



US 20050168583A1

(19) **United States**

(12) **Patent Application Publication**
Thomason

(10) **Pub. No.: US 2005/0168583 A1**

(43) **Pub. Date: Aug. 4, 2005**

(54) **IMAGE ROTATION CORRECTION FOR
VIDEO OR PHOTOGRAPHIC EQUIPMENT**

Publication Classification

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(51) **Int. Cl.⁷ H04N 5/228**

(52) **U.S. Cl. 348/208.4**

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**PHILIPS INTELLECTUAL PROPERTY &
STANDARDS**

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(57) **ABSTRACT**

(21) **Appl. No.: 10/510,783**

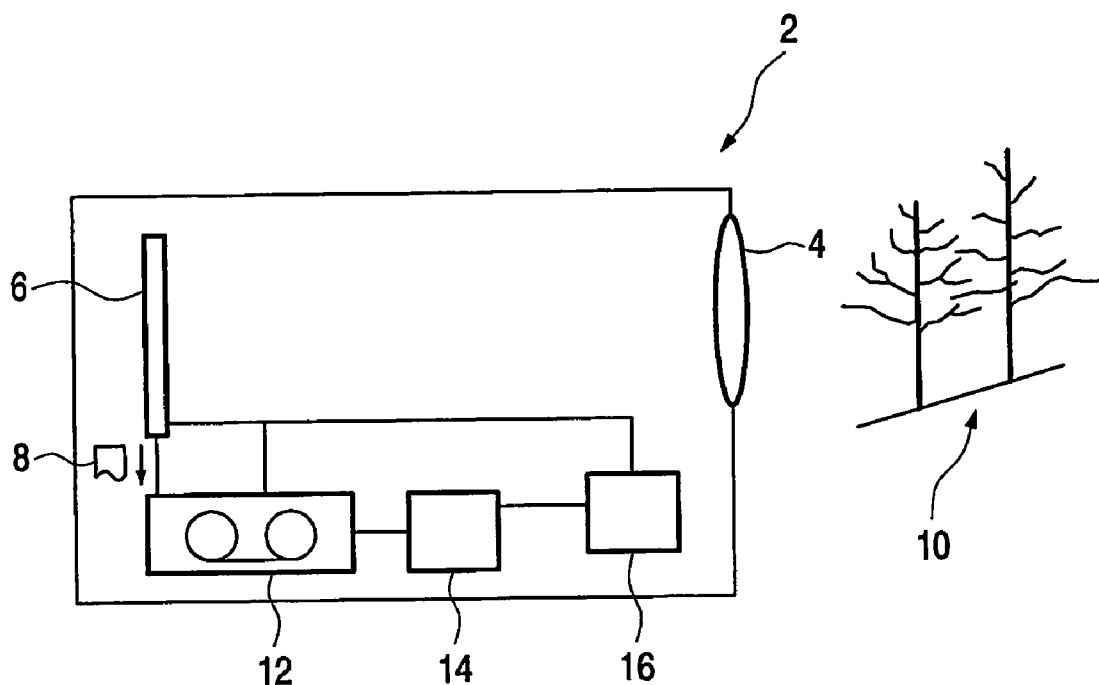
(22) **PCT Filed: Apr. 3, 2003**

(86) **PCT No.: PCT/IB03/01363**

(30) **Foreign Application Priority Data**

Apr. 16, 2002 (GB) 0208654.4

Image recording apparatus such as a camera (2) stores data (8) representing still or moving image data on a data carrier (12). A rotation sensor (14) measures the angle of orientation of the camera. The stored data is based both on the image data and the output angle data to allow the captured image to be rotated for display to have the true horizontal displayed as horizontal.



