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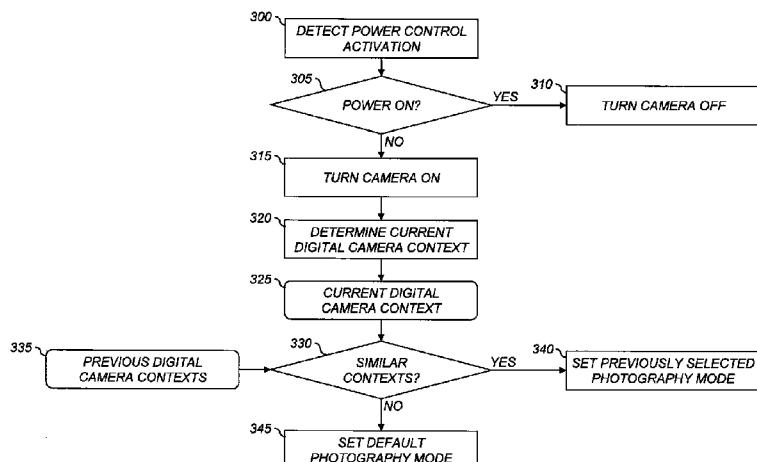


FIG. 3

(57) Abstract: A digital camera having a plurality of photography modes, comprising: an image sensor; an optical system for imaging a scene onto the image sensor; an image capture control for initiating an image capture operation; a photography mode user interface for selecting between a plurality of photography modes, the photography modes having associated image capture and image processing settings; a power control for turning the digital camera on or off, wherein when the camera is in an off state and the power control is activated with a first activation pattern the digital camera is turned on and set to operate in a default photography mode and when the power control is activated with a second activation pattern the digital camera is turned on and set to operate in a previously selected photography mode.

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AUTOMATIC DIGITAL CAMERA PHOTOGRAPHY
MODE SELECTION

FIELD OF THE INVENTION

5 This invention pertains to the field of digital cameras and more particularly to the automatic selection of a photography mode.

BACKGROUND OF THE INVENTION

Digital cameras with a multitude of operational features including 10 but not limited to exposure control, white balance, auto focus, etc. have been a consumer staple for decades. As camera complexity has increased, required actions by the user to operate digital cameras have increased.

Most digital cameras have a variety of photography modes that can be selected by the user to control various elements of the image capture process, 15 and the image processing chain. Examples of typical photography modes include smart capture, portrait, sport, landscape, close-up, sunset, backlight, children, bright, self-portrait, night portrait, night landscape, high-ISO and panorama. Various methods have been described to select an appropriate photography mode and control other digital camera functions. Some digital cameras include 20 mechanical dials that can be used to select the photography mode. However, this adds expense to the digital camera and limits the number of choices that can be offered.

In other digital camera models, the photography mode can be selected by navigating a series of menus on a soft-copy display on the back of the 25 digital camera. Often it can be a lengthy process for the user to navigate through several levels of menus to choose the desired photography mode. Then, if the user turns the camera off and back on again, it is generally necessary to repeat those time-consuming steps again in order to return to the same photography mode. This can be a frustrating experience for the user.

30 In some digital camera models, a photography mode can automatically be selected based on context, such as scene brightness, scene motion. For example, the KODAK EASYSHARE Z915 Digital Camera includes a

"Smart Capture" feature which automatically adjusts the camera settings. The camera detects and analyzes scene conditions, and then automatically sets camera settings including exposure, focus and ISO speed based on these conditions. This selection can be convenient, since it does not require user intervention. However, it

5 is limited because the user has no simple way to influence the selection of the photography mode, aside from simply overriding the automatic photography mode selection. Because automatic selection of photographic mode is imperfect, there remains a need for user control, but there is also a need to easily get the camera to operate in a user-selected mode at power-up.

10 U.S. patent 7,646,297 to Aaron, entitled "Context-detected auto-mode switching" describes a method for self configuration of a communication device to adjust to the user's environmental circumstances. At predetermined intervals, a suite of environmental sensors integral to the device, which can include a camera, periodically samples the user's environment. A derived set of

15 environmental circumstances may then be compared to mode templates to determine a matching template. The operational settings of the device, such as the audio level and display screen contrast, are changed based on the matching template.

U.S. Patent 6,571,066 to Tsai, entitled "Camera with multimode power button," describes a method for using the power button to either turn on the camera or to select the camera operation mode. This scheme requires multiple pushes of the power button to first turn on the camera then select the operating mode.

U.S. Patent 7,721,227 to Ronkainen, entitled "Method for

25 describing alternative actions caused by pushing a single button," describes a user interface for making a choice between two different actions dependent on how long a button is depressed. If the button is released immediately, a first action is taken. If the button is held for a longer period of time, a message is displayed indicating that if the button is continued to be held a second action will be taken.

30 If the button is not released within a specified time interval, the second action is then taken.

U.S. Patent 6,727,830 to Lui, entitled "Time based hardware button for application launch," teaches the use of a time dependent press of an "application" button to select between various functions. Multiple button presses can also be used to select different functions.

5 U.S. Patent 6,976,215 to Roderick et al., entitled "Pushbutton user interface with functionality preview," teaches a user-interface that uses a pressure-sensitive multi-state button. If the button is pushed with a first pressure a preview is provided of the effect that will be produced if the button is pressed using a higher pressure.

10 These approaches all rely on a user interface to control the selection of a photography mode when the camera is powered on. In some instances, photography of a particular event may occur over an extended period of time, such as during a concert or ceremony, during a day of skiing, or during a soccer game. During such extended events, the camera is likely to be powered down occasionally between shots. This generally requires that the user manually navigate the user interface at each power up to return the digital camera to the appropriate photography mode.

15 There remains a need for a method to automatically return a digital camera to a previously-selected photography mode while photographing a particular event, without adding the cost of additional buttons or the inconvenience of needing to navigate complex user-interface menus.

SUMMARY OF THE INVENTION

The present invention represents a digital camera having a plurality 25 of photography modes, comprising:

an image sensor;
an optical system for imaging a scene onto the image sensor;
an image capture control for initiating an image capture operation;
a photography mode user interface for enabling a user to select
30 between a plurality of photography modes, the photography modes having associated image capture and image processing settings;

a memory for storing captured digital images, and for storing one or more previous digital camera contexts and corresponding user-selected photography modes; and

5 a power control for powering up or powering down the digital camera;

 wherein when the power control is activated to power up the digital camera, a digital camera context is determined and compared to the stored previous digital camera contexts, and if the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts, the 10 digital camera is set to operate in the corresponding user-selected photography mode, otherwise the digital camera is set to operate in a default photography mode.

