SPECIFICATION

OPEN-ENDED DEVICE INDEPENDENT MEDIA USAGE MONITORING AND MEASUREMENT SYSTEM

Detailed Specification

Entities involved in the creation, distribution, sponsorship and sale of media content, among others, are interested in how individual media products are used in the marketplace.

In one aspect, an exemplary measurement system creates a record of media usage over time for a group of individual human subjects in a measurement sample. Such a record may, for example, be analyzed (in whole or in part) and reports may be generated to provide information to entities interested in media usage. (See Figure 1.)

In another aspect, an exemplary measurement system creates a record of location over time for a group of individual human subjects in a measurement sample.

In another aspect, an exemplary measurement system may enable the monitoring of individuals' media usage across multiple sources of audio and/or audiovisual content by means of live presentation and/or storage and later playback (e.g. broadcast, satellite and cable television; broadcast, satellite and Internet radio; vinyl, CD and DVD discs; video and audio tapes; console- and computer-based video games) without requiring that the media to be monitored and tracked be pre-encoded with an embedded code of any kind. (See Figure 2.)

In another aspect, an exemplary measurement system employs audio fingerprinting and recognition technology in order to permit the recognition of media content itself. Such an audio fingerprinting and recognition technology may, for example, include one or more previously developed technologies of the kind commercialized by Philips Research, Shazam Entertainment Ltd., and MusiKube LLC, among others, in the context of song identification. In contrast to the limited context of song identification, the context of media measurement, in which a record of media usage for an individual human subject in a measurement sample is created over time, provides the opportunity to employ additional matching and scrubbing techniques that can improve upon the recognition accuracy of existing song-identification technologies, as well as facilitate application of those technologies to aspects of recognizing other forms of content (e.g. radio programs, non-musical recordings, movies, television programs, Internet multi-media downloads, video games, and other content including at least some audio elements). In another respect, by utilizing audio fingerprinting and recognition in the context of media measurement, an exemplary system can be open-ended in that it does not necessarily need prior tagging, watermarking or other encoding of media to be monitored. Alternative measurement systems currently employed are "closed-ended" in that they require a code or watermark to be embedded in the media content before the media are sent out. Detection mechanisms detect these codes or watermarks – rather than unique characteristics of the content itself – in order to measure usage of the media content. Since an exemplary system relies instead on recognizing the media content, such codes or watermarks are not necessary.

In another aspect, an exemplary measurement system operates independently of media playback device. It is therefore capable of measuring media usage across a wide range of devices and technologies, providing a unique capability to measure how media content is used as new media technologies evolve.

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In another aspect, a measurement system is designed to measure individual usage of audio and audiovisual media over long periods of time in order to create data sets that enable the use of analytical methods to discern patterns among individuals' usage behaviors.

In one aspect, an exemplary method creates a record of individual media usage over time by means of an open-ended measurement system that employs portable and stationary detection devices to generate digital fingerprints of the audio signal portion of the media content itself and identifies media played in the environment by means of matching such fingerprints against a database of known media.

Another aspect of an exemplary method includes analyzing digital fingerprints of audio energy collected from portable and stationary audio detection devices that enhances the ability to match against a database of known media over time.

In another aspect, time sequence data (e.g. correlation of successive fingerprint data samples) may be used to enhance the speed and accuracy of matches of audio fingerprints against the database of known media.

In another aspect, collaborative filtering technologies may be applied to related fingerprint data samples and may be used to enhance the speed and accuracy of matches of audio fingerprints against the database of known media.

In another aspect, comparison to known and prearranged sequences of media broadcast and/or known and prearranged sequences of recorded media content may be used to enhance the speed and accuracy of matches of audio fingerprints against the database of known media.

In another aspect, the location of a measurement subject may be used to compare that subject's media usage to that of other monitored media usage in the same location in order to enhance the speed and accuracy of matches of audio fingerprints against the database of known media.

In another aspect, media usage data collected directly from media playback devices in the monitored location may be used to enhance the speed and accuracy of matches of audio fingerprints against the database of known media (e.g. using log files from a computer, router, digital video recorder, digital music playback device, remote control or other electronic device to enhance the media recognition process).

In another aspect, an exemplary method may detect the manipulation of media playback by individuals by means of temporal correlation of data from individual subjects as well as correlation of subject media sequence data with that from known media sources. This may be used to detect pausing and resumption of media playback. This may also be used to detect skipping from one point in media playback to another. This may also be used to detect slow-motion playback of media content. This may also be used to detect fast-motion playback of media content. This may also be used to detect change from one program stream to another.

Another exemplary method determines the source of transmission or storage of the media played by an individual based on audio characteristics of that signal (e.g. recognizes particular types of encoding or compression, or hears screen refresh on tv or computer, or recognizes compression or frequency range of FM or AM radio, or CD or DVD).

