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Nagorski et al.

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(54) **METHOD AND APPARATUS FOR SELECTION OF CONTENT FROM A STREAM OF DATA**

(58) **Field of Classification Search**
None
See application file for complete search history.

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(73) Assignee: **Roku, Inc.**, San Jose, CA (US)

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This patent is subject to a terminal disclaimer.

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(63) Continuation of application No. 16/734,283, filed on Jan. 3, 2020, now Pat. No. 10,924,816, which is a (Continued)

(57) **ABSTRACT**

A main stream contains successive content elements of video and/or audio information that encode video and/or audio information at a first data rate. A computation circuit (144) computes main fingerprints from the successive content elements. A reference stream is received having a second data rate lower than the first data rate. The reference stream defines a sequence of the reference fingerprints. A comparator unit (144) compares the main fingerprints with the reference fingerprints. The main stream is monitored for the presence of inserted content elements between original content elements, where the original content elements have main fingerprints that match successive reference fingerprints and the inserted content elements have main fingerprints that do not match reference fingerprints. Rendering of inserted content elements to be skipped. In an embodiment when more than one content element matches only one is

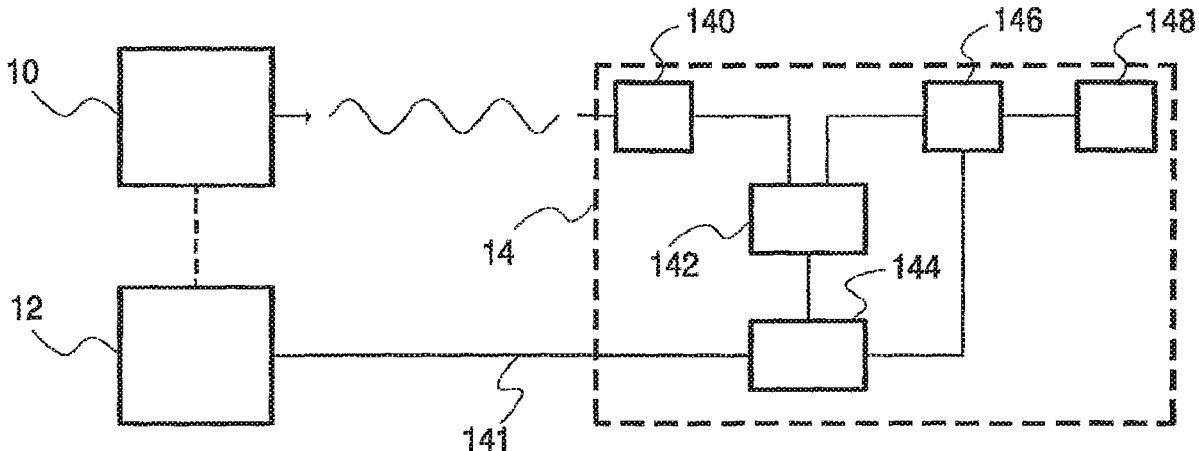
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CPC **H04N 21/8133** (2013.01); **H04N 5/50** (2013.01); **H04N 19/467** (2014.11);
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rendered. In another embodiment matching is used to control zapping to or from the main stream. In another embodiment matching is used to control linking of separately received mark-up information such as subtitles to points in the main stream.

42 Claims, 3 Drawing Sheets

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continuation of application No. 15/971,608, filed on May 4, 2018, now Pat. No. 10,555,052, which is a continuation of application No. 15/703,687, filed on Sep. 13, 2017, now Pat. No. 9,986,306, which is a continuation of application No. 15/285,056, filed on Oct. 4, 2016, now Pat. No. 9,794,644, which is a continuation of application No. 15/204,366, filed on Jul. 7, 2016, now Pat. No. 9,736,549, which is a continuation of application No. 14/789,048, filed on Jul. 1, 2015, now Pat. No. 9,414,008, which is a continuation of application No. 13/778,439, filed on Feb. 27, 2013, now Pat. No. 9,143,718, which is a continuation of application No. 11/573,455, filed as application No. PCT/IB2005/052642 on Aug. 9, 2005, now Pat. No. 8,406,607.

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- H04N 21/2343** (2011.01)
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- H04N 21/435** (2011.01)
- H04N 21/4385** (2011.01)
- H04N 21/8549** (2011.01)
- H04N 5/50** (2006.01)
- H04N 21/438** (2011.01)
- H04N 21/44** (2011.01)
- H04N 21/462** (2011.01)
- H04N 21/466** (2011.01)
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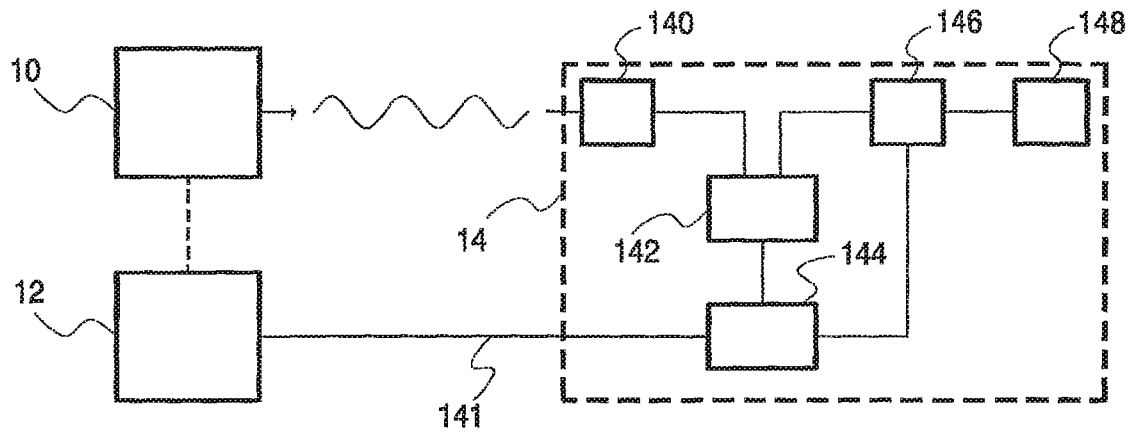


