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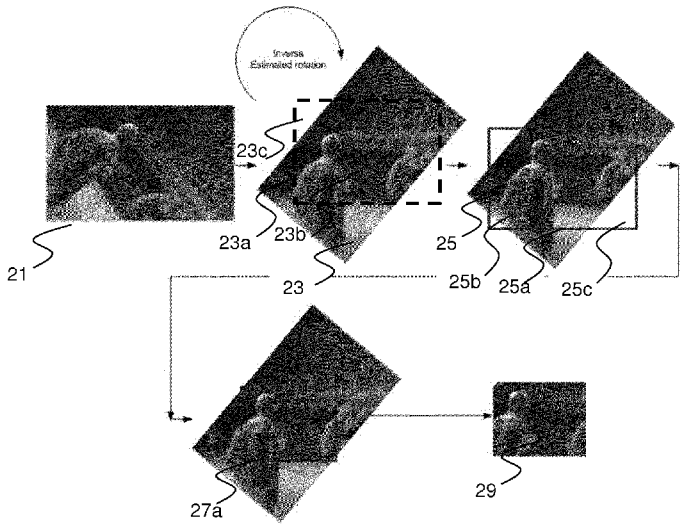

Figure 2b

(57) Abstract: An image processing method, performed by a computer, for generating, from a source image (21), a rotated image of modified size (29) is disclosed. The method comprises obtaining a rotated image by compensating the source image rotation according to an information representative of the rotation of the source image; determining (24) one rectangular image part (25a) in the rotated image according to information representative of the perceptual interest associated with each pixel of the rotated image; obtaining a rotated image (29) of modified size by modifying the size of the rectangular image part (27a) in the rotated image according to a ratio between the width and height of the rectangular image part and according to an information representative of the rotated image. Alternative embodiments for image processing method as well as apparatus implementing the method are further described.

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METHOD AND APPARATUS FOR GENERATING A ROTATED IMAGE OF MODIFIED SIZE FROM A SOURCE IMAGE

TECHNICAL FIELD

The present invention relates generally to the field of image processing. More precisely, the invention relates to a method and an apparatus for generating a rotated image of modified size from a source image.

BACKGROUND

This section is intended to introduce the reader to various aspects of art, which may be related to various aspects of the present invention that are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

With the blossom of video enabled mobile devices, people can capture videos whenever they like without any preparation and without thinking about the final rendering. This sometimes leads to videos that do not match basic capture rules such as: “do not rotate a device while capturing a video”. **Figure 1** illustrates images of a video captured with a rotating device.

However, existing video players render video in static orientation, usually landscape orientation. Thus the rotation of the scene represented in the video images due to the device rotation during the capture is not compensable by a rotation of the rendering in the video player. In others words, a video presenting a device rotation during the capture leading to an orientation conflict is rendered with rotated objects. It is thus desirable for the user to post-process such a video to correct the orientation of the scene by rotating the video images.

To cope with this issue, there exists dedicated video editors, such as Adobe After Affect, that perform a step by step inverse rotation of the video compensating the effective device rotation performed during capture. This process is heavily manual and requires some knowledge as well as an expensive software. Besides the

process requires huge computation power and is time consuming. This process is therefore not achievable for the naive end user that made the device rotation error. Finally, although the orientation is corrected in such compensated video, the video player, limited by the display output format, registers the rotated image into a window compliant to the requested output format. At most, the rotated image is geometrically cropped where the cropping relies on the image center for instance. Hence, the rendered image comprises part with no image information.

Besides, unlike in image stabilization method wherein the rotation is limited to a low threshold (less than 10° for instance), the rendering is acceptable because of the low rotation of the device, a geometrical cropping is less noticeable to a user. Thus a method handling any rotation angle is desirable.

A highly desirable functionality is to provide an enhanced and automatic solution to the issue of a friendly rendering a video captured by a device having suffered a rotation during the capture.

SUMMARY OF INVENTION

It is an object of the invention to provide an automatic solution to the issue of rendering a video captured by a device having suffered a rotation during the capture that can be implemented in the capture device (among still image camera, a mobile device or video camera,…) while storing the video, as an offline post-processing step or directly in a video player at rendering time.

In a first aspect, the invention is directed to an image processing method, performed by a processor, to generate, from a source image, a rotated image of modified size, comprising obtaining a rotated image by compensating the source image rotation according to an information representative of the rotation of said source image ; determining one rectangular image part in the rotated image according to an information representative of the perceptual interest associated with each pixel of said rotated image; obtaining a rotated image of modified size by modifying the size of the rectangular image part in the rotated image according to a

ratio between the width and height of the rectangular image part and according to an information representative of the rotated image.

According to a first variant, obtaining a rotated image of modified size comprises for each rectangular image part corner: a) determining if the corner comprises a pixel without image information according to the information representative of the rotated image; b) modifying the position of the corner towards the center of the rectangular image part when the corner comprises a pixel without image information ; and c) modifying the position of other corners towards the center of the rectangular image part so that the ratio remains unchanged; d) repeating step a), b) and c) until the corner comprises a pixel with image information; and e) repeating step a), b), c) and d) for each corner until four corners comprise pixel with image information.

According to a second variant, obtaining a rotated image of modified size comprises: a) determining if at least one corner comprises pixel without image information according to the information representative of the rotated image; b) modifying the position of four corner towards the center of the rectangular image part of a same displacement when at least one corner comprises a pixel without image information so that the ratio remains unchanged; and c) repeating step a) and b) until four corners comprise pixel with image information.

In a second aspect, the invention is directed to an image processing method to generate, from a source image, a rotated image of modified size, comprising determining one rotated rectangular image part according to an information representative of the rotation of the source image ; modifying the position of the rotated rectangular image part in the source image according to information representative of the perceptual interest associated with each pixel of the source image; modifying the size of the modified rotated rectangular image part according to a ratio between the width and height of the rectangular image part and according to an information representative of the source image ; obtaining a rotated image of modified size by compensating the modified rotated rectangular image part according to an information representative of the rotation of the source image.

According to a first variant, modifying the size of the modified rotated rectangular image part comprises for each rectangular image part corner:a) determining if the corner comprises a pixel without image information according to the information representative of the rotated image; b) modifying the position of the corner towards the center of the rectangular image part when said corner comprises a pixel without image information ; and c) modifying the position of other corners towards the center of the rectangular image part so that the ratio remains unchanged; d) repeating step a), b) and c) until the corner comprises a pixel with image information; and e) repeating step a), b), c) and d) for each corner until four corners comprise pixel with image information.

According to a second variant, modifying the size of the modified rotated rectangular image part comprises: a) determining if at least one corner comprises pixel without image information according to the information representative of the rotated image; b) modifying the position of four corner towards the center of the rectangular image part of a same displacement when at least one corner comprises a pixel without image information; and c) repeating step a) and b) until four corners comprise pixel with image information.

