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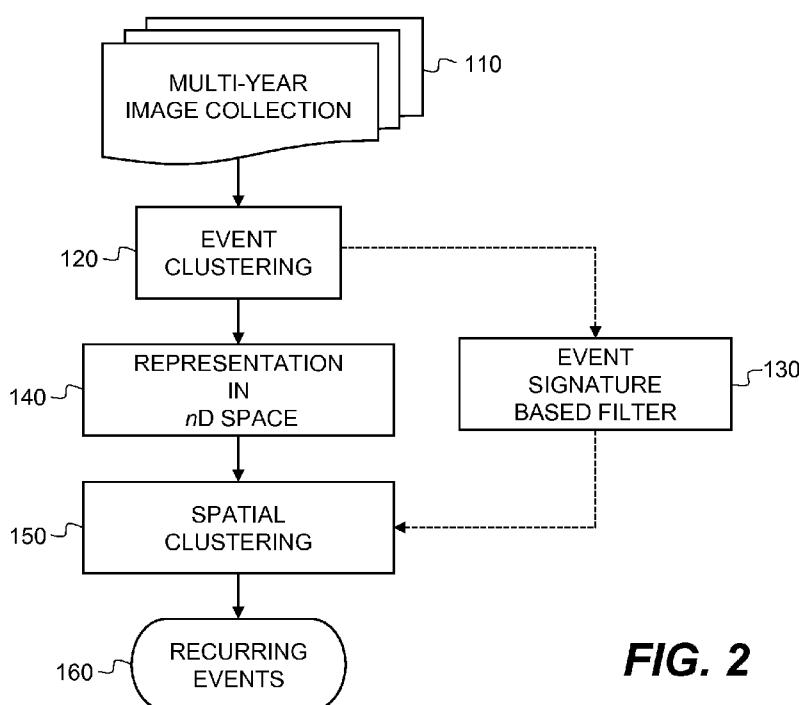
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(54) Title: DETECTING RECURRING EVENTS IN CONSUMER IMAGE COLLECTIONS



(57) Abstract: A method of detecting recurring events in a digital image collection taken over a pre-determined period of time is disclosed. The method uses a processor for analyzing the digital image collection to produce a two-dimensional representation of the distribution of image capture activity over time and detecting recurring events by identifying spatial clusters in the two-dimensional representation.

**FIG. 2**



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**DETECTING RECURRING EVENTS IN CONSUMER  
IMAGE COLLECTIONS**

**FIELD OF THE INVENTION**

The invention relates generally to the field of digital image  
5 processing, and in particular to a method for identifying groups of digital images  
that portray recurring events in consumer image collections.

**BACKGROUND OF THE INVENTION**

With the ubiquitous presence of digital cameras and camera  
phones, people capture large numbers of images and videos to mark events  
10 important to them. The highlights of such events are then shared online to be  
accessed by the user's social networks. Large digital media collections  
accumulated over time contain a wealth of information that can be useful to  
understand individual users as well as groups of people. Temporal information is  
valuable for information management and retrieval in general, enhancing search  
15 and browsing applications. Analyzing the content and timing of a user's media in  
a collection that spans several years can yield dates of importance and a view into  
the user's interests. This knowledge can enable organization of the personal  
collection, sharing with contacts, as well as personalized and well-timed  
advertising. For example, if evidence from a user's personal photo collection  
20 suggests that he/she regularly takes a vacation during a school break in March, the  
images in this group can be organized appropriately with links to previous years'  
vacations. Travel and tourism-related advertising can be targeted to fall within  
the planning phase of this time period, and the images can be shared with contacts  
with which the user regularly shares this type of images.

25           Attempting to identify some of these events using a generic  
calendar of important dates can detect a limited number of events, and none of the  
user-specific special dates (e.g. birthdays) can be detected in this manner. Also,  
this approach makes an assumption that the user actually celebrates the same  
holidays as the region they are in, when in reality there would need to be a  
30 different calendar for each group of people in a diverse population. In addition to

differences in calendar due to cultural differences, the location of the user also contributes local events to the calendar e.g. Lilac Festival in Rochester, NY, International Balloon Fiesta in Albuquerque, NM. In response to these problems, there has been work in associating users' captured images with their personal 5 calendars (e.g. "Image Annotation Using Personal Calendars as Context", Gallagher et al, ACM Intl. Conf. on Multimedia 2008). However, notations on personal calendars often relate to appointments and work tasks that are not associated with picture-taking.

There has been work in grouping images into events. U.S. Patent 10 No. 6,606,411 by Loui and U.S. Patent No. 6,351,556 by Loui, disclose algorithms for clustering image content by temporal events and sub-events. According to U.S. Patent No. 6,606,411 events have consistent color distributions, and therefore, these pictures are likely to have been taken with the same backdrop. For each sub-event, a single color and texture representation is computed for all 15 background areas taken together. The above two patents teach how to cluster images and videos in a digital image collection into temporal events and sub-events. The terms "event" and "sub-event" are used in an objective sense to indicate the products of a computer mediated procedure that attempts to match a user's subjective perceptions of specific occurrences (corresponding to events) and 20 divisions of those occurrences (corresponding to sub-events). Another method of automatically organizing images into events is disclosed in U.S. Patent No. 6,915,011 by Loui et al. The events detected are chronologically ordered in a timeline from earliest to latest.

Using the above methods, a reduction can be made in the amount 25 of browsing required by the user to locate a particular event by viewing representatives of the events along a timeline, instead of each image thumbnail. However, due to the large temporal separation of related events (such as birthdays), these event groups are spaced far apart on the timeline and are not easy to visualize as a group. Therefore, a need exists to detect groups of images that 30 are semantically related to each other but are temporally separated by long time differences.

## SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a method of detecting recurring events in a digital image collection taken over a pre-determined period of time comprising, using a processor for:

- 5 (a) analyzing the digital image collection to produce a multi-dimensional representation of the distribution of image capture activity over time; and
- 10 (b) detecting recurring events by identifying spatial clusters in the multi-dimensional representation. The similarity between events can also be taken into consideration during the clustering process.

In this invention, a framework for mining temporal recurring events from multi-year consumer collections is described. Collections are described in terms of events that are represented in an appropriate multi-dimensional space. Density-based clustering at different neighborhood sizes is used, filtering the neighborhood based on event characteristics to reduce the number of false matches in the group. An event signature based on event classification, location, and temporal characteristics is created to characterize events. This invention detects personal special dates such as birthdays and anniversaries, seasonal activities and holidays celebrated customized to a user's personal collection.

The present invention, for example, is applicable for two of the commonly occurring classes of calendar-based recurring events in consumer collections—events that typically occur around the same date every year, e.g., birthdays, anniversaries, and some holidays; and events that are loosely tied to the calendar date. Although events in this second class have similar temporal characteristics, the exact date is often not followed year-over-year. These include holidays that do not follow the exact date, e.g., those that are on a certain day of the week during a specified week and month (such as Labor Day in the US; Mother's Day), and those that are computed from the phase of the moon or sun (such as many Asian religious and cultural festivals). In addition, there are regular

vacations (e.g., during school breaks), parties/gatherings (to celebrate calendar-based events but moved to a convenient weekend instead of the exact date), and sporting events, which also fall in this category of loosely being related to the calendar but not on a specific date.

5                   The organization and retrieval of images and videos is a problem for the typical consumer. It is useful for the user to be able to browse an overview of important events in their collection. Technology disclosed in prior art permits the classification of images in a collection into events, but not the ability to associate related events when they are temporally separated. This invention is  
10                  effective in detecting recurring events that typically occur around the same date every year and events that are loosely associated with the calendar date. This includes personal special dates such as birthdays and anniversaries, seasonal activities and holidays celebrated, that is customized to the user whose collection is being analyzed.

15                    **BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a block diagram of a system that practices the present invention;

FIG. 2 is an overall flowchart of the method of the present invention;

20                   FIG. 3 is a more detailed flowchart of the event signature generation shown in block 130 of FIG. 2;

FIG. 4 shows a specific example of the 2D representation of events produced in accordance with the present invention;

25                   FIG. 5 shows a specific example of a 3D representation of events produced in accordance with the present invention; and

FIGS. 6A and 6B show two examples of displaying an organized collection showing the recurring event groups detected in the collection.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention can be implemented in computer systems as will be well known to those skilled in the art. In the following description, some embodiments of the present invention will be described as software programs.

5 Those skilled in the art will readily recognize that the equivalent of such a method can also be constructed as hardware or software within the scope of the invention.

Because image manipulation algorithms and systems are well known, the present description will be directed in particular to algorithms and systems forming part of, or cooperating more directly with, the method in 10 accordance with the present invention. Other aspects of such algorithms and systems, and hardware or software for producing and otherwise processing the image signals involved therewith, not specifically shown or described herein can be selected from such systems, algorithms, components, and elements known in the art. Given the description as set forth in the following specification, all 15 software implementation thereof is conventional and within the ordinary skill in such arts.

The present invention can be implemented in computer hardware and computerized equipment. For example, the method can be performed in a digital camera, a multimedia smart phone, a digital printer, on an internet server, 20 on a kiosk, and on a personal computer. Referring to FIG. 1, there is illustrated a computer system for implementing the present invention. Although the computer system is shown for the purpose of illustrating a preferred embodiment, the present invention is not limited to the computer system shown, but can be used on any electronic processing system such as found in digital cameras, home 25 computers, kiosks, or any other system for the processing of digital images. A computer 10 includes a microprocessor-based unit 20 (also referred to herein as a processor) for receiving and processing software programs and for performing other processing functions. A memory unit 30 stores user-supplied and computer-generated data which can be accessed by the processor 20 when running a 30 computer program. A display device (such as a monitor) 70 is electrically

connected to the computer 10 for displaying information and data associated with the software, e.g., by a graphical user interface. A keyboard 60 is also connected to the computer 10. As an alternative to using the keyboard 60 for input, a mouse can be used for moving a selector on the display device 70 and for selecting an item on which the selector overlays, as is well known in the art. Input devices 50 such as compact disks (CD) and DVDs can be inserted into the computer 10 for inputting the software programs and other information to the computer 10 and the processor 20. Still further, the computer 10 can be programmed, as is well known in the art, for storing the software program internally. In addition, media files (such as images, music and videos) can be transferred to the memory unit 30 of the computer 10 by use of input devices 50 such as memory cards, thumb drives, CDs and DVDs, or by connecting a capture device (such as camera, cell phone, video recorder) directly to the computer 10 as an input device. The computer 10 can have a network connection, such as a telephone line or wireless connection 80, to an external network, such as a local area network or the Internet. Software programs and media files can be transferred to the computer 10 from other computers or the Internet through the network connection.

It should also be noted that the present invention can be implemented in a combination of software or hardware and is not limited to devices which are physically connected or located within the same physical location. One or more of the devices illustrated in FIG. 1 can be located remotely and can be connected via a network. One or more of the devices can be connected wirelessly, such as by a radio-frequency link, either directly or via a network.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. Videos in a collection are included in the term "images" in the rest of the description.