 The present invention has the advantage that it simplifies camera 15 operation by automatically returning to a previously selected photography mode when the digital camera is powered on and the current picture-taking context is sufficiently similar to a previous picture-taking context.

 It has the additional advantage that consistency of camera behavior is enhanced during photography in a particular context. Because the previously selected mode is automatically selected if the context is the same, there is no need 20 to rely on the user to maintain consistency of the photography mode. At the same time, user control is preserved, since the normal user-interface for controlling photography mode is preserved.

 It has the further advantage that no additional user interface controls are required to provide the added functionality.

25

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a high-level diagram showing the components of a system for capturing digital images according to an embodiment of the present invention;

 FIG. 2 is a flow diagram depicting typical image processing 30 operations used to process digital images in a digital camera;

FIG. 3 is a flowchart illustrating a method for selecting a photography mode in a digital camera at power on according to an embodiment of the present invention;

5 FIG. 4 is a flowchart depicting photography mode selection in a digital camera according to an embodiment of the present invention; and

FIG. 5 is a flowchart depicting a power down sequence in a digital camera according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

10 In the following description, a preferred embodiment of the present invention will be described in terms that would ordinarily be implemented as a software program. Those skilled in the art will readily recognize that the equivalent of such software can also be constructed in hardware. Because image manipulation algorithms and systems are well known, the present description will 15 be directed in particular to algorithms and systems forming part of, or cooperating more directly with, the system and method in accordance with the present invention. Other aspects of such algorithms and systems, and hardware or software for producing and otherwise processing the image signals involved therewith, not specifically shown or described herein, can be selected from such 20 systems, algorithms, components and elements known in the art. Given the system as described according to the invention in the following materials, software not specifically shown, suggested or described herein that is useful for implementation of the invention is conventional and within the ordinary skill in such arts.

25 Still further, as used herein, a computer program for performing the method of the present invention can be stored in a computer readable storage medium, which can include, for example; magnetic storage media such as a magnetic disk (such as a hard drive or a floppy disk) or magnetic tape; optical storage media such as an optical disc, optical tape, or machine readable bar code; 30 solid state electronic storage devices such as random access memory (RAM), or read only memory (ROM); or any other physical device or medium employed to

store a computer program having instructions for controlling one or more computers to practice the method according to the present invention.

The invention is inclusive of combinations of the embodiments described herein. References to "a particular embodiment" and the like refer to

5 features that are present in at least one embodiment of the invention. Separate references to "an embodiment" or "particular embodiments" or the like do not necessarily refer to the same embodiment or embodiments; however, such embodiments are not mutually exclusive, unless so indicated or as are readily apparent to one of skill in the art. The use of singular or plural in referring to the
10 "method" or "methods" and the like is not limiting. It should be noted that, unless otherwise explicitly noted or required by context, the word "or" is used in this disclosure in a non-exclusive sense.

Because digital cameras employing imaging devices and related circuitry for signal capture and processing, and display are well known, the
15 present description will be directed in particular to elements forming part of, or cooperating more directly with, the method and apparatus in accordance with the present invention. Elements not specifically shown or described herein are selected from those known in the art. Certain aspects of the embodiments to be described are provided in software. Given the system as shown and described
20 according to the invention in the following materials, software not specifically shown, described or suggested herein that is useful for implementation of the invention is conventional and within the ordinary skill in such arts.

The following description of a digital camera will be familiar to one skilled in the art. It will be obvious that there are many variations of this
25 embodiment that are possible and are selected to reduce the cost, add features or improve the performance of the camera.

FIG. 1 depicts a block diagram of a digital photography system, including a digital camera 10 in accordance with the present invention. Preferably, the digital camera 10 is a portable battery operated device, small enough to be
30 easily handheld by a user when capturing and reviewing images. The digital camera 10 produces digital images that are stored as digital image files using image memory 30. The phrase "digital image" or "digital image file", as used

herein, refers to any digital image file, such as a digital still image or a digital video file.

In some embodiments, the digital camera 10 captures both motion video images and still images. The digital camera 10 can also include other

5 functions, including, but not limited to, the functions of a digital music player (e.g. an MP3 player), a mobile telephone, a GPS receiver, or a programmable digital assistant (PDA).

The digital camera 10 includes a lens 4 having an adjustable aperture and adjustable shutter 6. In a preferred embodiment, the lens 4 is a zoom 10 lens and is controlled by zoom and focus motor drivers 8. The lens 4 focuses light from a scene (not shown) onto an image sensor 14, for example, a single-chip color CCD or CMOS image sensor. The lens 4 is one type optical system for forming an image of the scene on the image sensor 14. In other embodiments, the optical system may use a fixed focal length lens with either variable or fixed 15 focus.

The output of the image sensor 14 is converted to digital form by Analog Signal Processor (ASP) and Analog-to-Digital (A/D) converter 16, and temporarily stored in buffer memory 18. The image data stored in buffer memory 18 is subsequently manipulated by a processor 20, using embedded software 20 programs (e.g. firmware) stored in firmware memory 28. In some embodiments, the software program is permanently stored in firmware memory 28 using a read only memory (ROM). In other embodiments, the firmware memory 28 can be modified by using, for example, Flash EPROM memory. In such embodiments, an external device can update the software programs stored in firmware memory 28 25 using the wired interface 38 or the wireless modem 50. In such embodiments, the firmware memory 28 can also be used to store image sensor calibration data, user setting selections and other data which must be preserved when the camera is turned off. In some embodiments, the processor 20 includes a program memory (not shown), and the software programs stored in the firmware memory 28 are 30 copied into the program memory before being executed by the processor 20.

It will be understood that the functions of processor 20 can be provided using a single programmable processor or by using multiple

programmable processors, including one or more digital signal processor (DSP) devices. Alternatively, the processor 20 can be provided by custom circuitry (e.g., by one or more custom integrated circuits (ICs) designed specifically for use in digital cameras), or by a combination of programmable processors) and custom circuits. It will be understood that connectors between the processor 20 from some or all of the various components shown in FIG. 1 can be made using a common data bus. For example, in some embodiments the connection between the processor 20, the buffer memory 18, the image memory 30, and the firmware memory 28 can be made using a common data bus.