In a third aspect, the invention is directed to an image processing method to generate, from a source image, a rotated image of modified size, comprising obtaining a rotated image by compensating the source image rotation according to information representative of the rotation of the source image; determining one rectangular image part in the rotated image according to a ratio between the width and height of the rectangular image part and to according to an information representative of the source image; determining an axis in the rotated image according to an information representative of the rotation of said source image; obtaining a rotated image of modified size by modifying the position of the rectangular image part along the axis according to an information representative of the perceptual interest associated with each pixel of the rotated image.

According to a further advantageous characteristic, wherein the source image belongs to a sequence of several images, the method is applied to each image of the sequence and comprises, after determining one rectangular image part in a current rotated image, a temporal filtering of the rectangular image part consisting in

modifying at least one parameter of the rectangular image part among the following parameters: the height, the width and the position along the axis such that the modified parameter is equal to the median value of the set of values comprising the corresponding parameters of the rectangular image parts of the N images preceding the current image and the N' images following the current image, with N and N' positive integers. This characteristic is also compatible with the first or second aspect of the invention.

These functionalities can then be integrated into an image processor or a GPU of a capturing device, of a video player device or of a computer.

In a fourth aspect, the invention is directed to a computer-readable storage medium storing program instructions computer-executable to perform the disclosed methods.

In a fifth aspect, the invention is directed to a device comprising at least one processor; a display coupled to the at least one processor; and a memory coupled to the at least one processor, wherein the memory stores program instructions, wherein the program instructions are executable by the at least one processor to perform the disclosed methods on the display.

Any characteristic or variant described for the methods is compatible with a device intended to process the disclosed methods and with a computer-readable storage medium storing program instructions.

BRIEF DESCRIPTION OF DRAWINGS

Preferred features of the present invention will now be described, by way of non-limiting example, with reference to the accompanying drawings, in which:

Figure 1 illustrates images of a video captured with a rotating device;

Figure 2a illustrates the steps of the method according to a first embodiment of the invention;

Figure 2b illustrates modifications of a source image to obtain a rotated image of modified size according to the first embodiment of the invention;

Figure 3a illustrates the steps of the method according to a second embodiment of the invention;

Figure 3b illustrates modifications of a source image to obtain a rotated image of modified size according to the second embodiment of the invention;

Figure 4a illustrates the steps of the method according to a third embodiment of the invention;

Figure 4b illustrates modifications of a source image to obtain a rotated image of modified size according to the third embodiment of the invention; and

Figure 5 illustrates an apparatus according to a particular embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

A salient idea of the invention is to apply a smart reframing along with an on-going rotation of the source video. At least three embodiments are described for generating, from a source image having suffered a rotation during the capture, a rotated image of modified size adapted to a requested output format. The sequence resulting rotated images of modified size when rendered by a video player offers an enhanced feeling to the user. The three embodiments describe alternative solutions to the same issue of automatic rendering of a source image having suffered a rotation during the capture.

Figure 1 illustrates images of a video captured with a rotating device. A parameter representative of the rotation of the device is defined. Hereafter the terms orientation of the image or rotation of the image are indifferently used and refer to a circular movement of the images of the sequences around a point in said images. The determination of such rotation parameter is not in the scope of the present invention. There exist methods for determining such rotation parameter at the time of the capture or as a post-processing step. The rotation parameter is obtained for example by applying a method for determining an orientation of a video described in a European Patent Application N° 14305275.1. The orientation/rotation parameter is defined at the frame level. In an illustrative example, the rotation parameter is a rotation angle defined respectively to a reference capture format. For instance, with

reference to figure 1, the rotation parameter to is set to 0° when the image 10 is captured in landscape mode, to 90° or -90° when the image 12 is captured in portrait mode and varies from 0° to 90° or -90° for an image 11 with an on-going rotation capture.

The user defines an output format for the rendered image on the video player. In the described embodiments, the requested output format is a rectangular image part oriented in landscape, that is to say the width of the rectangle is larger than its height. Besides the output format is described by a parameter representative of the aspect ratio of the player display. Such aspect ratio parameter is defined by the ratio between the width and height of the rendered image for instance 4/3 or 16/9. The skilled in the art will easily adapt the disclosed method to any format of a rectangular image part.

Figure 2a illustrates the steps of the method according to a first embodiment of the invention. **Figure 2b** illustrates modifications of a source image to obtain a rotated image of modified size according to the first embodiment described with reference to **figure 2a**.

In a first step 22, the rotation of the input source image 21 is compensated by any state-of-the art algorithm of motion estimation and compensation. J.M. Odobez, P. Bouthemy, describe in “Robust multiresolution estimation of parametric motion models” (Journal of Visual Communication and Image Representation, 6(4):348-365, December 1995) such an algorithm.

At the output of step 22, a rotated image 23 is obtained. The compensation is obtained through an inverse rotation according to an information representative of the rotation of the source image, such as the rotation parameter previously defined, with respect to the expected output format. For instance, if the rotation parameter of the source image 21 is set 45°, the rotated image 23 is obtained by a -45° rotation. Advantageously the reference orientation of the capture is the same as the requested orientation of the output format. Otherwise, an offset, taking into account the distinct orientation of source reference and output, is added to the rotation parameter. Although, the orientation is corrected in such image, the video player, limited by the display output format, registers the rotated image in a rectangle 23a

compliant to the requested output format. Hence, the rendered image comprises a part 23b with information representative of the rotated source image but also a part 23c without information of the source image. It is a purpose of the invention to offer a rendered image wherein each pixel of the rendered image comprises information representative of the source image at the cost of a reframing and cropping. For this purpose, a binary mask is generated which associates a first value (e.g. zero) with each pixel of the rectangle image part when the pixel corresponds to a location in the rotated source image and a second value (e.g. 255) otherwise. In other words, a pixel with image information is associated to the first value and a pixel without image information is associated to the second value. In a variant of the binary mask, an information representative of the some rectangle only is used to define the information representative of the source image. Such rectangle corresponds to the four lines defining the informative region of the source image.

In a second step 24, one rectangular image part 25a is determined in the rotated image according to information representative of the perceptual interest associated with each pixel of the rotated image. Such rectangular image part is obtained for example by applying the method described in the European Patent Application N° 08101073.8 (published as EP 1 956 550 A1) describing a video reframing technology based on region of interest of an image from the computation of salient information. However, such method is designed for source videos to reframe having one single input format all along the video, i.e., one wants to go from a 4/3 format to a 16/9 format for example for a whole video. When applied to a rotated image, such method still offers a rendered image comprising a part 25b with information representative of the rotated source image but also a part 25c without information of the rotated source image even if the rendered image surrounds the region of interest in the image.