Referring to FIG. 2, a user's multi-year digital image collection 110 resides in the memory unit 30 of the computer 10. In the preferred embodiment, the digital image collection 110 spans at least 5 years of time. The other blocks in the figure are implemented by a software program and are 5 executed by the processor 20 of the computer 10. The digital image collection 110 is provided to an event clustering algorithm 120 that groups the images in the digital image collection 110 into temporal events. In the preferred embodiment, the event and sub-event detector described in U.S. Patent No. 6,606,411, by Loui and U.S. Patent No. 6,351,556 by Loui are used. According to U.S. Patent No. 10 6,606,411 events have consistent color distributions, and therefore, these pictures are likely to have been taken with the same backdrop. For each sub-event, a single color and texture representation is computed for all background areas taken together. The above two patents teach how to cluster images and videos in a digital image collection into temporal events and sub-events. The terms "event" 15 and "sub-event" are used in an objective sense to indicate the products of a computer mediated procedure that attempts to match a user's subjective perceptions of specific occurrences (corresponding to events) and divisions of those occurrences (corresponding to sub-events). Briefly summarized, a collection of images is classified into one or more events determining one or more 20 largest time differences of the collection of images based on time or date clustering of the images and separating the plurality of images into the events based on having one or more boundaries between events where one or more boundaries correspond to the one or more largest time differences. For each event, sub-events can be determined (if any) by comparing the color histogram 25 information of successive images as described in U.S. Patent No. 6,351,556. This is accomplished by dividing an image into a number of blocks and then computing the color histogram for each of the blocks. A block-based histogram correlation procedure is used as described in U.S. Patent No. 6,351,556 to detect sub-event boundaries. Another method of automatically organizing images into events is 30 disclosed in U.S. Patent No. 6,915,011 by Loui et al, which is herein incorporated by reference. Briefly

summarized, according to one aspect of the above invention, an event clustering method uses foreground and background segmentation for clustering images from a group into similar events. Initially, each image is divided into a plurality of blocks, thereby providing block-based images. Using a block-by-block

5 comparison, each block-based image is segmented into a plurality of regions including at least a foreground and a background. One or more luminosity, color, position or size features are extracted from the regions and the extracted features are used to estimate and compare the similarity of the regions including the foreground and background in successive images in the group. Then, a measure

10 of the total similarity between successive images is computed, thereby providing image distance between successive images, and event clusters are delimited from the image distances.

Referring to FIG. 2, the events detected in event clustering algorithm 120 are represented 140 in a multi-dimensional space. In one embodiment, a 2D space is used as illustrated in FIG. 4. Referring to FIG. 4, each event forms an event point 310 in the space defined by the year number on the y-axis 320 and the day of the year on the x-axis 330, also referred to as *event points* in this application. The years are simply numbered chronologically to generate the year number e.g. if the collection spans 2005 to 2010, 2005 would correspond to year number 1, 2006 to year number 2 and so on with 2010 corresponding to year number 6. The day of the year is counted from the beginning of the year with January 1st as day 1. February 29th, if occurring in the year, is currently ignored in the count so that dates in consecutive years correspond to the same day of the year. Representing events in this 2D-space places potentially recurring events in spatial proximity with each other, spatial clustering methods can be used to find groups of events. The events can also be represented in multi-dimensional space, where the number of dimensions,  $n$ , is more than 2. Other event characteristics such as event type or event size can be used as additional axes to further localize events spatially by their characteristics. In another embodiment, the week of year and day of the week are used as the x-axis and y-axis respectively. FIG. 5 shows

an example of this embodiment with the year number as the z-axis, creating a 3-dimensional representation. The week of year refers to the sequential number of the week starting with the first week of the year as 1. The last week of the year is week 53 when the first and last weeks are partial weeks. The day of the week are 5 numbered sequentially from -3 to +3 (including 0) starting with Monday. This representation is useful for detecting recurring events that are associated with the day of the week e.g. school sporting leagues, regular weekly gatherings, Easter, Thanksgiving and other holidays.

Referring to FIG. 2, spatial clustering 150 is performed on the 10 event representation in the multi-dimensional space generated in 140. In the preferred embodiment, the density-based clustering approach (Data Mining Concepts and Techniques by Han and Kamber, Elsevier, 2006, pg. 418-420) is used for generating spatial clusters. This algorithm grows regions with sufficiently high point density into clusters. In our embodiment, the neighborhood 15 around any given central event point (x, y) is defined as  $(x \pm 2, y \pm 2)$  for detecting events closely tied to the calendar date. Core objects are identified that have greater than a threshold of points (5 points in this embodiment) in their neighborhood. The density-based clustering algorithm iteratively collects directly density-reachable objects from these core objects, terminating when no new points 20 can be added. For detecting recurring events that are loosely associated with the calendar, a larger neighborhood of  $(x \pm 7, y \pm 2)$  is selected around the central event point (x, y) with the same threshold (5 points) for qualifying as a core point. However, only event points 310 that pass the event signature filtering process 25 described in the next paragraph are included to compute the neighborhood points for any given event point 310.

Referring to FIG. 2, filtering based on event signature 130 can be used to refine the spatial clustering 150. This additional step is especially useful when using larger neighborhoods or when detecting recurring events within a year. The event signature 130 is used as a filter to determine whether points can 30 be

considered to be in the same neighborhood as any given central event point 310. The event signature 130 captures the commonality of features between events, and can be derived from content-based analysis at the image level or event-based analysis at the event level or both. In one embodiment, three main features 5 obtained at the event level are used —day of the week, event category, and location—that show good correlation within events from the same recurring group to perform the event signature based filtering as shown in FIG. 3.