10 The processed images are then stored using the image memory 30. It is understood that the image memory 30 can be any form of memory known to those skilled in the art including, but not limited to, a removable Flash memory card, internal Flash memory chips, magnetic memory, or optical memory. In some embodiments, the image memory 30 can include both internal Flash memory chips and a standard interface to a removable Flash memory card, such as a Secure Digital (SD) card. Alternatively, a different memory card format can be used, such as a micro SD card, Compact Flash (CF) card, MultiMedia Card (MMC), xD card or Memory Stick.

15 The image sensor 14 is controlled by a timing generator 12, which produces various clocking signals to select rows and pixels and synchronizes the operation of the ASP and A/D converter 16. The image sensor 14 can have, for example, 12.4 megapixels (4088x3040 pixels) in order to provide a still image file of approximately 4000x3000 pixels. To provide a color image, the image sensor is generally overlaid with a color filter array, which provides an image sensor having 20 an array of pixels that include different colored pixels. The different color pixels can be arranged in many different patterns. As one example, the different color pixels can be arranged using the well-known Bayer color filter array, as described in commonly assigned U.S. Patent 3,971,065, "Color imaging array" to Bayer, the disclosure of which is incorporated herein by reference. As a second example, the 25 different color pixels can be arranged as described in commonly assigned U.S. Patent Application Publication 2007/0024931 to Compton and Hamilton, entitled

"Image sensor with improved light sensitivity". These examples are not limiting, and many other color patterns may be used.

It will be understood that the image sensor 14, timing generator 12, and ASP and A/D converter 16 can be separately fabricated integrated circuits, or 5 they can be fabricated as a single integrated circuit as is commonly done with CMOS image sensors. In some embodiments, this single integrated circuit can perform some of the other functions shown in FIG. 1, including some of the functions provided by processor 20.

The image sensor 14 is effective when actuated in a first mode by 10 timing generator 12 for providing a motion sequence of lower resolution sensor image data, which is used when capturing video images and also when previewing a still image to be captured, in order to compose the image. This preview mode sensor image data can be provided as HD resolution image data, for example, with 1280x720 pixels, or as VGA resolution image data, for example, with 640x480 15 pixels, or using other resolutions which have significantly fewer columns and rows of data, compared to the resolution of the image sensor.

The preview mode sensor image data can be provided by combining values of adjacent pixels having the same color, or by eliminating some of the pixel values, or by combining some color pixel values while 20 eliminating other color pixel values. The preview mode image data can be processed as described in commonly assigned U.S. Patent 6,292,218 to Parulski, et al., entitled "Electronic camera for initiating capture of still images while previewing motion images".

The image sensor 14 is also effective when actuated in a second 25 mode by timing generator 12 for providing high resolution still image data. This final mode sensor image data is provided as high resolution output image data, which for scenes having a high illumination level includes all of the pixels of the image sensor, and can be, for example, a 12 megapixel final image data having 4000x3000 pixels. At lower illumination levels, the final sensor image data can be 30 provided by "binning" some number of like-colored pixels on the image sensor, in order to increase the signal level and thus the "ISO speed" of the sensor.

The zoom and focus motor drivers 8 are controlled by control signals supplied by the processor 20, to provide the appropriate focal length setting and to focus the scene onto the image sensor 14. The exposure level of the image sensor 14 is controlled by controlling the f/number and exposure time of

5 the adjustable aperture and adjustable shutter 6, the exposure period of the image sensor 14 via the timing generator 12, and the gain (i.e., ISO speed) setting of the ASP and A/D converter 16. The processor 20 also controls a flash 2 which can illuminate the scene.

The lens 4 of the digital camera 10 can be focused in the first mode

10 by using "through-the-lens" autofocus, as described in commonly-assigned U.S. Patent 5,668,597, entitled "Electronic Camera with Rapid Automatic Focus of an Image upon a Progressive Scan Image Sensor" to Parulski et al.. This is accomplished by using the zoom and focus motor drivers 8 to adjust the focus position of the lens 4 to a number of positions ranging between a near focus

15 position to an infinity focus position, while the processor 20 determines the closest focus position which provides a peak sharpness value for a central portion of the image captured by the image sensor 14. The focus distance which corresponds to the closest focus position can then be utilized for several purposes, such as automatically setting an appropriate scene mode, and can be stored as

20 metadata in the image file, along with other lens and camera settings.

The processor 20 produces menus and low resolution color images that are temporarily stored in display memory 36 and are displayed on the image display 32. The image display 32 is typically an active matrix color liquid crystal display (LCD), although other types of displays, such as organic light emitting diode (OLED) displays, can be used. A video interface 44 provides a video output signal from the digital camera 10 to a video display 46, such as a flat panel HDTV display. In preview mode, or video mode, the digital image data from buffer memory 18 is manipulated by processor 20 to form a series of motion preview images that are displayed, typically as color images, on the image display 32. In

25 review mode, the images displayed on the image display 32 are produced using the image data from the digital image files stored in image memory 30.

The graphical user interface displayed on the image display 32 is controlled in response to user input provided by user controls 34. The user controls 34 are used to select various camera modes, such as video capture mode, still capture mode, and review mode, and to initiate capture of still images and

5 recording of motion images. User controls 34 typically include some combination of buttons, rocker switches, joysticks, or rotary dials. In some embodiments, some of the user controls 34 are provided by using a touch screen overlay on the image display 32. In other embodiments, additional status displays or images displays can be used. In a preferred embodiment, the user controls 34 include a power

10 control 35 (e.g., a power button) which is used to turn on or off the camera, as well as other controls such as a lens control to control the lens 4, and an image capture control (e.g., a shutter button) to initiate an image capture operation. In some embodiments, the still preview mode is initiated when the user partially depresses the shutter button, and the still image capture mode is initiated when the

15 user fully depresses the shutter button.

The camera modes that can be selected using the user controls 34 include a "timer" mode. When the "timer" mode is selected, a short delay (e.g., 10 seconds) occurs after the user fully presses the shutter button, before the processor 20 initiates the capture of a still image.

20 An audio codec 22 connected to the processor 20 receives an audio signal from a microphone 24 and provides an audio signal to a speaker 26. These components can be used to record and playback an audio track, along with a video sequence or still image. If the digital camera 10 is a multi-function device such as a combination camera and mobile phone, the microphone 24 and the speaker 26

25 can be used for telephone conversation.

