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Buxton

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(54) **EMPLOYING ARTIFACTS FOR VIDEO INDEXING**

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G06F 17/30	(2006.01)
H04N 5/76	(2006.01)
G11B 27/28	(2006.01)
H04N 9/82	(2006.01)
H04N 5/91	(2006.01)
H04N 5/765	(2006.01)

(52) **U.S. Cl.**

CPC ***H04N 5/76*** (2013.01); ***G06F 17/3079*** (2013.01); *H04N 9/8205* (2013.01); *H04N 5/91* (2013.01); ***G06F 17/30831*** (2013.01); *H04N 5/765* (2013.01); ***G11B 27/28*** (2013.01)

USPC **386/241**

(58) **Field of Classification Search**

CPC G06F 17/3079; H04N 5/00; H04N 5/76

See application file for complete search history.

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* cited by examiner

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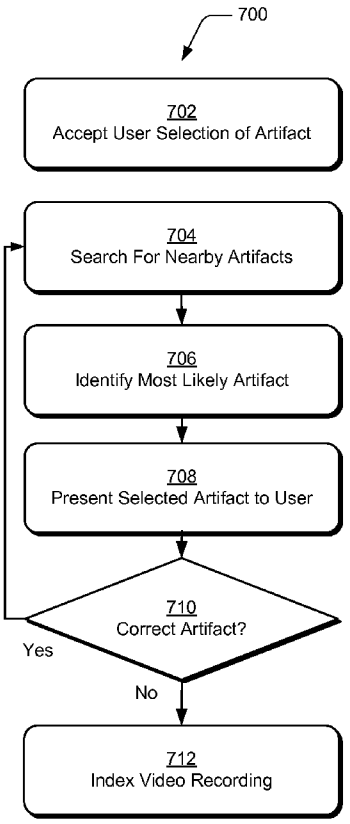
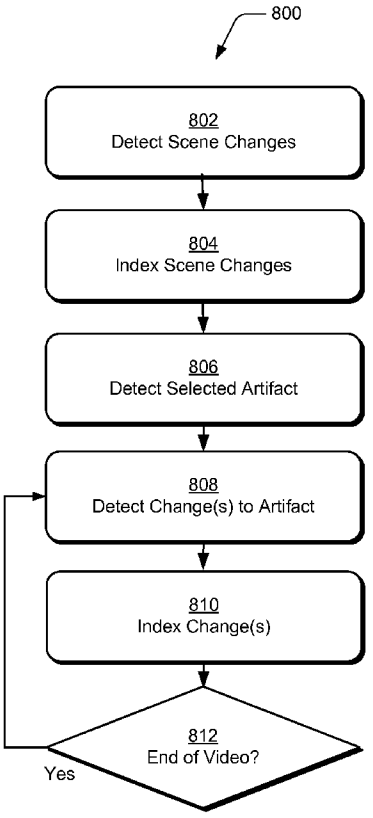
(57) **ABSTRACT**

One or more embodiments disclosed herein provide methods and systems for indexing video recordings of scenes using artifacts. More specifically one or more embodiments provide methods which identify artifacts in video recordings and index the video recordings according to the artifacts. These methods and systems also output portions of the video recordings according to the artifact-based indexing.