Referring to FIG. 3, when the neighborhood of one central event point 205 is being considered, other event points 310 in its neighborhood 210 are 10 processed one at a time as follows. Event category matching 220 determines if the potential neighboring event point 210 has the same event category label as the central point 205. In the preferred embodiment, the method described in *Event Classification in Personal Image Collections* by Das and Loui, IEEE Intl. Workshop on Media Information Analysis for Personal and Social Applications at 15 ICME 2009 is used to provide a broad event category (“Vacation”, “Party”, “Sports” or “Family Moment”) for each event. In this method, a variety of high-level visual and temporal features that show good correlation with the event class are used to train a Bayesian belief network for event classification that computes the a posteriori probability of the event class given the input features.

20 A location matching module 230 checks if the potential neighboring event point 210 can be co-located with the central event point 205. The location where an event occurs is an important factor when determining whether it forms a recurring group with other events. Many recurring groups 25 contain events that occur in the same locality. In the absence of GPS information, the event locations are matched using SIFT features as described by Das et al in “*Event-based Location Matching for Consumer Image Collections*” in the Proceedings of the ACM Int. Conf. on Image and Video Retrieval, 2008. In this method, events in consumer image collections are matched by location using SIFT

features to match automatically detected unusual objects present in the scene.

Using this method, if there is a positive scene match between the two events, their location is considered to have matched. It should be noted that if two events could not be matched using the scene-based method referenced above, it does not

5 indicate that the events could not have been captured at the same location. Events can fail to be matched because there are no unique or unusual objects that are captured in images from both events. However, positive matches strongly indicate that the events were captured at the same location. When GPS-based location is available for matching, these are used to determine whether two events

10 can have occurred at the same location. However, even in this case, a negative match does not exclude the possibility of belonging to the same recurring group.

A user may take regular vacations to a particular region, forming a recurring group, but they may be visiting different specific spots in the area. The region in which a recurring group can be said to be located can be very broad, e.g., Florida

15 during spring break. Conversely, there can be distinctions in the event groups based on much finer granularity than the town where they are located, e.g., the user may consider “School” to be a different location than “Home,” both of which are in the same town. In some instances, the location information can be irrelevant. For example, birthday parties are usually celebrated in the user’s home

20 town, but some can be at home and others can be at some special location.

Therefore, only positive matches are included in the event signature comparison.

The day of week is used as a part of the event signature-based filter because in studies of consumer media collections, a significant association was found between members of the same recurring event group and the day of the week the event occurred, e.g. events from the same group could all occur on Sunday. Many holidays are tied to the day of the week, e.g., Easter, Thanksgiving (US). Typically, there are more picture-taking activities near and during the weekend. Given this distribution of events, Friday through Monday are kept as unique choices, and merge Tuesday through Thursday into the “weekday” label.

The day of week match 240 determines if two events have the same day of week label described above. For multi-day events, any overlap of day of the week is considered to be a match.

Features derived from content-based analysis of images in the 5 event can also be included in the event signature. One such example is people-based matching where the presence of common people in both events is determined using available facial recognition technology (such as “OKAO Vision” Face Sensing Technology from Omron). Matching a common object can provide another matching criterion. Common scene classification (such as beach, 10 urban scene, or field) of the images in the two events can also be used as a matching criterion.

The event signature comparison block 250 generates the final decision on whether the potential neighboring event point 210 should be considered to be in the neighborhood of the central event point 205. The features 15 described above that are included in the event signature 130 are not combined into a single value, as that is not meaningful in the given context. In addition, mismatches are not necessarily significant for any of the three features 220, 230, 240 discussed above. Instead, positive matches are meaningful, and these are noted. Equal weight is assigned to positive matches from any of the three 20 features. For example, two events that occur on the same day of the week, have the same event category and the same location, would have an event signature-based match score of 3; whereas two events that occur on the same day of the week but have different event categories and no location match was found would have a score of 1. Events that have a score of at least 1 have passed the event 25 signature filtering process. Therefore, for any given event, the points that are considered to be within its neighborhood are those that occurred on the same day of the week during the previous and next week, or those that have the same event category, or those that are captured in the same location in the given time period.

The clusters generated by the spatial clustering process 150 are output as recurring events 160 detected in the multi-year collection 110. The interpretation of these recurring events is based on the axes used in the multi-dimensional representation of the events. The images belonging to each recurring 5 event are indexed so that they are linked to other images in the group. The recurring events are displayed to the user in an organized multi-year collection view. The events can be represented by a representative image or a collage of images from the event. Referring to FIGS. 6A and 6B, two common visualizations of an organized collection are shown – the timeline view 440 in 10 FIG. 6A, and the calendar view 450 in FIG. 6B. The non-recurring events 420 are displayed on the timeline and in the calendar based on their date of occurrence. The recurring events 400 appear with icons 425, 430 that link to events in the previous and next time period in that recurring group. For example, a person's birthday event in 2010 would be linked to his birthday in 2009 and 2011. This 15 formulation allows the user an easy access to related events that are separated by large time differences.