FIG. 1

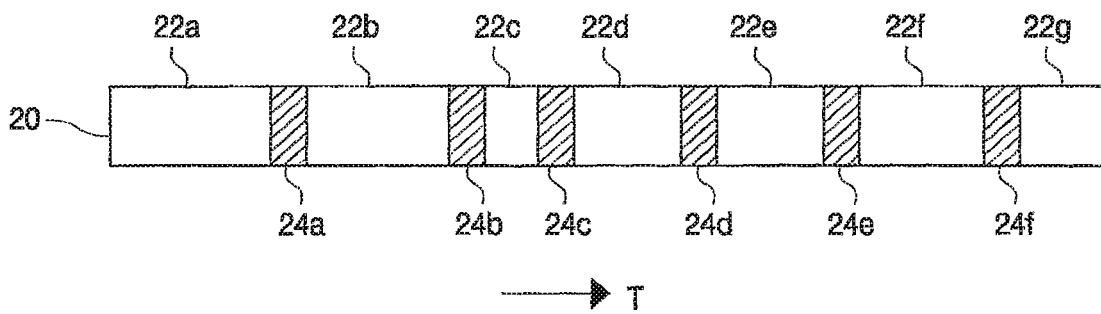


FIG. 2

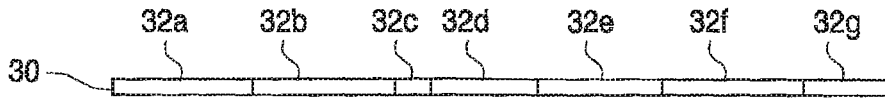


FIG. 3

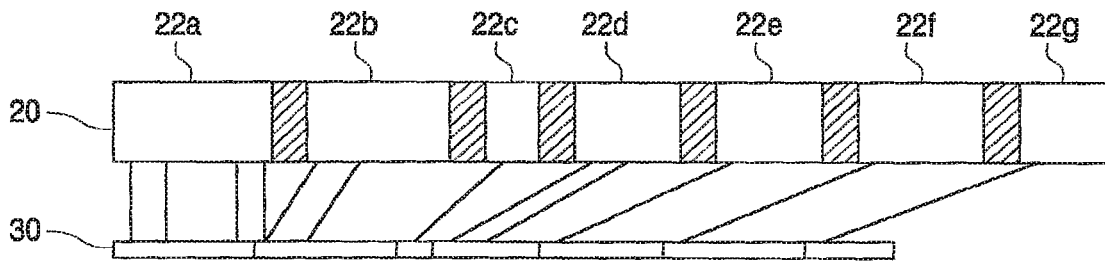


FIG. 3a

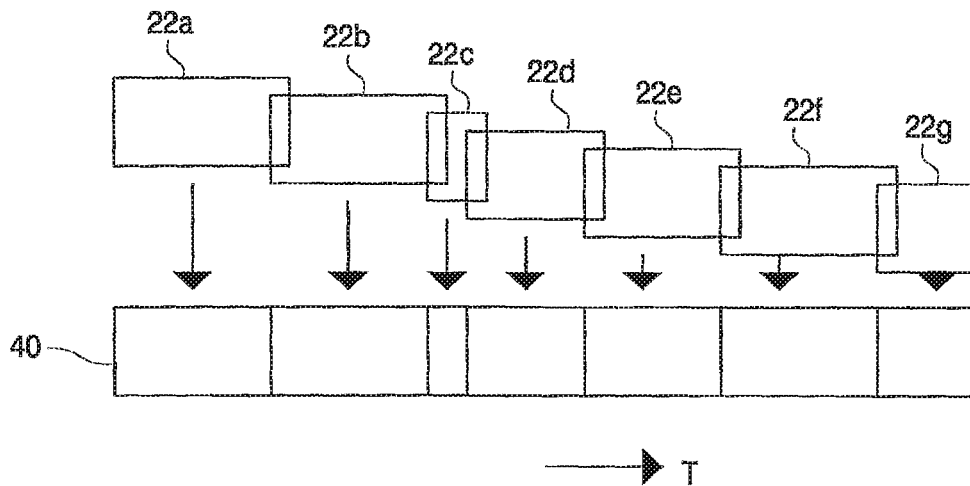


FIG. 4

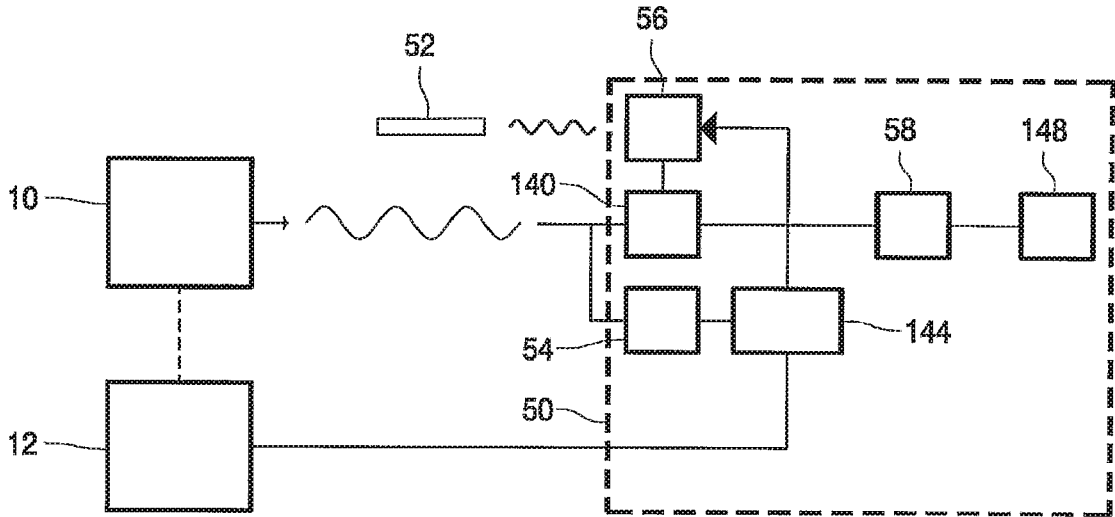


FIG. 5

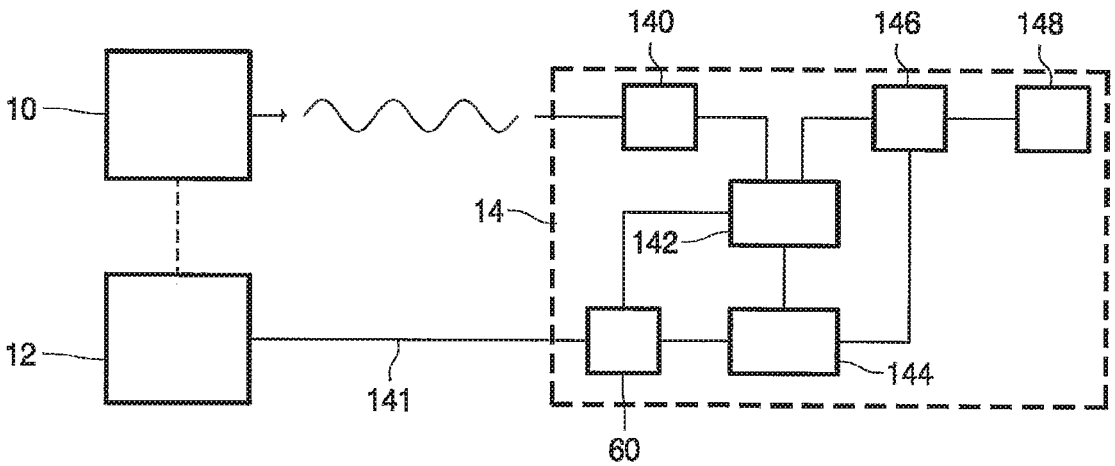


FIG. 6

**METHOD AND APPARATUS FOR
SELECTION OF CONTENT FROM A
STREAM OF DATA**

PRIORITY

This disclosure is a continuation of, and claims priority to, U.S. patent application Ser. No. 16/734,283 filed Jan. 3, 2020, which is a continuation of, and claims priority to, U.S. patent application Ser. No. 15/971,608 filed May 4, 2018 (now U.S. Pat. No. 10,555,052 issued Feb. 4, 2020), which is a continuation of, and claims priority to, U.S. patent application Ser. No. 15/703,687 filed Sep. 13, 2017 (now U.S. Pat. No. 9,986,306 issued May 29, 2018), which is a continuation of, and claims priority to, U.S. patent application Ser. No. 15/285,056 filed Oct. 4, 2016 (now U.S. Pat. No. 9,794,644 issued Oct. 17, 2017), which is a continuation of, and claims priority to, U.S. patent application Ser. No. 15/204,366 filed Jul. 7, 2016 (now U.S. Pat. No. 9,736,549 issued Aug. 15, 2017), which is a continuation of, and claims priority to, U.S. patent application Ser. No. 14/789,048 filed Jul. 1, 2015 (now U.S. Pat. No. 9,414,008 issued Aug. 9, 2016), which is a continuation of, and claims priority to, U.S. patent application Ser. No. 13/778,439 filed Feb. 27, 2013 (now U.S. Pat. No. 9,143,718 issued Sep. 22, 2015), which is a continuation of, and claims priority to, U.S. patent application Ser. No. 11/573,455 filed Feb. 9, 2007 (now U.S. Pat. No. 8,406,607 issued Mar. 26, 2016), which is a national stage entry of Int. Pat. App. No. PCT/IB2005/052642 filed Aug. 9, 2005, which claims priority to European Pat. App. No. 041039025 filed Aug. 12, 2004.

DESCRIPTION

The invention relates to a method and apparatus for selection of content from a stream of data, in particular video and/or audio data, that has been distributed for example by means of broadcasting. More particularly, according to one aspect, the invention relates to a method and apparatus for replay of a stream of data, in particular video and/or audio data, that has been edited after it has been distributed. According to one aspect, the invention relates to a method and apparatus for channel switching (zapping).

Television broadcasts typically contain successive items of content. Examples of items of content are motion pictures, sports game registrations, talk shows etc. Video recording equipment has been designed to record and replay selected items from such broadcasts, typically by means of selection under control of a timer. A well-known problem of timer controlled recording is that does not take account of unpredicted delays of the broadcast of an item, unpredicted extension of the item etc. Moreover, timer controlled recording inevitably also records commercials that have been inserted in the stream, and repetitions of brief preceding parts of the selected item immediately after commercials.