20 Claims, 8 Drawing Sheets





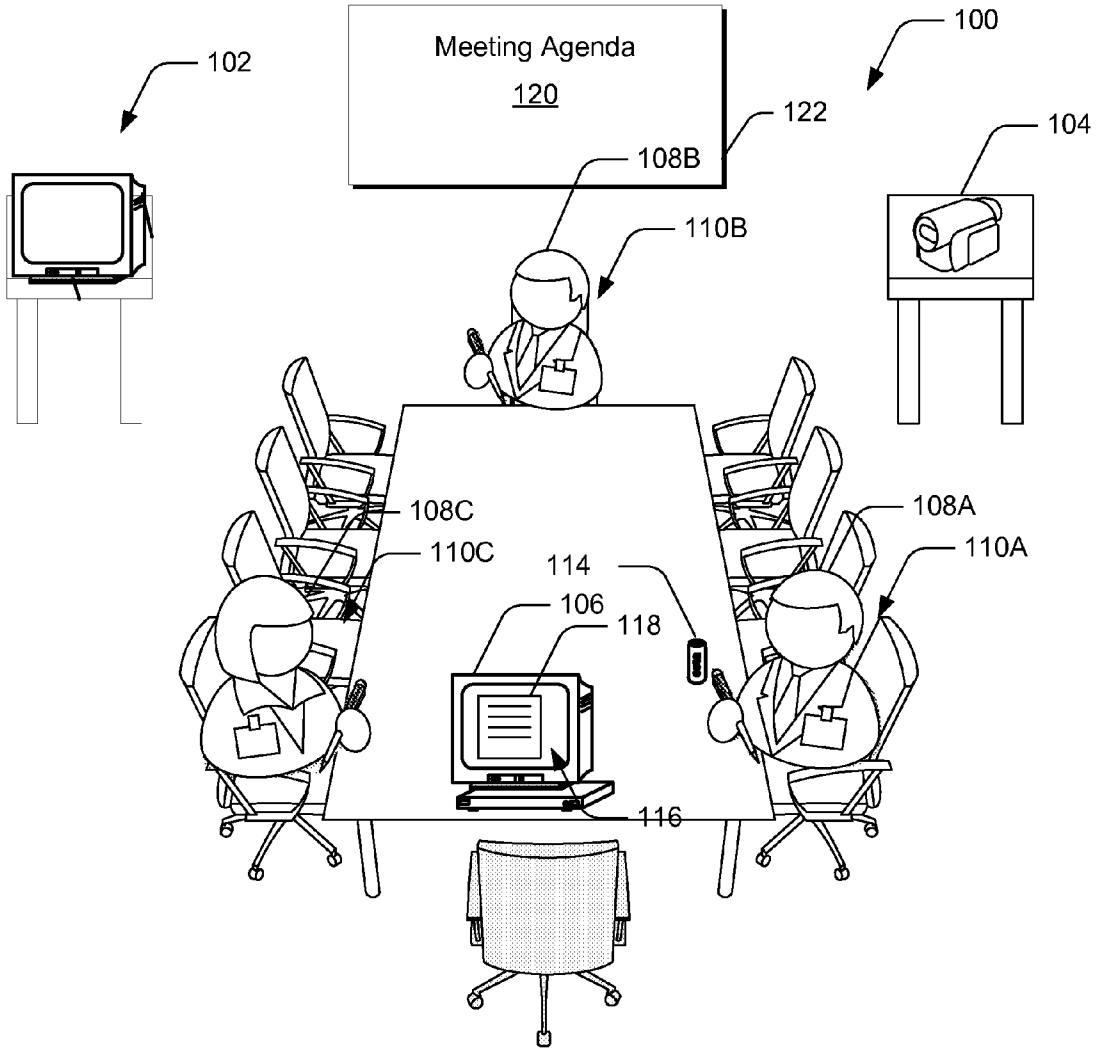

Meeting Agenda
120
100
102
122
104
108B
110B
108C
110C
114
108A
110A
106
118
116

Fig. 1

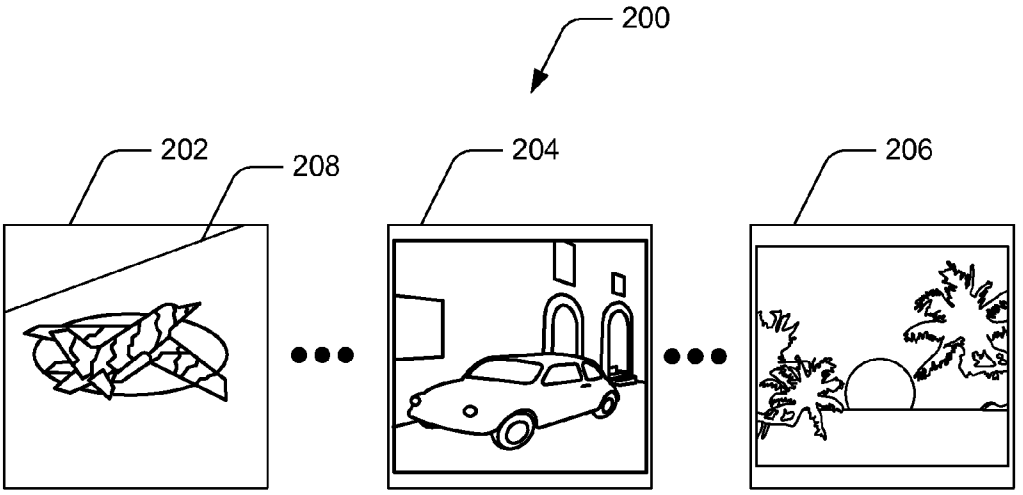

200
202
208
204
206

Fig. 2

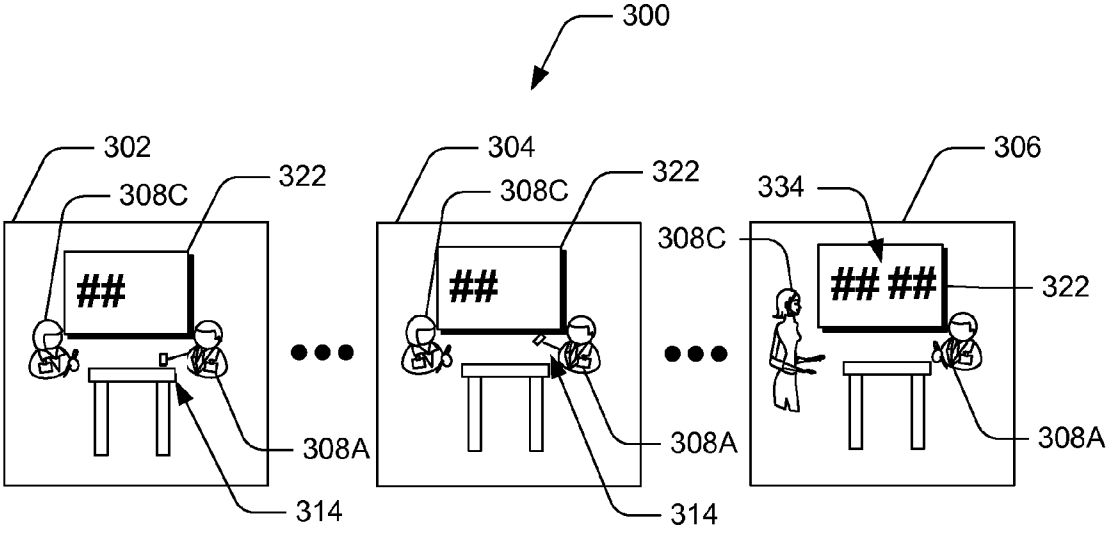

300
302
308C
322
##
308A
314
304
308C
322
##
308A
314
306
334
308C
##
322
308A

Fig. 3

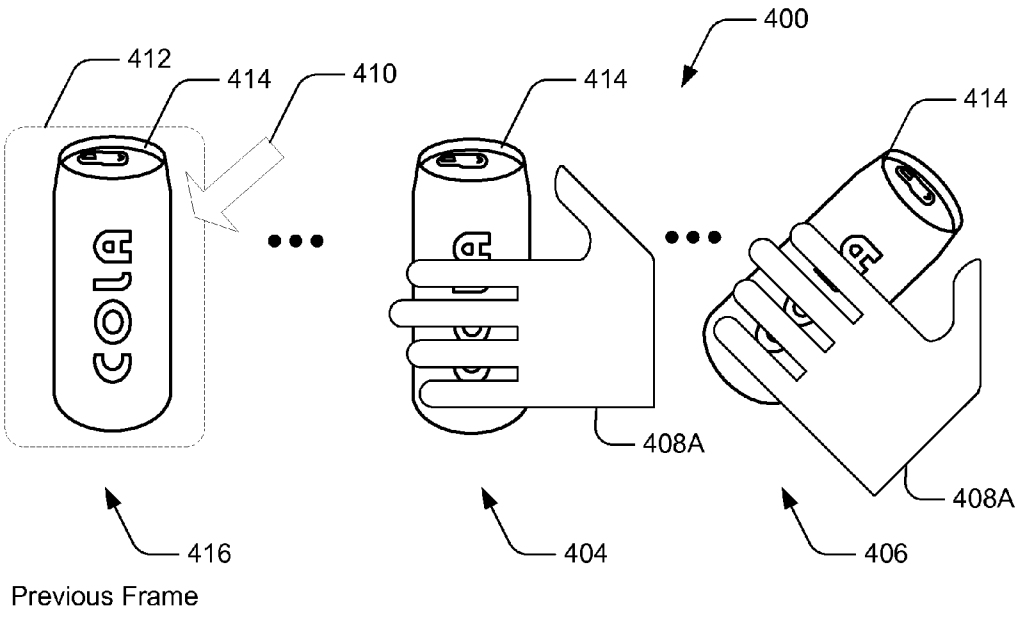

400
412
414
410
414
414
cola
408A
408A
416
404
406
Previous Frame

Fig. 4

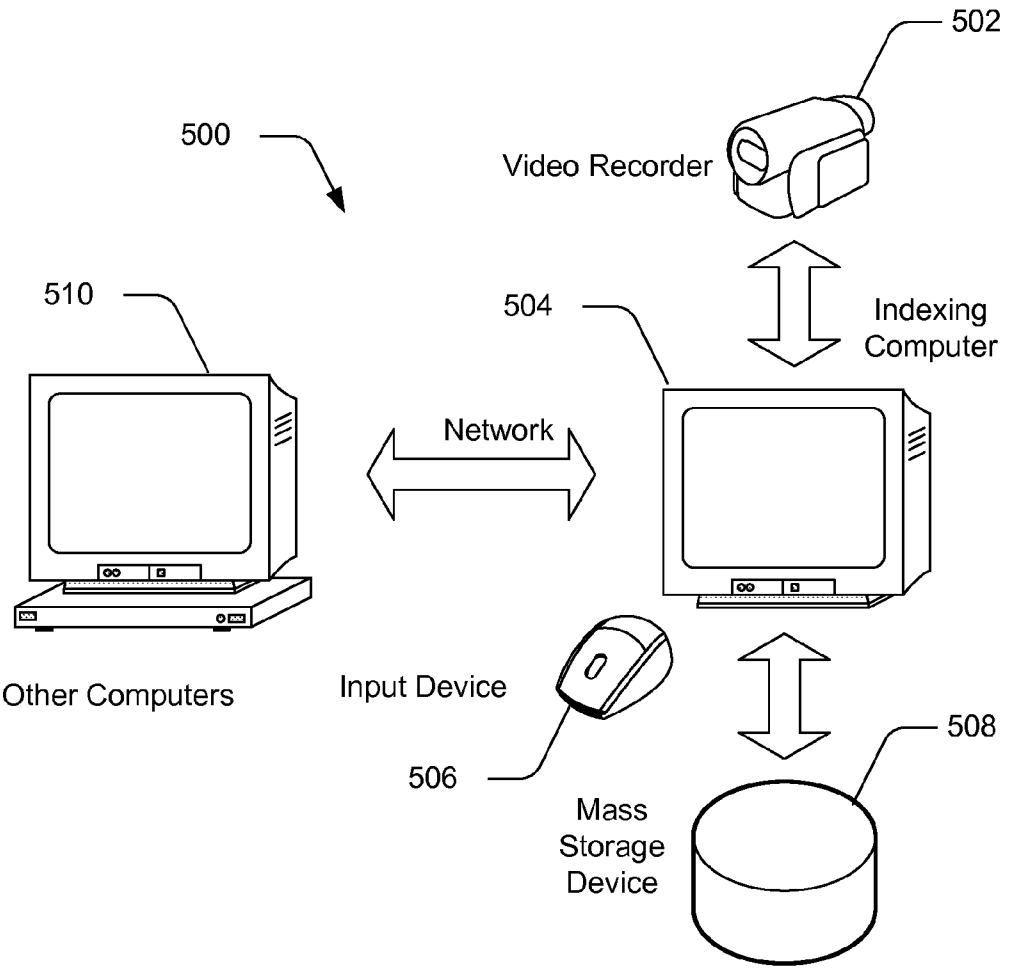

500
502
Video Recorder
504
Indexing Computer
510
Network
Other Computers
Input Device
506
508
Mass Storage Device