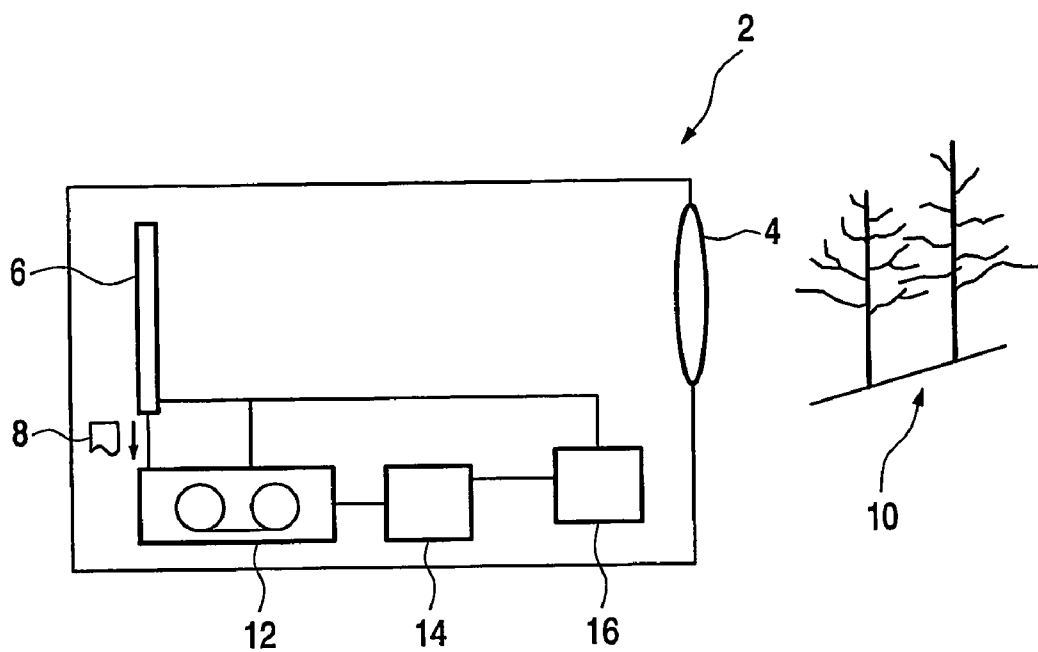


Fig.1

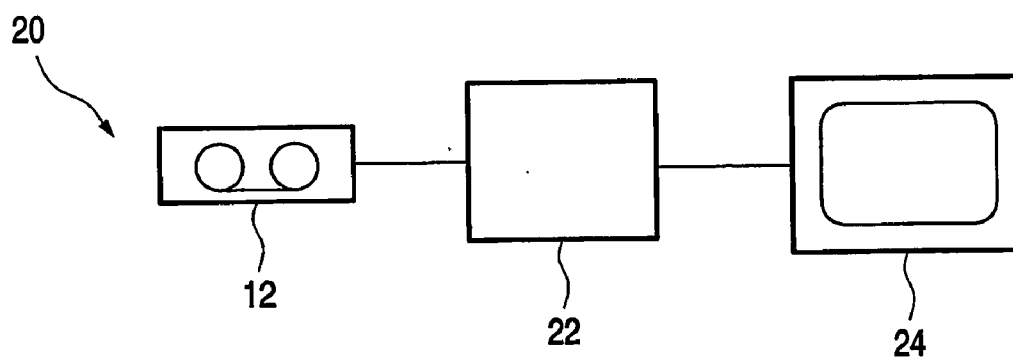


Fig.2

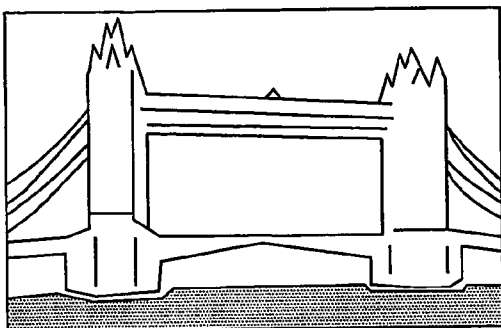


Fig. 3a

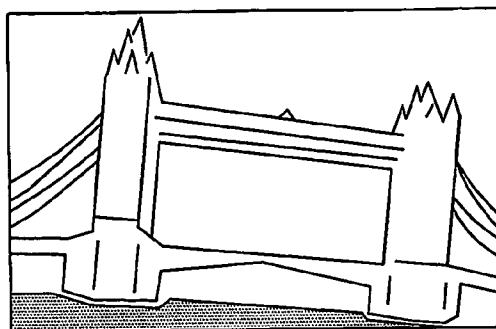


Fig. 3b

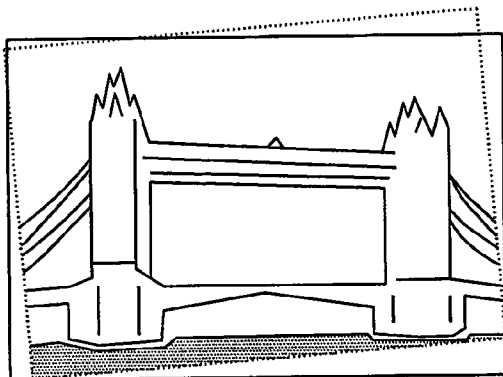


Fig. 3c

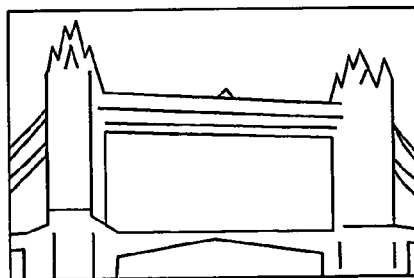


Fig. 3d

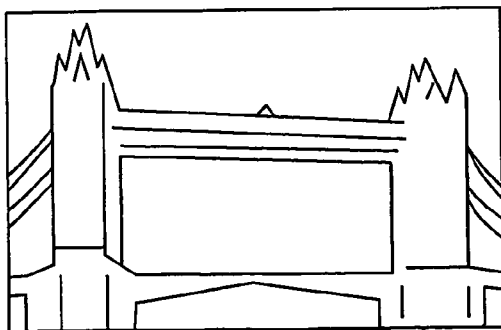


Fig. 3e

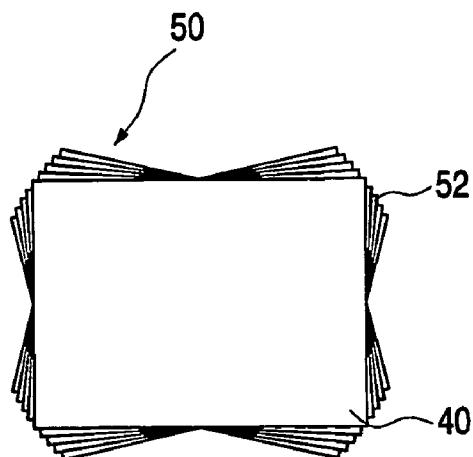


Fig. 4