A number of improvements over timer based recording and replay have been suggested in the prior art. US patent application No 20010051037, for example, discloses how automated access to an electronic program guide can be used to enable a recorder to select the start and times of a recording more accurately. When the electronic program guide is updated with information about broadcast delays and time extensions of a content item, the recorder that is programmed to record the item can adapt the start and end times accordingly. An electronic program guide is an

example of the use of an index table for a broadcast stream with pointers to time points in the stream where the content changes.

Another solution proposed by US patent application No 20010051037 is the use of mark up tags in the broadcast stream itself from which the recorder can determine the start and end of an item of content. US patent application No. 20020176702 similarly uses the use of identifiers in the broadcast stream, which can also be used to eliminate recording of commercials.

These solutions have the problem that the broadcaster must provide additional information that is dedicated to abnormal access to the stream, in the form of an index table (e.g. a real-time updated electronic program guide) or mark up tags. Errors in this additional information, as well as failure to provide proper timing, can significantly affect recording. Moreover, the broadcaster may be reluctant to provide this information because it is merely overhead, or because it only reduces attractiveness of the television channel for advertisers. The same kinds of problems occur when data is distributed for example on disk.

In addition to recording and replay additional information may have use for other applications, such as automated intelligent zapping or mark up of video information. An apparatus that supports automated intelligent zapping may for example be designed to skip channels that are broadcasting commercials or to zap back to an original channel once broadcast of an original item of video information is resumed on that channel. For this purpose the same type of information is needed as for selective recording, suffering from the same problems if that information is not accurate.

Mark up of video information may involve adding subtitles, alternative language audio information, chapter markers, menu's, premium content etc. For this purpose the same type of information is needed as for selective recording, suffering from the same problems if the information is inaccurate.