In a nutshell, such method comprises determining a rectangular image part 25a, also called a bounding box, complying with the requested output format. The bounding box delimits the selected image part. A saliency map is obtained for example by applying the method described in the European Patent Application n° 03293216.2 (publication EP1 544 792 A1). Such a map associates a saliency value with each pixel of the source image. The selection of the image part is then made so as to maximize a function depending of the saliency value. For instance, the function is the sum of all the saliency values corresponding to each pixel of the bounding box.

The skilled in the art will notice that, in this embodiment, the saliency map is computed on the rotated image.

In a third step 26, the size of the selected (from reframing step 24) rectangle image part of the rotated image is modified so that the final rectangle image part 27 only remains in the rotated image while still complying with the requested output format. Two variants are now described for determining the size of the rectangular image part in the rotated image according to an information representative of the oriented image (i.e the binary mask or the rectangle lines previously defined) and according to the ratio between the width and height of the rectangular image part. An advantageously method of determining if the bounding box remains inside the rotated image comprises testing if the four corners of the bounding box correspond to pixels with information. In a variant, the value associated in the mask with the pixel at the corner of the bounding box is tested: if the value is set to first value, the corner is inside the rotated image, if the value is set to the second value, the pixel is outside the rotated image. In another variant, the coordinates the pixel at the corner of the bounding box is tested with regards to the rectangle outlines: if the coordinates is inside the rectangle, the corner is inside the rotated image, if the coordinates is outside the rectangle, the pixel is outside the rotated image.

A first variant is adapted to the maximizing of the bounding box size at the cost of displacement of the center of the bounding box. In a first sub-step a) a first corner of the bounding box is tested to determine if the first corner comprises a pixel without image information according to the information representative of the rotated image. In a second sub-step b), when the corner comprises a pixel without image information, i.e. the corner is outside the rotated image, the first corner is moved towards the center of the bounding box. Such modification of the position of the corner is defined by a displacement of x pixels in width and y pixels in height. Advantageously, a parameter determines the quantification step of displacement of the corner, i.e. the values x and y. Typically x is set to at least 1 and y is set to x divided by the output aspect ratio, thus pixel wise displacement is tested. Accordingly in a sub-step c), the other corners, preferably the two neighbouring corners are also moved towards the center of the bounding box so that the ratio of the bounding box remains unchanged. In a variant, the corners are moved in clockwise order. The sub-steps a), b) and c) are repeated until the sub-step a)

results in a first corner comprising a pixel with image information, i.e the first corner is inside the rotated image. Then the whole process, i.e sub-steps a), b), c) is repeated for second, third and fourth corner until the four corners comprise pixel with image information.

A second variant is adapted to the preservation of the bounding box center at the cost of the maximization of the bounding box size. Besides, the iterative loop is reduced in this second variant. In a first sub-step a), the four corners of the bounding box are tested to determine if at least one corner comprises pixel without image information according to the information representative of the rotated image. In a second sub-step b), when at least a corner comprises a pixel without image information, i.e. at least a corner is outside the rotated image; the four corners are moved towards the center of the bounding box. Such modification of the position of the corners is defined by a displacement of x pixels in width and y pixels in height. According to a particular characteristic, a parameter determines the quantification step of displacement of the corners, i.e. the value x and y. The values x and y are adjusted so that the ratio remains unchanged. Typically x is set to at least 1 and y is set to x divided by the output aspect ratio. The sub-steps a) and b) are repeated until the sub-step a) results in all corners comprising a pixel with image information, i.e. four corners are inside the rotated image. According to a particular characteristic, the displacement is defined for the farthest corner with regards to the rotated image, thus reducing the iterative loop.

Thus, a bounding box 27a is determined so that the image part in the bounding box remains in the rotated image while still complying with the requested output format. In a final sub-step of step 26, the rotated image is cropped according to the bounding box to obtain the rendered image 29 : a rotated image of modified size of the source image.

Figure 3a illustrates the steps of the method according to a second embodiment of the invention. **Figure 3b** illustrates modifications of a source image to obtain a rotated image of modified size according to the second embodiment of the invention. The second embodiment differs from the first embodiment in that it is not

the image which is compensated for rotation in the first step, but the bounding box only.

Accordingly, in a first step 32, a rotated rectangular image part 35a is determined according to an information representative of the rotation of the source image 31. Firstly, the rectangular image part is defined so as to comply with the requested output format. Secondly, the rectangular image part is compensated by a rotation of the rectangle according to a rotation parameter function of the rotation of the source image with respect to the requested output format. A rotated bounding box 35a is thus obtained.

In a second step 34, the position of the rotated rectangular image part in the source image is modified according to an information representative of the perceptual interest associated with each pixel of said source image. To that end, the reframing method previously described for a landscape bounding box is applied to the rotated bounding box. The skilled in the art will notice that, in this embodiment, the saliency map is computed on the source image on an rotated bounding box.

In a third step 36, the size of the previously modified rotated rectangular image part is further modified according to a ratio between the width and height of the rectangular image part and according to an information representative of the source image. The characteristics and variants described for the modification of the size in step 26 are compliant with this step 36. Thus, a rotated bounding box 37a is determined so that the image part in the bounding box remains in the image while still complying with the requested output format.

Finally in a step 38, a rotated image of modified size of the source image 39 is obtained. The source image is cropped according to the rotated bounding box 37a to obtain the image 37. Then, the image 39 is obtained by compensating the modified rotated rectangular image part 37 according to an information representative of the rotation of the source image. In particular, the compensation comprises an inverse rotation of the rotation parameter previously defined, with respect to the expected output format.

Figure 4a illustrates the steps of the method according to a third embodiment of the invention. **Figure 4b** illustrates modifications of a source image to obtain a

rotated image of modified size according to a third embodiment of the invention. The third embodiment differs from the first and second embodiments in that the reframing step based on saliency map is simplified. Indeed the third embodiment relies on computing a bounding box compatible with the aspect ratio and with the source image rotation. The optimal bounding box size is determined under a geometric only point of view. This bounding box is then moved along the picture sides to maximize the associated saliency: the resulting position is the one that contains the most important saliency information, this information being computed as the sum of all the saliency values corresponding to each pixel of the bounding box.

In a first step 42, a rotated image 43 is obtained by compensating the source image 41 rotation according to information representative of the rotation of the source image. The characteristics and variants described for step 22 herein also apply.

In a second step 44, a rectangular image part 45a is determined in the rotated image according to a ratio between the width and height of the rectangular image part and according to information representative of the source image. Advantageously, such bounding box is obtained under geometric point of view. The bounding box is the rectangle of maximum size that is registered into the rotated source image and that complies with the ratio of the requested output format. The bounding box is geometrically computed from the size of the input image, the rotation angle of the input image and the output requested format. An axis of displacement of the rectangle image part in the rotated image is further determined in this step 44 according to the information representative of the rotation of the source image. Upon geometric properties, when moved along the displacement axis, the bounding box remains inside the rotated image until it reaches upper and lower outline of the rotated image. Accordingly, there is a limited number of positions of the bounding box in the rotated image which simplifies the estimation of the saliency.

