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Nagaoka et al.

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(54) **METHOD AND APPARATUS FOR ORGANIZING DIGITAL MEDIA BASED ON FACE RECOGNITION**

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(51) **Int. Cl.**
G06K 9/00 (2006.01)

(52) **U.S. Cl.** **382/118**; 382/224

(58) **Field of Classification Search** 382/224, 382/190, 118; 348/100, 231.2
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,714,665 B1 * 3/2004 Hanna et al. 382/117
6,738,494 B1 * 5/2004 Savakis et al. 382/100
6,751,353 B1 * 6/2004 Grigorievich et al. 382/218
6,751,780 B1 * 6/2004 Neff et al. 715/530
2002/0167538 A1 * 11/2002 Bhetanabhotla et al. 345/700
2004/0141658 A1 * 7/2004 Haas et al. 382/278
2004/0264780 A1 * 12/2004 Zhang et al. 382/224
2005/0060636 A1 * 3/2005 Mathe 715/500

FOREIGN PATENT DOCUMENTS

JP 2002-189724 A 7/2002
JP 2002-216643 A 8/2002
JP 2003-150603 A 5/2003
JP 2003-288881 A 10/2003

* cited by examiner

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(57) **ABSTRACT**

In one aspect, the present invention is directed to a method and an apparatus for organizing digital media, particularly digital photos, using face recognition. According to a first aspect of the present invention, a computer-based method for organizing digital photos comprises: extracting objects of interest from a plurality of photographs; cropping said plurality of photographs to generate images of isolated objects of interest; applying a recognition algorithm to determine the similarity of isolated objects of interest with a reference; displaying a plurality of objects arranged as a function of the determined similarity; and receiving user input to associate said objects with a particular classification.

18 Claims, 7 Drawing Sheets

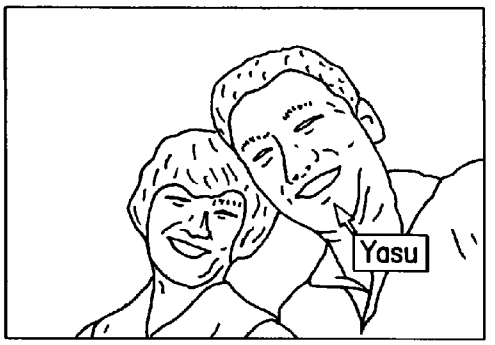


FIG. 1

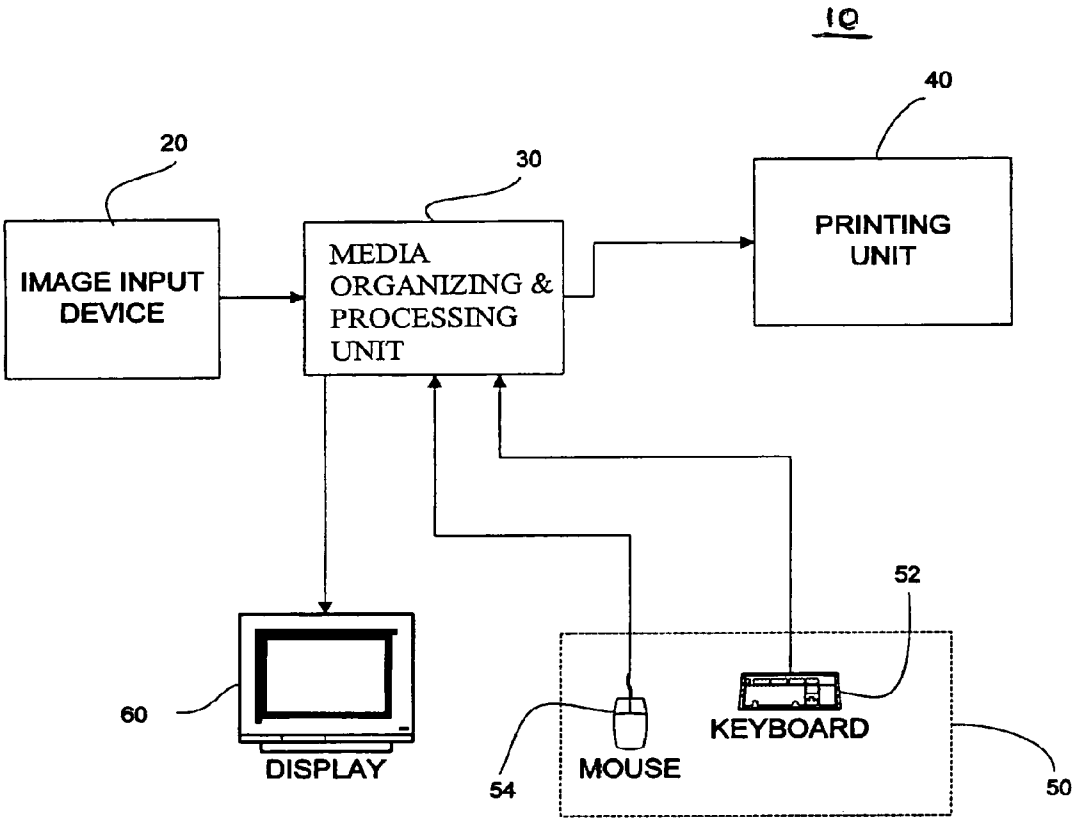
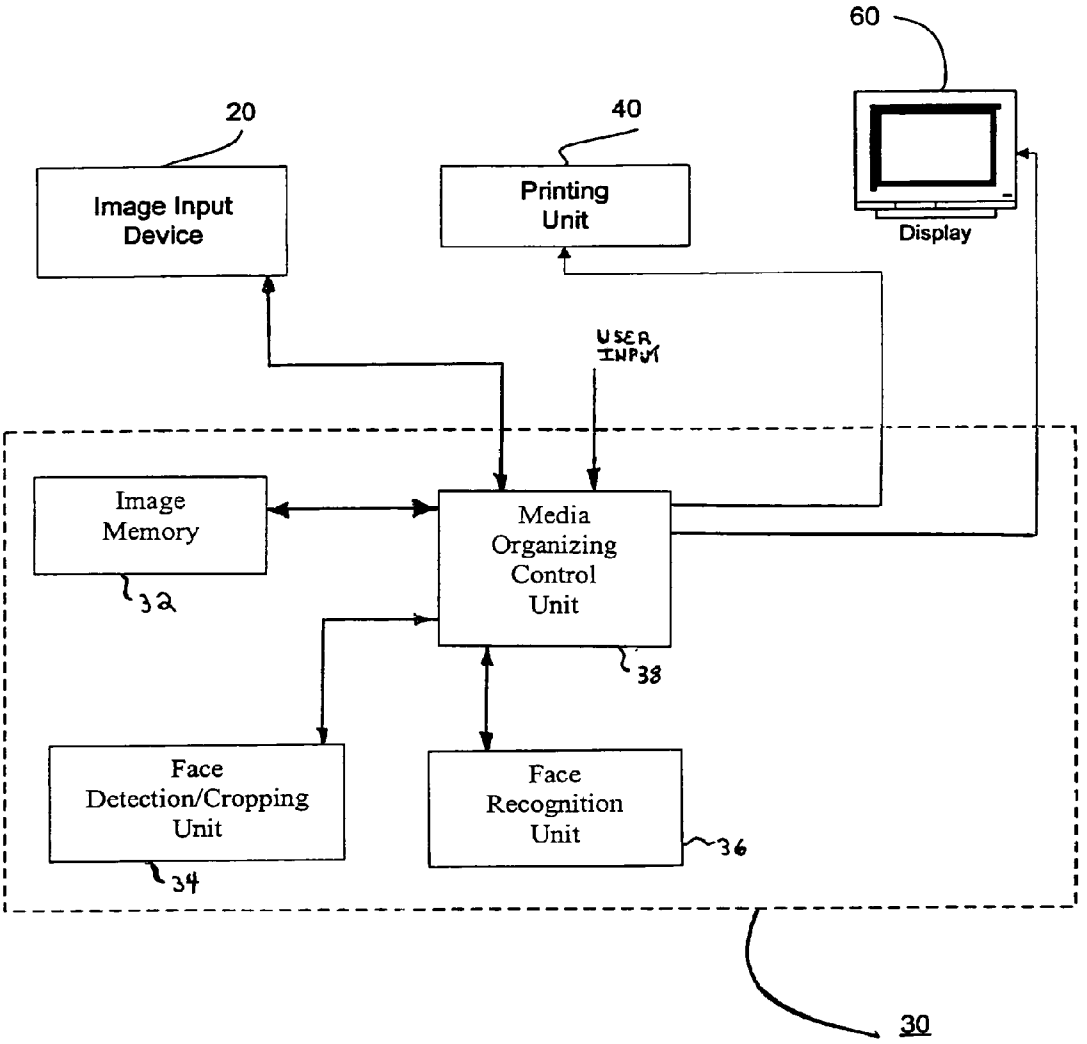