From PCT patent application No 2004019527 (assigned to the same assignee as the present patent application) it is known to trigger a video recorder by means of digital fingerprint matching (the fingerprints being called "signatures" in this publication). PCT patent application No 2004019527 gives examples of fingerprint computation techniques. As used herein, "fingerprint" refers to information that is obtained from a signal (or signal part) that represents video and/or audio content, so that the fingerprint is substantially affected by factors that determine the perceptive impression when a human viewer and/or listener when the video and/or audio content perceives content. Thus, the fingerprint is to a large extent unique for the perceived content. In this sense a fingerprint as used herein differs from a watermark in video and/or audio signals in that a watermark is independent on the perceptive content.

The recording method of PCT patent application No 2004019527 is based on the observation that content items on television often start with the same introductory images, called the "intro". A fingerprint of an example of the intro is computed and fingerprints of an incoming video stream are computed and compared with the fingerprint of the intro. When a match is found the recorder is started.

PCT patent application No 2004019527 describes use of fingerprint to search for intros in recorded material, to facilitate selective replay. However these known fingerprint method are limited to content that is preceded by a known intro. Selection of content is limited to the point at the start of programs which contains standard imagery.

Among others it is an object of the invention to enable fine grained selection of insertions in a video and/or audio stream after the stream has been distributed with the insertions, preferably from a broadcast stream, without requiring a table of addresses in the stream from the distributor or mark up tags in the stream.

Among others it is an object of the invention to enable substantially seamless reconstruction of an item of video and/or audio information that is distributed in a video and/or audio stream intermixed with other video and/or audio data.

Among others it is an object of the invention to enable intelligent zapping among a plurality of video and/or audio streams that are broadcast simultaneously, without requiring a table of addresses in the stream from the distributor or mark up tags in the stream.

Among others it is an object of the invention to support mark-up of video and/or audio streams that is broadcast.

An apparatus and method according to the invention are set forth in the independent Claims. According to the invention fine grained matching of fingerprints (in the sense defined in the preceding) for a main stream of video and/or audio data is made possible by the supply of an additional reference stream which defines a series of fingerprints and a sequence order of these fingerprints. The reference stream may be distributed in the form of a file, for example. The reference stream corresponds to a core of the main stream (e.g. a motion picture), but not to inserted sections in the main stream (e.g. commercials) that do not correspond to the core of the main stream. The reference stream usually has a lower data rate than the main stream. That is, the amount of data used for corresponding rendering time intervals is lower in the reference stream than in the main stream. In one embodiment, the reference stream is a low (temporal or spatial) resolution version of the main stream without commercials. In this case reference fingerprints can be computed from the video and/or audio content of the reference stream and their sequence can be derived from the sequence of the reference stream. In another embodiment the reference stream contains the reference fingerprints directly.

The supply of this type of reference stream makes it possible to edit the main stream. Since the reference stream may have a much lower data rate than the main stream, the reference stream can be "sold" to enable improved quality access to the main stream without the need to redistribute a stream at the high data rate of the main stream. Preferably the fingerprints of the main stream and the reference stream are matched according to their respective positions in the main stream and the reference stream. That is, a main fingerprint obtained for a particular content element from the main stream is detected to match if it substantially equals a particular reference fingerprint obtained from the reference stream and a main fingerprint for a further content element from the main stream that is temporally adjacent to the particular content element also matches.

In an embodiment the reference stream is also used to detect duplication of content in the main stream, such as for example just in front and after an inserted commercial. In this way it can be ensured that only one copy of the duplicated part is rendered. In principle duplication can be detected simply by testing whether the same reference fingerprint matches with the fingerprint of more than one content element of the main stream. In a preferred embodiment duplication of a stream section is eliminated provided that it is detected that the section immediately precedes and follow a same section of inserted content elements (as detected by the absence of a matching fingerprint). Thus, the risk of accidental elimination of duplication is avoided.

Another application is that the reference stream may be used to support intelligent zapping, for example by skipping channels that broadcast information with fingerprints that do not match reference fingerprints, or by returning to a main channel, terminating zapping once matching fingerprints are found in the video and/or audio data of the main channel.

Another application is that the reference stream may be used to add mark up information. The mark up information, such as sub-title information, alternative language channels, menus, chapter markers, premium content etc. may be supplied in conjunction with the reference stream, so that the mark-up can be linked to positions in the reference stream that are selected by fingerprint matching. In this way a high quality stream can be constructed for individual users, without requiring the full bandwidth for transmission of the stream to be reserved for these individual users (this bandwidth is provided in a broadcast channel that is shared with other users that do not receive the mark up information).

These and other objects and advantageous aspects of the invention will be described in more detail using non-limitative examples illustrated by the accompanying Figures.

FIG. 1 shows a video and/or audio rendering system

FIG. 2 symbolically shows a broadcast stream of video and/or audio data

FIG. 3 symbolically shows a reference stream of video and/or audio data

FIG. 3a symbolically shows associations between time points

FIG. 4 symbolically shows an edited stream of video and/or audio data

FIG. 5 shows a video and/or audio rendering system with automated zapping

FIG. 6 shows a video and/or audio rendering system that supports mark-up

FIG. 1 shows a video and/or audio rendering system comprising a broadcast transmission apparatus 10, a reference transmission apparatus 12 and a receiver apparatus 14. Receiver apparatus 14 comprises a channel receiver 140, a storage device 142, a reference comparator 144, an editing unit 146 and a rendering unit 148. Channel receiver 140 has an input for receiving a broadcast data stream from broadcast transmission apparatus 10 and an output coupled to storage device 142. Editing unit 146 has an interface coupled to storage device 142 and an output coupled to rendering unit 148. Rendering unit 148 comprises for example a display screen and/or a loudspeaker for rendering video and/or audio information supplied by editing unit 146. Reference comparator 144 has an input 141 for receiving a reference stream from reference transmission apparatus 12, an interface to storage device 142 and an output coupled to a control input of editing unit 146.

In operation broadcast transmission apparatus 10 broadcasts a stream of video and/or audio data and reference transmission apparatus 12 transmits a reference stream. FIG. 2 illustrates a broadcast stream 20 as a function of time T. The stream contains an item of video information, such as a motion picture, which has been cut into parts 22a-g that are broadcast temporally intermixed with other items 24a-f such as commercials. Ordinarily, when stream 20 is received, decoded and rendered, this would result in visual and/or acoustical rendering of the parts 22a-g intermixed with visual and/or acoustical rendering of the other items 24a-f.