In some embodiments, the speaker 26 can be used as part of the user interface, for example to provide various audible signals which indicate that a user control has been depressed, or that a particular mode has been selected. In some embodiments, the microphone 24, the audio codec 22, and the processor 20

30 can be used to provide voice recognition, so that the user can provide a user input to the processor 20 by using voice commands, rather than user controls 34. The speaker 26 can also be used to inform the user of an incoming phone call. This can

be done using a standard ring tone stored in firmware memory 28, or by using a custom ring-tone downloaded from a wireless network 58 and stored in the image memory 30. In addition, a vibration device (not shown) can be used to provide a silent (e.g., non audible) notification of an incoming phone call.

5 The processor 20 also provides additional processing of the image data from the image sensor 14, in order to produce rendered sRGB image data which is compressed and stored within a "finished" image file, such as a well-known Exif-JPEG image file, in the image memory 30.

10 The digital camera 10 can be connected via the wired interface 38 to an interface/recharger 48, which is connected to a computer 40, which can be a desktop computer or portable computer located in a home or office. The wired interface 38 can conform to, for example, the well-known USB 2.0 interface specification. The interface/recharger 48 can provide power via the wired interface 38 to a set of rechargeable batteries (not shown) in the digital camera 10.

15 The digital camera 10 can include a wireless modem 50, which interfaces over a radio frequency band 52 with the wireless network 58. The wireless modem 50 can use various wireless interface protocols, such as the well-known Bluetooth wireless interface or the well-known 802.11 wireless interface. The computer 40 can upload images via the Internet 70 to a photo service provider 20, such as the Kodak EasyShare Gallery. Other devices (not shown) can access the images stored by the photo service provider 72.

20 In alternative embodiments, the wireless modem 50 communicates over a radio frequency (e.g. wireless) link with a mobile phone network (not shown), such as a 3GSM network, which connects with the Internet 70 in order to upload digital image files from the digital camera 10. These digital image files can be provided to the computer 40 or the photo service provider 72.

25 FIG. 2 is a flow diagram depicting image processing operations that can be performed by the processor 20 in the digital camera 10 (FIG. 1) in order to process color sensor data 100 from the image sensor 14 output by the 30 ASP and A/D converter 16. In some embodiments, the processing parameters used by the processor 20 to manipulate the color sensor data 100 for a particular digital

image are determined by various user settings 175, which can be selected via the user controls 34 in response to menus displayed on the image display 32.

The color sensor data 100 which has been digitally converted by the ASP and A/D converter 16 is manipulated by a white balance step 95. In some 5 embodiments, this processing can be performed using the methods described in commonly-assigned U.S. patent 7,542,077 to Miki, entitled "White balance adjustment device and color identification device". The white balance can be adjusted in response to a white balance setting 90, which can be manually set by a user, or which can be automatically set by the camera.

10 The color image data is then manipulated by a noise reduction step 105 in order to reduce noise from the image sensor 14. In some embodiments, this processing can be performed using the methods described in commonly-assigned U.S. patent 6,934,056 to Gindele et al., entitled "Noise cleaning and interpolating sparsely populated color digital image using a variable noise cleaning kernel". The 15 level of noise reduction can be adjusted in response to an ISO setting 110, so that more filtering is performed at higher ISO exposure index setting.

The color image data is then manipulated by a demosaicing step 115, in order to provide red, green and blue (RGB) image data values at each pixel location. Algorithms for performing the demosaicing step 115 are commonly 20 known as color filter array (CFA) interpolation algorithms or "deBayering" algorithms. In one embodiment of the present invention, the demosaicing step 115 can use the luminance CFA interpolation method described in commonly-assigned U.S. Patent 5,652,621, entitled "Adaptive color plane interpolation in single sensor color electronic camera," to Adams et al. The demosaicing step 115 can 25 also use the chrominance CFA interpolation method described in commonly-assigned U.S. Patent 4,642,678, entitled "Signal processing method and apparatus for producing interpolated chrominance values in a sampled color image signal", to Cok.

In some embodiments, the user can select between different pixel 30 resolution modes, so that the digital camera can produce a smaller size image file. Multiple pixel resolutions can be provided as described in commonly-assigned U.S. Patent 5,493,335, entitled "Single sensor color camera with user selectable

"image record size," to Parulski et al. In some embodiments, a resolution mode setting 120 can be selected by the user to be full size (e.g. 3,000x2,000 pixels), medium size (e.g. 1,500x1000 pixels) or small size (750x500 pixels).

The color image data is color corrected in color correction step

5 125. In some embodiments, the color correction is provided using a 3x3 linear space color correction matrix, as described in commonly-assigned U.S. Patent 5,189,511, entitled "Method and apparatus for improving the color rendition of hardcopy images from electronic cameras" to Parulski, et al. In some embodiments, different user-selectable color modes can be provided by storing 10 different color matrix coefficients in firmware memory 28 of the digital camera 10. For example, four different color modes can be provided, so that the color mode setting 130 is used to select one of the following color correction matrices:

Setting 1 (normal color reproduction)

15

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} 1.50 & -0.30 & -0.20 \\ -0.40 & 1.80 & -0.40 \\ -0.20 & -0.20 & 1.40 \end{bmatrix} \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix} \quad 0)$$

Setting 2 (saturated color reproduction)

20

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} 2.00 & -0.60 & -0.40 \\ -0.80 & 2.60 & -0.80 \\ -0.40 & -0.40 & 1.80 \end{bmatrix} \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix} \quad (2)$$

Setting 3 (de-saturated color reproduction)

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} 1.25 & -0.15 & -0.10 \\ -0.20 & 1.40 & -0.20 \\ -0.10 & -0.10 & 1.20 \end{bmatrix} \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix} \quad (3)$$

25

Setting 4 (monochrome)

$$\begin{bmatrix} R_{out} \\ G_{out} \\ B_{out} \end{bmatrix} = \begin{bmatrix} 0.30 & 0.60 & 0.10 \\ 0.30 & 0.60 & 0.10 \\ 0.30 & 0.60 & 0.10 \end{bmatrix} \begin{bmatrix} R_{in} \\ G_{in} \\ B_{in} \end{bmatrix} \quad (4)$$

In other embodiments, a three-dimensional lookup table can be used to perform the color correction step 125.

The color image data is also manipulated by a tone scale correction 5 step 135. In some embodiments, the tone scale correction step 135 can be performed using a one-dimensional look-up table as described in U.S. Patent No. 5,189,511, cited earlier. In some embodiments, a plurality of tone scale correction look-up tables is stored in the firmware memory 28 in the digital camera 10. These can include look-up tables which provide a "normal" tone scale correction 10 curve, a "high contrast" tone scale correction curve, and a "low contrast" tone scale correction curve. A user selected contrast setting 140 is used by the processor 20 to determine which of the tone scale correction look-up tables to use when performing the tone scale correction step 135.