Fig. 5

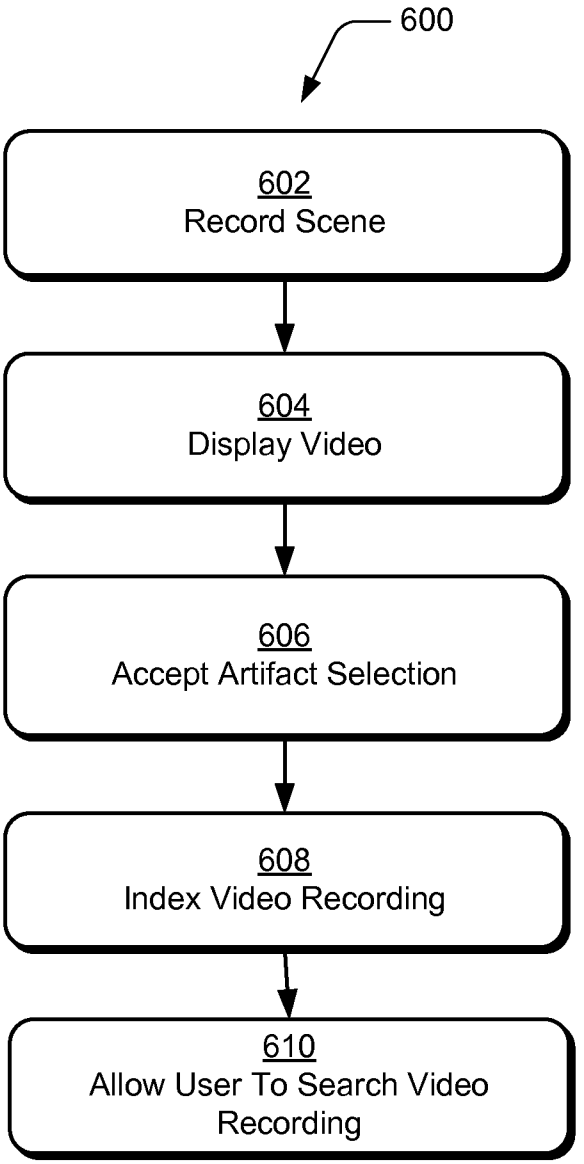

600
602
Record Scene
604
Display Video
606
Accept Artifact Selection
608
Index Video Recording
610
Allow User To Search Video Recording

Fig. 6

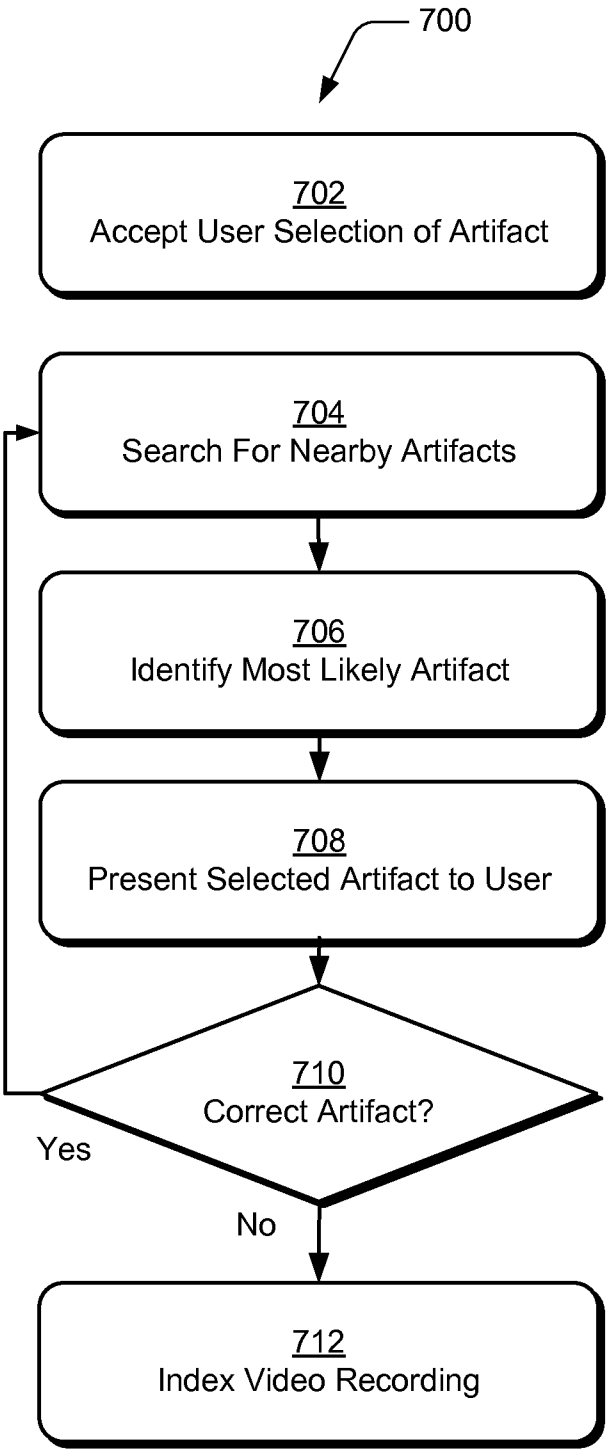

700
702
Accept User Selection of Artifact
704
Search For Nearby Artifacts
706
Identify Most Likely Artifact
708
Present Selected Artifact to User
710
Correct Artifact?
Yes
No
712
Index Video Recording

Fig. 7

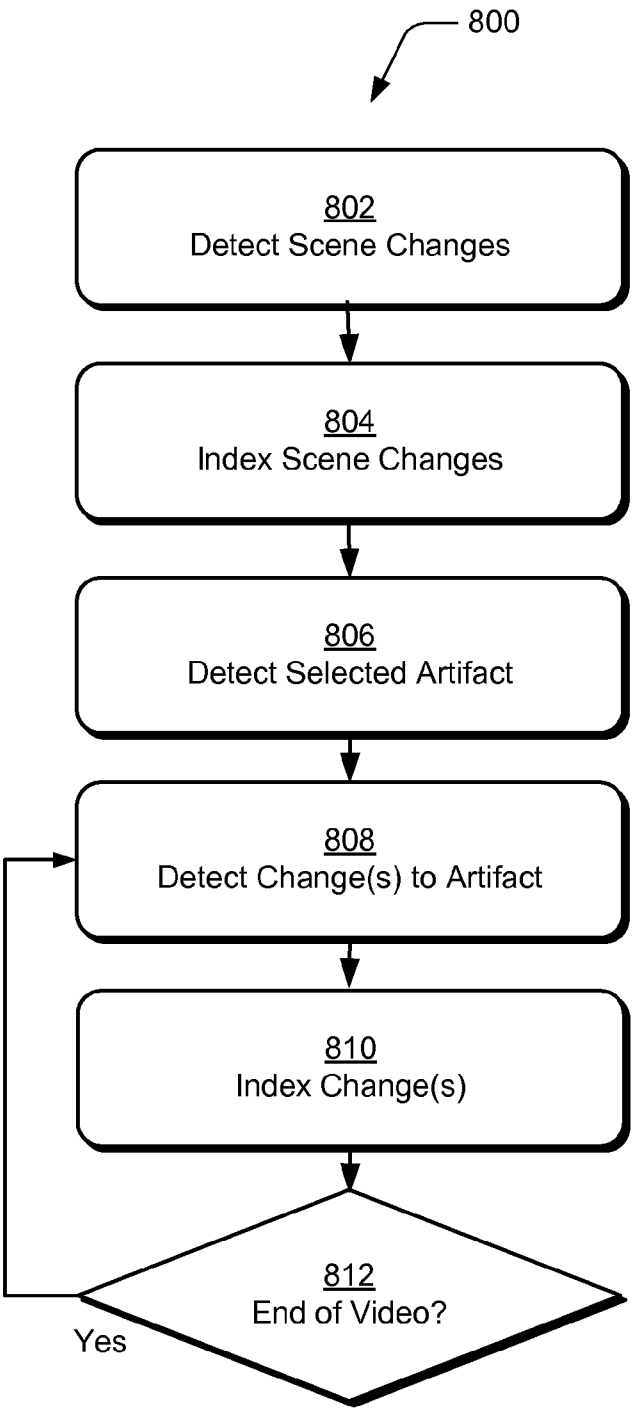

800
802
Detect Scene Changes
804
Index Scene Changes
806
Detect Selected Artifact
808
Detect Change(s) to Artifact
810
Index Change(s)
812
End of Video?
Yes