FIG. 3 illustrates a reference stream 30. The reference stream 30 is contains parts 32a-g that correspond to a transmits a reference signal. In contrast to the broadcast stream 20 the parts 32a-g are not intermixed with other items. In an embodiment, reference signal 30 contains a

series of fingerprint data items, each corresponding to a fingerprint that can be computed from the video and/or audio data of a respective section of the broadcast stream 20, e.g. from video data in respective video frames, or groups of frames or time intervals of audio. In an alternative embodiment, reference stream 30 contains elements that represent the audio and/or video-encoding elements from the broadcast stream at low spatial and/or temporal resolution, without intermixed commercials. In each embodiment the information in the reference stream is constructed so that the data rate (and thereby the number of data bits that needs to be transmitted for a same time interval during rendering) in reference stream 30 is much lower than the data rate in broadcast stream 20. This is indicated symbolically by the fact that the broadcast stream 20 of FIG. 2 is drawn with broader lines than the reference stream 30 of FIG. 2.

In operation, receiver apparatus 14 receives both broadcast stream 20 and reference stream 30. In principle the same communication medium may be used to receive both streams (e.g. from satellite or terrestrial wireless broadcast, or from a cable TV network). However, preferably different media are used, reference stream 30 being received via the Internet for example, or distributed on a data carrier like a disk. Channel receiver 140 receives the broadcast stream and stores data from that stream in storage device 142 which may contain a magnetic hard disk, a flash memory etc.

After the broadcast stream of a part of it has been stored editing unit 146 starts retrieving data from the stream from storage device 142, decodes the retrieved data to derive a video and/or audio signal and supplies the decoded signal to rendering unit 148. Editing unit 146 is arranged to skip selected parts of the broadcast stream 20, so that rendering unit 148 does not render the corresponding video and/or audio signal for those parts. Reference comparator 144 controls the selection of the parts that are skipped. Reference comparator is implemented for example as a suitably programmed programmable processor, or as a dedicated circuit.

Reference comparator 144 receives reference stream 30. In an embodiment reference stream 30 is received substantially simultaneously with broadcast stream 20, but alternatively reference stream 30 may be received earlier or later. Preferably reference comparator 144 stores the entire reference stream 30, or parts of it, or fingerprints computed from reference stream 30, for later use, for example in storage device 142 or in another memory. Alternatively reference comparator 144 may receive reference stream 30 for substantially immediate use, in which case no long-term storage of the entire reference stream 30 is needed.

During editing reference comparator 144 retrieves sections of broadcast stream 20 from storage device 142, computes fingerprints for those retrieved sections and compares these computed fingerprints with fingerprints obtained from reference stream 30. Example of fingerprint computation techniques can be found in WO2004019527. When reference stream 30 contains a series of fingerprints these fingerprints may be compared substantially directly with the computed fingerprints, but in an embodiment wherein reference stream 30 contains a low resolution version of the elements of broadcast stream 20, but no fingerprints, the fingerprints may need to be computed from the low resolution version first, before comparison.

As a result of comparison reference comparator 144 detects for which segment of broadcast stream 20 the fingerprint matches a particular fingerprint obtained from reference stream 30. In this case a time point defined by reference stream 30 is associated with the segment of broadcast stream 20 that resulted in the matching fingerprint.

FIG. 3a uses connecting lines to symbolize the resulting association of time points defined by reference stream 30 with time points in broadcast stream 20 (typically a time point in broadcast stream 20 defines the start of a segment from which a matching fingerprint was computed or for example a video frame from which a matching fingerprint was computed). It should be understood that only a few of the associations are illustrated for the sake of clarity. Typically, there associations are detected for time points that are no more than one second apart and preferably no more than a tenth of a second apart. At one point it is shown that two time points separated by a commercial break in broadcast stream 20 are associated with one time point defined by reference stream 30. This may occur under special circumstances as will be discussed later.

The time points that have been detected to be associated in this way with broadcast stream 20 are used to control editing by editing unit 146. Typically it will be found that during parts 22a-g successive segments of broadcast stream 20 are associated with successive time points. For interruptions 24a-f no matching fingerprints will be found and a next time point will only be associated with a next part 22a-g of broadcast stream 20 after the interruption 24a-f. In an embodiment editing unit 146 selectively skips segments of the broadcast stream 20 that are not associated with time points defined by reference stream 30. In a further embodiment fingerprints are determined for sampled segments that are separated by other segments for which no fingerprint matching is performed. In this embodiment the other segments from broadcast stream 20 between segments for which matching segments were found not skipped. Other segments from broadcast stream 20 between segments for which no matching segments were found are skipped. Preferably, editing unit 146 selects the length of the skipped parts so that the remaining parts of the broadcast stream 20 will be rendered at mutual distances defined by the associated time points.

In many broadcast streams 20 in which an item of video and/or audio data is interrupted by commercials a last part of the item that precedes the commercial is repeated after the commercial. This is done to allow the viewer to regain the context after the commercial, before new video and/or audio information is rendered. In this case, it may occur that reference comparator 144 identifies two segments from broadcast stream 20 whose fingerprints match the same fingerprint obtained from reference stream 30. Preferably, it is also detected whether these duplicate segments immediately precede and follow the same inserted segment respectively. Editing unit 146 is preferably arranged to skip one of these two segments, in response to detection of such a duplication, so that the remaining parts of the broadcast stream 20 will be rendered at mutual distances defined by the associated time points.

In an embodiment, editing unit 146 includes all segments from broadcast stream 20 up to a first segment of which the fingerprint did not match a fingerprint obtained from reference stream 30 (at the start of a commercial break 24a-f). In this case the fingerprints obtained from reference stream 30 include a sequentially first subsequent fingerprint that does not match with a fingerprint computed from broadcast stream 20 for a segment at a normal time distance from a previous segment of broadcast stream 20 for which a matching fingerprint was obtained from reference stream. Reference comparator 144 searches for a subsequent segment in broadcast stream 20 (after the commercial break 24a-f) with a fingerprint that matches the sequentially first subsequent fingerprint. This corresponds to the first as yet unbroadcast

information after the commercial break. Editing unit **146** skips broadcast stream **20** until this subsequent segment. In this way the commercial break and the duplicated part of the stream is eliminated.