10
40
20
30
IMAGE INPUT DEVICE
MEDIA ORGANIZING & PROCESSING UNIT
PRINTING UNIT
52
60
DISPLAY
54
MOUSE
KEYBOARD
50

FIG. 2


60
20
40
Image Input Device
Printing Unit
Display
USER INPUT
Image Memory
32
Media Organizing Control Unit
38
Face Detection/Cropping Unit
34
Face Recognition Unit
36
30

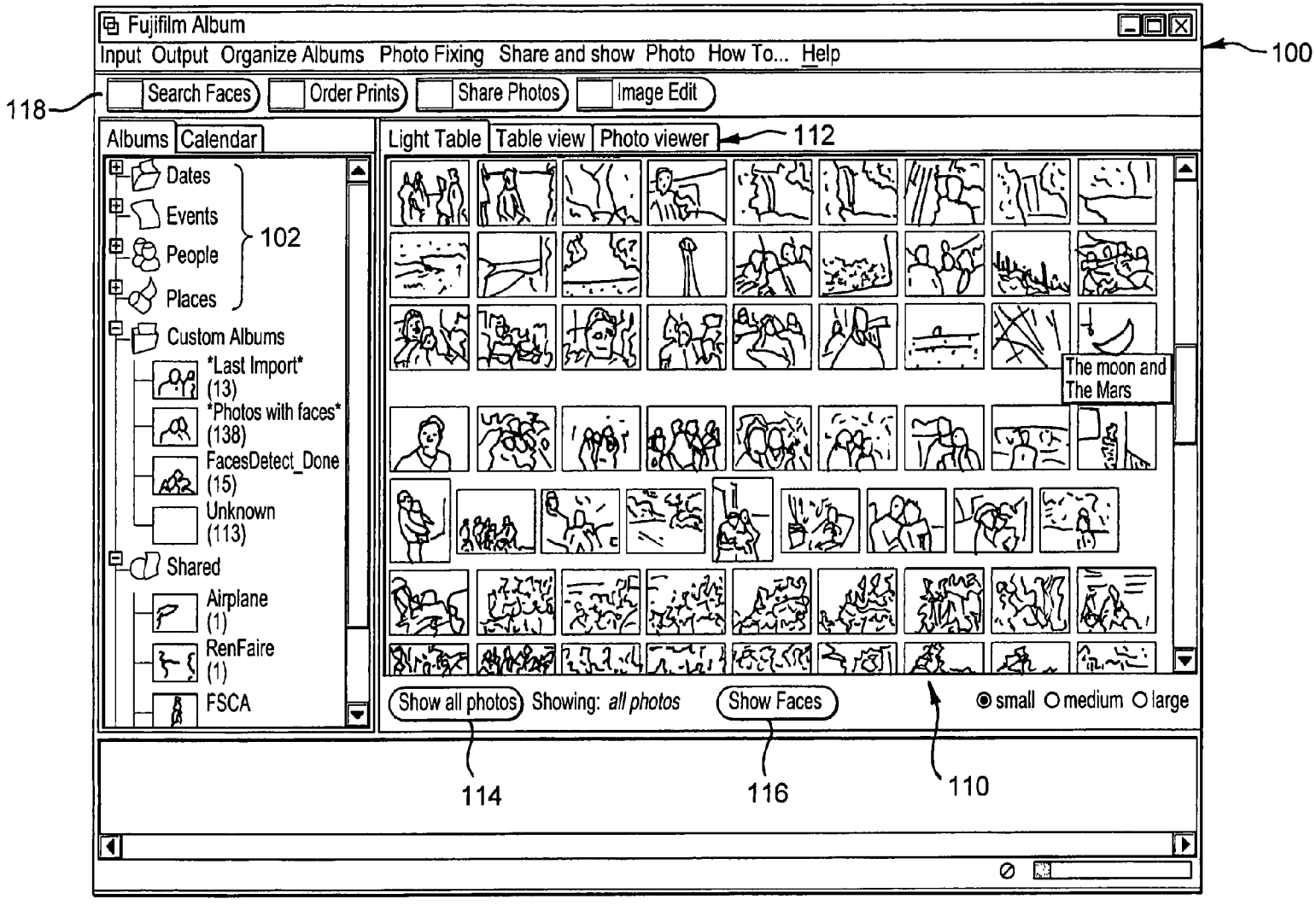
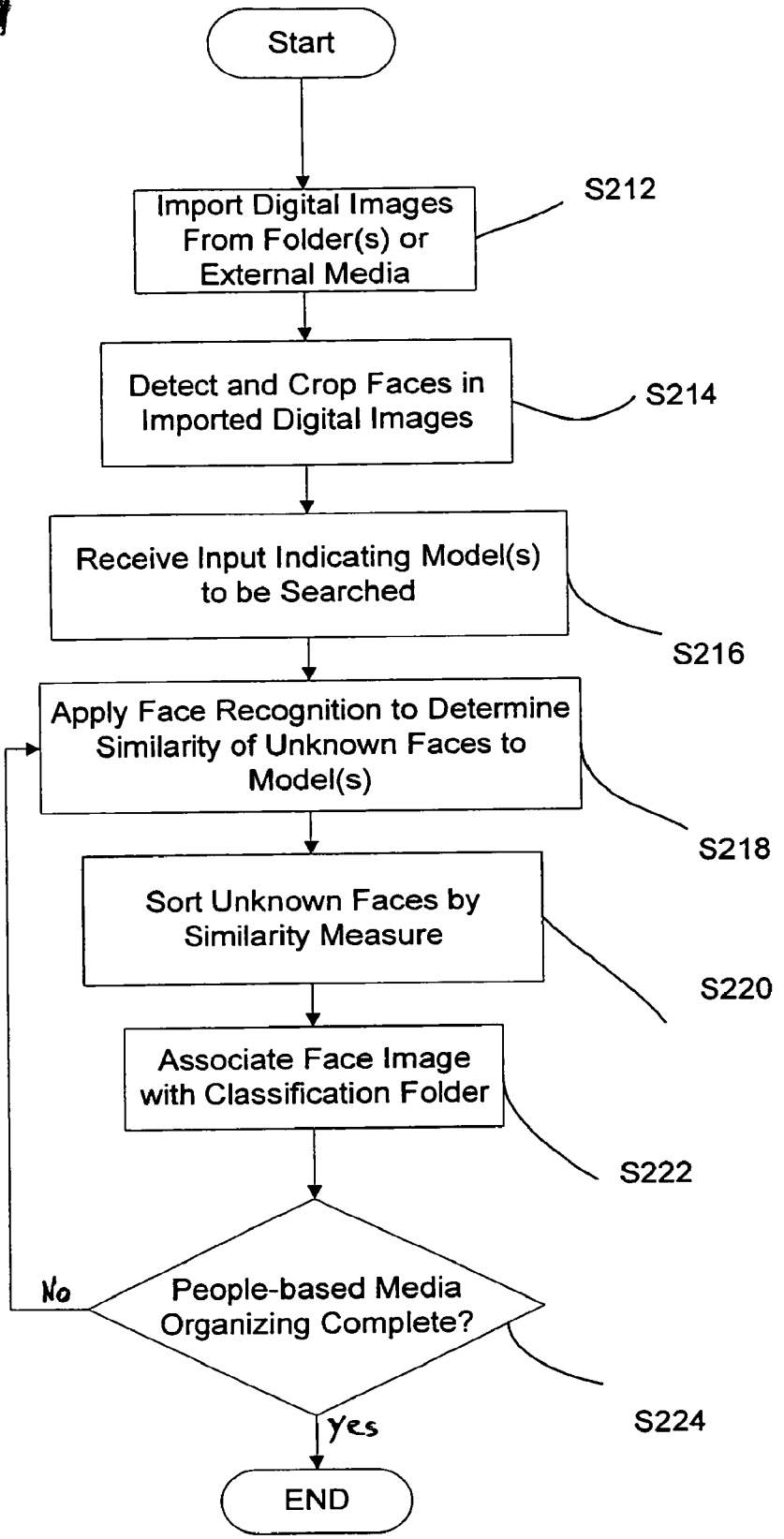

