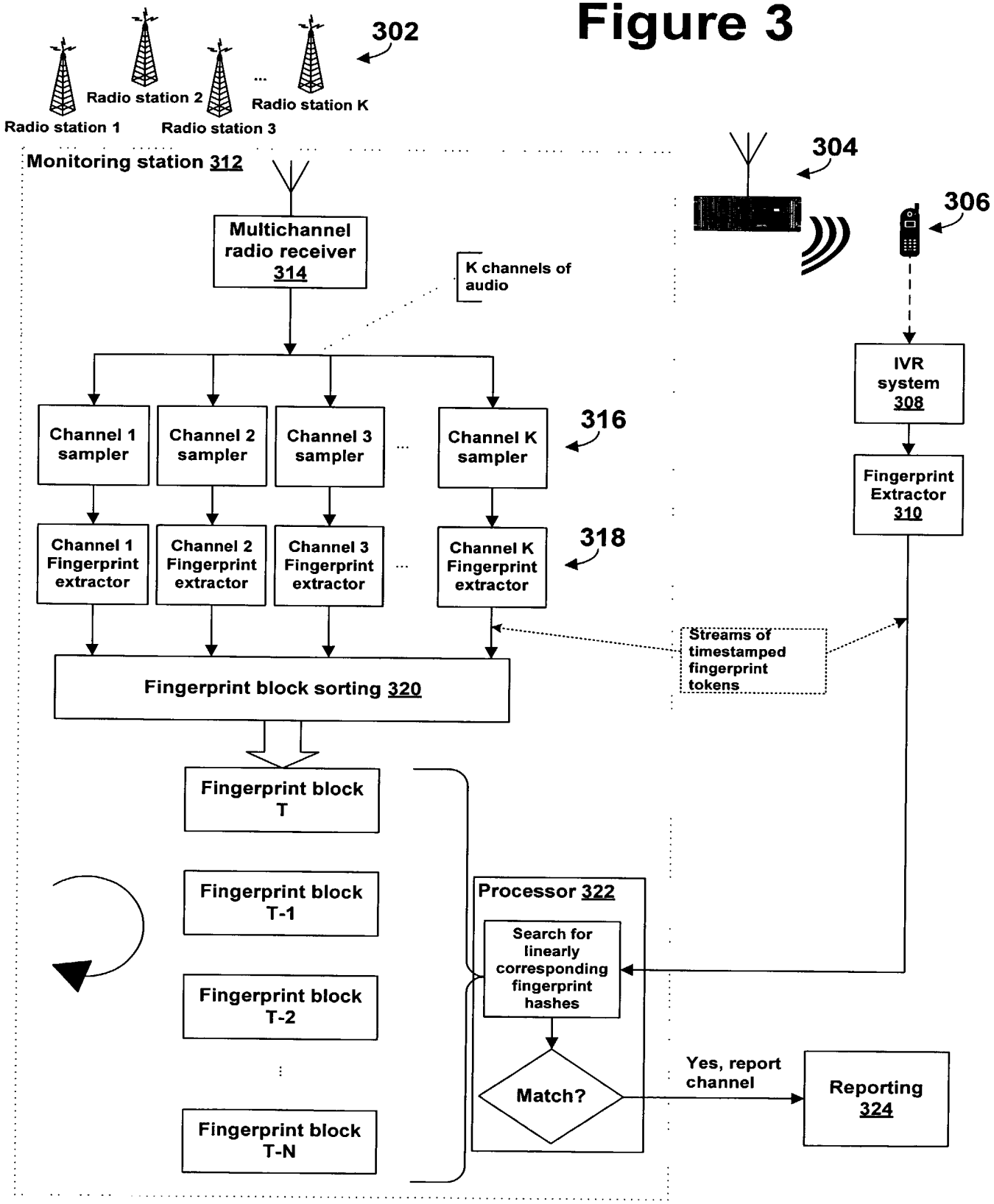

START
User collects an audio sample with timestamp
202
Identify characteristics of audio sample
204
Determine time offset of user sample
206
Collect broadcast samples with timestamps
208
Identify characteristics of audio sample
210
Determine time offset of broadcast sample
212
Matching Characteristics ?
214
NO
Select another broadcast channel for comparison
218
YES
Matching Relative Times?
216
NO
Select another broadcast channel for comparison
220
YES
Identify broadcast channel
222
END