In a refinement, the optimal bounding box size is determined under some temporal filtering constraints to avoid fast variation of bounding box size. In a step (not shown) wherein the source image belongs to a sequence of several images, the method is applied to each image of the sequence and comprises, after determining one rectangular image part in a current rotated image, a temporal filtering of the rectangular image part consisting in modifying at least one parameter of the rectangular image part among the height, the width and the position along the axis

such that the modified parameter is equal to the median value of the set of values comprising the corresponding parameters of the rectangular image parts of the N images preceding the current image and the N' images following the current image, with N and N' positive integers. In another variant, a Kalman filtering is applied to the parameters. This filtering applied to the parameters of the bounding box obtained by the third embodiment, is also compatible with to the parameters of the bounding box obtained the first and second embodiment. In first and second embodiment, this filtering is either implemented at the reframing step disclosed in the European Patent Application N° 08101073.8 (published as EP 1 956 550 A1) or at the later resizing step.

Finally, in a step 46, a rotated image of modified size 49 is obtained by modifying the position of the rectangular image part 47a along the displacement axis according to the information representative of the perceptual interest associated with each pixel of the rotated image. A saliency map associates a saliency value with each pixel of the rotated source image. The selection of the image part is then made so as to maximize a function depending of the saliency value. For instance, the function is the sum of all the saliency values corresponding to each pixel of the bounding box. In a final sub-step of step 48, the rotated image is cropped according to the bounding box 47a to obtain the rendered image 49 : a rotated image of modified size of the source image. The skilled in the art will notice that, unlike in first and second embodiment, this reframing step is independent from the previously cited method of European Patent Application N° 08101073.8 (published as EP 1 956 550 A1).

The embodiments of the present invention are described with respect to a single image of video sequence. However the disclosed embodiments are applied to each image of a sequence of images in order to produce an enhanced video. The skilled in the art will appreciate, that from a system point of view, it is advantageous to divide the sequence of images into segments of homogeneous orientations wherein an orientation of an image sequence for instance comprises portrait, landscape or on-going rotation. A reframing will then be applied separately for each segment. For segments with on-going rotation mode, a smart reframing adapted to the rotation parameter information as disclosed in the present patent application is applied. For segments captured in landscape mode, no reframing will be applied. For

segments captured in portrait mode, a classic reframing technique such as described in the reframing method of the European Patent Application N° 08101073.8 (published as EP 1 956 550 A1) or a more simple geometric reframing will be used to match the format of the rendered video when in landscape mode.

In a variant of the invention, it may be decided to apply some reframing also to segments in landscape mode. In this case, a classic reframing process will be applied, as for segments in portrait mode. In this case, the reframing applied to segments in portrait mode should target the same input format as the one chosen for landscape segments.

In another variant of the invention particularly adapted to the case of real-time application, the smart reframing thanks to the rotation parameter information is applied on the whole video.

Figure 5 represents an exemplary architecture of an apparatus 100 configured to generate, from a source image having suffered a rotation at captured, a rotated image of modified size according to any exemplary embodiment of the invention. The apparatus 100 comprises one or more processor(s) 110, which is(are), for example, a CPU, a GPU and/or a DSP (English acronym of Digital Signal Processor), along with internal memory 120 (e.g. RAM, ROM, EPROM). The apparatus 100 comprises one or several Input/Output interface(s) 130 adapted to display output information and/or allow a user to enter commands and/or data (e.g. a keyboard, a mouse, a touchpad, a webcam); and a power source 140 which may be external to the apparatus 100. The apparatus 100 may also comprise network interface(s) (not shown). The image may be obtained from a source. According to different embodiments of the invention, the source belongs to a set comprising:

- a local memory, e.g. a video memory, a RAM, a flash memory, a hard disk ;
- a storage interface, e.g. an interface with a mass storage, a ROM, an optical disc or a magnetic support;
- a communication interface, e.g. a wireline interface (for example a bus interface, a wide area network interface, a local area network interface) or a wireless interface (such as a IEEE 802.11 interface or a Bluetooth interface); and

- an image capturing circuit (e.g. a sensor such as, for example, a CCD (or Charge-Coupled Device) or CMOS (or Complementary Metal-Oxide-Semiconductor)).

According to different embodiments of the invention, the reframed video may be sent to a destination. As an example, the reframed video is stored in a remote or in a local memory, e.g. a video memory or a RAM, a hard disk. In a variant, the reframed video is sent to a storage interface, e.g. an interface with a mass storage, a ROM, a flash memory, an optical disc or a magnetic support and/or transmitted over a communication interface, e.g. an interface to a point to point link, a communication bus, a point to multipoint link or a broadcast network.

According to an exemplary and non-limitative embodiment of the invention, the apparatus 100 further comprises a computer program stored in the memory 120. The computer program comprises instructions which, when executed by the apparatus 100, in particular by the processor 110, make the apparatus 100 carry out the method described with reference to figures 2a, 3a or 4a. According to a variant, the computer program is stored externally to the apparatus 100 on a non-transitory digital data support, e.g. on an external storage medium such as a HDD, CD-ROM, DVD, a read-only and/or DVD drive and/or a DVD Read/Write drive, all known in the art. The apparatus 100 thus comprises an interface to read the computer program. Further, the apparatus 100 could access one or more Universal Serial Bus (USB)-type storage devices (e.g., “memory sticks.”) through corresponding USB ports (not shown).

According to exemplary and non-limitative embodiments, the apparatus 100 is a device, which belongs to a set comprising:

- a mobile device ;
- a communication device ;
- a game device ;
- a tablet (or tablet computer) ;
- a laptop ;
- a still image camera;
- a video camera ;
- an encoding chip;
- a still image server;

- a video server (e.g. a broadcast server, a video-on-demand server or a web server) ;
- a video uploading platform; and
- a display or a decoding chip.

The implementations described herein may be implemented in, for example, a method or a process, an apparatus, a software program, a data stream, or a signal. Even if only discussed in the context of a single form of implementation (for example, discussed only as a method or a device), the implementation of features discussed may also be implemented in other forms (for example a program). An apparatus may be implemented in, for example, appropriate hardware, software, and firmware. The methods may be implemented in, for example, an apparatus such as, for example, a processor, which refers to processing devices in general, including, for example, a computer, a microprocessor, an integrated circuit, or a programmable logic device. Processors also include communication devices, such as, for example, computers, cell phones, portable/personal digital assistants ("PDAs"), and other devices that facilitate communication of information between end-users.

Implementations of the various processes and features described herein may be embodied in a variety of different equipment or applications, particularly, for example, equipment or applications. Examples of such equipment include an encoder, a decoder, a post-processor processing output from a decoder, a pre-processor providing input to an encoder, a camera, a video coder, a video decoder, a video codec, a web server, a set-top box, a laptop, a personal computer, a cell phone, a PDA, and other communication devices. As should be clear, the equipment may be mobile and even installed in a mobile vehicle.