Fig. 8

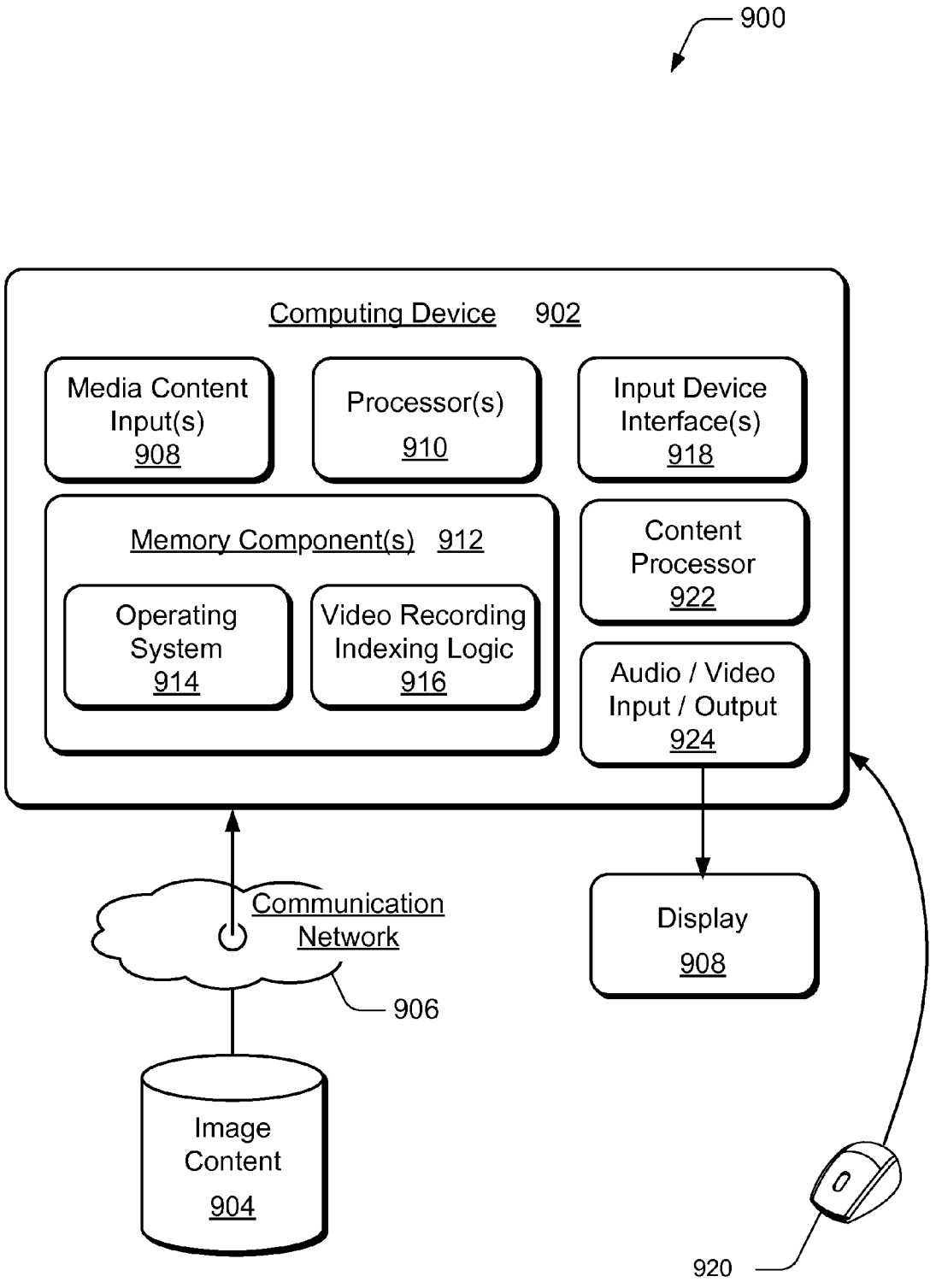

900
Computing Device 902
Media Content Input(s) 908
Processor(s) 910
Input Device Interface(s) 918
Memory Component(s) 912
Operating System 914
Video Recording Indexing Logic 916
Content Processor 922
Audio / Video Input / Output 924
Communication Network
906
Display 908
Image Content 904
920

Fig. 9

EMPLOYING ARTIFACTS FOR VIDEO INDEXING

BACKGROUND

People often videotape or otherwise record meetings, conferences, corporate events, ceremonies, and other scenes to capture the activities and events occurring in the scenes and information generated therein. For instance, some businesses memorialize (by way of video recording, audio recording, or a combination thereof) meetings convened to discuss some issue(s) of interest to the participants. The participants and others can, as desired, peruse the video recording of the scene to refresh their memories, to clarify some point regarding the issue, to learn what transpired during certain portions of the scene, etc.

While having the recording available is certainly better than having no (or an incomplete) record of the scene, users often grow frustrated as they search for some desired portion of the video recording. At times, users find it necessary to watch or fast-forward through the entire video recording to locate and watch some relatively small portion of the same. Sometimes the user can remember (or know of) certain events occurring during portions of the video recording which they wish to view. Still, even with this knowledge, the user must skim through potentially lengthy portions of the video recording to spot the event and, having spotted the event, hunt around that event for the portion of the video recording which they desire to view.

SUMMARY

One or more embodiments disclosed herein provide methods and systems for indexing video recordings of scenes using artifacts. More specifically, one or more embodiments provide identification of artifacts in video recordings and index the video recordings according to the artifacts. In addition, output portions of the video recordings may be based according to artifact-based indexing.

Furthermore, techniques and technologies are disclosed herein for indexing a video recording of a scene and outputting a portion of the video recording according to an artifact-based index. Such techniques and technologies allow a video recording of a scene to be indexed according to artifacts identified in the video recording. Moreover, some of the techniques and technologies output a portion of the video recording according to the artifact-based indexing.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter. The term "tools," for instance, may refer to system(s), method(s), computer-readable instructions, and/or technique(s) as permitted by the context above and throughout the document.

BRIEF DESCRIPTION OF THE CONTENTS

The detailed description is described with reference to accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items.

FIG. **1** depicts an illustrative scene including certain events, activities, objects, and a video indexing system.

FIG. **2** depicts an illustrative video recording of several scenes including certain events, activities, objects, and a video indexing system.

FIG. **3** depicts an illustrative video recording of another scene including certain events, activities, objects, and a video indexing system.

FIG. **4** depicts an illustrative artifact of an object in a video recording.

FIG. **5** depicts an illustrative block diagram of a system for indexing video recordings.

FIGS. **6-8** depict illustrative flow charts of methods related to indexing video recordings.

FIG. **9** depicts an illustrative block diagram of a computing system for implementing video indexing methods.

DETAILED DESCRIPTION

This document describes tools for indexing video recordings of scenes using artifacts. Moreover, the tools described herein allow for efficiently and accurately indexing certain types of scenes which traditional indexing techniques can not index. Furthermore, this application discloses methods, systems, apparatus, etc. for indexing a video recording of a scene (using artifacts of objects in the scene) for facilitating searches for desired portions of the video recording.

A method of some embodiments includes accepting an input indicative of an object in the scene. In these embodiments, the scene was substantially static (as is further disclosed herein) during the time the video recording was recorded. Responsive to the input, the method also includes identifying an artifact of the object in the video recording. Following the identification of the artifact, the method includes searching the video recording for a change associated with the identified artifact. Additionally, the method outputs a portion of the video recording from about the time that the change associated with the artifact occurred.

In some embodiments the video recording is indexed according to the various changes which occurred to the appearance of the object during the recording of the scene. Moreover, the input can also indicate the type of changes so that the video recording is searched for that type of change. For instance, the indicated change can be speaker moving to a new position in the scene. Moreover, the method can include accepting a selection of a level of significance associated with the change so that the searching of the video recording is for changes greater than the selected level (or within a range).

Furthermore, in some embodiments, the method includes (before the input is accepted) additional activities. For instance, a plurality of artifacts corresponding to a plurality of objects can be identified. The video recording is searched for and indexed according to these changes to these artifacts in some embodiments.

Additionally, or in the alternative, another input indicative of a change to an electronic file (which occurred on a computer in the scene and during the recording of the scene) is accepted. The method then outputs another portion of the video recording which is from about the time that the change to the electronic file occurred). Moreover, the application discloses computer readable storage media which store computer readable instructions for performing methods similar to the foregoing. Likewise, the application discloses systems for performing methods similar to the forgoing. These systems include a computer with a processor for performing such methods; a user input device for accepting the input(s); a display for displaying the outputs; and a memory for storing the video recordings and the computer readable instructions.