It will be appreciated that other solutions are possible, such as skipping a last part of broadcast stream **20** before the commercial break and resuming immediately behind the commercial break from the first segment with a matching fingerprint. Other solutions may be used which skip part of the broadcast stream before and part after the commercial break as long as a substantially continuous flow of time points is realized.

FIG. 4 illustrates composition of the output stream **40** that is supplied to rendering unit **148**. Relative timing of the start of parts **22a-g** of the item from broadcast stream is controlled by time points defined by reference stream **30** for matching fingerprints, and repetitions are prevented by starting successive parts **22a-g** before preceding parts have been completed.

It will be appreciated that this technique is not limited to elimination of repetitions around commercial breaks. Other repetitions, for example replays during sports games may be used as well. In this case a search is made for duplicate fingerprint matches and editing unit **146** skips broadcast stream **20** from a first segment whose fingerprint matches a same fingerprint from reference stream **30** as a preceding segment from broadcast stream **20**, to a first next first segment from broadcast stream **20** whose fingerprint matches a fingerprint from reference stream **30** that does a preceding segment from broadcast stream **20**. Preferably, editing unit **146** is switchable between respective modes in which this type of skipping is enabled and disabled respectively. Preferably editing unit **146** is also arranged to prevent skipping if the length of time interval that is to be skipped exceeds a threshold length.

Any type of search for segments with matching fingerprints may be used. In an embodiment reference comparator **144** selects an initial position of a next segment from broadcast stream **20** for which a next fingerprint is matched to a particular fingerprint from reference stream **20** by an offset from a preceding segment with a fingerprint that matches a preceding fingerprint from the reference stream. The offset is selected equal to the time interval defined by the reference stream between the preceding fingerprint and the next fingerprint. If no match is found at the initial position new comparisons are performed for successive segments of the broadcast stream **20**, until a segment is found that matches the next fingerprint from the reference stream **30**. This has the advantage that no search will be performed for further fingerprints from the broadcast stream **20** that match a particular reference fingerprint, once a fingerprint for the broadcast stream has been found that matches the reference fingerprint. Thus, the risk of accidental matches is reduced.

An exception is preferably made however, if it is detected that the main fingerprint from the broadcast stream that matches the particular reference fingerprint is followed in the broadcast stream by a main fingerprint that does not match. In this case a search made for subsequent duplicate matches of the particular reference fingerprint with main fingerprints from the broadcast stream. In this way duplication of content before and after interruptions can be detected.

However, it should be understood that alternatively a search for matching fingerprints may be conducted by comparison of a fingerprints from reference stream **30** with a plurality of fingerprints for a range time points from broadcast stream **20**, or vice versa by comparing a finger-

print from broadcast stream **20** with a plurality of fingerprints for a range time points from reference stream **30**. This works well when the fingerprints are sufficiently unique.

In an embodiment the comparison of the fingerprints, and optionally the computation of the fingerprints is performed during rendering, while the broadcast stream **20** is read from storage device **142**. For this embodiment the reference stream **30** may be supplied at a different time than broadcast stream **20**, for example only during rendering. This has the advantage that edited rendering can be selectively enabled by later supply of reference stream **30**, e.g. after payment of a fee, or after a lapse of time (e.g. for non-live viewing of a game of sports).

It should be understood that other embodiments are possible. For example, reference comparator **144** may be arranged to compute fingerprints and select matching time points in reference stream **30** and broadcast stream **20** in advance. In an embodiment reference comparator **144** stores information about the matching time points in an index table for use by editing unit **146** during rendering. These computations may be performed when the broadcast stream **20** is recorded or while the broadcast stream **20** is present in storage device **142**.

In another embodiment the described editing on the basis of fingerprints is performed already during reception and storage of the broadcast stream **20**. This reduces the amount of data that needs to be retained in storage device **142**. Alternatively, editing may be performed after storage, but before rendering, by selectively deleting parts of the stored broadcast stream **20** from storage device **142**.

Although these embodiments have been described for a broadcast stream **20**, which has been broadcast by a broadcast transmission apparatus **10**, e.g. via a terrestrial broadcast medium, or via cable or satellite broadcast, it should be understood that the described techniques can be applied to a stream that is distributed via other media, for example on an optical disk like a DVD etc. In this way the value of the distributed stream can be upgraded by supplying a reference stream, without consuming the bandwidth for a full data rate stream. Moreover, the invention is not limited to applications wherein the stream is necessarily stored.

FIG. 5 shows a system wherein the invention is applied to intelligent zapping. In this embodiment a reception apparatus **50** with a remote control unit **52** is used. Reception apparatus **50** contains a second channel receiver **54** and a channel selector **56**. Like channel receiver **140**, which will be referred to as first channel receiver **140**, second channel receiver **54** is coupled to receive broadcast data. Second channel receiver **54** has an output coupled to reference comparator **144**, which has an output coupled to channel selector **56**. First channel receiver **140** has an output coupled to a decoder **58**, which has an output coupled to rendering unit **148**. Channel selector **56** has a control output coupled to first channel receiver **140**. First and second channel receiver **140**, **54** support tuning to different channels (or selection of different programs from a transport stream).

In operation channel selector **56** supports zapping (channel changing) under control of remote control unit **52**. According to an aspect of the invention zapping is controlled dependent on the results of fingerprint matching. In one embodiment, channel selector **56** is arranged to control first channel receiver **140** to receive successive channels selected with remote control unit **52** (e.g. by pushing a channel up or down button), to predict a next channel that will be selected and to control second channel receiver **54** to receive the predicted next channel.

Reference comparator **144** then compares fingerprints computed from the broadcast stream in the predicted channel with fingerprints from a reference stream for that broadcast stream and signals to channel selector **56** whether a match is found. Upon receiving a command from remote control unit **52** to select the next channel, channel selector **56** controls first channel receiver to switch to this channel if reference comparator **144** indicates the recent presence (within a predetermined preceding time interval) of matching fingerprints. If no such fingerprints have been found channel selector **56** controls first channel receiver **140** to switch to another channel in response to the command. In this way zapping automatically skips a channel that does not match a reference stream.

In a further embodiment, channel selector **56** is arranged to respond to the absence of matching fingerprints in the predicted next channel by predicting a predicted subsequent next channel that will be selected during zapping after the predicted next channel and to cause second channel receiver **54** to receive the predicted subsequent next channel. Reference comparator **144** then compares fingerprints computed from the broadcast stream for the predicted subsequent next channel with fingerprints from a reference stream for that broadcast stream and signals to channel selector **56** whether a match is found.