The color image data is also manipulated by an image sharpening 15 step 145. In some embodiments, this can be provided using the methods described in commonly-assigned U.S. Patent 6,192,162 entitled "Edge enhancing colored digital images" to Hamilton, et al. In some embodiments, the user can select between various sharpening settings, including a "normal sharpness" setting, a "high sharpness" setting, and a "low sharpness" setting. In this example, the 20 processor 20 uses one of three different edge boost multiplier values, for example 2.0 for "high sharpness", 1.0 for "normal sharpness", and 0.5 for "low sharpness" levels, responsive to a sharpening setting 150 selected by the user of the digital camera 10.

The color image data is also manipulated by an image compression 25 step 155. In some embodiments, the image compression step 155 can be provided using the methods described in commonly-assigned U.S. Patent 4,774,574, entitled "Adaptive block transform image coding method and apparatus" to Daly et al. In some embodiments, the user can select between various compression settings. This can be implemented by storing a plurality of quantization tables, for 30 example, three different tables, in the firmware memory 28 of the digital camera 10. These tables provide different quality levels and average file sizes for the compressed digital image file 180 to be stored in the image memory 30 of the

digital camera 10. A user selected compression mode setting 160 is used by the processor 20 to select the particular quantization table to be used for the image compression step 155 for a particular image.

The compressed color image data is stored in a digital image file 180 using a file formatting step 165. The image file can include various metadata 170. Metadata 170 is any type of information that relates to the digital image, such as the model of the camera that captured the image, the size of the image, the date and time the image was captured, and various camera settings, such as the lens focal length, the exposure time and f-number of the lens, and whether or not the camera flash fired. In a preferred embodiment, all of this metadata 170 is stored using standardized tags within the well-known Exif-JPEG still image file format. In a preferred embodiment of the present invention, the metadata 170 includes information about camera settings 185.

The present invention will now be described with reference to FIG. 3, which is a flowchart illustrating a method for using the power control 35 (FIG. 1) on a digital camera 10 (FIG. 1) to select a photography mode according to an embodiment of the present invention. In FIG. 3, a detect power control activation step 300 detects a press of the power control 35 (FIG. 1). A power on test 305 checks whether the power is already on and makes a decision. If the power is already on, a turn camera off step 310 is executed, turning the camera power off. (Note that when the digital camera 10 (FIG. 1) is in the power off mode, the digital camera 10 may not be totally powered down, but may be in a sleep mode which uses a minimal level of power consumption.) If the power on test 305 determines that the power is not already on, the process continues to a turn camera on step 315, turning the camera power on. A determine current digital camera context step 320 is next used to determine a current digital camera context 325. The digital camera context is a set of information characterizing the picture-taking environment. As will be discussed in more detail later, the digital camera context can include information such as a date/time, a camera location, sensed scene characteristics, sensed audio signals, and event calendar entries. One or more previous digital camera context(s) 335 are stored in a persistent memory, together with information specifying corresponding previously selected

photography modes that the digital camera user had selected to use with the previous digital camera contexts) 335. A similar contexts test 330 determines whether the current digital camera context 325 is sufficiently similar to one of the previous digital camera contexts) 335. If the current digital camera context 325 is 5 sufficiently similar to one of the previous digital camera contexts) 335, then a set previously selected photography mode step 340 is used to set the digital camera 10 to operate in the corresponding previously selected photography mode. Otherwise, a set default photography mode step 345 is executed, setting the digital camera 10 to operate in a default photography mode. In this way, the previous 10 user-selected photography mode is respected when the digital camera 10 is powered up, but only if the digital camera context is sufficiently similar.

In some embodiments of the present invention, the power control 35 is a pressure-sensitive button, or some other form of touch-sensitive surface. There are a variety of different types of pressure-sensitive buttons. Some pressure-sensitive buttons are spring-loaded mechanical buttons that depress to different 15 positions depending on the depress pressure. When the button is depressed with a light pressure, the button depresses to a first position and gives a first signal (S1); and when the button is depressed with a heavy pressure, the button depresses to a second position and gives a second signal (S2). Other types of pressure-sensitive 20 buttons use electronic pressure sensors which produce a variable electrical signal according to the applied pressure. There are a variety of different electronic pressure sensors known in the art, including piezoresistive pressure sensors, piezoelectric pressure sensors, electromagnetic pressure sensors or capacitive pressure sensors.

25 Digital cameras typically provide a variety of photography modes that the user can select from according to the photography conditions and their personal preferences. A wide variety of photography modes are known in the art. Examples of typical photography modes include smart capture, portrait, sport, landscape, close-up, sunset, backlight, children, bright, self-portrait, night portrait, 30 night landscape, high-ISO, panorama, color boost, grayscale, sepia tone, aperture priority and shutter priority. Typically the photography mode can be selected using interactive menus provided as part of the user controls 34. Often it may be

necessary to navigate through several levels of menus in order to select a particular photography mode.

In a preferred embodiment, the default photography mode selected by the set default photography mode step 345 is an automatic mode which is

5 designed to produce good results under a wide variety of photography conditions. Such automatic modes go by a variety of different names such as "auto mode," "default mode," "smart capture mode" or "program mode." In this automatic mode, the digital camera 10 typically analyzes the photography conditions to automatically determine various image capture settings such as the exposure 10 index, the lens F#, the exposure time and the electronic flash setting, as well as other user settings 175, such as those discussed with reference to FIG. 2. In other embodiments, some other photography mode can be used as the default photography mode. In some embodiments, the user can be allowed to designate a preferred photography mode to be the default photography mode.

15 As an example of a scenario where the method of the present invention is valuable, consider the case where a user is capturing images at a soccer game, and has manually set the camera to operate in a sport photography mode. The sport photography mode would generally choose appropriate image capture settings to minimize the motion blur associated with moving subjects. The 20 user may then choose to power down the digital camera 10 to save the battery life (or the digital camera 10 may automatically power itself down after a period of inactivity). If the user then desires to resume capturing additional images at the soccer game, they would typically desire to power the camera back on directly into the sport photography mode rather than the default photography mode in 25 order to save the trouble of navigating through the various user control menus to select the appropriate photography mode. According to the method of the present invention, this is done automatically at power on by comparing the current digital camera context 325 with the previous digital camera context 335 when the sport photography mode was previously selected. If the digital camera contexts are 30 sufficiently similar, the digital camera 10 is automatically returned to the previously selected sport photography mode.