Further still, this application discloses systems of some particular embodiments which include a laptop computer with a processor, a user input device, a display, and a memory. The laptop computer is configured for searching a video recording of a scene for a portion of the video recording. In the current embodiment, the memory stores the video recording of a scene and an electronic document. Some of the methods performed by these systems include searching the video recording of the scene for a change associated with the artifact of the object in the scene. The system then outputs, on the display, a portion of the video recording from about the time that the change associated with the artifact occurred.

Additionally, the systems of the current embodiment accept another input indicative of a change to the electronic file which occurred during the recording of the scene. These systems then output on the display another portion of the video recording from about the time that the change to the electronic file occurred.

Having disclosed certain embodiments at a general level, this application next discloses various aspects of scenes including (but not limited to) certain events, activities, and objects of the scenes. This application further discloses some differences between video recordings of substantially static scenes and video recordings of other scenes. In the contexts of video recording, this application next discloses various aspects of artifacts. This application discloses various embodiments of artifact-based video indexing systems and methods.

With reference now to FIG. **1**, the drawing illustrates a scene including an embodiment of a system for indexing a video recording. FIG. **1** illustrates a scene **100**, a video indexing system **102**, a video recording subsystem **104**, a computing subsystem **106**, several participants **108**A, **108**B, **108**C, their respective personal spaces **110**A, **110**B, and **110**C, a beverage container **114**, a work space **116** and an electronic document **108** on the computing subsystem **106**, and various other objects **120** such as a whiteboard **122**. As discussed previously, certain users might wish to record the events and activities occurring within the scene **100** to memorialize the same. For instance, the illustrated scene **100** is a business conference, although many other types of scenes **100** are possible (and will be further elaborated upon herein). Thus, the video indexing system **102** can include the video recording subsystem **104** generally focused on the scene **100**. Moreover, the computing subsystem **106** provides a particular participant **108** (and other users) the ability to perform certain electronic functions (such as working on electronic documents) during the recording of the scene **100** and to access the video recording of the scene **100** as may be desired. For accessing the video recordings, the computing subsystem **106** need not be present in the scene **100**.

In addition, FIG. **1** illustrates that each participant **108**A, **108**B, and **108**C has associated therewith their respective personal space **110**A, **110**B, and **110**C. Actions associated with a particular participant **108**A, **108**B, and **108**C characterize and define their respective personal space **110**A, **110**B, and **110**C. These actions involve the particular participant manipulating certain objects **120** (a refreshment such as beverage container **114** illustrating one particular type of object **120**) within the scene **100**. Of course, the manipulated object **120** could be the particular participant him/herself such as when the particular participant **108** moves. These actions associated with the personal space **110** of the particular participant **108** often have little, if anything, to do with the underlying issue for which the scene **100** was convened and/or recorded.

On the other hand, particular participants **108** often carry a computing subsystem **106** (e.g., a laptop computer) which they use for purposes related to the issue for which the scene **100** was convened and/or recorded. In the case where the computing subsystem **106** is a laptop computer, the participant **108**A, **108**B, and **108**C might find it convenient to take notes, re-write documents (in whole or in part), manipulate information, access information, display information or otherwise alter some electronic file as events and activities occur during the scene **100**. More particularly, the computing subsystem **106** of the current embodiment defines a work space **116** in which the particular participant manipulates electronic files **118** as the scene develops.

Moreover, as the scene **100** unfolds, the participants **108**A, **108**B, and **108**C are likely to be discussing certain issues, developing certain documents, drawing on whiteboards, etc. in collaborative or individual manners. Often, the motivation for setting up the video recording system **102** includes capturing the inception, development, and products of these collaborative and individual efforts. Thus, after the scene **100** ends, a participant of participants **108**A, **108**B, and **108**C might wish to view a particular portion of the video recording of the scene **100** during which some point in the foregoing efforts was reached. Due to the nature of human memory, though, the participant might not be able to remember when that point in the discussion was reached. However, the participant might be able to remember that it occurred more or less simultaneously (or before or after) with some event or activity during the scene **100**. In the alternative, or in addition, a user might have been told that such was the case.

Here it is noted that the terms "event" and "activity" each involve a change in or associated with an object **120** in the scene **100**. For instance, while the scene **100** unfolds, certain participants might draw or write on a particular object **120** which happens to be a white board in the illustrative scene **100** of FIG. **1**. Objects **120** are not limited to whiteboards **122** of course. Objects **120** include furniture, the participants **108** themselves, beverage containers, the door to a room, and any other objects whose appearance (and changes thereto) can be captured by video recording subsystem **104**.

As further illustrated by FIG. **1**, various activities and events can cause the appearance of an object **120** to change. For instance, participant **108**A might pick up, throw away, or otherwise move the beverage container **114**. Participant **108**B might enter the room wherein the scene **100** is occurring thereby changing his/her own appearance within the video recording. Hence, the entrance of the participant **108**B into the room might signal an event such as the beginning of a new discussion while the discussion itself might be considered an activity. The participants **108**A, **108**B, and **108**C might associate these object-appearance-changing-events and activities with portions of the scene **100** which they wish to review via the video recording of the scene **100**. Embodiments disclosed herein provide systems, methods, apparatus, etc. which reflect how humans recall such memories in everyday life (and otherwise). For instance, one of the participants **108**A might recall that some portion of interest of the scene **100** occurred "just before Sally got up and got a soda." By indexing video recordings according to such information, embodiments allow users to locate portions of video recordings in an intuitive, user-friendly manner.

One aspect of the systems, methods, apparatus, etc. disclosed herein includes indexing the video recording of the scene **100** according to the changes in appearance of various objects (such as beverage container **114**) in the scene **100**. Using such indexes, the systems, methods, apparatus, etc. described herein allow portions of the video recording of the

scene **100** to be rapidly identified for viewing by the participants **108** (and/or other users). Having discussed certain aspects of the scene **100** of FIG. **1**, it may now be useful to further elaborate on the types of scenes **100** for which the video indexing system **102** can be used to index video recordings.

With reference now to FIG. **2**, and by way of contrast with scene **100** (i.e., the conference room illustrated in FIG. **1**), a video recording **200** of a particular scene is depicted. More particularly, FIG. **2** illustrates three illustrative frames **202**, **204**, and **206** of the particular video recording **200**. Of course many more frames than three, or even less, could be included in the video recording **200**. In any case, frames **202**, **204**, and **206** illustrate that some video recordings **200** are characterized by overall changes in the scenes recorded therein. More specifically, at a general level, the scenes change abruptly between frames **202**, **204**, and **206**. Some of these abrupt or overall changes in the scene involve camera angle changes. For instance, frame **202** illustrates, when compared to frames **204** and **206**, that the camera which recorded the frame **202** was tilted at an angle with respect to the horizontal as evidenced by the non horizontal horizon **208** in the frame **202**. Some of these changes involve light level changes. Other changes can involve bulk changes to the background or subject matter of the scenes recorded in video recording **200**.

As illustrated, each of the three frames **202**, **204**, and **206** involve different underlying backgrounds and/or subject matter. More specifically, the frames **202**, **204**, and **206** depict an aircraft, a motor vehicle, and a nature scene, respectively. Thus, even though the frames **202**, **204**, and **206** have been included in a particular video recording **200**, the frames involve disparate subject matter with disparate video related characteristics.

However, a number of frames involving similar subject matter could be, and indeed likely would be, adjacent to any of these particular frames **202**, **204**, and **206**. Thus, some portions of video recording **200** could exhibit a high degree of frame-to-frame coherency. Video indexing system **102** (see FIG. **1**) determines the frame-to-frame coherence between any two adjacent frames **202**, **204**, or **206** by correlating pixels in one frame **202**, **204**, or **206** with pixels in an adjacent (or other) frame **202**, **204**, or **206**. The characteristics of the pixels involved include brightness, luma, hue, chroma, saturation, etc. In some embodiments, the video indexing system **102** uses vector graphic or other image processing techniques to correlate the frames **202**, **204**, and **206** by determining the frame-to-frame coherence of the video recording **200**. Of course, combinations of these types of correlation techniques can be used without departing from the scope of the disclosure.

Having determined the frame-to-frame coherence of the video recording **200**, the video indexing system **102** can determine when relatively large changes occur between any two frames **202**, **204**, or **206** (or over the course of several or more frames **202**, **204**, and **206**). The degree of change in the frame-to-frame coherence sufficient to indicate a scene change in the video recording **200** can be user selected, statistically determined, or determined empirically by observing such frame-to-frame coherence changes across known scene changes. In any case, the video indexing system of some embodiments examines the video recording **200** and indexes scene changes where the frame-to-frame coherence changes by about an appropriate amount or more. Thus, whether the video recording **200** includes many scene changes (as some movies, television shows, etc. include) or one relatively static scene (such as the scene **100** of FIG. **1**) video indexing system **102** indexes the video recording **200** for scene changes and other substantial changes in which the frame-to-frame coherence changes by more than some threshold amount.