Another exemplary method detects the simultaneous playback of more than one media source in a measured environment (e.g. if the TV and radio are on at the same time, recognize each a/v work and associated form of audiovisual delivery separately and/or if music is the background of an advertisement, recognize the music and the ad separately, and the TV as the source for both).

In an aspect of some exemplary methods, multiple audio fingerprints of differing depth, size, and complexity may be created during the monitoring process in order to enhance the speed and reduce the data processing power required to match audio fingerprints against the database of known media (e.g. recognizing am radio or cspan with fewer features to make searching faster and the database smaller, or running a first pass against the database with a fingerprint that is more efficient but less accurate, and only when necessary, run subsequent passes against the same or other databases with more complex fingerprints that are less efficient but more accurate).

In another aspect, audio fingerprints representing multiple time windows may be created during the monitoring process in order to enhance the speed and reduce the data processing power required to match audio fingerprints against the database of known media (e.g. using varying segment lengths where longer segments are recognized until the recognition is unexpected or unclear, then use smaller segment lengths to determine what the change(s) were).

In another aspect, only a selected sample of audio fingerprints from each source may be matched against the database of known media in order to enhance the speed and reduce the data processing power required to create playlists (e.g. matching every nth fingerprint (in order of time monitored) against the database of known media, and not matching the others).

In another aspect, additional audio fingerprints from a source may be selected for matching based on whether temporally adjacent or proximate fingerprints have matched against the database of known media (e.g. when an nth fingerprint matches successfully, matching the x prior and following fingerprints (in order of time monitored) against the database of known media).

In another aspect, particular meta-data may be associated with an audio fingerprint for the purpose of creating a record of individual media usage over time (e.g. Subject and device ID, Subject movement, Sampler location (such as GPS), Sample time, Source of transmission and/or storage medium), etc.).

In another aspect, a record of media usage and/or location over time for an individual human subject in a measurement sample may be associated with demographic and psychographic data about that individual.

In another aspect, "closed-ended" methods of media usage monitoring (e.g. systems that require media to be pre-encoded with watermarks, codes, or other signals in order to be tracked) may be combined with methods like these various exemplary methods to enhance the speed, accuracy, scalability and/or overall performance of a system.

Another exemplary method creates a record of individual media usage over time by means of an open-ended measurement system that employs portable and stationary detection devices to generate digital fingerprints of the video signal portion of the media content itself and identifies media played in the environment by means of matching such fingerprints against a database of known media. Such a video-based system may be built upon direct electrical connections and optical sensors (rather than microphones).

These various exemplary methods may involve video rather than audio.

EXEMPLARY SYSTEM ARCHITECTURE

An example of the measurement system includes three component subprocesses (see Figure 3):

SAMPLE ACQUISITION

Environment Monitoring

An electronic device is either impermanently affixed to the individual whose media usage is to be monitored, or placed in a stationary location to be monitored. This device samples audio energy either from the air by means of a microphone or directly from one or more sources of media content to be monitored by means of a direct electrical connection to such device or devices.

Fingerprint Creation

Every few seconds, the sampler takes an audio snapshot of all detectable media activity within its range, extracts features of the audio snapshot, and creates a digital fingerprint identifying the signals present.

The fingerprint is tagged with relevant meta-data including the following:
- Subject and device ID
- Subject movement
- Sampler location (such as GPS)
- Sample time
- Source of detected media transmission and/or storage medium

Fingerprint Collection

Fingerprints and associated metadata are collected in a data storage buffer of the sampling device and are uploaded to a data center on a regular basis over a fixed or wireless data connection.

MATCHING AND SCRUBBING

Raw data collected from individual sampling devices is run through a series of mathematical and statistical analyses to reconstruct the media usage behavior of the sample subjects. This process requires both a comprehensive database of fingerprints of all media to be recognized, as well as a set of processes that have been carefully tuned to recreate subjects' media usage patterns from the raw data as efficiently and as accurately as possible. These processes may include:

Fingerprint Matching

Individual sequences of fingerprints are matched against the fingerprint database. Match results (or recognitions) and corresponding meta-data are ordered in time-sequence order. This collection of unprocessed time-ordered match results and corresponding meta-data from a single monitoring device is referred to as a "raw playstream."