Figure 2

Figure 3


302
Radio station 1
Radio station 2
Radio station 3
...
Radio station K
Monitoring station 312
Multichannel radio receiver 314
K channels of audio
Channel 1 sampler
Channel 2 sampler
Channel 3 sampler
...
Channel K sampler
316
Channel 1 Fingerprint extractor
Channel 2 Fingerprint extractor
Channel 3 Fingerprint extractor
...
Channel K Fingerprint extractor
318
Fingerprint block sorting 320
Fingerprint block T
Fingerprint block T-1
Fingerprint block T-2
Fingerprint block T-N
Processor 322
Search for linearly corresponding fingerprint hashes
Match?
Yes, report channel
Reporting 324
304
306
IVR system 308
Fingerprint Extractor 310
Streams of timestamped fingerprint tokens

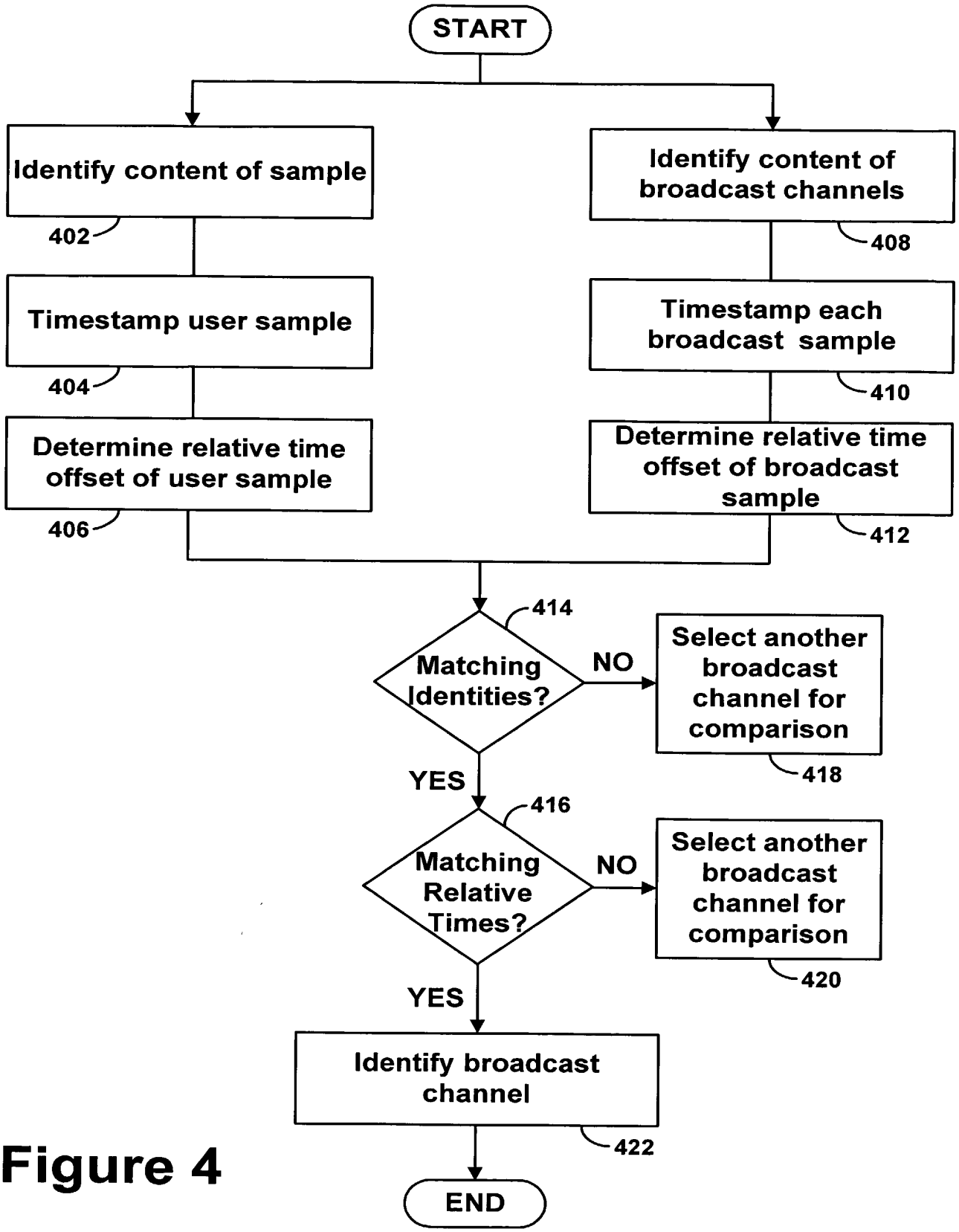
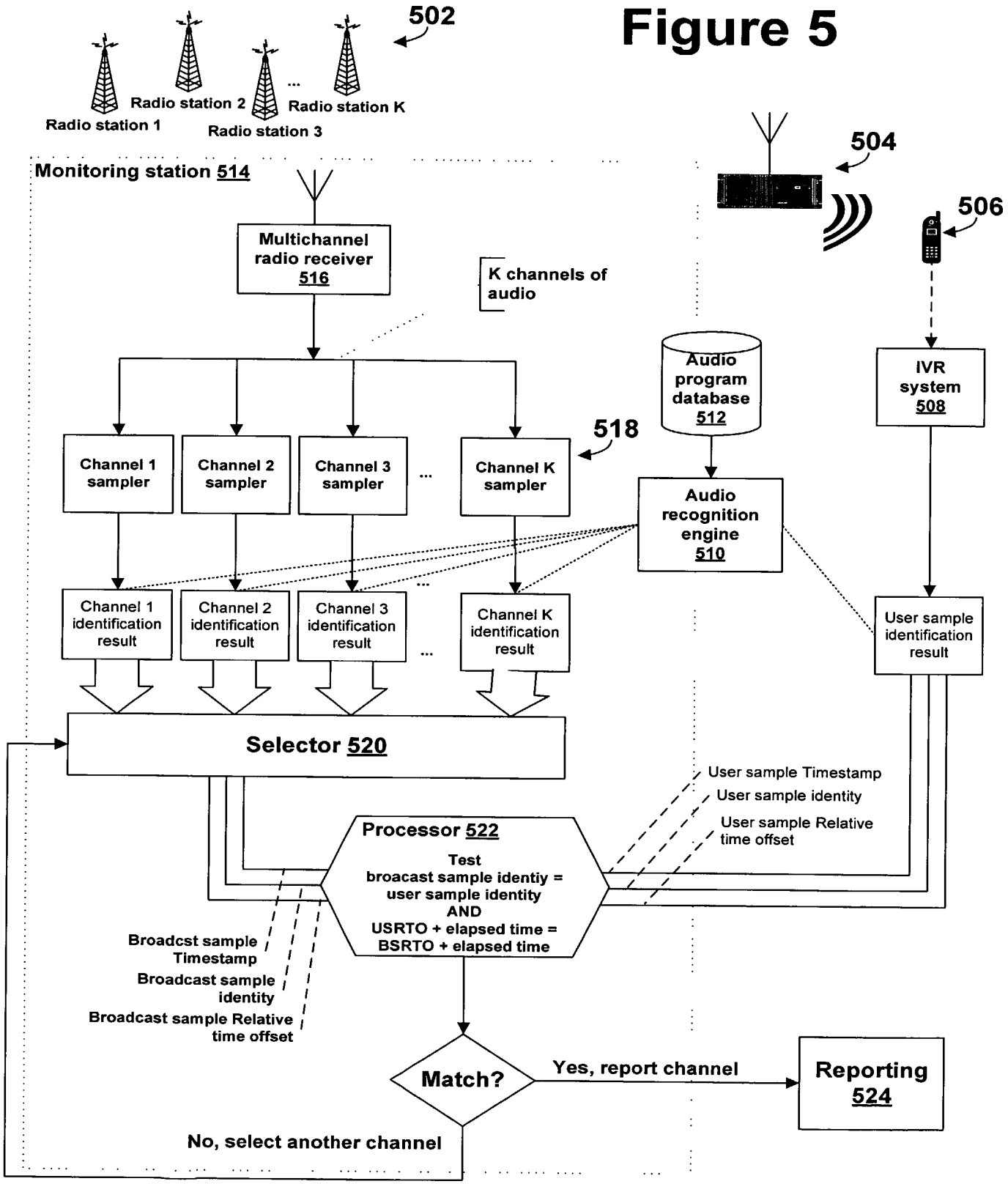