Additionally, the methods may be implemented by instructions being performed by a processor, and such instructions (and/or data values produced by an implementation) may be stored on a processor-readable medium such as, for example, an integrated circuit, a software carrier or other storage device such as, for example, a hard disk, a compact diskette (“CD”), an optical disc (such as, for example, a DVD, often referred to as a digital versatile disc or a digital video disc), a random access memory (“RAM”), or a read-only memory (“ROM”). The instructions may form an application program tangibly embodied on a processor-readable medium. Instructions may be, for example, in hardware, firmware, software, or a

combination. Instructions may be found in, for example, an operating system, a separate application, or a combination of the two. A processor may be characterized, therefore, as, for example, both a device configured to carry out a process and a device that includes a processor-readable medium (such as a storage device) having instructions for carrying out a process. Further, a processor-readable medium may store, in addition to or in lieu of instructions, data values produced by an implementation.

As will be evident to one of skill in the art, implementations may produce a variety of signals formatted to carry information that may be, for example, stored or transmitted. The information may include, for example, instructions for performing a method, or data produced by one of the described implementations. For example, a signal may be formatted to carry as data the rules for writing or reading the syntax of a described embodiment, or to carry as data the actual syntax-values written by a described embodiment. Such a signal may be formatted, for example, as an electromagnetic wave (for example, using a radio frequency portion of spectrum) or as a baseband signal. The formatting may include, for example, encoding a data stream and modulating a carrier with the encoded data stream. The information that the signal carries may be, for example, analog or digital information. The signal may be transmitted over a variety of different wired or wireless links, as is known. The signal may be stored on a processor-readable medium.

A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made. For example, elements of different implementations may be combined, supplemented, modified, or removed to produce other implementations. Additionally, one of ordinary skill will understand that other structures and processes may be substituted for those disclosed and the resulting implementations will perform at least substantially the same function(s), in at least substantially the same way(s), to achieve at least substantially the same result(s) as the implementations disclosed. Accordingly, these and other implementations are contemplated by this application.

CLAIMS

1. Image processing method to generate, from a source image (21), a rotated image of modified size (29), comprising :
   - obtaining (22) a rotated image by compensating said source image rotation according to an information representative of the rotation of said source image ;
   - determining (24) one rectangular image part in said rotated image according to an information representative of the perceptual interest associated with each pixel of said rotated image;
   - obtaining a rotated image of modified size by modifying (26) the size of said rectangular image part in said rotated image according to a ratio between the width and height of said rectangular image part and according to an information representative of the rotated image.

2. The method according to claim 1 wherein obtaining a rotated image of modified size comprises for each rectangular image part corner:
   a) determining if said corner comprises a pixel without image information according to said information representative of the rotated image;
   b) modifying the position of said corner towards the center of said rectangular image part when said corner comprises a pixel without image information ; and
   c) modifying the position of other corners towards the center of said rectangular image part so that the ratio remains unchanged;
   d) repeating step a), b) and c) until said corner comprises a pixel with image information; and
   e) repeating step a), b), c) and d) for each corner until four corners comprise pixel with image information.

3. The method according to claim 1 wherein obtaining a rotated image of modified size comprises:
   a) determining if at least one corner comprises pixel without image information according to said information representative of the rotated image;

b) modifying the position of four corner towards the center of said rectangular image part of a same displacement when at least one corner comprises a pixel without image information so that the ratio remains unchanged; and

c) repeating step a) and b) until four corners comprise pixel with image information.

4. Image processing method to generate, from a source image (31), a rotated image of modified size (39), comprising :

- Determining (32) one rotated rectangular image part according to an information representative of the rotation of said source image ;
- Modifying (34) the position of said rotated rectangular image part in said source image according to an information representative of the perceptual interest associated with each pixel of said source image;
- modifying (36) the size of said modified rotated rectangular image part according to a ratio between the width and height of said rectangular image part and according to an information representative of the source image ;
- obtaining a rotated image of modified size by compensating (38) said modified rotated rectangular image part according to an information representative of the rotation of said source image.

5. The method according to claim 4 wherein modifying (36) the size of said modified rotated rectangular image part comprises for each rectangular image part corner:

a) determining if said corner comprises a pixel without image information according to said information representative of the rotated image;

b) modifying the position of said corner towards the center of said rectangular image part when said corner comprises a pixel without image information ; and

c) modifying the position of other corners towards the center of said rectangular image part so that the ratio remains unchanged;

d) repeating step a), b) and c) until said corner comprises a pixel with image information; and

e) repeating step a), b), c) and d) for each corner until four corners comprise pixel with image information.

6. The method according to claim 4 wherein modifying (36) the size of said modified rotated rectangular image part comprises:
   a) determining if at least one corner comprises pixel without image information according to said information representative of the rotated image;
   b) modifying the position of four corner towards the center of said rectangular image part of a same displacement when at least one corner comprises a pixel without image information; and
   c) repeating step a) and b) until four corners comprise pixel with image information.

7. Image processing method to generate, from a source image (41), a rotated image of modified size (49), comprising :
   - obtaining a rotated image by compensating (42) said source image rotation according to an information representative of the rotation of said source image;
   - determining (44) one rectangular image part in said rotated image according to a ratio between the width and height of said rectangular image part and according to an information representative of the source image;
   - determining an axis in said rotated image according to said information representative of the rotation of said source image;
   - obtaining a rotated image of modified size by modifying (48) the position of said rectangular image part along said axis according to an information representative of the perceptual interest associated with each pixel of said rotated image.

8. Method according to claim 7, wherein said source image belongs to a sequence of several images, said method is applied to each image of the sequence and comprises, after determining one rectangular image part in a current rotated image, a temporal filtering of said rectangular image part consisting in modifying at least one parameter of said rectangular image part among the following parameters: the height, the width and the position along said axis such that said modified parameter is equal to the median value of the set of values comprising the corresponding parameters of the rectangular image parts of the N images

preceding said current image and the N' images following said current image, with N and N' positive integers.

9. An apparatus (20) configured to generate, from a source image, a rotated image of modified size, the apparatus (20) comprising a processor (110) configured to:
   - obtain a rotated image by compensating said source image rotation according to an information representative of the rotation of said source image ;
   - determine one rectangular image part in said rotated image according to information representative of the perceptual interest associated with each pixel of said rotated image;
   - obtain a rotated image of modified size by modifying 26 the size of said rectangular image part in said rotated image according to a ratio between the width and height of said rectangular image part and according to an information representative of the rotated image.