This may be repeated for further predicted channels as long as no matching fingerprints are found. In this way channel selector **56** may cause more than one channel to be skipped during zapping so that the rendered channel skips to the next channels for which on reference stream is available or a reference stream is available and the recent broadcast stream contains matching fingerprints. Thus, for example, if the reference streams describe transmitted items but not commercials in those items, channel selector can cause channels that are broadcasting commercials to be skipped during zapping.

Other applications are possible. For example, in another embodiment channel selector **56** may be used to allow zapping during the time that a commercial is broadcast on a preferred channel and to switch back to the preferred channel at the end of the commercial. For this purpose embodiment channel selector **56** may be arranged to set second channel receiver **54** to a selected channel during zapping of the channel selection of first channel receiver **140** and to disable zapping and switch back channel receiver **140** to the preferred channel once a matching fingerprint is detected in the broadcast stream from the preferred channel. In a further embodiment channel selector **56** is arranged to support different zapping modes, wherein mutually different use is made of the fingerprint information.

FIG. **6** illustrates an embodiment wherein reference transmission apparatus **12** also transmits mark-up information in the reference stream **30**. Mark-up information as such is known for example from DVD systems and may include for example sub-title information in one or more languages, alternative audio channels, menus for accessing the stream, chapter markers, or premium video information that is not included in the broadcast. Reference transmission apparatus **12** transmits information that links the mark-up information to video information or fingerprints of the video information in the reference stream.

In the embodiment of FIG. **6** an information selection circuit **60** receives the reference stream, extracts the mark-up information and stores the mark-up information in storage device **142**. Reference comparator **144** compares fingerprints for the broadcast stream with fingerprints obtained from the reference stream that reference transmission appa-

ratus **12** has linked to an item of mark up information. When it detects a match, reference comparator **144** stores information in storage device **142** that links the relevant part of the broadcast information to the mark-up information. This may be done for example so as to construct the type of information that is contained in a DVD disk (which allows language or subtitle selection, viewing of menu's and/or chapter tables, viewing of premium content etc.) from a combination of data from the broadcast stream and the reference stream.

In the embodiment of FIG. **6** editing unit **146** may be arranged as a DVD replay controller to process the stored information basically as if it was received from a DVD disk, allowing the user to access the information interactively, to select languages or subtitles etc. Of course, other types of access (not similar to DVD access may be used).

Although the invention has been illustrated using an embodiment using a receiving apparatus **14** with different components, it will be understood that in practice the different components may be implemented using the same circuits, or using suitably programmed programmable computers to implement any or all of the functions such as fingerprint computation, matching and editing. Accordingly the invention also encompasses computer program products with instructions which when executed by such a computer make the computer perform the invention.

The invention claimed is:

1. A method comprising:

accessing, by a media device, a media stream that includes a first sequence of items of content corresponding to a first channel and a second sequence of items of content corresponding to a second channel;
 accessing, by the media device, a first reference stream defining a sequence of first reference fingerprints corresponding to respective segments of at least some of the items of content in the first sequence;
 accessing, by the media device, a second reference stream defining a sequence of second reference fingerprints corresponding to respective segments of at least some of the items of content in the second sequence;
 computing, by a processor of the media device, a first computed fingerprint from a particular segment of the first sequence of items of content of the media stream and a second computed fingerprint from a particular segment of the second sequence of items of content of the media stream;
 performing, by the processor of the media device, comparisons of (i) the first computed fingerprint to one or more of the first reference fingerprints and (ii) the second computed fingerprint to one or more of the second reference fingerprints;
 making a decision, based on the comparisons, to render the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content; and
 rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content.

2. The method of claim **1**, further comprising:

tuning, by a channel selector of the media device, to the first sequence of items of content corresponding to the first channel; and
 while tuning to the first sequence of items of content corresponding to the first channel, determining that the second channel is a predicted next channel to which the channel selector will tune.

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3. The method of claim 2, wherein accessing the second reference stream is responsive to determining that the second channel is a predicted next channel to which the channel selector will tune.

4. The method of claim 2, wherein making the decision whether to render the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises:

making, based on the comparisons, a determination that (i) the first computed fingerprint mismatches the one or more of the first reference fingerprints and (ii) the second computed fingerprint matches the one or more of the second reference fingerprints; and

responsive to the determination, deciding to render the particular segment of the second sequence of items of content.

5. The method of claim 4, further comprising:

while tuning to the first sequence of items of content corresponding to the first channel, receiving a command from a remote control unit to select the second channel.

6. The method of claim 1, wherein accessing the media stream is substantially simultaneous with accessing the first reference stream.

7. The method of claim 6, wherein accessing the media stream is substantially simultaneous with accessing the second reference stream.

8. The method of claim 1, wherein accessing the media stream is performed at a different time than accessing the first reference stream and accessing the second reference stream.

9. The method of claim 1, wherein accessing the first reference stream comprises:

accessing, by the processor of the media device, a modified version of at least some of the items of content of the first sequence; and

computing, by the processor of the media device, the one or more of the first reference fingerprints from the modified version of the at least some of the items of content of the first sequence.

10. The method of claim 1, wherein accessing the first reference stream comprises receiving, by the receiver of the media device, the first sequence of reference fingerprints.

11. The method of claim 1, wherein each item of content of the media stream comprises audio content.

12. The method of claim 1, wherein each item of content of the media stream comprises video content.

13. The method of claim 1, wherein making the decision comprises deciding to render the particular segment of the first sequence of items of content, and

wherein rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises rendering the particular segment of the first sequence of items of content.

14. The method of claim 1, wherein making the decision comprises deciding to render the particular segment of the second sequence of items of content, and

wherein rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises rendering the particular segment of the second sequence of items of content.