**PARTS LIST**

- 10 Computer
- 20 Processor
- 30 Memory
- 50 Input device
- 60 Keyboard
- 70 Monitor
- 80 Network connection
- 110 Multi-year image collection
- 120 Event clustering module
- 130 Event signature-based filter module
- 140 Representing events in  $n$ D space step
- 150 Spatial clustering module
- 160 Recurring events detected
- 205 Central event point
- 210 Potential neighboring event point
- 220 Event category matching step
- 230 Location matching step
- 240 Day of week matching step
- 250 Event signature comparison step
- 310 Event point
- 320 Year number as y-axis
- 330 Day of year as x-axis
- 400 Recurring event
- 420 Non-recurring events
- 425 Icon indicating previous event in recurring group

**Parts List cont'd**

- 430      Icon indicating next event in recurring group
- 440      Timeline view of organized collection
- 450      Calendar view of organized collection

**CLAIMS:**

1. A method of detecting recurring events in a digital image collection taken over a pre-determined period of time comprising, using a processor for,
  - 5 (a) analyzing the digital image collection to produce a multi-dimensional representation of the distribution of image capture activity over time; and
  - (b) detecting recurring events by identifying spatial clusters in the multi-dimensional representation.
- 10 2. The method of claim 1 wherein the detection of recurring events is further refined by analyzing the commonality of features between events.
3. The method of claim 1 wherein the digital image collection wherein the pre-determined period of time includes multiple years and step (b) includes identifying spatial clusters that span the multiple years.
- 15 4. The method of claim 1 wherein the digital image collection wherein the pre-determined period of time includes a year or less and step (b) includes identifying spatial clusters that occur within the pre-determined period of time.
5. The method of claim 1 wherein the multi-dimensional representation of the digital image capture activity is based on representing events on a day-of-the-year axis and a year axis.
- 20 6. The method of claim 1 wherein the multi-dimensional representation of the digital image capture activity is based on representing events on a week-of-the-year axis and a day-of-the-week axis.
- 25 7. The method of claim 2 wherein the analysis of the commonality of features includes content based analysis or event based analysis.
8. The method of claim 7 wherein the content based analysis includes using people recognition, scene classification, or object identification.
9. The method of claim 7 wherein the event based analysis 30 includes event classification, location matching, or time based features.

10. The method of claim 1 wherein the detected recurring events are displayed to a user.

11. A method of organizing a digital image collection by detecting recurring events in a digital image collection taken over a pre-determined period of time comprising, using a processor for:

- (a) analyzing the digital image collection to produce a multi-dimensional representation of the distribution of image capture activity over time;
- (b) detecting recurring events by identifying spatial clusters in the multi-dimensional representation; and
- (c) indexing images based on the detected recurring events.

12. The method of claim 11 wherein the detection of recurring events is further refined by analysis of the commonality of features between events.

13. The method of claim 11 wherein the digital image collection wherein the pre-determined period of time includes multiple years and step (b) includes identifying spatial clusters that span the multiple years.

14. The method of claim 11 wherein the digital image collection wherein the pre-determined period of time includes a year or less and step (b) includes identifying spatial clusters that occur within the pre-determined period of time.

15. The method of claim 11 wherein the two-dimensional representation of the digital image capture activity is based on representing events on a day-of-the-year axis and a year axis.

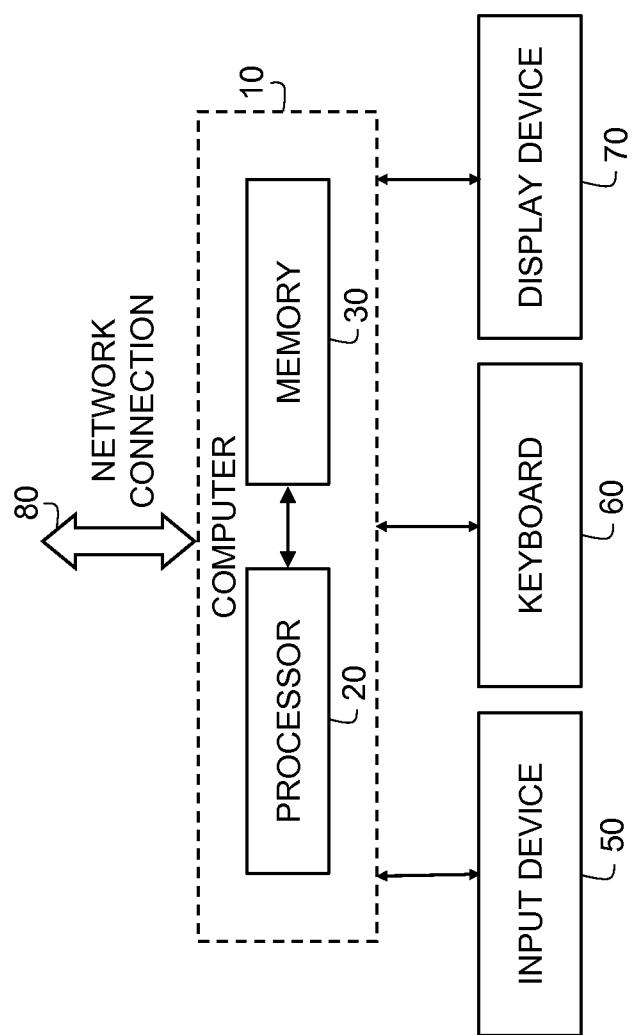
16. The method of claim 11 wherein the multi-dimensional representation of the digital image capture activity is based on representing events on a week-of-the-year axis and a day-of-the-week axis.

17. The method of claim 12 wherein the analysis of the commonality of features includes content based analysis or event based analysis.

18. The method of claim 17 wherein the content based analysis includes using people recognition, scene classification, or object identification.

19. The method of claim 17 wherein the event based analysis includes event recognition, location matching, or time based features.

5 20. The method of claim 11 wherein the organized digital image collection is displayed to the user.