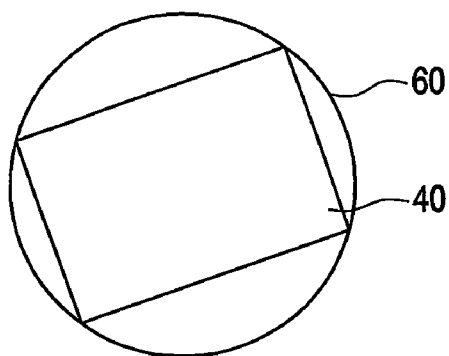


Fig. 5

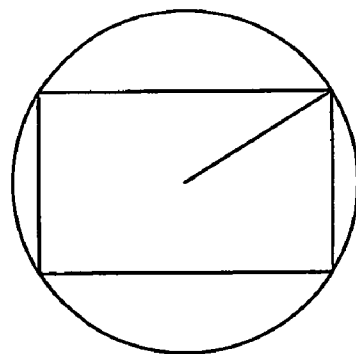


Fig. 6

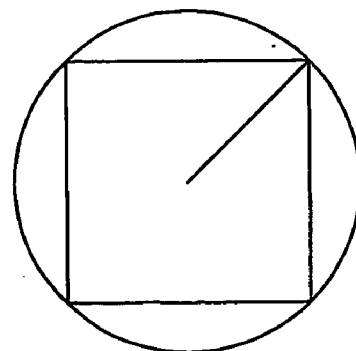


Fig. 7

IMAGE ROTATION CORRECTION FOR VIDEO OR PHOTOGRAPHIC EQUIPMENT

[0001] The invention relates to the processing of image information, particularly in video or photographic equipment, and to apparatus for recording images such as video or photographic images.