FIG. **3** illustrates some differences between a video recording **300** of a substantially static scene and the more dynamic video recording **200**. More particularly, FIG. **3** illustrates three frames **302**, **304**, and **306** of the video recording **300** of the scene **100** of FIG. **1**. FIG. **3** illustrates that as the video recording **300** of the scene **100** (see FIG. **1**) was recorded, several illustrative activities occurred. One of these activities involved participant **108**C moving to the white board **122** while another illustrative activity involved participant **108**A throwing away the beverage container **114**.

A comparison of the artifacts in frames **304** and **306** reveals that participant **108**C (i.e., artifact **308**C) was seated in a chair in frame **304** and moved to the whiteboard **122** (i.e., artifact **322**) by the time that frame **306** was recorded. Of course, all of the real-world objects in the scene **100** are represented by recorded artifacts (illustrative artifacts include artifacts **308**A, **308**C, **314**, **330**, and **334**) in the video recording **300** and its frames **302**, **304**, and **306**. Artifacts, therefore, appear in the video recording **300** and reflect the changing appearance of real-world objects as the scene **100** was recorded. Herein, when real world objects **120** are being referred to, reference numbers from FIG. **1** (i.e., 100 series reference numbers) are generally used. Moreover, when artifacts corresponding to those objects are being referred to, reference numbers from FIGS. **2-4** (i.e., 200, 300, and 400 series reference number) are generally used. Thus, a particular participant **108**B might move causing the corresponding artifact **308**B to change.

During the illustrative move of participant **108**C to the whiteboard **122** the appearance of several objects (and therefore their artifacts) changed within the scene **100**. For instance, participant **108**C (i.e., artifact **308**C) stood up, probably pushed his or her chair back (likely causing it to translate to/from the camera, translate laterally relative to the camera, and/or to rotate or swivel). Participant **108**C also walked to the whiteboard **122** passing between the table and the whiteboard **122** while perhaps gesticulating and/or handling various objects (for instance picking up an erasure or marker from the tray of the whiteboard **122**). Moreover, as participant **108**C moved, he or she (in whole or in part) eclipsed some objects while being eclipsed by others.

Similarly, although perhaps not as dramatically, as participant **108**A threw away the beverage container **114** (i.e., artifact **314**), the appearance of other objects changed. For instance, in frame **302** participant **108**A (i.e., artifact **308**A) held his or her arm out nearly straight to reach for the beverage container **114**. Then, in frame **304**, participant **108**A bent his or her arm while causing the beverage container **114** to tilt or rotate relative to the horizontal. Of course, participant **108**A also grasped the beverage container **114** thereby partially eclipsing the beverage container **114** (and vice versa).

Moreover, at some time between frames **304** and **306** additional information appeared on the right side of whiteboard **122** (i.e., artifact **322**) as indicated by artifact **334**. Furthermore, artifact **334** illustrates another aspect of the differences between artifacts and objects. An artifact (such as more information artifact **334**) can appear in a video recording **300** while having no, or an insubstantial, physical object associated therewith. Here, the object associated with the more information artifact **334** is a film left on whiteboard **122**. Furthermore, it is possible that some artifacts recorded in a particular video recording **300** might have no tangible object associated therewith. For instance, had whiteboard **122** been some electronic image display device (such as a CRT, LCD, or other type of display), the projected image could, once recorded, produce

an artifact in video recording **300** even though no object per se was present in the recorded scene **100**. For instance, the appearance of a participant on a teleconferencing display could be considered a change to an artifact in the video recording **300**. Likewise, the appearance of documents **118** on the display of subsystem **106** could produce artifacts in the video recording **300**.

With continuing reference to FIG. **3**, human participants and other users often remember (or know or believe) that some activity or event occurred at about the time that some portion of the scene **100** was recorded. For instance, a particular user might have information that suggests that a particular issue or subject was discussed about the time that the participant **108**C moved to the whiteboard **122**. In the alternative, or in addition, another user might believe that some idea was discussed at about the time that participant **108**A threw away the beverage container **114**. Thus, searching the video recording **300** for changes to the artifacts **308**C or **314** respectively of participant **108**C or the beverage container **114** will possibly reveal that portion of the video recording **300** where the desired information can be reviewed.

FIG. **4** depicts an illustrative artifact in a video recording and changes thereto as the video recording moves between its various frames. More particularly, FIG. **4** illustrates an artifact **414** of the beverage container **114** as video recording **400** progresses. For instance, FIG. **4** illustrates frames **404** and **406** as well as an earlier frame **416** (shown in FIG. **4** but not FIG. **3**). In frame **416**, artifact **414** reflects the appearance of the beverage container **114** (see FIG. **1**) in which the beverage container **114** is upright and visible to the extent possible (i.e., un-eclipsed). At some point between frame **416** and frame **404**, though, participant **108**A (i.e., artifact **408**) has grasped the beverage container **114** with his or her hand. Thus, in frame **404**, the artifact **414** has changed reflecting the change in the appearance of the corresponding object (that is, the beverage container **114**). Another change to the artifact **414** occurs between frames **404** and **406** in which the (partially eclipsed) object rotates relative to the horizontal.

Moreover, and as discussed further herein, FIG. **4** illustrates a pointer **410** and a highlighting effect **412**. Briefly, in some embodiments, pointer **410** can be used to select artifacts **414**, thereby initiating a search of the video recording **400** for changes to those artifacts. Such changes to the artifacts **414** indicate an activity or event affecting the object corresponding to that artifact. Accordingly, by detecting such changes to the artifacts **414** the activities and events affecting the corresponding objects can be used to index the video recording **400**. Moreover, detecting such changes to the artifacts **414** in the video recording **400** enables rapid and efficient searching of that video recording **400**.

FIG. **5** depicts a block diagram of an illustrative system for indexing video recordings. The system **500** includes a video recorder **502**, an indexing computer **504** including an input device **506**, a mass storage device **508**, and (in some embodiments) one or more computers **510**. The video recorder **502**, the indexing computer **504**, and the mass storage device **508** are in communication with each other over a network such that video recordings recorded by the video recorder **502** can be indexed, searched, and stored by the indexing system **500**.

More particularly, video recorder **502** can be any type of device capable of recording video recordings. For instance, video recorder **502** could be a camcorder, a cell phone (including a camera), a television camera, or other device. In some embodiments, the video recorder **502** is a computer with an embedded camera and which performs at least some of the functions of the indexing computer **504** (as further disclosed herein). Video recorder **502** can also include means for recording audio information of various scenes. Moreover, video recorder **502** can use digital or analog recording means without departing from the scope of the disclosure. For instance, video recorder **502** could be a camera in a video conferencing system. In any case, video recorder **502** captures sequential images of the scene which it views and stores them as frames of a video recording. Video recorder **502** can store these images locally, can transmit them to indexing computer **504**, or a combination thereof.

Indexing computer **504** can be any type of computer capable of receiving the video recordings from sources such as video recorder **502**, mass storage device **508**, its internal memory(s), other computers **510**, from a network, and many other sources too numerous for enumeration herein. Indexing computer **504** can, if desired, digitize video recordings that it receives for further processing and can also process digital video recordings. Furthermore, indexing computer **504** includes a display device on which it displays the various video recordings as desired by the user. Moreover, indexing computer **504** can receive user inputs (via for instance user input device **506**). One type of input which the indexing computer **504** can accept indicates artifacts **414** within the video recording(s) **400** which the user(s) wish to use to index various video recordings **400**. In some embodiments, input device **506** is a mouse although touchpads, joysticks, keyboards, and many other devices could serve as input device **506**.

No matter the type of input device **506** used, indexing computer **504** determines which artifact the user has selected, searches the video recording being displayed (and/or perhaps other video recordings) for the selected artifact, and indexes the same based on changes to the selected artifact. In addition, in some embodiments, indexing computer **504** allows a user to access the portions of the video recording which include changes to the selected artifact. Thus, the user can quickly review those portions of the video recording for the change which the user believes indicates the portion of the video recording including the sought after information.