START
Identify content of sample
402
Timestamp user sample
404
Determine relative time offset of user sample
406
Identify content of broadcast channels
408
Timestamp each broadcast sample
410
Determine relative time offset of broadcast sample
412
414
Matching Identities?
NO
Select another broadcast channel for comparison
418
YES
416
Matching Relative Times?
NO
Select another broadcast channel for comparison
420
YES
Identify broadcast channel
422
END

Figure 4

Figure 5


502
Radio station 1
Radio station 2
Radio station 3
Radio station K
504
506
Monitoring station 514
Multichannel radio receiver 516
K channels of audio
Audio program database 512
IVR system 508
518
Channel 1 sampler
Channel 2 sampler
Channel 3 sampler
Channel K sampler
Audio recognition engine 510
Channel 1 identification result
Channel 2 identification result
Channel 3 identification result
Channel K identification result
User sample identification result
Selector 520
User sample Timestamp
User sample identity
User sample Relative time offset
Processor 522
Test broacast sample identiy = user sample identity AND USRTO + elapsed time = BSRTO + elapsed time
Broadcst sample Timestamp
Broadcast sample identity
Broadcast sample Relative time offset
Match?
Yes, report channel
Reporting 524
No, select another channel

PCT/US 05/05254

DT03 Rec'd PCT/PTO 18 FEB 2005

PCT/US05/05254

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TRANSMITTAL LETTER TO THE UNITED STATES RECEIVING OFFICE

Express Mail mailing number:	**EV565834413US**	Date of Deposit:	**February 18, 2005**
File reference no.:	**04-103PCT**	International Application no. (if known):	
Title of the invention: **Method and Apparatus for Identification of Broadcast Source**			
Earliest priority date claimed (Day/Month/Year):		**19 February 2004**	

☒ **This is a new International Application**

SCREENING DISCLOSURE INFORMATION:

In order to assist in screening the accompanying international application for purposes of determining whether a license for foreign transmittal should and could be granted and for other purposes, the following information is supplied. (check as many boxes as apply):

☐ The invention disclosed was **not** made in the United States of America.

☐ There is no prior U.S. application relating to this invention.

☐ The following prior U.S. application(s) contain subject matter which is related to the invention disclosed in the attached international application. *(NOTE: priority to these applications may or may not be claimed on the Request (form PCT/RO/101) and this listing does **not** constitute a claim for priority.)*

application no.	**60/545,879**	filed on	**19 February 2004**
application no.		filed on	

☐ The present international application contains additional subject matter not found in the prior U.S. application(s) identified above. The additional subject matter is found on pages _____ and ☐ **DOES NOT ALTER** ☐ **MIGHT BE CONSIDERED TO ALTER** the general nature of the invention manner which would require the U.S. application to have been made available for inspection by the appropriate defense agencies under 35 U.S.C. 181 and 37 CFR 5.15.

Itemized list of contents

Sheets of Request form:	**3**	Check no.:	
Sheets of description (excluding sequence listing):	**26**	Return receipt postcard:	**1**
Sheets of claims:	**7**	Power of attorney:	
Sheets of abstract:	**1**	Certified copy of priority document (specify):	
Sheets of drawings:	**5**	Other (specify):	
Sheets of sequence listing:			
Sequence listing diskette/CD:			
Tables related to sequence listing CD:			

The person signing this form is the:		
☐ Applicant		**Joseph A. Herndon**
☒ Attorney/Agent (Reg. No.) 50,469		Name of person signing
☐ Common Representative		Signature

This collection of thinformation is required by 37 CFR 1.10 and 1.412. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Comfidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering information, preparing, and submitting the completed form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

PTO-1382 (Rev. 07/2004) PCTUS2.FRP /REV05

PCT/US05/05254

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Serial Number PCT/US 05/05254

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	Cover Letter	

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☐ ADD'L SHEETS

IDENTIFICATION OF THE INTERNATIONAL APPLICATION

INTERNATIONAL APPLICATION NUMBER	INTERNATIONAL FILING DATE

APPLICANT (Name)

PAYMENTS								REFUNDS			
Payment on Filing				Deposit Account		Deposit Account		To Deposit Account		To Deposit Account	
Deposit Account				DATE		DATE		DATE		DATE	
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150								159			
151											
153											
800											
801											
802											
899											
566		Total Paid:		Total Paid:		Total Paid:		Total Refunded:		Total Refunded:	
159											
States included for 892:				892:		892:					
States included for 893:				893:		893:					

03/01/2005 SNAJARRO 00000036 132490 PCT/US05/05254

01 FC:1601 300.00 DA
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NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

HERNDON, Joseph, A.
McDonnell Boehnen Hulbert & Berghoff LLP
300 S. Wacker Drive
Chicago, IL 60606
United States of America

Date of mailing (day/month/year)
24 October 2005 (24.10.2005)

Applicant's or agent's file reference
04-103PCT

IMPORTANT NOTIFICATION

International application No.
PCT/US2005/005254

International filing date (day/month/year)
18 February 2005 (18.02.2005)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
SHAZAM ENTERTAINMENT, LTD. 2925 Ross Road Palo Alto, CA 94303 United States of America	US	US
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address	State of Nationality	State of Residence
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	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:

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[ ] the International Preliminary Examining Authority
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[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 338.70.10	Authorized officer Richard FORAX (Fax : 338 70 10) Telephone No. (41-22) 338 8199

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PCT/US2005/005254 24 10 2005

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Facsimile No. 214-855-8200
Teleprinter No.

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18 May 2006 (18.05.2006)

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Teleprinter No.

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