**FIG. 1**

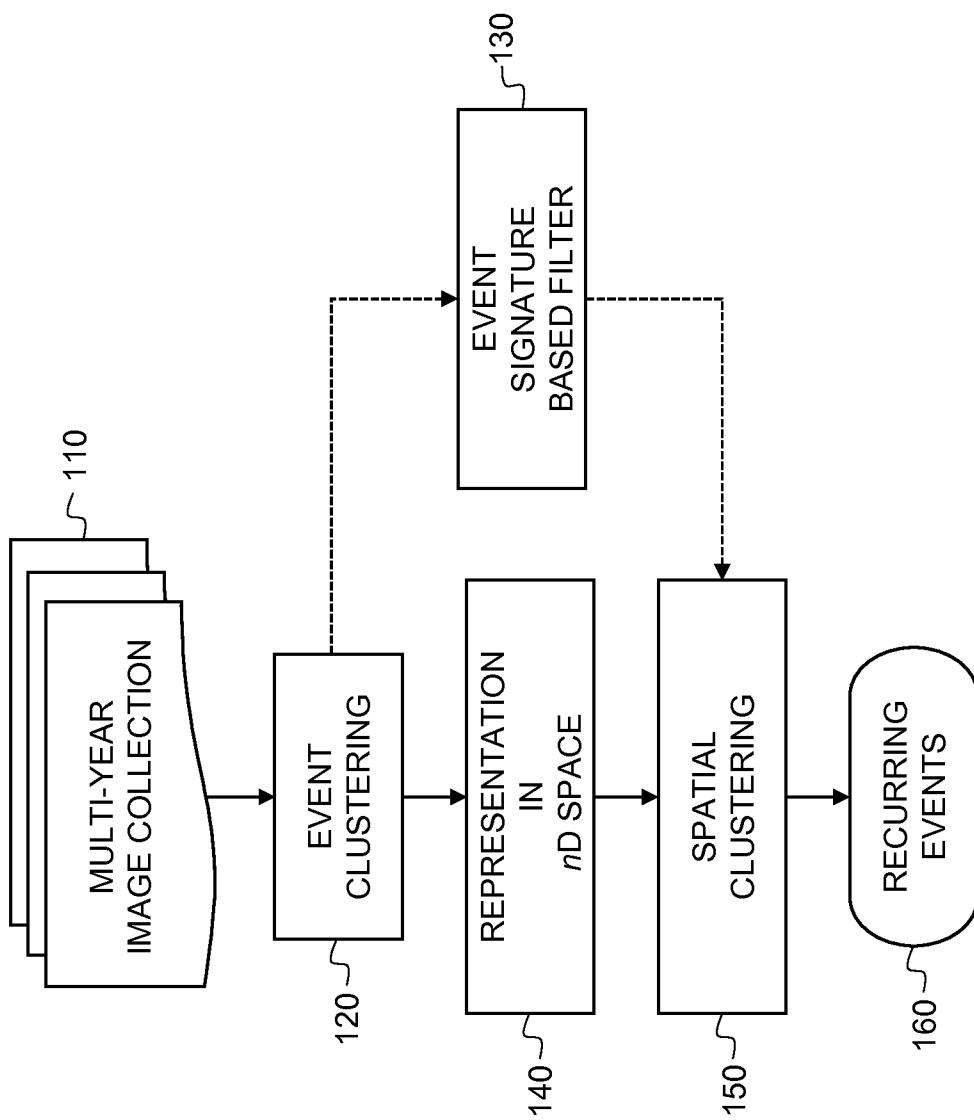
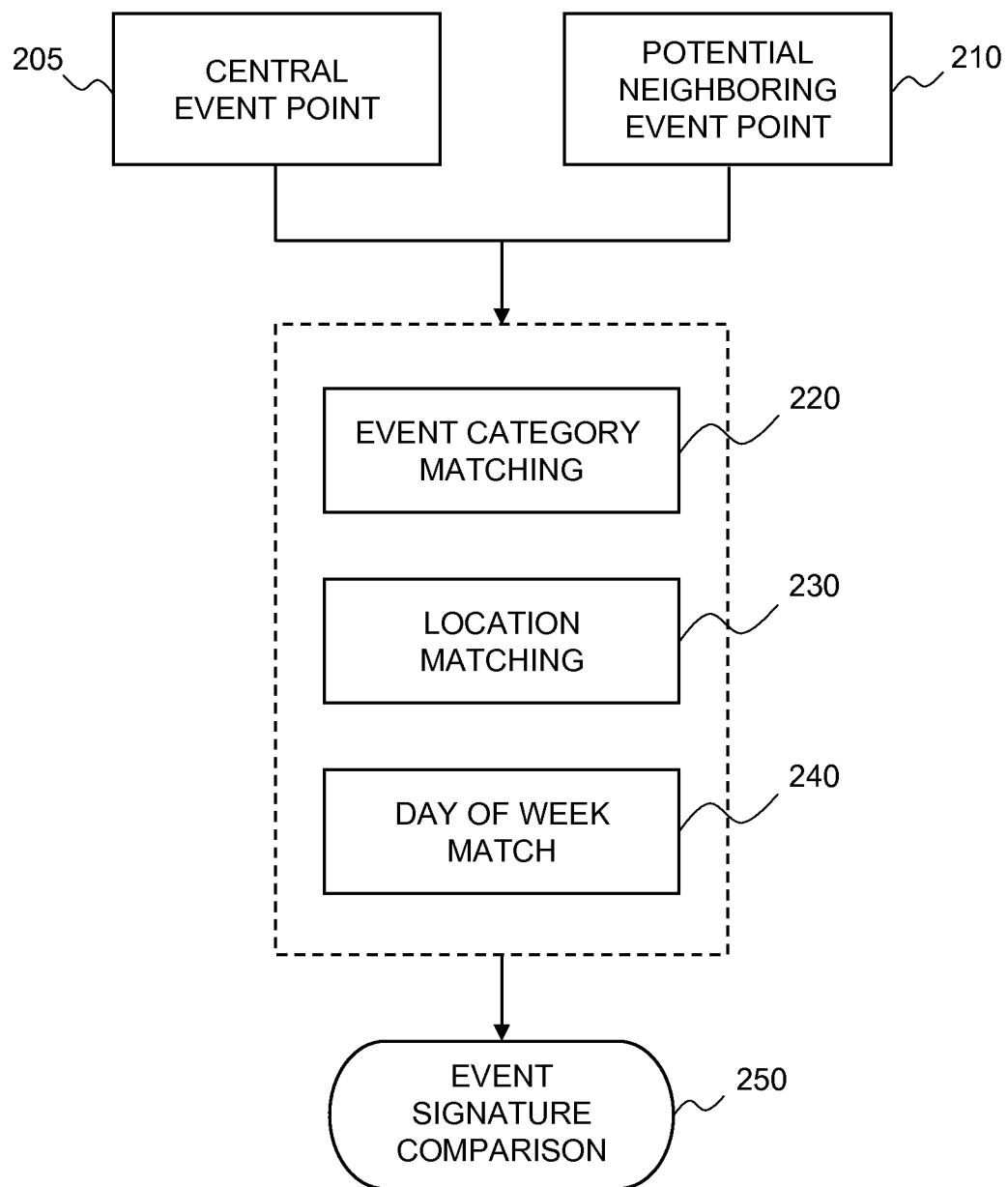