Fujifilm Album
Input Output Organize Albums Photo Fixing Share and show Photo How To... Help
100
118
Search Faces
Order Prints
Share Photos
Image Edit
Albums
Calendar
Light Table
Table view
Photo viewer
112
Dates
Events
People
Places
102
Custom Albums
Last Import (13)
Photos with faces (138)
FacesDetect_Done (15)
Unknown (113)
Shared
Airplane (1)
RenFaire (1)
FSCA
The moon and The Mars
Show all photos
Showing: all photos
Show Faces
small
medium
large
114
116
110

FIG.3

FIG. 4


Start
Import Digital Images From Folder(s) or External Media
S212
Detect and Crop Faces in Imported Digital Images
S214
Receive Input Indicating Model(s) to be Searched
S216
Apply Face Recognition to Determine Similarity of Unknown Faces to Model(s)
S218
Sort Unknown Faces by Similarity Measure
S220
Associate Face Image with Classification Folder
S222
People-based Media Organizing Complete?
S224
No
Yes
END

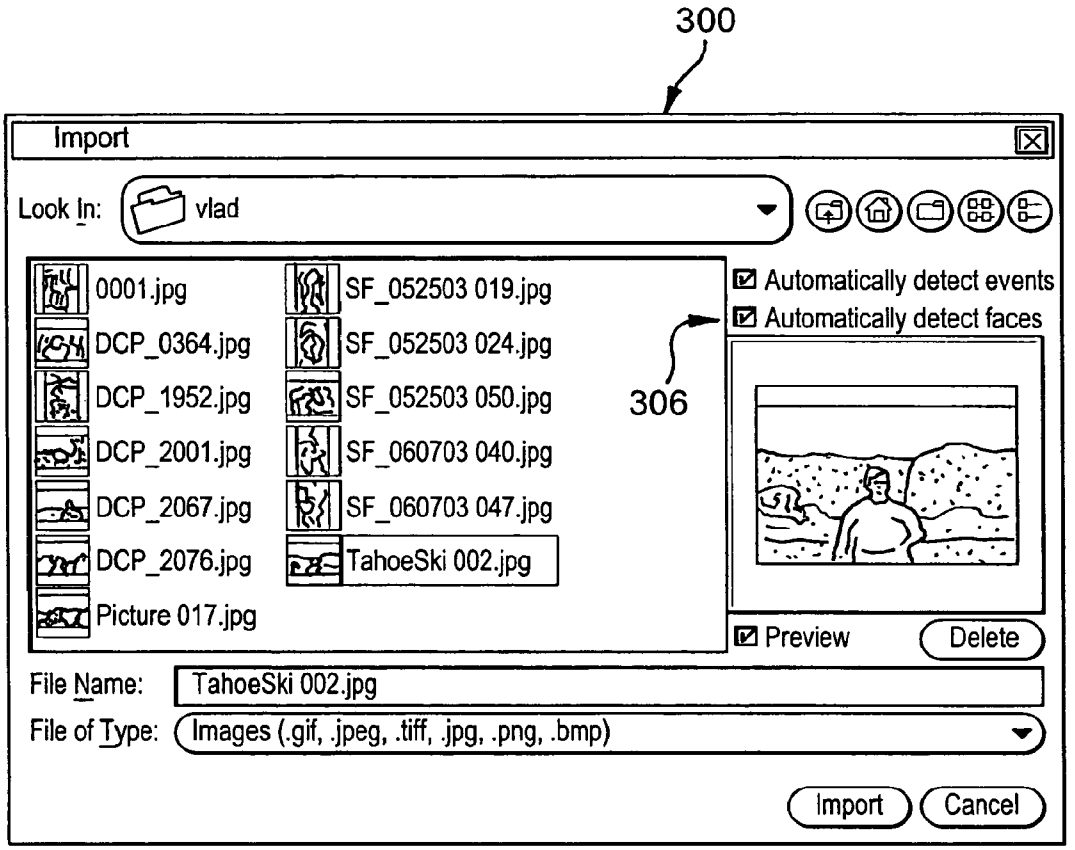

300
Import
Look In:
vlad
0001.jpg
DCP_0364.jpg
DCP_1952.jpg
DCP_2001.jpg
DCP_2067.jpg
DCP_2076.jpg
Picture 017.jpg
SF_052503 019.jpg
SF_052503 024.jpg
SF_052503 050.jpg
SF_060703 040.jpg
SF_060703 047.jpg
TahoeSki 002.jpg
306
Automatically detect events
Automatically detect faces
Preview
Delete
File Name:
TahoeSki 002.jpg
File of Type:
Images (.gif, .jpeg, .tiff, .jpg, .png, .bmp)
Import
Cancel