As was discussed earlier, according to the method of the present invention, the similar contexts test 330 compares the current digital camera context 325 to one or more previous digital camera contexts 335. The previous digital camera contexts 335 are recorded in a persistent memory, together with 5 indications of the corresponding user-selected photography mode.

In some embodiments, only a single previous digital camera context 335 is stored corresponding to the most recent user-selected photography mode.

10 In other embodiments, provision is made for storing a plurality of previous digital camera contexts 335. For example, the previous digital camera contexts 335 can be stored corresponding to the five most recent user-selected photography modes. Alternately, the previous digital camera contexts and the corresponding user-selected photography modes are stored for a predefined period of time (e.g., 48 hours). Storing a plurality of digital camera contexts can provide 15 a number of advantages, especially with recurring events. For example, the sports photography mode can be selected while at a soccer game, then the portrait mode selected during a family party. When the camera is powered up again for another soccer game, the current digital camera context can be determined to be similar to the previous digital camera context associated with the sport photography mode 20 and this mode can be automatically selected even though it was not the most recent user-selected photography mode.

In some embodiments, the digital camera context and the corresponding photography mode are stored at the time when a user selects a particular photography mode as illustrated in FIG. 4. An interactive photography 25 mode selection process 400 is used by a user to select a photography mode 405. The interactive photography mode selection process 400 can use any method known in the art for selection of a photography mode using the user controls 34 of the digital camera 10. For example, the user can select the photography mode 405 by navigating a series of interactive menus, or by using a photography mode dial. 30 A set photography mode step 410 is used to set the digital camera 10 to operate in the selected photography mode 405. A determine current digital camera context step 415 is then used to determine a current digital camera context 420. An

indication of the photography mode 405 and the current digital camera context 420 are then stored in a persistent memory using a record photography mode and current digital camera context step 425. In some implementations, the current digital camera context 420 is stored only at the time that the user first selects the

5 photography mode. In other implementations, the current digital camera context 420 is updated and stored every time a digital image is captured using the user-selected photography mode. In this case, the stored current digital camera context 420 will correspond to the most recent image capture. When the digital camera context information includes a time/date factor, this approach may be preferable to

10 ensure that the stored previous digital camera context 335 is most relevant for comparison with the current digital camera context 325 using the similar contexts test 330.

In some embodiments, the digital camera context and the corresponding user-selected photography mode are updated and stored at the time

15 that the digital camera 10 is powered off. In this case, the process of storing the digital camera context and the corresponding photography mode can be incorporated into the turn camera off step 310 (FIG. 3). Additional details for a version of the turn camera off step 310 adapted for this purpose are illustrated in FIG. 5. When the process of turning the digital camera 10 to an OFF state is

20 initiated, a user selected photography mode test 505 determines whether or not the current photography mode 500 was user-selected. If not, execution proceeds to a power down camera step 510, which executes a power down procedure to put the digital camera 10 into an OFF state. Otherwise, the determine current digital camera context step 415 is used to determine the current digital camera context

25 420. An indication of the current photography mode 500 and the current digital camera context 420 are then stored in a persistent memory using the record photography mode and current digital camera context step 425. Finally, the power down camera step 510 is executed to complete the process of putting the digital camera 10 into an OFF state. In some embodiments, only one digital camera

30 context is stored corresponding to the user-selected photography mode that was active when the digital camera was most recently powered down. In other

embodiments, multiple digital camera contexts can be stored as was discussed above.

The process shown in FIG. 5 makes the assumption that the user would only be concerned with returning to the previous photography mode if it is 5 one that was manually user-selected. In alternate embodiments, indications of the current photography mode 500 and the current digital camera context 420 are then stored in memory whether or not the current photography mode 500 was user-selected.

It should be noted that the processes for storing the digital camera 10 context described in FIGS. 4 and 5 are not mutually exclusive. In some 10 embodiments, the photography mode and the digital camera context could be recorded both when a photography mode is manually user-selected and also at the time when the digital camera 10 is powered down. The digital camera context and the photography mode could also be recorded at other times as well. For example, 15 they could be recorded at fixed time intervals (e.g., every 10 minutes) during an extended photography session, or they could be recorded if a substantial change in the digital camera context is detected (e.g., a significant change in the lighting level).

According to the present invention, the current digital camera 20 context 325 associated with a photography mode selection includes one or more context factors characterizing the picture-taking environment. One skilled in the art will recognize that there are many different context factors that can be useful for characterizing the digital camera context. For example, useful context factors would include a time/date factor, a camera location factor, a scene similarity 25 factor, a scene information factor, an audio similarity factor and a scheduled event factor. Each of these types of factors will be described in more detail below.

In some embodiments, the similar contexts test 330 (FIG. 3) 30 considers only one type of context factor (e.g., time/date) in order to determine whether the current digital camera context 325 is sufficiently similar to one of previous digital camera contexts 335. In other cases, the similar contexts test 330 uses a plurality of independent context factors (e.g., both the camera location as well as the time/date).

In a preferred embodiment of the present invention, one context factor that is used by the similar contexts test 330 is the time/date. Generally, if a short length of time has transpired between the time that the digital camera 10 was operated in the previous photography mode and the current time, then it is

5 reasonable to assume that the user would desire to return to the previously selected photography mode. For example, if the digital camera 10 was powered down for 5 minutes, the probability is high that the photography environment would be similar to the previous photography environment, and therefore that it would be appropriate to set the digital camera 10 to operate in the previously selected photography mode.

10 According to one embodiment of the present invention, the similar contexts test 330 determines that the current digital camera context 325 is sufficiently similar to a previous digital camera context 335 by determining a time interval between the current time/date and the time/date associated with the 15 previous digital camera context and comparing it to a predetermined threshold (e.g., one hour). If the time interval is less than the predetermined threshold, then the digital camera 10 is set to operate in the previously selected photography mode, otherwise it is set to operate in the default photography mode.

15 In some embodiments, the similar contexts test 330 considers a 20 camera location factor in the process of comparing the digital camera contexts. In this case, the digital camera context includes a camera location value. If a distance between camera locations is less than a predetermined threshold (e.g., 100 meters), then the digital camera can be set to operate in the previously selected 25 photography mode. In some implementations, the camera location is a geographic location (e.g., longitude and latitude) determined using a global positioning system (GPS) sensor. In alternate implementations, the camera location is a relative location determined using an inertial sensing system including one or 30 more accelerometers or gyroscopes. While such inertial sensing systems can not determine an absolute geographic location (unless they are provided with a known reference location), they can be used to effectively determine distances between two locations.