Playstream Scrubbing

Filtering processes are applied to the raw playstream in order to create a "clean" playstream that is devoid of missed matches and make effective use of all available data to correct any match results that may be inaccurate:
- Sequence Filter: Determine the most likely match result(s) for a particular time sample based on the match results for proximate time samples, and use this (along with other filters) to determine if the match result for that particular time sample is likely to be inaccurate and if so, alter the match result.
- Collaborative Filter: Determine the most likely match result(s) for a particular time sample based on the typical media usage patterns for that subject and/or other subjects, and use this (along with other filters) to determine if the match result for that particular time sample is likely to be inaccurate and if so, alter the match result.
- Temporal Filter: Determine the most likely match result(s) for a particular time sample based on broadcast programming schedules, and use this (along with other filters) to determine if the match result for that particular time sample is likely to be inaccurate and if so, alter the match result.

• Location Filter: Determine the most likely match result(s) for a particular time sample based on the match results for other individuals of a measurement sample in the same physical location at the same time, and use this (along with other filters) to determine if the match result for that particular time sample is likely to be inaccurate and if so, alter the match result.

Playlist Creation

Samples that appear in the playstream are taken every few seconds; however, interesting media usage events are unlikely to happen so frequently. Therefore, a critical task of the Anonymous system is to sift through the moment-by-moment time samples and turn them into a "playlist" of salient media events over time.

Once the playstream has been cleaned, salient media usage events are much more easily detected. Of particular interest are events like the following:
• Pausing: no media activity for a period of time, followed by restarting playback at the same point at which it was interrupted
• Skipping: jumping backward or forward in a media timeline, suggesting that the subject played a particular event more than once or skipped over a particular section of media
• Scanning: playback of media at faster than real time speeds
• Slow motion: playback of media at slower than real time speeds
• Program change: transition from one program to another
• Device change: transition from one media playback device to another

Once candidate media usage events have been detected and categorized, the playlist creation process examines the sequence of events against known real-time broadcast sequences and other out-of-band data to create an accurate representation of a subject's media usage over time.

Although Figure 3 shows a particular exemplary order for matching, playstream scrubbing, and playlist creation, in alternatives, the order of these steps may be changed or the steps may be executed in parallel or partially in parallel.

Abstract of Disclosure

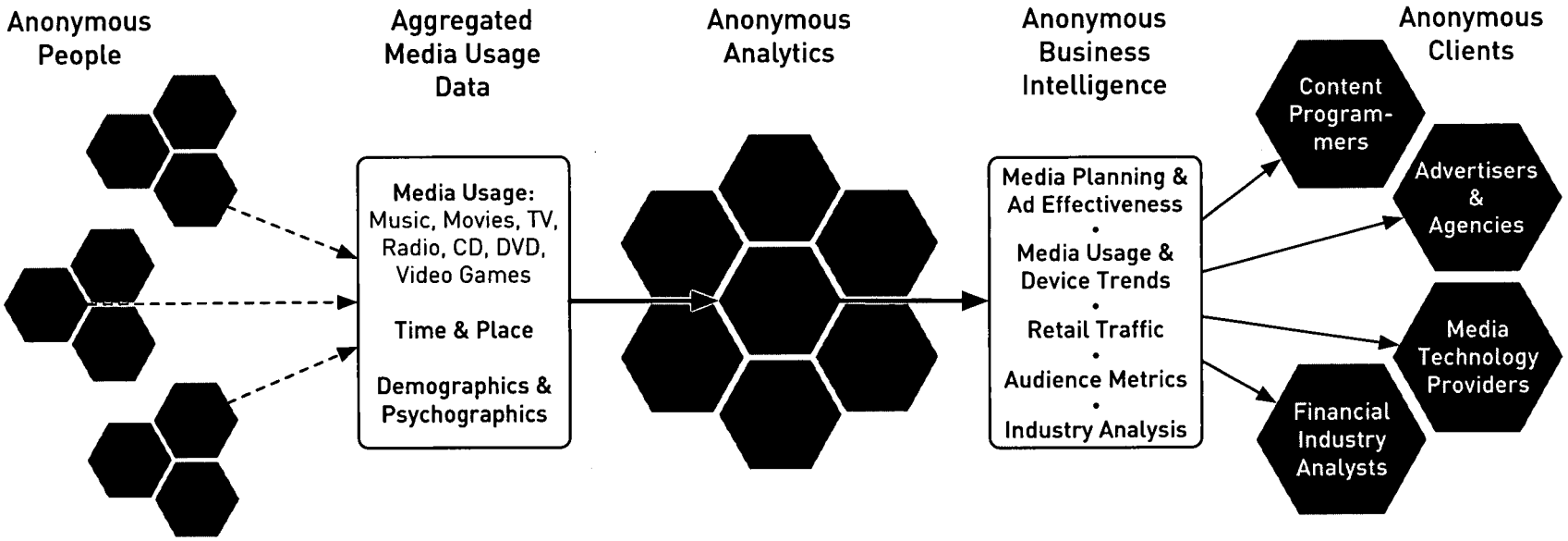
A system is disclosed for measuring individuals' usage of audio and audiovisual media in order to understand how media content is used across a range of devices and transmission methods. The system uses portable and stationary devices to detect audio signals in the local environment and/or from the media devices to be measured. The system matches digital fingerprints of the audio signal present in audio and audiovisual media to the corresponding fingerprints of known media content stored in a database. The system uses various matching and scrubbing techniques to enhance the speed and accuracy with which individuals' media usage patterns are measured. The system uses correlation of time-sequenced samples to detect manipulation of the media playback stream.