FIG.5

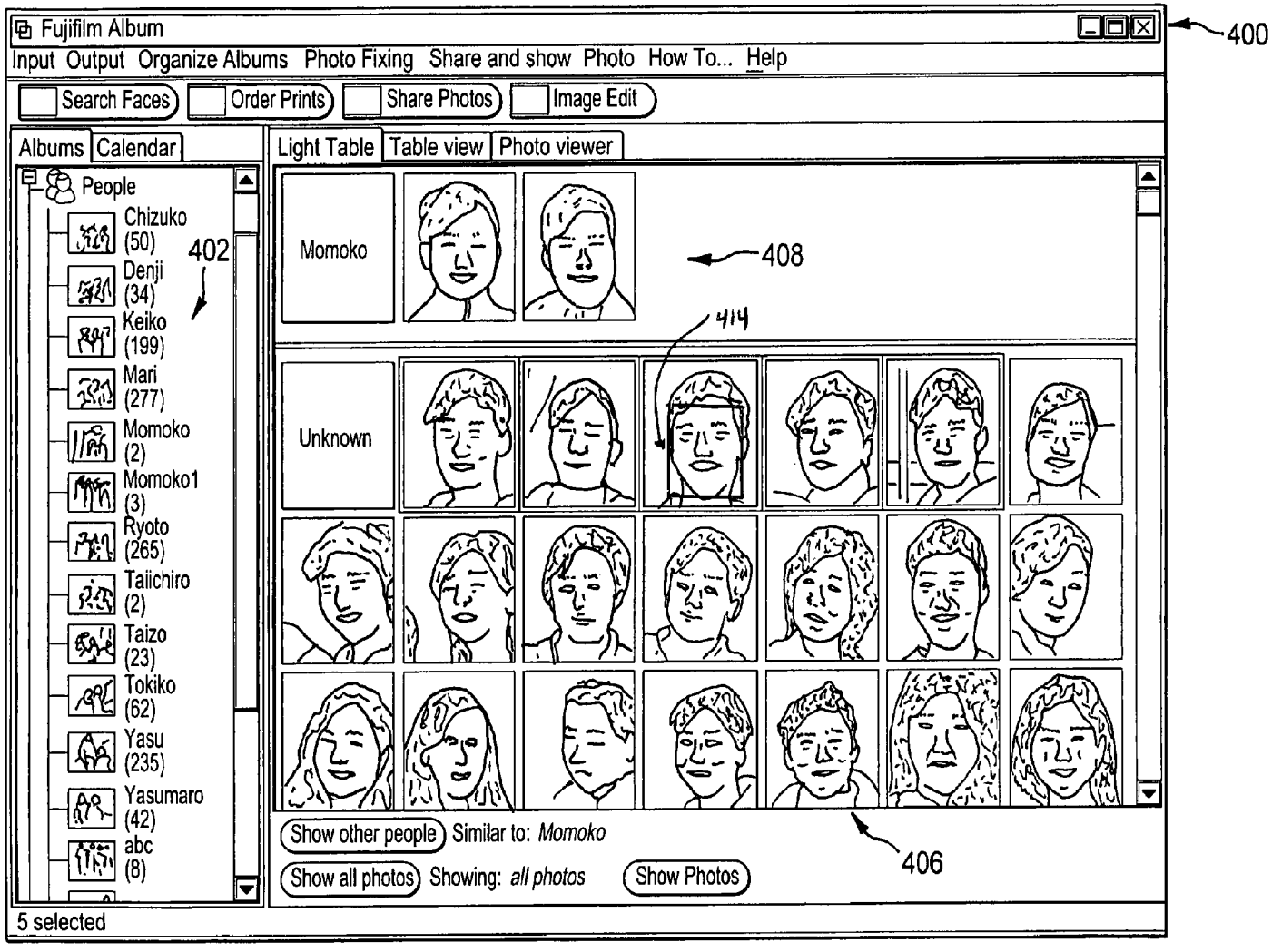

Fujifilm Album
400
Input Output Organize Albums Photo Fixing Share and show Photo How To... Help
Search Faces
Order Prints
Share Photos
Image Edit
Albums
Calendar
Light Table
Table view
Photo viewer
People
Chizuko (50)
Denji (34)
Keiko (199)
Mari (277)
Momoko (2)
Momoko1 (3)
Ryoto (265)
Taiichiro (2)
Taizo (23)
Tokiko (62)
Yasu (235)
Yasumaro (42)
abc (8)
402
Momoko
408
414
Unknown
Show other people
Similar to: Momoko
Show all photos
Showing: all photos
Show Photos
406
5 selected

FIG.6

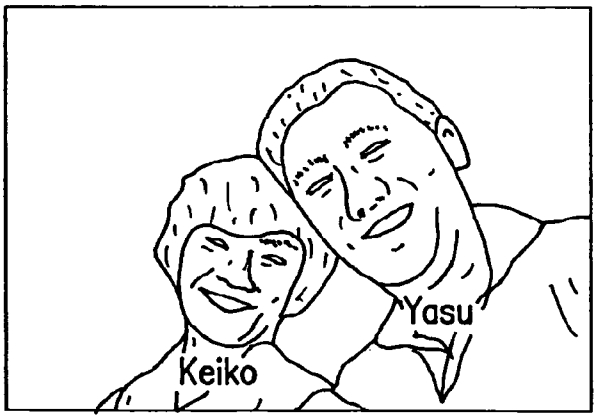


FIG.7A

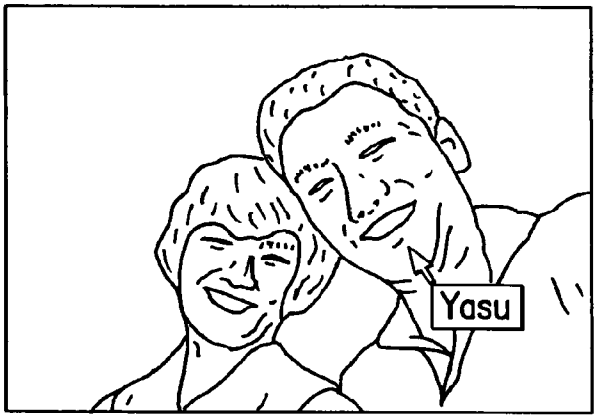


FIG.7B

FIG.7C

METHOD AND APPARATUS FOR ORGANIZING DIGITAL MEDIA BASED ON FACE RECOGNITION

CROSS-REFERENCE TO RELATED APPLICATION

This non-provisional application claims priority under 35 U.S.C. §119(e) of U.S. Provisional Application No. 60/519,639 filed Nov. 14, 2003, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a computer-based technique for organizing media, and more particularly to a method and apparatus for organizing digital media based on face recognition.