10. An apparatus (20) configured to generate, from a source image, a rotated image of modified size, the apparatus (20) comprising:
   - Means for obtaining a rotated image by compensating said source image rotation according to an information representative of the rotation of said source image ;
   - Means for determining one rectangular image part in said rotated image according to information representative of the perceptual interest associated with each pixel of said rotated image;
   - Means for obtaining a rotated image of modified size by modifying the size of said rectangular image part in said rotated image according to a ratio between the width and height of said rectangular image part and according to an information representative of the rotated image

11. A computer program product comprising program code instructions to execute of the steps of the method according to any of claims 1 to 8 when this program is executed on a computer.

12. A processor readable medium having stored therein instructions for causing a processor to perform at least the steps of the method according to any of claims 1 to 8.

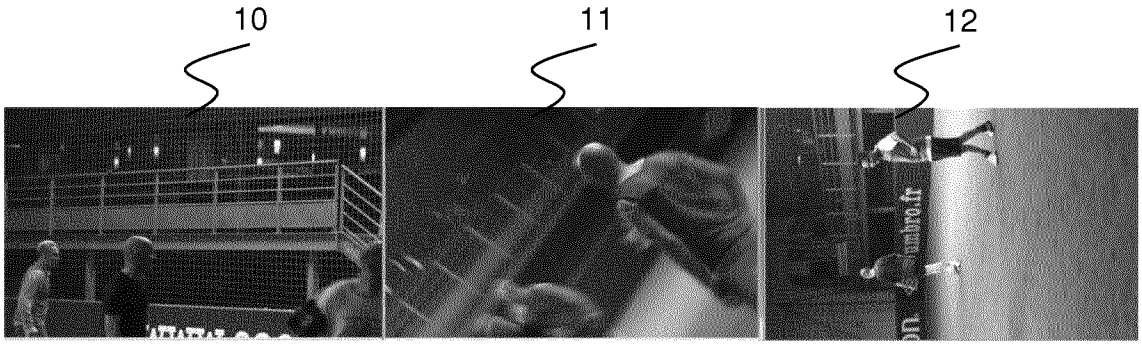

Figure 1

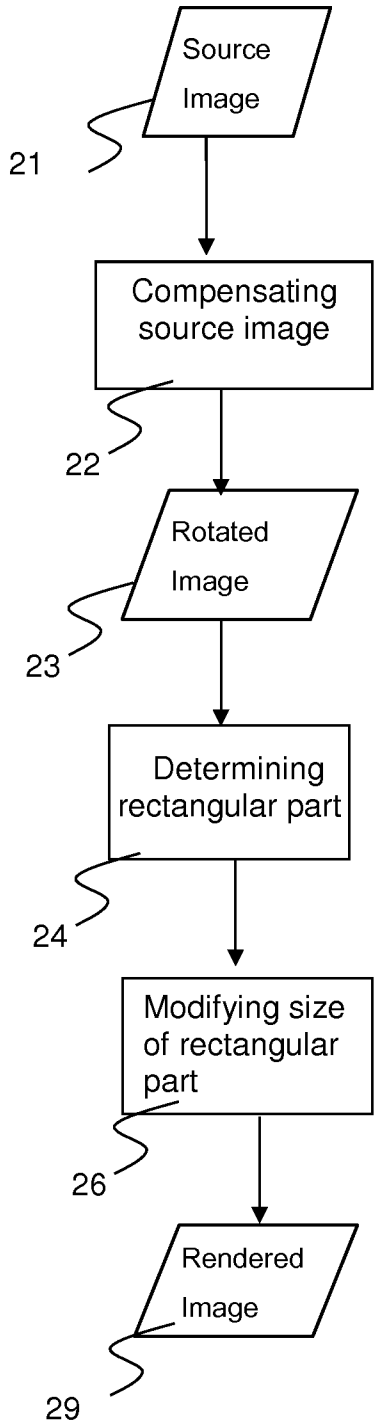
Source Image
21
Compensating source image
22
Rotated Image
23
Determining rectangular part
24
Modifying size of rectangular part
26
Rendered Image
29

Figure 2a

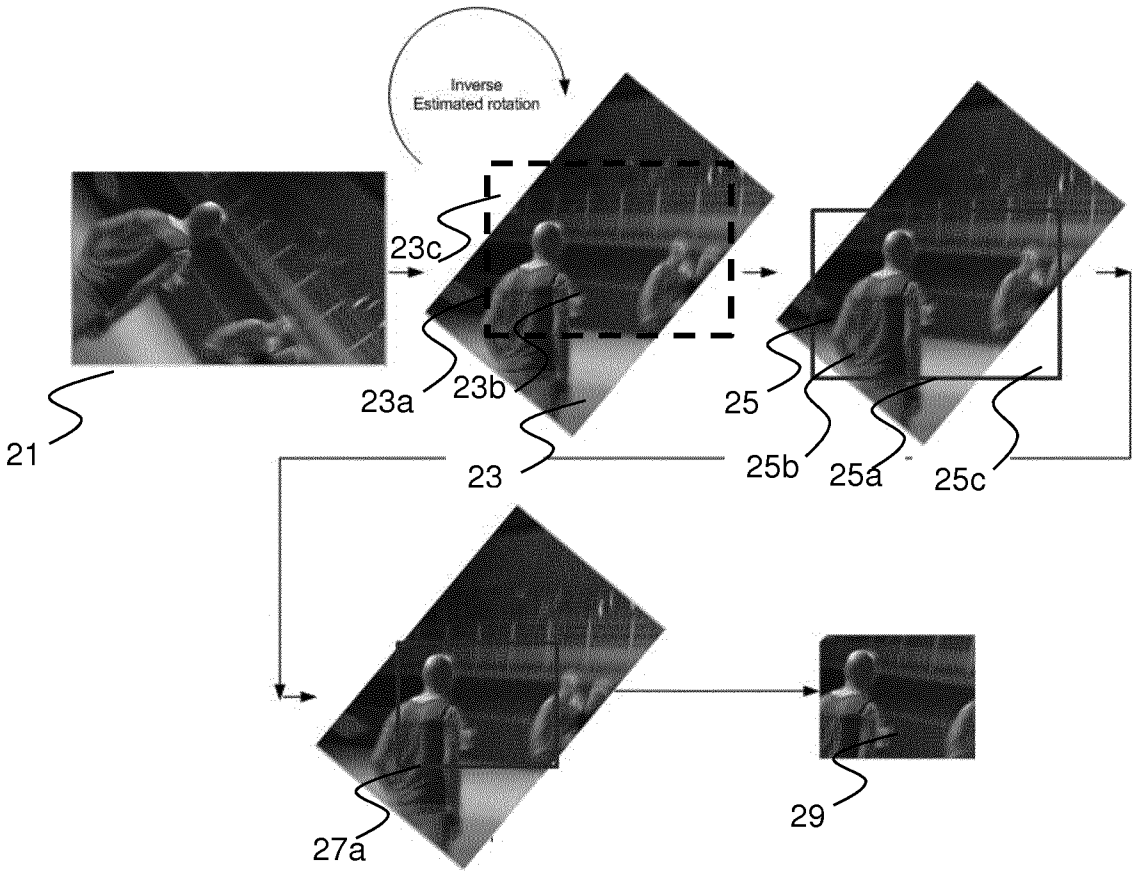
Inverse
Estimated rotation
23c
23a
23b
21
23
25
25b
25a
25c
27a
29