In some embodiments, the other computers **510** also communicate with the indexing computer **504**. These other computers **510** can be used by participants during the recording of the scene. More particularly, such computers **510** can execute applications which allow users to make audio recordings of various scenes while working on documents and files on the computers **510**. These applications record each keystroke and other user inputs as the user works on various files on the other computer **510** and indexes the audio recordings according to these user inputs. Moreover, in some embodiments, the indexing computer **504** and the other computer **510** cooperate to synchronize the audio indexing performed by the computer **510** and the video indexing being performed by the indexing computer **504**.

With reference now to FIG. **6**, a method **600** related to the indexing of video recordings is illustrated. In operation, the indexing system **500** of FIG. **5** can be used to implement the method **600** of FIG. **6** as well as the methods illustrated by FIGS. **7-8**. More particularly, FIG. **6** illustrates that a scene may be recorded with the video recorder **502** at step **602**. Audio information from the scene may also be recorded during the video recording in step **602**. Additionally, or in the alternative, information related to a user's activities with a computer **510** can also be recorded also.

At step **604** a user can select a video recording to index and/or search. Based on the user's selection the video recording can be displayed. During the display of the video recording, the user can cause the video recording to be stopped, paused, played at a slower speed, fast forwarded and could

perform other time shifting techniques to enhance the user's ability to find an occurrence of the artifact which the user wishes to select. When the user finds an occurrence of the artifact, the user can select it using the input device **506** or through some other means. For instance, the user can position the pointer **410** (see FIG. **4**) over or near an occurrence of an artifact **432** in the displayed video recording and select it accordingly.

Thus, the indexing system, at step **606**, accepts the user's selection of a particular artifact. Depending on the form of the user's input, the system **500** can detect the location of the pointer **410** to determine which artifact **414** the user is attempting to select. However, it might be the case that the pointer **410** might be located near more than one artifact **414**. It might also be the case that the user positioned the pointer **410** near artifacts **414** that overlap or in some other manner leave the user's selection ambiguous. In such situations, the system **500** can use boundary finding and/or other image processing techniques to determine which artifact **414** the user has indicated. See step **606**.

Once the selected artifact **414** has been identified, the system **500** can search through the video recording **400** identifying and indexing changes to the artifact **414** which might indicate that some event or activity associated with the underlying object occurred. See step **608**. With the video recording **400** indexed (or partially indexed) the system **500** can allow the user to search through the video recording **400** accessing indexed portions of the video recording **400** which are associated with the indexed change searching for the information which the user wishes to review. See step **610**.

With further regard to the selection of an occurrence of an artifact **414**, FIG. **7** depicts another method **700** associated with indexing video recordings. The method **700** can also be implemented using system **500** of FIG. **5** although (as with the other methods disclosed herein) other systems, apparatus, etc. could be used to implement the methods described herein. Nonetheless, method **700** includes various steps such as step **702** at which the user's attempted selection of an artifact **414** is accepted. In some embodiments, the system **500** can detect artifacts associated with certain objects within the video recording (or a particular frame), place a highlighting affect **412** on them, and accept an input from the user which indicates which one of the pre-determined artifacts the user wishes to use to index the system. The system **500** can search the frame **416** (in which the user's attempt at selecting the artifact **414** occurred) for various artifacts **414** near the pointer **410**. See step **704**.

Since the system **500** might return more than one artifact **414** from the foregoing search, some means for determining which artifact **414** was the most likely target can be included in the system **500**. For instance, step **706** illustrates that the method **600** selects the artifact that is the mostly likely user target. For instance, the system **500** can include provisions for selecting the artifact **414** closest to the pointer **410**. In the alternative, or in addition, the system **500** can be configured to select the most prominent artifact **414** (by reason of relative size, brightness, aspect ratio, duration of appearance in the video recording, etc.) in the frame **416** (or surrounding frames **404** and **406**). Moreover, the system **500** can invert the factors affecting the selection of the most likely artifact **414** so that, for instance, obscure or apparently insignificant artifacts **414** can be used to index the video recording **400**. Regardless of the method used to determine which artifact **414** was the one targeted by the user, the system **500** can output an indication of which artifact **414** that the system **500** determined was the intended target of the user. See step **708** at which the system **500** could generate an effect to highlight the likely target. For instance a highlighting effect **412** could be applied to the likely target. See FIG. **4** in which the identification of the likely target by system **500** is illustrated by highlighting effect **412**.

With continuing reference to FIG. **7**, at step **710**, the system **500** can prompt the user to verify that the highlighted artifact **414** is indeed the intended target. If the user indicates that the highlighting effect **412** indicates some artifact **414** other than the target artifact **414**, the system **500** can present another artifact **414** as the next most likely target. If, however, the user indicates that the system **500** correctly identified the target, then the system **500** can respond by indexing the video recording **400** (or some portion thereof) based on changes to the target. See step **712**.

FIG. **8** depicts a flowchart of yet another method **800** related to indexing video recordings. The method **800** includes various steps such as step **802** at which the system **500** searches the video recording for overall scene changes. As disclosed elsewhere herein, it may be the case that at one or more locations (i.e., times) in the video recording **400** an overall change to the recorded scene **100** occurred. For instance, the video recorder **502** may have been paused, stopped, moved, etc. or combinations thereof during the scene(s) **100** recorded in the video recording **400**. Thus, at a general level it might be useful to index (see step **804**) the video recording **400** based on these overall changes. Moreover, as disclosed elsewhere herein, changes in frame-to-frame coherency can be used to indicate these overall scene **100** changes.

Once the overall scene changes have been indexed, or in the absence of such overall scene-change indexing, the video indexing system **500** can begin searching the video recording **400** for occurrences of the targeted artifact **414** identified via method **700** of FIG. **7**. The video indexing system **500** can search the video recording **400** from the beginning, from the end, or in any order as desired by the user to detect occurrences of the targeted artifact **414**. See step **806**. Once at least one occurrence of the selected artifact **414** has been located, the video indexing system **500** begins searching for changes to that artifact **414**. See step **808**.

These changes can be compared to some user selected criteria such that only those changes meeting the criteria are indexed. For instance, the user can select a threshold which the change to the artifact **414** must rise above (or fall below) in order for an index to be inserted into the video recording **400** for that change. In other cases, the user might select a range that the change must fall within in order for the video indexing system **500** to index the change. In the alternative, or in addition, the user can select a type of change which the change to the artifact **414** must satisfy in order for the video indexing system **500** to index the change. Some illustrative change types include a change in color, a change in orientation, a change in aspect ratio, a change in brightness, the artifact being eclipsed (in part or in whole), the artifact **414** emerging from behind the artifact **414** of an eclipsing object, an overall scene change (for instance an overall scene change caused by the re-positioning of video recorder **502**), etc.

In any case, the video indexing system **500** indexes the change according to the selected criteria, if any. Moreover, in some embodiments, the video indexing system **500** time stamps the change as well as indexing it. See step **810**. Method **800** continues until the video recording **400** (or a selected portion thereof) has been indexed as indicated by step **812**.

FIG. **9** illustrates various components of an exemplary computing system **900** in which a video indexing system, such as those disclosed with reference to FIGS. **1-8**, can be

implemented. The computing system **900** includes a computing device **902** which can be implemented in any number of embodiments with numerous other general purpose or special purpose computing system environments or configurations. Examples of well known computing systems, environments, and/or configurations that may be implemented in the exemplary computing system **900** include, but are not limited to, personal computers, hand held or laptop devices, multiprocessor systems, microprocessor-based systems, set-top boxes, programmable consumer electronics, network PCs, gaming consoles, distributed computing environments that include any of the above systems or devices, and the like.

Computing system **900** includes remote image content **904** which can be received via a communication network **906**. The image content **904** is stored for display as sequential images on the display device **908** and for indexing by computing device **902**. The image content **904** can include any combination of video, still images, and interpolated synthetic images captured and/or generated to form dynamic scenes for display as sequential images such as video recordings. Although the computing device **902** and the image content **904** are illustrated and described as separate and/or remote components of the computing system **900**, the computing device **902** may contain the image content **904** in an internal memory component.

The computing device **902** includes one or more media content inputs **904** which may include Internet Protocol (IP) inputs over which streams of media content (e.g., image content **904**) are received via an IP-based network (e.g., communication network **906**). The computing device **902** also includes one or more processors **910** (e.g., any of microprocessors, controllers, and the like) which process various instructions to control the operation of computing device **902** and to communicate with other electronic and computing devices and to record, display, and index video recordings.