[0002] Cameras, such as video or still digital cameras, are frequently used by amateurs who may have difficulties in correctly orienting the camera. There is thus a need for a camera capable of reducing the effect of poor orientation.

[0003] U.S. Pat. No. 5,764,291 describes a camera having an orientation signal that outputs one of four values, indicating left, right, inverted or upright operation. This enables the camera orientation to be correctly recorded as one of these four orientations.

[0004] According to the invention, there is provided an image recording apparatus comprising: a lens; a means for capturing an image projected by the lens; a rotation sensor for providing an output representing the angle of the captured image to the horizontal to an accuracy of 5° or better; and a data carrier for recording data based on both image data representing the captured image and angle data representing the angle measured by the rotation sensor so that a rotated image corrected to have the true horizontal in the captured image displayed as horizontal can be displayed from the data recorded on the data carrier.

[0005] In this way, the image data can be used to output a corrected image with the horizontal of the scene captured by the camera displayed horizontally even if the camera is not exactly aligned.

[0006] The image recording apparatus according to the invention thus has a different effect and purpose to that disclosed in U.S. Pat. No. 5,764,591. U.S. Pat. No. 5,764,591 discloses recording one of four basic camera orientations, i.e. portrait and landscape each in two possible orientations. In contrast, the apparatus according to the invention corrects for fine misalignment between the actual camera orientation and the desired basic orientation.

[0007] Preferably, the accuracy of the rotation sensor is much better than 5°, i.e. 2° or better, or further preferably 1° or better, or even 0.5° or better.

[0008] Conveniently, the stored image data can simply be the data output by the digital recording sensor and the angle measured by the rotation sensor, leaving correction to occur on playback.

[0009] Alternatively, the camera may include a correction module for correcting the image data captured by the camera based on the output of the digital recording sensor and storing the corrected image data in the memory.

[0010] The camera may be a stills camera or a video camera. The data carrier may be any convenient form of memory, including a tape, a flash memory, or any other memory suitable for storing digital data.

[0011] In a particularly beneficial embodiment, the digital recording sensor has a plurality of pixels arranged as a normal rectangular frame together with additional pixels arranged around the periphery of the normal frame. The additional pixels are not used for an image that is recorded

with the camera vertical, but provide the additional pixels needed to deliver a rotated image with the same size of rectangular frame.

[0012] Alternatively, the rotated image may be resized slightly compared with the normal image.

[0013] In a particularly preferred embodiment, the pixels of the digital recording sensor are arranged as a circular array to allow rotation of the image to an arbitrary angle without needing to resize the image frame.

[0014] The pixels may be arranged as a hexagonal array.

[0015] A plurality of sensors may be provided to allow for image correction in a number of planes, for example corrections for rotation and tilt. The camera may be able to use the information from the sensors to record a panoramic image by stitching together a plurality of individual images.

[0016] The invention also relates to a camera as set out above incorporated into a further device, including for example a mobile telephone, or computer.

[0017] In another aspect, the invention relates to a method of processing image information, including capturing image information in a camera; measuring the orientation of the camera with respect to vertical to an accuracy of better than 5°, and recording image data based on the image information and the measured orientation of the camera.

[0018] The step of recording image data may include recording the image information and the measured orientation of the camera as separate pieces of data. The method may further include correcting the recorded image data based on the measured orientation of the camera; and replaying the corrected image information.