In some embodiments, the scene itself, as sensed by the image sensor 14 (FIG. 1), can also be used to provide context information. If a currently sensed scene is sufficiently similar to a previously captured scene, then this can provide a valuable clue that the digital camera is being operated in a similar image capture environment. For example, consider the case where the user was previously capturing images of a soccer game and then powered down the digital camera. When the user powers the digital camera back on and captures a preview image of the current scene, if the user is still at the soccer game then the currently sensed image will generally have a very similar appearance to the previously captured scene.

To provide the scene context information for the previously captured scene, a context image, preferably of low resolution, such as the same size as a preview image or smaller, can be stored as part of the previous digital camera context 335 and can be compared with a currently sensed context image, generated from a currently sensed preview image. In some embodiments, a captured full-resolution digital image that was captured using the previous user-selected photography mode can be used to provide the scene context information.

Any method for assessing image similarity known in the art can be used to assess the similarity between the sensed scenes. In some embodiments, scene similarity can be assessed by determining a difference image between the currently sensed scene and a previously captured scene. If the average difference signal is less than a predetermined threshold, then the digital camera contexts can be designated as being similar.

Directly comparing the previously captured scene to the currently sensed scene will often show differences due to differences in the camera orientation or changes in the scene content. To improve the scene comparison, some embodiments can use motion compensation to compensate for small differences in the camera orientation before computing the difference image signal.

Because image differences, even with motion compensation, will often be significant even with subtle scene changes, it will generally be preferable to utilize more sophisticated image similarity algorithms to assess scene

similarity. Such algorithms typically assess scene similarity by analyzing the scene to determine feature vectors representing various scene attributes (e.g., color histograms, scene texture features and scene motion features). An example of an algorithm that can be used to determine a scene similarity value according to the 5 present invention is the scale-invariant features (SIFT) algorithm described by Lowe in the article "Distinctive image features from scale invariant keypoints" (Intl. Journal of Computer Vision, Vol. 60, pp. 91-110, 2004), which is incorporated herein by reference.

In other embodiments, a semantic scene classification algorithm 10 can be used to analyze the sensed scene and classify it into one of a set of predetermined scene classification categories. For example, the scenes can be classified according to scene type (e.g., beach, sunset), event type (e.g., birthday, wedding), location (e.g., museum, playground) or object type (e.g., animal, boat). One such classification algorithm that can be used in accordance with the present 15 invention is disclosed in commonly-assigned, co-pending U.S. Patent Application Publication 2009/0297032, to Loui et al., entitled "Semantic event detection for digital content records.". A current digital camera context 325 can be designated to be similar to a previous digital camera context 335 if it is classified according to the same classification category.

20 In some embodiments, the similar contexts test 330 assesses digital camera context similarity by considering one or more scene information factors related to sensed information about the scene. For example, the sensed scene information can include a scene brightness level, a scene color balance and a focus distance. If the currently sensed scene has a similar brightness level, a similar 25 color balance, and a similar focus distance to the previously sensed scene, it can be inferred that the current digital camera context is similar to the previous digital camera context. In some embodiments, a scene brightness difference, a scene color balance difference and a scene focus distance difference are determined. A total difference is then determined by performing a weighted sum of these 30 difference values. If the total difference is less than a predetermined threshold, then the current digital camera context 325 can be designated to be sufficiently similar to the previous digital camera context. In other embodiments, only a subset

of these scene information attributes are considered, or alternately other pieces of information can be included.

Audio signals associated with an image-capture environment can provide important clues about the digital camera context. For example, beach

- 5 scenes, or sporting event scenes or birthday party scenes are typically associated with very different sound characteristics. In some embodiments, the similar contexts test 330 assesses digital camera context similarity by considering an audio similarity factor. Any techniques known in the art for comparing audio signals can be used to assess a similarity of the digital camera context. Such
- 10 techniques often involve computing frequency spectrum representations of the audio signals and computing differences between the frequency spectrums. In some embodiments, frequency spectrum associated with the previous digital camera contexts are determined and are stored as part of the digital camera context representation. The frequency spectrum of an audio signal captured in the
- 15 current environment can then be determined for comparison.

Another type of factor that can be considered by the similar contexts test 330 is a scheduled event factor. Scheduled event factors are useful for digital cameras 10 that have access to an event calendar used to store scheduled events associated with the digital camera user. In some embodiments,

- 20 the event calendar can be stored locally within the digital camera 10. This is commonly the case for applications such as smart phones, PDAs or laptop computers that include digital cameras. In other embodiments, the digital camera 10 can access an externally stored event calendar through a communications network, either wired or wireless. As described in commonly assigned U.S. Patent
- 25 Application Publication 2007/0008321 entitled "Identifying collection images with special events" to Gallagher et al., an event calendar can be used to associate digital images with events on an event calendar.

In some embodiments, the current digital camera context 325 is determined to be sufficiently similar to the previous digital camera context 335 if

- 30 both the current time/date and a time/date associated with the previous digital camera context fall within a time interval associated with a stored scheduled event. For example, if the event calendar shows a soccer game being scheduled

between 6-8 PM on a particular date, and if both digital camera contexts have time/dates that fall within this range, then it can be inferred that they have similar digital camera contexts. Therefore, if a user-selected sport photography mode was associated with the previous digital camera context, the same photography mode 5 can be automatically selected.

In some implementations, the digital camera context can be designated to be sufficiently similar to one of the stored previous digital camera contexts if the current time/date corresponds to a current scheduled event on the event calendar that is of a same event type as a scheduled event corresponding to a 10 time/date associated with one of the stored previous digital camera contexts. For example, if a previous digital camera context is associated with a time/date corresponding to a soccer game, and the current time/date also corresponds to a soccer game, then the same photography mode can be automatically selected.

In some cases, an event type can be associated with a previously 15 captured digital image, or set of digital images. The associated event type can then be associated with the digital camera context. The event type can be determined using an event calendar, or alternatively can be manually user-designated or can be determined by automatically analyzing the captured digital images. In some cases, it may be possible to infer an event type from the user-selected photography 20 mode (e.g., if a sport photography mode is selected, it can be assumed that the digital camera is being used to photograph a sporting event). In such cases, the digital camera context can be designated to be sufficiently similar to a previous digital camera context if the current time/date corresponds to a current scheduled event that is of a same event type as the event type associated with the previous 25 digital camera context.