2. Description of the Related Art

Digital cameras have gained popularity in recent in years, in part due to the flexibility offered by electronic image storage. By storing digital photos on a personal computer, laptop, a network accessible server, etc., users are able to organize, edit, and share their images. Also, as compared to film-based photography, the user of a digital camera can typically assess the quality of a photo immediately, without spending time and money on a set of prints containing at least some low quality images. In view of the widespread transition from analog to digital photos, service providers and vendors have introduced a variety of products, web-based services, and software tools, including processing software tools for editing digital photos and services for remotely ordering prints and other products (e.g., holiday cards) using the user's picture file(s). File browsing and media viewing software typically allows users to organize and view their photos in electronic Albums, for example organized in folders based on dates (e.g., October 2003) and events (e.g., Ski Trip—January 2002). Considering that the average user has hundreds of photos, such tools offer a convenient way to organize and retrieve photos.

Despite these existing products and services, the inventors of this application has found that the need exists for more-advanced techniques and software tools for conveniently and quickly organizing digital photos.

SUMMARY OF THE INVENTION

In one aspect, the present invention is directed to a computer-based method and apparatus for organizing digital media, particularly digital photos, using recognition techniques. According to a first aspect of the present invention, a computer-based method for organizing digital photos comprises: extracting objects of interest from a plurality of digital photos; cropping the plurality of digital photos to generate images of isolated objects of interest; applying a recognition algorithm to determine the similarity of isolated objects with a reference; displaying a plurality of objects of interest arranged as a function of the determined similarity; and receiving user input to associate the objects and corresponding digital photos with a particular classification.

According to a second aspect of the present invention, an apparatus for organizing digital photos comprises: an object detecting unit for detecting objects of interest in a plurality of digital photos and cropping the plurality of digital photos to generate images of isolated objects of interest; a recognition unit for applying a recognition algorithm to determine the similarity of isolated objects with a reference; a display output for displaying a plurality of objects arranged as a function of the determined similarity; and a user input for receiving user input to associate the objects and corresponding digital photos with a particular classification.

In accordance with one embodiment of the present invention, the operations of applying the recognition algorithm and displaying image objects as a function of determined similarity are repeated as objects are classified. In one embodiment, the objects are faces.

BRIEF DESCRIPTION OF THE DRAWINGS

Further aspects and advantages of the present invention will become apparent upon reading the following detailed description and with reference to the appended drawings, in which:

FIG. **1** is a block diagram of a system for organizing digital media according to an embodiment of the present invention;

FIG. **2** is a block diagram illustrating in more detail aspects of the media organizing and processing unit of the system illustrated in FIG. **1** according to an embodiment of the present invention;

FIG. **3** is an exemplary graphical user interface display screen associated with media organizing and browsing according to an embodiment of the present invention;

FIG. **4** is a flow diagram illustrating operations performed for recognition-based organization of digital photos in accordance with an embodiment of the present invention;

FIG. **5** is an exemplary graphical user interface display screen associated with importing images for face recognition-based organizing of digital photos in accordance with an embodiment of the present invention;

FIG. **6** is an exemplary graphical user interface display screen associated with displaying face images sorted by similarity to model face images to assist the user in organizing digital photos; and

FIGS. **7A-7C** illustrate an exemplary digital photo presentation using the results of face recognition in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention are more specifically set forth in the following description with reference to the appended figures. Generally, the present invention is directed to a computer-based method and system for organizing media, and more particularly to a computer-based system and method for organizing digital photos in accordance with objects detected and recognized in the digital photos. In one implementation described in detail below, a group of digital photos is organized by detecting and recognizing faces appearing therein.

The present invention may be implemented as a computer-executed software product, installed on a user's personal computer (or some other suitable device) to allow the user to organize a collection of digital photographs in accordance with the people appearing in the photographs. In one embodiment, a system for organizing and processing photographs is provided with at least one face recognition algorithm, which determines the similarity of faces appearing in a collection of photographs to at least one face in a model folder. The present invention may be implemented to allow a user to set up folders for different people, find similar faces to a face or faces in these folders, and add photographs to the "people folders" based on detected similarity. One implementation of the present invention is described in which face detection and recognition are used as tools (e.g., as a software plug-in for a

photo storing/processing application) for facilitating digital photo organization (e.g., allowing the user to organize hundreds or photographs based on people in a few minutes). Although the following description details a specific workflow with reference to specific display screens shown in the figures, it should be recognized that many variations are possible.

FIG. **1** is a block diagram of a system for organizing digital photos according to an embodiment of the present invention. The system **10** illustrated in FIG. **1** includes the following components: an image input device **20**; a media organizing and processing unit **30**; a printing unit **40**; a user input unit **50**; and a display **60**. Operation of and functional interaction between the components illustrated in FIG. **1** will become apparent from the following description.

The image input device **20** provides digital image data representing a photograph. The image input device **20** may be one or more of any number of devices for providing digital image data derived from photographic film or a digital camera, e.g., a recording medium (a CD-R, floppy disk, etc.) or a network connection. The image input device **20** may be a scanner for scanning images recorded on paper or film, e.g., including CCD sensors for photoelectronically reading R (red), G (green), and B (blue) image information from film, frame by frame. The media organizing and processing unit **30** receives digital image data from the image input device **20** and performs recognition-based media organizing in a manner discussed in detail below. Although not a focus of this application, the media organizing and processing unit **30** may perform other functions, such as image compression, editing, color/density correction, etc., in accordance with commands received from the user input device **50**. A user views graphical user interface (GUI) display screens and other information (including photos) output by the media organizing and processing unit **30** on a display **60** and inputs commands and other information to the media organizing and processing unit **30** via the user input device **50**. In the embodiment illustrated in FIG. **1**, the user input device **50** includes a keyboard **52** and a mouse **54**. The printing unit **40** selectively receives image data from the media organizing and processing unit **30** to generate prints.