Figures

Figures 1, 2 and 3 enclosed.

Anonymous Media Research - Jonathan S. Steuer *et al.*
Open-ended Device-independent Media Monitoring and Measurement System

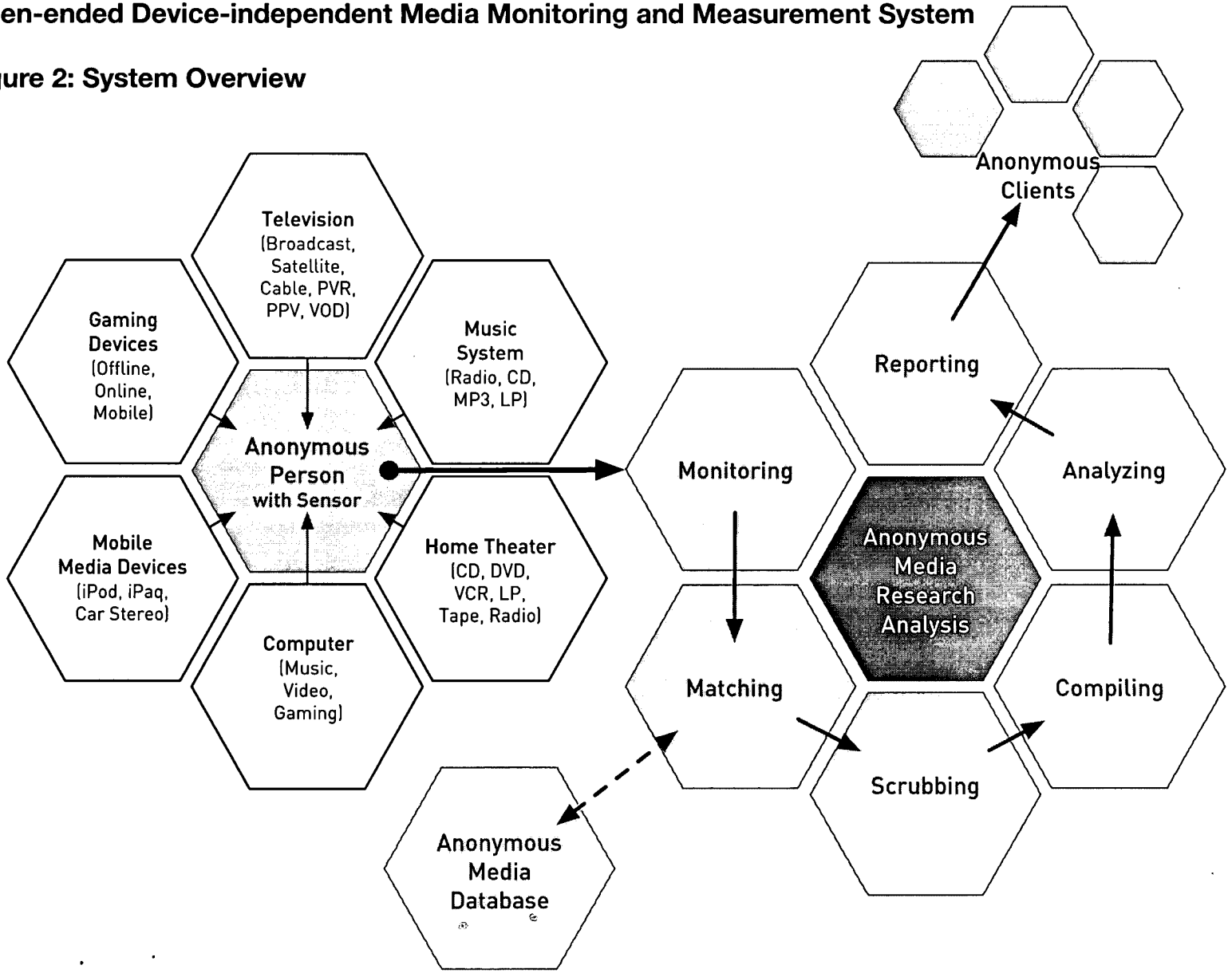
Figure 1: System Context / Business Value Chain



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Figure 2: System Overview



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Figure 3: Process Flow