[0019] For a better understanding of the invention, embodiments will now be described, purely by way of example, with reference to the accompanying drawings, in which:

[0020] FIG. 1 is a schematic drawing of a camera according to the invention;

[0021] FIG. 2 is a schematic drawing of replay apparatus according to the invention;

[0022] FIG. 3 is a schematic illustrating the operation of a method according to the invention;

[0023] FIG. 4 is an illustration of the frame area;

[0024] FIG. 5 illustrates a circular image frame;

[0025] FIG. 6 illustrates a frame aspect ratio of 760:480 in a circular image frame; and

[0026] FIG. 7 illustrates a frame aspect ratio of 1:1 in a circular image frame.

[0027] A camera 2 includes a lens 4 and a charge-coupled device (CCD) 6 which acts as a sensor to capture image data 8 representing a scene 10 in front of the camera. The camera may record either still images or moving images, in the latter case by capturing a sequence of items of image data 8 representing sequential frames of the moving image.

[0028] The camera 2 also includes memory 12 for recording the image data 8. The memory is in the example shown a tape, although the skilled person will be familiar with many other forms of memory suitable for storing still or

video images and these may also be used. For example, the memory may be a solid state memory such as a flash memory, a removable memory card, a magnetic disc, an optically recordable disc or film.

[0029] A rotation sensor **14** is provided that measures the angle of the camera to the vertical and outputs a corresponding measurement signal. This angle is recorded in the memory **12**. The rotation sensor is an accurate accelerometer.

[0030] Suitable solid state accelerometers are commercially available at moderate cost with an accuracy of 1° . These accelerometers include a micro-etched tongue that bends under gravity and so changes a capacitance. Improved performance is available at higher cost. Other suitable devices are sold as "tilt meters".

[0031] The camera **2** is under the control of camera processor **16**. The camera processor **16** may be arranged to be switchable between a correction mode measuring and storing the angle information for correcting the image and a normal mode in which the rotation sensor is not used.

[0032] A playback device **20** is provided that can accept memory **12** and process the recorded image data **8** and rotation angle in replay processor **22**. The processed image data is played back on display device **24**, for example a television set. It will be appreciated by the skilled person that the replay processor **22** may be incorporated in camera **2** and may indeed be the same processor as camera processor **16**.

[0033] The processor **22** can operate in a correction mode that corrects for inaccurate orientation of the camera with respect to the vertical. Thus, the processor **22** uses the recorded rotation angle information to cause an image to be displayed on display **24** that has the horizontal horizontal, even if the camera was slightly misaligned when the image was recorded.

[0034] FIG. 3 illustrates the use of the system. FIG. 3a shows the image that the user should have taken i.e. with the camera horizontally aligned. FIG. 3b shows the image taken with a camera angle at an angle of about 10° to the vertical. The true horizontal in the image is thus also at an angle of 10° to the horizontal in the recorded image.

[0035] The image as shown in FIG. 3b is recorded in the memory together with the data item that records the camera angle.

[0036] On replay, the processor **22** calculates the image on display **24** as shown in FIG. 3c, with a rotation correction applied using the camera item data angle by replay processor **22** so that true horizontals appear as horizontal. Some of the image frame of the rotation corrected image is blank, as may be seen. Accordingly, the image is cropped to eliminate blank space as illustrated in FIG. 3d. Frame **40** represents the recorded image and frame **42** represents the image frame of the displayed image.

[0037] As illustrated in FIG. 3e, the corrected image **42** is resized so that the final image frame **44** is the same size as original image frame **40**.

[0038] In a modification of the invention, illustrated in FIG. 4, the recorded image area **50** is greater than that of the nominal image frame **40** in order that the image may be

rotated without resizing. Marginal pixels **52** outside the nominal frame **40** may be switched on only when required to avoid excessive power drain when the automatic alignment feature is not in use.

[0039] In a further modification, the sensor array may be circular to enable arbitrary rotation to take place without any loss at the edges. FIG. 5 illustrates such a circular sensor **60** with nominal image frame **40**. Rotation to any angle is possible without size reduction. The individual pixels of circular sensor **60** may be arranged on a hexagonal grid.