FIG. **2** illustrates details of the media organizing and processing unit **30** for performing recognition-based media organizing of digital photos according to an embodiment of the present invention. As shown in FIG. **2**, the media organizing and processing unit **30** according to this embodiment includes: an image memory **32**, which stores digital image data; a face detection/cropping unit **34**; a face recognition unit **36**; and a media organizing control unit **38**. Although the various components of FIG. **2** are illustrated as discrete elements, such an illustration is for ease of explanation and it should be recognized that certain operations of the various components may be performed by the same physical device, e.g., by a microprocessor of a user's personal computer. Operation of the components of the media organizing and processing unit **30** in FIG. **2** will next be described with reference to FIGS. **3-7**.

FIG. **3** is an exemplary GUI display screen **100** output by the media organizing control unit **38** to the display **60** in accordance with one implementation of the present invention. The GUI display screen **100** illustrated in FIG. **3** allows the user to initiate and control various media organizing and viewing functions provided by the media organizing control unit **38**. The display screen **100** includes a category list **102** of general media organizing categories, including "dates," "events," "places," and "people," which constitute digital photo albums. Accordingly, the user may select from this category list **102** to organize digital photos and/or access previously-organized digital photos based on these general categories. For example, the user may select "dates" from the category list **102** to organize and/or browse digital photos organized by date. Likewise, the user may select "events" to organize and/or browse digital photos organized by the event at which they were taken (e.g., vacation 2002, graduation 2003, etc.). Furthermore, in accordance with principles of the present invention, the user may select "people" to organize digital photos based on the faces appearing therein, using face recognition, and browse digital photos previously organized based on people. Each general category in the category list **102** will typically include multiple folders, which may further contain sub-folders. Thus, under the "people" category, separate folders may be set up for "family," "classmates," "work colleagues," etc., each containing a sub-folder for an individual member of the particular category.

The GUI display screen **100** further includes a display window **110** for viewing photos. In the example of FIG. **3**, the display window **110** displays an index view of photos in a selected folder. This may be initiated by selecting a "show all photos" button **114**. Also, the user may view cropped faces appearing in photos of the selected folder in the display window **110** by selecting a "show faces" button **116**. Extracting and cropping faces from a group of digital photos will be described in greater detail below. An individual photo may be viewed by clicking on the desired photo in the display window **110** and selecting a "photo viewer" tab **112**. In accordance with principles of the invention, the face recognition-based organization may be initiated by selecting a "search faces" button **118** from the display screen **100**. The display screen **100** includes various additional icons and menus for performing related functions, such as ordering prints, sharing photos, editing images, etc.

FIG. **4** is a flow diagram illustrating functions performed by the media organizing and processing unit **30** to organize digital photos based on face recognition in accordance with an embodiment of the present invention. Initially, digital images are imported for organization in one or more of the digital photo album categories in list **102** (step S**212**). These digital images may be imported from existing folders (e.g., stored in image memory **32**) or input via external media, such as the image input device **20**. FIG. **5** illustrates an exemplary GUI display screen **300** for importing digital photos, which allows the user to select folders or individual images to be imported. The face detection/cropping unit **34** detects faces in the imported digital photos and crops out the face(s) from the digital photos to obtain a view of the individual faces in the imported digital photos (S**214**). The face detection/cropping unit **34** may utilize a face detection algorithm such as that disclosed in U.S. patent application Ser. No. 10/440,173, titled "Method and Apparatus for Red-Eye Detection," which is herein incorporated by reference. Other techniques for face detection may also be utilized.

The user is able to control whether to automatically detect and crop out faces for images being imported, e.g., by selecting the "automatically detect faces" button **306** on the GUI display screen **300** shown in FIG. **5**. In other words, the face detection/cropping unit **34** may perform face detection and cropping in the background as the user is performing other functions. If a user decides not to detect faces at the time of importing the photos, the user can select a "detect faces" menu option (not shown) at any time. Again, the face detection/cropping unit **34** may operate in the background with low priority, meaning that other tasks (operations) can be performed while the detection is being done. The detect faces operation need only be performed once for each imported

digital photo. After face detection and cropping has been performed for a set of imported digital photos, the user may select a "show faces" button **116** of the GUI display screen **100** to view the detected faces in the display window **110**.

At any time after face detection and cropping for a group of imported digital images has been executed, the user may initiate face recognition-based organization of such digital photos. FIG. **6** is an exemplary graphical user interface display screen associated with displaying face images sorted by similarity to model face images to assist the user in organizing digital photos. Although the face detection/cropping unit **34** extracts faces appearing in digital photos, it can be seen from FIG. **6** that the face view may show an area larger than the face (face area **414**) so that the user can view the entire face and surrounding features, such as the head, neck, and hat (if worn). This results in a better viewing image as compared to just viewing the face itself.

The user may select a folder **402** under the "people" category in GUI display screen **400** (in category list **102**) or create a new person folder (S**216**). To serve as a basis for face recognition, the selected folder or new folder must contain at least one face image. The user may drag and drop any of the faces from an "unknown" display window portion **406** (i.e., displaying faces from imported digital photos that have not been associated with a particular person folder). Once the user has selected the person folder for matching with "unknown" faces (which serves as a comparison model), the face recognition unit **36** applies face recognition to determine similarity of unknown faces to the selected model (S**218**).