15. A non-transitory machine-readable medium having instructions embodied thereon, which, when executed by one or more processors of a machine, cause the machine to perform operations comprising:

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accessing, a media stream that includes a first sequence of items of content corresponding to a first channel and a second sequence of items of content corresponding to a second channel;

accessing a first reference stream defining a sequence of first reference fingerprints corresponding to respective segments of at least some of the items of content in the first sequence;

accessing a second reference stream defining a sequence of second reference fingerprints corresponding to respective segments of at least some of the items of content in the second sequence;

computing a first computed fingerprint from a particular segment of the first sequence of items of content of the media stream and a second computed fingerprint from a particular segment of the second sequence of items of content of the media stream;

performing comparisons of (i) the first computed fingerprint to one or more of the first reference fingerprints and (ii) the second computed fingerprint to one or more of the second reference fingerprints;

making a decision, based on the comparisons, whether to render the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content; and

rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content.

16. The non-transitory machine-readable medium of claim 15, wherein operations further comprise:

causing a channel selector of a media device to tune to the first sequence of items of content corresponding to the first channel; and

while tuning to the first sequence of items of content corresponding to the first channel, determining that the second channel is a predicted next channel to which the channel selector will tune.

17. The non-transitory machine-readable medium of claim 16, wherein accessing the second reference stream is responsive to determining that the second channel is a predicted next channel to which the channel selector will tune.

18. The non-transitory machine-readable medium of claim 16, wherein making the decision whether to render the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises:

making, based on the comparisons, a determination that (i) the first computed fingerprint mismatches the one or more of the first reference fingerprints and (ii) the second computed fingerprint matches the one or more of the second reference fingerprints; and

responsive to the determination, deciding to render the particular segment of the second sequence of items of content.

19. The non-transitory machine-readable medium of claim 18, wherein operations further comprise:

while tuning to the first sequence of items of content corresponding to the first channel, receiving a command from a remote control unit to select the second channel.

20. The non-transitory machine-readable medium of claim 15, wherein accessing the media stream is substantially simultaneous with accessing the first reference stream.

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21. The non-transitory machine-readable medium of claim 20, wherein accessing the media stream is substantially simultaneous with accessing the second reference stream.

22. The non-transitory machine-readable medium of claim 15, wherein accessing the media stream is performed at a different time than accessing the first reference stream and accessing the second reference stream.

23. The non-transitory machine-readable medium of claim 15, wherein accessing the first reference stream comprises:

accessing a modified version of at least some of the items of content of the first sequence; and

computing the one or more of the first reference fingerprints from the modified version of the at least some of the items of content of the first sequence.

24. The non-transitory machine-readable medium of claim 15, wherein accessing the first reference stream comprises receiving the first sequence of reference fingerprints.

25. The non-transitory machine-readable medium of claim 15, wherein each item of content of the media stream comprises audio content.

26. The non-transitory machine-readable medium of claim 15, wherein each item of content of the media stream comprises video content.

27. The non-transitory machine-readable medium of claim 15, wherein making the decision comprises deciding to render the particular segment of the first sequence of items of content, and

wherein rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises rendering the particular segment of the first sequence of items of content.

28. The non-transitory machine-readable medium of claim 15,

wherein making the decision comprises deciding to render the particular segment of the second sequence of items of content, and

wherein rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises rendering the particular segment of the second sequence of items of content.

29. A media device comprising:

a plurality of receivers configured to access a media stream that includes a first sequence of items of content corresponding to a first channel and a second sequence of items of content corresponding to a second channel; a memory that stores instructions; and

one or more processors configured by the instructions to perform operations comprising:

accessing the media stream that includes the first sequence of items of content corresponding to the first channel and the second sequence of items of content corresponding to the second channel;

accessing a first reference stream defining a sequence of first reference fingerprints corresponding to respective segments of at least some of the items of content in the first sequence;

accessing a second reference stream defining a sequence of second reference fingerprints corresponding to respective segments of at least some of the items of content in the second sequence;

computing a first computed fingerprint from a particular segment of the first sequence of items of content of the media stream and a second computed finger-

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print from a particular segment of the second sequence of items of content of the media stream; performing comparisons of (i) the first computed fingerprint to one or more of the first reference fingerprints and (ii) the second computed fingerprint to one or more of the second reference fingerprints;

making a decision, based on the comparisons, whether to render the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content; and

rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content.

30. The media device of claim 29, wherein operations further comprise:

tuning, by a channel selector of the media device, to the first sequence of items of content corresponding to the first channel; and

while tuning to the first sequence of items of content corresponding to the first channel, determining that the second channel is a predicted next channel to which the channel selector will tune.

31. The media device of claim 30, wherein accessing the second reference stream is responsive to determining that the second channel is a predicted next channel to which the channel selector will tune.

32. The media device of claim 30, wherein making the decision whether to render the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises:

making, based on the comparisons, a determination that (i) the first computed fingerprint mismatches the one or more of the first reference fingerprints and (ii) the second computed fingerprint matches the one or more of the second reference fingerprints; and

responsive to the determination, deciding to render the particular segment of the second sequence of items of content.

33. The media device of claim 32, wherein operations further comprise:

while tuning to the first sequence of items of content corresponding to the first channel, receiving a command from a remote control unit to select the second channel.

34. The media device of claim 29, wherein accessing the media stream is substantially simultaneous with accessing the first reference stream.

35. The media device of claim 34, wherein accessing the media stream is substantially simultaneous with accessing the second reference stream.

36. The media device of claim 29, wherein accessing the media stream is performed at a different time than accessing the first reference stream and accessing the second reference stream.

37. The media device of claim 29, wherein accessing the first reference stream comprises:

accessing a modified version of at least some of the items of content of the first sequence; and

computing one or more of the first reference fingerprints from the modified version of the at least some of the items of content of the first sequence.

38. The media device of claim 29, wherein accessing the first reference stream comprises receiving, by the receiver of the media device, the first sequence of reference fingerprints.

39. The media device of claim 29, wherein each item of content of the media stream comprises audio content.

40. The media device of claim 29, wherein each item of content of the media stream comprises video content.

41. The media device of claim 29, wherein making the decision comprises deciding to render the particular segment of the first sequence of items of content, and

wherein rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises rendering the particular segment of the first sequence of items of content.

42. The media device of claim 29, wherein making the decision comprises deciding to render the particular segment of the second sequence of items of content, and

wherein rendering, based on the decision, the particular segment of the first sequence of items of content or the particular segment of the second sequence of items of content comprises rendering the particular segment of the second sequence of items of content.

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