FIG. 2

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**FIG. 3**

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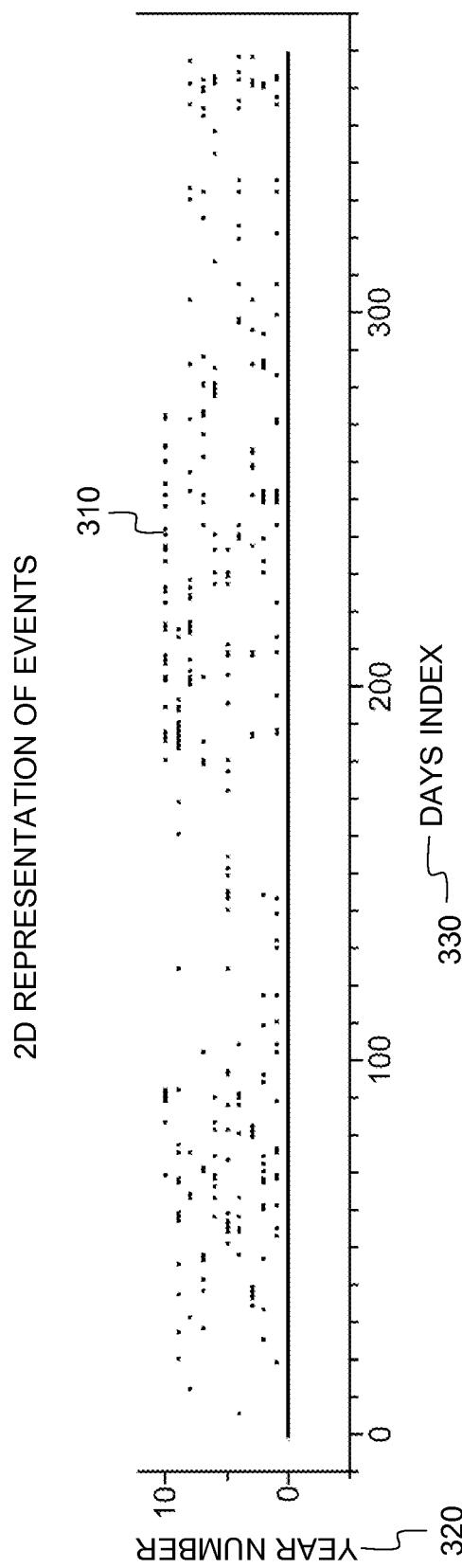