A previously classified image of a person may appear substantially different than the same person in other photographs (e.g., due to different angles, poses, photographing positions, aging, etc.). Thus, a preferred embodiment of the present invention utilizes a face recognition algorithm that provides good results under such conditions. One implementation of the present invention utilizes the face recognition algorithm described in the U.S. patent application titled "Method and Apparatus for Object Recognition Using Probability Models" filed on even date herewith and which is hereby incorporated by reference. Such a face recognition algorithm has also been described in U.S. Provisional Application No. 60/519,639 filed Nov. 14, 2003, which has been incorporated herein by reference in its entirety. After the face recognition unit **36** obtains a similarity measure for each unknown face, the media organizing control unit **38** sorts the unknown faces by similarity measure (most similar to least similar) and outputs an updated "unknown" display window portion **406** (FIG. **6**) showing the unknown faces in sorted order (S**220**). Using this updated display **400**, the user is able to drag and drop one or more of the sorted unknown faces from the "unknown" display window portion **406** into a model display window portion **408** (step S**222**). If, after the user has dragged and dropped an unknown face into the model display window portion **408**, there are additional unknown faces (S**224**), the face recognition algorithm is repeated (S**218**). In other words, the face recognition unit **36** in accordance with one embodiment of the present invention may output different results depending on the images in the model folder **402**, particularly because as additional faces from different conditions are added to the folder **402**, the accuracy of the recognition improves and the recognition results change. Thus, the arrangement of unknown faces in display window portion **406** is updated as the user drags and drops unknown faces into the model display window portion **408** to improve the user's ability to quickly and reliably associate unknown faces and the corresponding digital photos with the model folder **402**. When the media organizing control unit **38** determines that the people-based media organizing is complete (S**224**), the process ends. Using the above-described technique, the user is able to organize even hundreds of photos in a short time based on the people appearing therein.

Having detected and recognized faces in digital photos, the resulting information can be used in accordance with principles of the present invention to enhance photo viewing presentations. For example, as shown in FIG. **7**A, the folder name corresponding to a face in a digital photo can be displayed along with the digital photo. This may be done during a "slide presentation" of a group of digital photos. Furthermore, as shown in FIG. **7**B, the name of a classified face may be displayed when the user moves the cursor over a displayed face. Furthermore, by clicking on the person's name, the media organizing control unit **38** may initiate a zooming function to zoom in on the detected person as shown in FIGS. **7**B-**7**C. More than one person can be specified to initiate a panning display between multiple faces in the digital photo being viewed.

Although embodiments of the present invention have been described above in the context of face-recognition, principles of the present invention may be applied to organizing digital photos based on other types of objects that can be detected and recognized in the digital photos. The invention having thus been described, it should be apparent that various other modifications are possible without departing from the spirit and scope of the present invention. For example, depending on accuracy, digital photos may be automatically grouped in people folders based on face recognition, providing the user with the option of re-assigning incorrectly grouped photos.

We claim:

1. A computer-based method for organizing digital photos, comprising:

extracting faces from a plurality of digital photos;

cropping said plurality of digital photos to generate images of unknown isolated faces, wherein the images of the unknown isolated faces have not been associated with a particular person folder;

applying a face recognition algorithm to determine similarity of the unknown isolated faces with a reference model in a model folder which contains at least one face image;

displaying the images of unknown isolated faces sorted by the determined similarity;

receiving user input to automatically associate said unknown isolated faces with a particular classification, wherein said classification is generated from a category list including a plurality of folders each containing a sub-folder for an individual member belonging to said particular classification; and

controlling a zoom function based on said classification.

2. The invention of claim **1**, wherein said steps of applying a recognition algorithm and displaying are repeated as more faces are grouped as belonging to a certain identity.

3. The invention of claim **1**, wherein isolated faces are displayed in a view that includes an area surrounding the face.

4. The invention of claim **1**, further comprising annotating image faces based on said classification.

5. The invention of claim **1**, further comprising controlling a photo presentation based on said classification.

6. The invention of claim **5**, wherein said step of controlling a photo presentation displays a label for an isolated faces based on said classification.

7. The invention of claim **5**, wherein said photo presentation is a slide presentation.

8. The invention of claim **1**, wherein said step of displaying a plurality of faces displays the faces in order of similarity to the reference model.

9. The invention of claim **1**, wherein said user input drags an image of the face into a display area associated with said classification.

10. An apparatus for organizing digital photos, comprising:

a face detection and cropping unit for extracting faces of interest from a plurality of digital photos and cropping said plurality of digital photos to generate images of unknown isolated faces, wherein the images of the unknown isolated faces have not been associated with a particular person folder;

a recognition unit for applying a face recognition algorithm to determine similarity of the unknown isolated faces with a reference model in a model folder which contains at least one face image;

a display output unit for outputting a display of the images of the unknown isolated faces sorted by the similarity determined by said recognition unit; and

a user input unit for receiving user input to associate said unknown isolated faces with a particular classification, wherein said classification is generated from a category list including a plurality of folders each containing a sub-folder for an individual member belonging to said particular classification, wherein said display output controls a zoom function based on said classification.

11. The invention of claim **10**, wherein said recognition unit repeatedly applies said recognition algorithm and said display output updates said display as more faces are grouped as belonging to a certain identity.

12. The invention of claim **10**, wherein said display output displays isolated faces in a view that includes an area surrounding the face.

13. The invention of claim **10**, wherein said apparatus annotates image faces based on said classification.

14. The invention of claim **10**, wherein said output display outputs a photo presentation based on said classification.

15. The invention of claim **14**, wherein said display output displays a label for an isolated face of interest based on said classification.

16. The invention of claim **14**, wherein said photo presentation is a slide presentation.

17. The invention of claim **10**, wherein said display output displays the faces in order of similarity to the reference model.

18. The invention of claim **10**, wherein said user input drags an image of a face of interest into a display area associated with said classification.

* * * * *