[0040] The aspect ratio of image frame **40** in circular sensor array **60** changes the ratio of the circle within the image frame. For example, a rectangle of aspect ratio 760:480 as illustrated in FIG. 6 gives a useful area ratio of 57.48% of the area of the circle, whereas a square of aspect ratio 1:1 as illustrated in FIG. 7 gives a useful aspect ratio of 63.66%. The maximum area of the circular sensor is used in a substantially square frame, of aspect ratio in the range 1:0.7 to 1:1.4, preferably 1:0.9 to 1:1.1.

[0041] The rotation sensor **14** may be a multiple angle rotation sensor, capable of measuring orientation about more than 1 axis and storing the result in memory **12**. The sensor may include a plurality of accelerometers. The stored information may then be used, for example, to stitch together a high quality image from several successive image to make up a panoramic images using the orientation information to accurately align and stitch together the different still images.

[0042] In an alternative embodiment, the processor **16** may function as a correction module by taking the image captured by the sensor **6** and the angle of orientation of the camera **2** as output by rotation sensor **14**, correcting the image data so that the image is accurately horizontal and storing the corrected image in memory **12**.

[0043] The invention is not limited to the embodiments described above and the skilled person will be aware of many modifications that may be implemented.

[0044] In particular, the invention is applicable to any form of camera, whether a stills camera, a video camera, or a camera capable of both stills and video operation.

[0045] Although the invention is described with relation to a digital camera, the invention may also be used with an analogue camera recording images directly on a recordable medium acting as the memory as well as the recording sensor. It is in this case necessary to also record the angle information on the recordable medium, but technology for recording additional information is well known to the skilled person in both the fields of motion picture photography and still picture photography.

[0046] The invention is also applicable to the case where the camera is incorporated in other apparatus, such as a mobile telephone or computer.

1. Image recording apparatus comprising:

- a lens;
- a means for capturing an image projected by the lens;
- a rotation sensor for providing output angle data representing the angle of the captured image to the horizontal to an accuracy of 5° or better; and

a data carrier for recording data based on both image data representing the captured image and angle data representing the angle measured by the rotation sensor so that a rotated image corrected to have the true horizontal in the captured image displayed as horizontal can be displayed from the data recorded on the data carrier.

2. Image recording apparatus according to claim 1 wherein the rotation sensor has a precision of better than 1°.

3. Image recording apparatus according to claim 1 or 2 wherein the means for capturing an image is an optical sensor for outputting a signal representing the image.

4. Image recording apparatus according to claim 3 wherein the apparatus is arranged to store the data output by the recording sensor and a data item representing the angle measured by the rotation sensor.

5. Image recording apparatus according to claim 3 further comprising a correction module for correcting the captured image data based on the output of the rotation sensor and storing the corrected image data in the memory.

6. Image recording apparatus according to any preceding claim wherein the digital recording sensor has a plurality of pixels arranged as a normal rectangular frame corresponding to an unrotated image together with additional pixels arranged around the periphery of the normal frame to provide additional image data for use when rotating the captured image.

7. Image recording apparatus according to any preceding claim wherein the pixels of the digital recording sensor are arranged as a circular array to allow rotation of the image to an arbitrary angle without needing to resize the image frame.

8. Image recording apparatus according to any preceding claim comprising a plurality of sensors to allow for image correction in a number of planes.

9. Image recording apparatus comprising:

a lens;

a sensor for capturing an image projected by the lens and outputting image data;

a rotation sensor for measuring the angle of rotation of the image recording apparatus about a horizontal axis and outputting corresponding angle data; and

a data storage device for storing data both the image data and the angle data.

10. A method of processing image information, including:

capturing image information in a camera;

measuring the angle of orientation of the captured image information with respect to the true horizontal to an accuracy of better than 5°, and

recording image data based on the image information and the measured orientation of the camera.

11. A method according to claim 10, wherein the step of recording image data records the image information and the measured orientation of the camera, the method further comprising the steps of:

correcting the recorded image data based on the measured orientation of the camera; and

replaying the corrected image information.

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