FIG. 4

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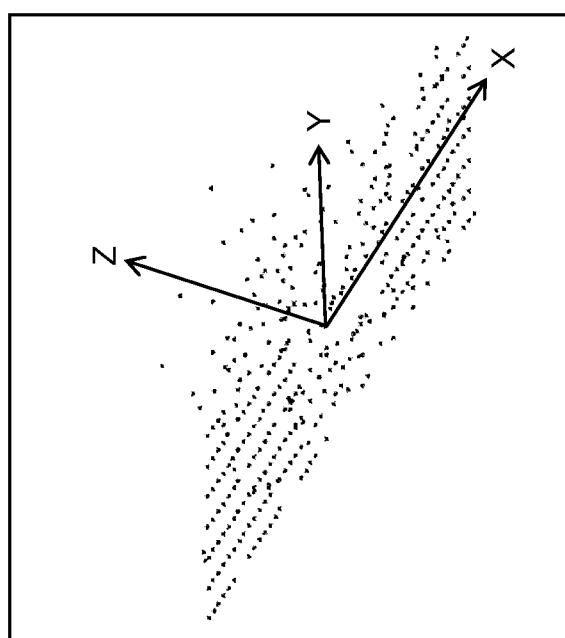
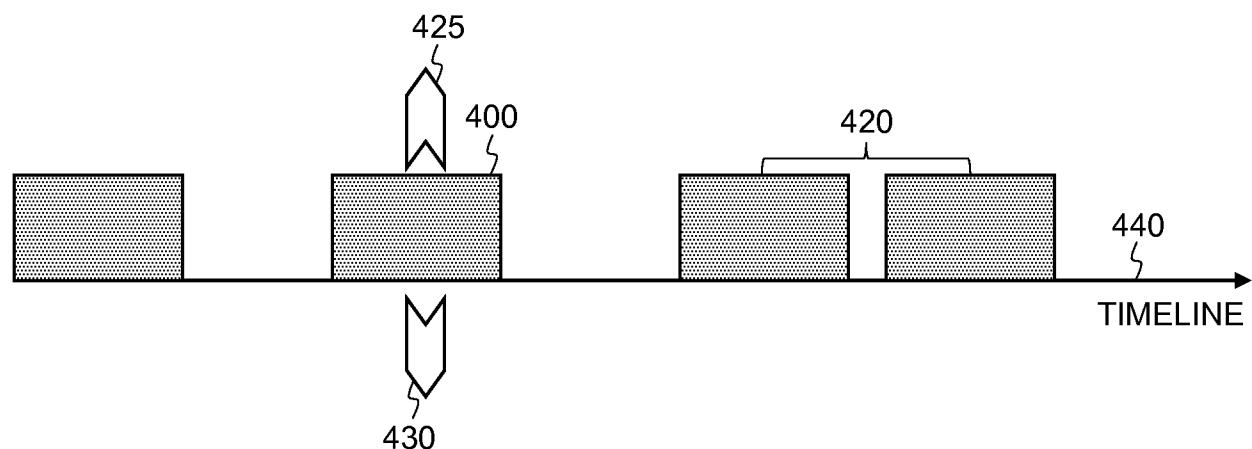
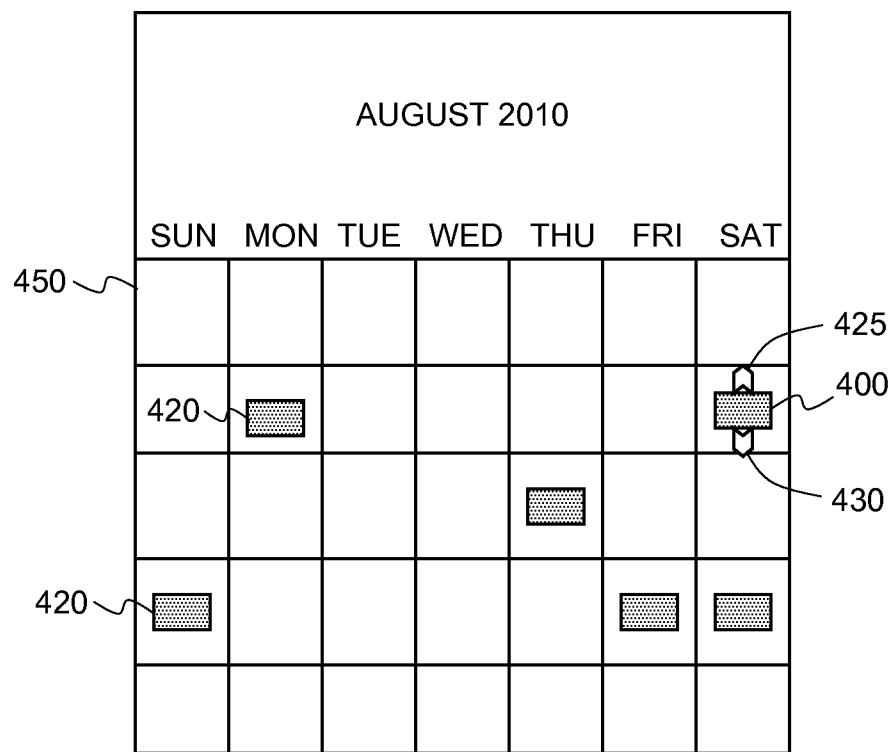


FIG. 5

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**FIG. 6A****FIG. 6B**

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2011/048169

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. G06F17/30  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LING CHEN ET AL: "Event detection from flickr data through wavelet-based spatial analysis", PROCEEDING OF THE 18TH ACM CONFERENCE ON INFORMATION AND KNOWLEDGE MANAGEMENT, CIKM '09, 1 January 2009 (2009-01-01), page 523, XP55009564, New York, New York, USA DOI: 10.1145/1645953.1646021 ISBN: 978-1-60-558512-3 the whole document -----	1-5,7-10
Y	US 2007/008321 A1 (GALLAGHER ANDREW C [US] ET AL) 11 January 2007 (2007-01-11) abstract paragraph [0041] - paragraph [0059] -----	6,11-20
Y	----- -/-	6,11-20

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance  
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"O" document referring to an oral disclosure, use, exhibition or other means  
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.  
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 2011	21/10/2011

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Dumitrescu, Cristina
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## INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/048169

## C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 636 733 B1 (ROTHMULLER KENNETH [US]) 22 December 2009 (2009-12-22) abstract column 1, line 22 - column 10, line 39 -----	1-20
X	US 2003/033296 A1 (ROTHMULLER KENNETH [US] ET AL) 13 February 2003 (2003-02-13) abstract paragraph [0017] - paragraph [0039] -----	1-20
X	WO 2009/150425 A2 (HALF MINUTE MEDIA LTD [GB]; LIENHART RAINER W [DE]; DOEHRING INA [DE]) 17 December 2009 (2009-12-17) abstract page 42, line 16 - page 52, line 4 -----	1-20

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No  
PCT/US2011/048169

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