The computing device **902** can be implemented with one or more memory components **912**, examples of which include random access memory (RAM), non-volatile memory (e.g., any one or more of a read-only memory (ROM), flash memory, EPROM, EEPROM, etc.), and a disk storage device. A disk storage device can include any type of magnetic or optical storage device, such as a hard disk drive, a recordable and/or rewriteable compact disc (CD), a DVD, a DVD+RW, and the like. The memory components **912** provide data storage mechanisms to store various information and/or data such as received media content, software applications, and any other types of information and data related to operational aspects of computing device **902** and to recording, displaying, and indexing video recordings.

An operating system **914** and video indexing logic **916** can be maintained as software applications in memory components **912** and executed on processor(s) **910** to implement embodiments of video indexing systems. As described above with reference FIGS. **1-8**, the video indexing logic **916** generates an indexed sequential image that corresponds to the video recording **400** of a scene **100** to facilitate rapid and efficient searches of the video recording. The indexed video recording **400** includes indexes at locations (or times) at which changes occurred to a selected artifact(s) **414**.

As used herein, the term "logic" (e.g., the video indexing logic **916**) can also refer to hardware, firmware, software, or any combination thereof that may be implemented to perform the logical operations associated with the embodiments of video indexing systems. Logic may also include any supporting circuitry utilized to complete a given task including supportive analog operations. For example, logic may also include analog circuitry, memory components, input/output (I/O) circuitry, interface circuitry, power providing/regulating circuitry, and the like.

An input device interface **918** provides an interface for a mouse **920** that can be used to select video recordings, select artifacts within the video recordings, and to control the display of various indexed and non-indexed video recordings. Although not shown, computing device **902** may also include other input devices such as keyboards, joysticks, pointing devices, and/or other mechanisms to interact with, and to input information to computing device **902**.

Computing device **902** also includes a content processor **922** which can include a video decoder and/or additional processors to receive, process, and decode media content, image content, and display data. Computing device **902** also includes audio and/or video input/outputs **924** that provides audio and/or video to an audio rendering and/or display device **908**, or to other devices that process, display, and/or otherwise render audio, video, and display data.

Embodiments of video indexing systems allow users to rapidly and efficiently search video recordings for changes to the recorded scene indicative of a portion of the video recording of interest. Moreover, embodiments allow users to locate information in video recordings which the users believe might be of interest. Furthermore, embodiments provide an indexing system based on changes to artifacts in video recordings which avoid resource consuming processing such as apriori processing of the entire video recording to identify every (or many) artifact and the changes thereto.

Although embodiments of video indexing systems and methods have been disclosed in language specific to structural features and/or methods, it is to be understood that the subject of the appended claims is not necessarily limited to the specific features or methods described. Rather, the specific features and methods are disclosed as non limiting implementations of video indexing systems and methods.

CONCLUSION

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed is:

1. A system comprising:

one or more processors;

a user input device;

a display;

a memory storing a video recording of a scene and an electronic file; and

computer readable instructions maintained in the memory and executable by the one or more processors to perform acts comprising:

presenting, on the display, the video recording of the scene, wherein the scene was substantially static during a time the video recording was recorded, the video recording at least recording one or more appearance changes being made to the electronic file;

accepting a first input from the user input device selecting an object from multiple objects displayed in the video recording presented on the display, the object being selected in response to the first input positioning an indicator on or near the object as displayed in the video recording presented on the display;

responsive to the first input, identifying an artifact of the object in the video recording of the substantially static scene;

searching the video recording of the substantially static scene for an appearance change in the artifact of the object as the artifact of the object is displayed in the video recording;

outputting on the display a portion of the video recording of the substantially static scene from about a time that the appearance change in the artifact of the object occurred;

accepting a second input indicative of a change to an appearance of the electronic file as recorded in the video recording of the scene; and

responsive to the second input, outputting on the display another portion of the video recording of the substantially static scene from about a time that the change to the appearance of the electronic file as recorded in the video recording occurred.

2. The system of claim **1**, the acts further comprising indexing the video recording responsive to a plurality of appearance changes in the artifact of the object.

3. The system of claim **1**, wherein the first input further indicates a type of the appearance change in the artifact of the object, and the searching of the video recording further comprises searching the video recording of the substantially static scene for the appearance change of the type in the artifact of the object.

4. The system of claim **3**, wherein the appearance change in the artifact is a video recording participant moving to a new position in the scene.

5. The system of claim **1**, the acts further comprising, before the accepting of the first input:

identifying a plurality of artifacts corresponding to a plurality of objects in the video recording of the scene;

searching the video recording of the substantially static scene for appearance changes in the artifacts of the objects; and

indexing the video recording of the substantially static scene according to the appearance changes.

6. The system of claim **1**, the acts further comprising accepting a selection of a level of significance associated with the appearance change in the artifact of the object, the searching of the video recording of the substantially static scene further comprising searching the video recording of the substantially static scene for an appearance change in the artifact of the object greater than the selected significance level.

7. A method comprising:

under control of one or more processors configured with executable instructions,

accepting an input to select an object in a video recording of a scene presented on a display, wherein the scene was substantially static when the video recording was recorded;

responsive to the input, identifying an artifact of the object in the video recording of the substantially static scene, the artifact being identified in response to the input positioning an indicator on or near the object as displayed in the video recording presented on the display;

searching the video recording of the substantially static scene for a change associated with the artifact of the object; and

outputting a portion of the video recording of the substantially static scene from about a time that the change associated with the artifact of the object occurred.

8. The method as recited in claim **7**, wherein:

the accepting the input further indicates the change associated with the artifact of the object; and

the searching of the video recording further comprises searching the video recording of the substantially static scene for the indicated change associated with the artifact of the object.

9. The method as recited in claim **8**, wherein the change associated with the artifact is a video recording participant moving to a new position in the scene.

10. The method as recited in claim **7**, further comprising indexing the video recording responsive to a plurality of changes associated with the artifact of the object.

11. The method as recited in claim **7**, further comprising:

accepting another input indicative of a change to an electronic file which occurred during the recording of the scene; and

outputting another portion of the video recording of the substantially static scene from about a time that the change to the electronic file occurred.

12. The method as recited in claim **7**, further comprising, before the accepting of the input:

identifying a plurality of artifacts corresponding to a plurality of objects in the video recording of the scene;

searching the video recording of the substantially static scene for changes associated with the artifacts of the objects; and

indexing the video recording of the substantially static scene according to the changes.

13. The method as recited in claim **7**, further comprising accepting a selection of a level of significance associated with the change associated with the artifact of the object, the searching of the video recording of the substantially static scene further comprising searching the video recording of the substantially static scene for a change associated with the artifact of the object greater than the selected significance level.

14. A computer readable storage medium maintaining computer readable instructions which, when executed, cause one or more processors to perform acts comprising:

accepting an input indicative of a visible change associated with an object selected in a video recording of a scene presented on a display, wherein the scene was substantially static during a time the video recording was recorded;

responsive to the input, identifying an artifact of the object in the video recording of the substantially static scene;

searching the video recording of the substantially static scene for an appearance change in the artifact of the object as the artifact of the object is displayed in the video recording; and

outputting a portion of the video recording of the substantially static scene from about a time that the change associated with the artifact of the object occurred.

15. The computer readable storage medium of claim **14**, the acts further comprising indexing the video recording responsive to a plurality of appearance changes in a plurality of artifacts of a plurality of objects as displayed in the video recording of the scene.

16. The computer readable storage medium of claim **14**, wherein the accepting the input includes accepting a selection of the object from a group of predetermined objects in the scene, the acts further comprising generating, in the video recording of the scene presented on the display, an effect to visually distinguish the artifact of the object from other objects in the group of predetermined objects.

17. The computer readable storage medium of claim 14, wherein:

the input further indicates the change associated with the artifact of the object; and

the searching of the video recording further comprises searching the video recording of the substantially static scene for the indicated change associated with the artifact of the object.

18. The computer readable storage medium of claim 17, wherein the appearance change in the artifact of the object is a video recording participant moving to a new position in the scene.

19. The computer readable storage medium of claim 14, the acts further comprising, before the accepting of the input:

identifying a plurality of artifacts corresponding to a plurality of objects in the video recording of the scene;

searching the video recording of the substantially static scene for appearance changes in the plurality of artifacts of the objects; and

indexing the video recording of the substantially static scene according to the appearance changes.

20. The computer readable storage medium of claim 14, the acts further comprising accepting a selection of a level of significance associated with the change associated with the artifact of the object, the searching of the video recording of the substantially static scene further comprising searching the video recording of the substantially static scene for an additional appearance change in the artifact of the object that is greater than the selected significance level.

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