Figure 2b

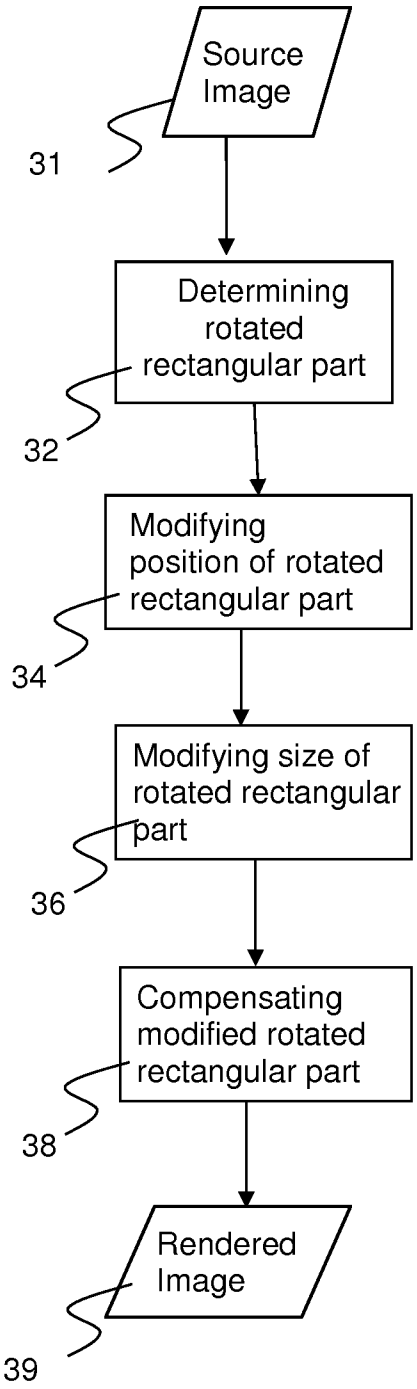
Source Image
31
Determining rotated rectangular part
32
Modifying position of rotated rectangular part
34
Modifying size of rotated rectangular part
36
Compensating modified rotated rectangular part
38
Rendered Image
39

Figure 3a

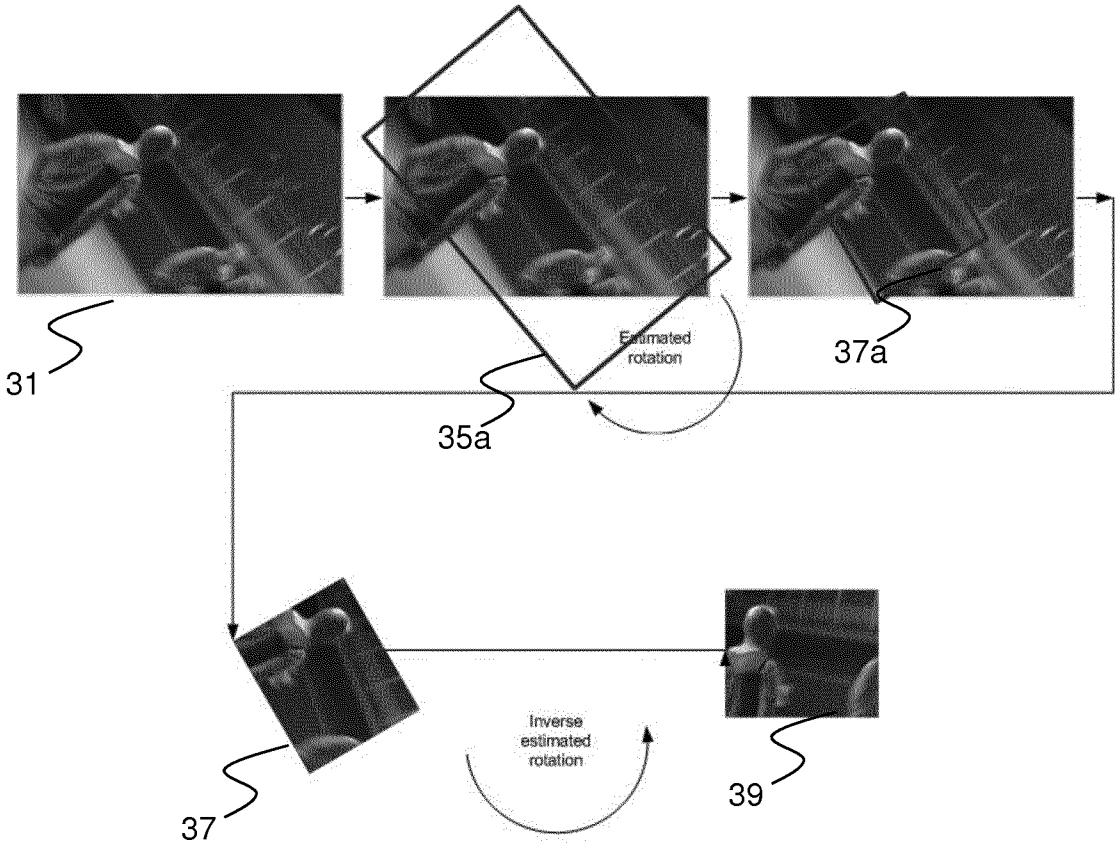
Estimated rotation
31
35a
37a
Inverse estimated rotation
37
39

Figure 3b

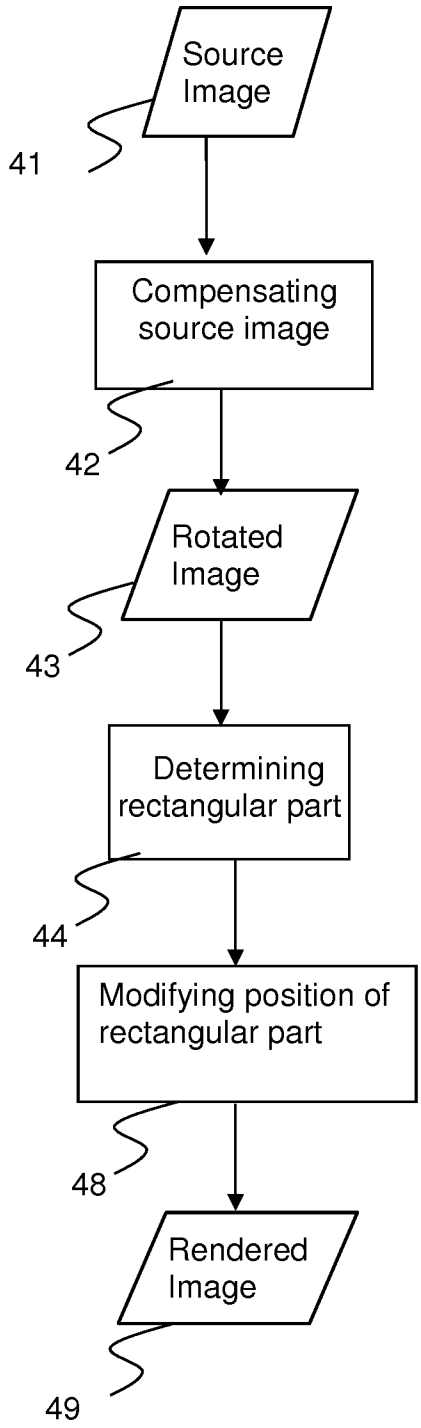
Source Image
41
Compensating source image
42
Rotated Image
43
Determining rectangular part
44
Modifying position of rectangular part
48
Rendered Image
49

Figure 4a

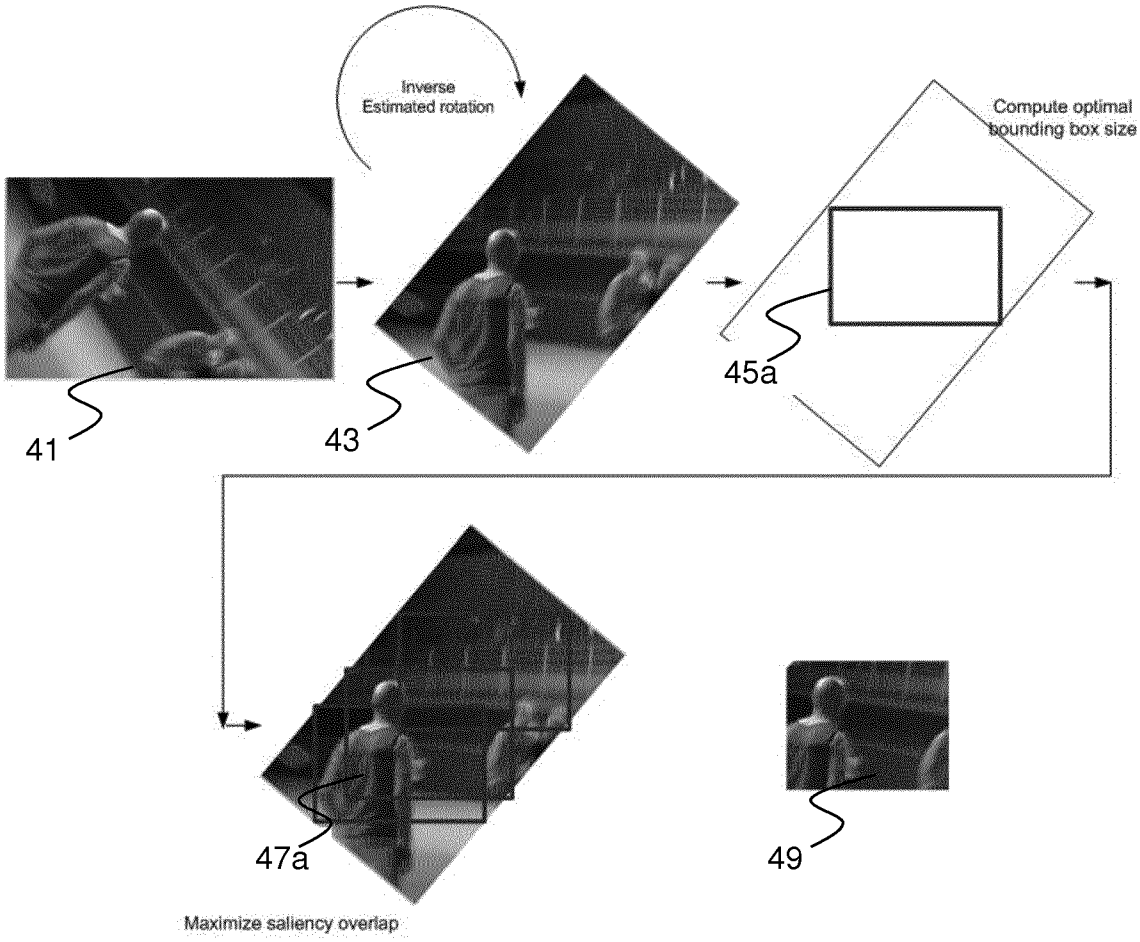
Inverse
Estimated rotation
Compute optimal
bounding box size
41
43
45a
47a
49
Maximize saliency overlap

Figure 4b

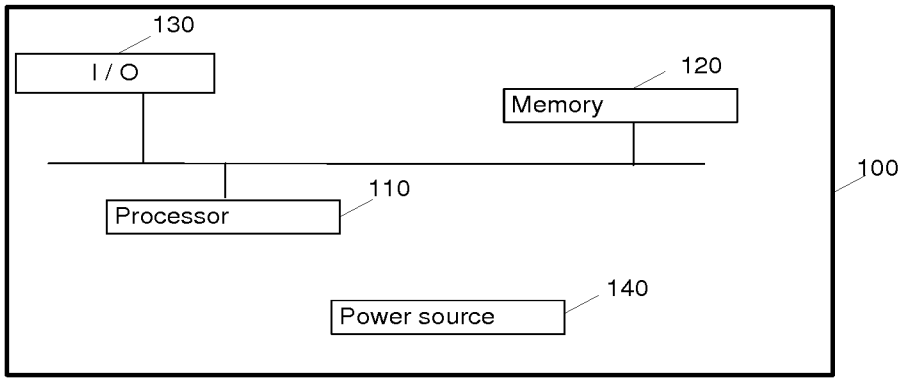

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/053787

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N1/387
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)
H04N

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2009/319887 A1 (WALTMAN DAVID W [US] ET AL) 24 December 2009 (2009-12-24) abstract; figures 5a,5b paragraphs [0006], [0016] - [0023], [0029] - [0035] -----	1,4,7, 9-12 2,3,5,6, 8
Y	EP 1 956 550 A1 (THOMSON LICENSING [FR]) 13 August 2008 (2008-08-13) cited in the application abstract paragraphs [0016], [0021] - [0024] -----	2,3,5,6, 8
A	US 2009/040569 A1 (HAMZY MARK JOSEPH [US]) 12 February 2009 (2009-02-12) abstract paragraphs [0009], [0021] - [0038] -----	1-12

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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
9 June 2015	15/06/2015

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

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/053787

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 544 792 A1 (THOMSON LICENSING SA [FR]) 22 June 2005 (2005-06-22) cited in the application abstract -----	1-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/053787

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