As mentioned earlier, the similar contexts test 330 can be based on a single context factor (e.g., a time/date factor), or alternately can consider a plurality of context factors. In such cases, the plurality of context factors can be 30 combined using any method known in the art to determine a combined context similarity value that is representative of the differences between the current digital camera context and the previous digital camera context. In some embodiments,

factor similarity values can be determined for a plurality of different context factors (e.g., a time/date similarity value and a location similarity value). The factor similarity values can then be combined using an appropriate mathematical relationship to determine the combined context similarity value. For example, the

5 combined context similarity value can be computed using a weighted summation of the individual factor similarity values. Alternately, the combined context similarity value can be determined based on the individual factor similarity value indicating the highest degree of similarity. In this way, the digital camera contexts would be indicated to be similar if the time/date is similar or the location is

10 similar, even if both the time/date and location attributes are not similar.

PARTS LIST

- 2** flash
- 4** lens
- 6** adjixstable aperture and adjustable shutter
- 8** zoom and focus motor drives
- 10** digital camera
- 12** timing generator
- 14** image sensor
- 16** ASP and A/D Converter
- 18** buffer memory
- 20** processor
- 22** audio codec
- 24** microphone
- 26** speaker
- 28** firmware memory
- 30** image memory
- 32** image display
- 34** user controls
- 35** power control
- 36** display memory
- 38** wired interface
- 40** computer
- 44** video interface
- 46** video display
- 48** interface/recharger
- 50** wireless modem
- 52** radio frequency band
- 58** wireless network
- 70** Internet
- 72** photo service provider
- 90** white balance setting

- 95 white balance step
- 100 color sensor data
- 105 noise reduction step
- 110 ISO setting
- 115 demosaicing step
- 120 resolution mode setting
- 125 color correction step
- 130 color mode setting
- 135 tone scale correction step
- 140 contrast setting
- 145 image sharpening step
- 150 sharpening setting
- 155 image compression step
- 160 compression mode setting
- 165 file formatting step
- 170 metadata
- 175 user settings
- 180 digital image file
- 185 camera settings
- 300 detect power control activation step
- 305 power on test
- 310 turn camera off step
- 315 turn camera on step
- 320 determine current digital camera context step
- 325 current digital camera context
- 330 similar contexts test
- 335 previous digital camera contexts
- 340 set previously selected photography mode step
- 345 set default photography mode step
- 400 interactive photography mode selection process step
- 405 photography mode
- 410 set photography mode step

- 410 set photography mode step
- 415 determine current digital camera context step
- 420 current digital camera context
- 425 record photography mode and current digital camera context step
- 500 current photography mode
- 505 user selected photography mode test
- 510 power down camera step

CLAIMS:

1. A digital camera having a plurality of photography modes, comprising:

- 5 an image sensor;
- an optical system for imaging a scene onto the image sensor;
- an image capture control for initiating an image capture operation;
- a photography mode user interface for enabling a user to select between a plurality of photography modes, the photography modes having
- 10 associated image capture and image processing settings;
- a memory for storing captured digital images, and for storing one or more previous digital camera contexts and corresponding user-selected photography modes; and
- 15 a power control for powering up or powering down the digital camera;

wherein when the power control is activated to power up the digital camera, a digital camera context is determined and compared to the stored one or more previous digital camera contexts, and if the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts, the digital camera is set to operate in the corresponding user-selected photography mode, otherwise the digital camera is set to operate in a default photography mode.

- 2. The digital camera of claim 1 wherein the memory stores only one previous digital camera context and a corresponding user-selected photography mode corresponding to the user-selected photography mode that was active when the digital camera was most recently powered down.

- 3. The digital camera of claim 1 wherein the user-selected photography mode and the current digital camera context are stored in the memory at the time that the user selects the user-selected photography mode.

4. The digital camera of claim 1 wherein the user-selected photography mode and the current digital camera context are stored in the memory when a substantial change in the digital camera context is detected.

5 5. The digital camera of claim 1 wherein the user-selected photography mode and the current digital camera context are stored in the memory at predefined time intervals.

10 6. The digital camera of claim 1 wherein the memory stores a plurality of previous digital camera contexts and corresponding user-selected 10 photography modes.

15 7. The digital camera of claim 1 wherein the digital camera context includes a time/date, and wherein the digital camera context is determined to be sufficiently similar to the most-recently stored digital camera context if a time interval between the associated time/date values is less than a predetermined threshold.

20 8. The digital camera of claim 1 wherein the digital camera context includes a camera location, and wherein the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts if a distance between the camera locations is less than a predetermined threshold.

25 9. The digital camera of claim 8 wherein the camera location is a geographic location determined using a global positioning system sensor.

30 10. The digital camera of claim 8 wherein the camera location is a relative camera location determined using an inertial sensing system including one or more accelerometers or gyroscopes.

11. The digital camera of claim 1 wherein the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts if a currently sensed scene is sufficiently similar to a previously captured scene.

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12. The digital camera of claim 11 wherein the previously captured scene is a stored digital image.

13. The digital camera of claim 11 wherein the previously captured scene is represented as a set of features related to a previously captured digital image.

14. The digital camera of claim 11 wherein a scene classification algorithm is used to analyze the sensed scenes to determine one or more scene classification categories, and wherein the previously captured scene and the currently sensed scene are determined to be sufficiently similar if they are classified in the same scene classification category.

15. The digital camera of claim 1 wherein the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts if sensed information about the scene is sufficiently similar to sensed information about a previously captured scene.

16. The digital camera of claim 15 wherein the sensed information about the scene includes a scene brightness level, a scene color balance or a focus distance.

17. The digital camera of claim 1 wherein the digital camera further includes a microphone for capturing audio signals, and wherein the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts if a current audio signal is sufficiently similar to a previously captured audio signal.

18. The digital camera of claim 1 wherein the digital camera has access to an event calendar for storing scheduled events associated with the digital camera user, and wherein the digital camera context is determined to be 5 sufficiently similar to one of the stored previous digital camera contexts responsive to scheduled events stored on the event calendar.

19. The digital camera of claim 18 wherein the digital camera context is determined to be sufficiently similar to the previous digital camera 10 context if both the current time/date and a time/date associated with the previous digital camera context fall within a time interval associated with a stored scheduled event.

20. The digital camera of claim 18 wherein the digital camera 15 context is determined to be sufficiently similar to one of the stored previous digital camera contexts if the current time/date corresponds to a current scheduled event that is of a same event type as a scheduled event corresponding to a time/date associated with one of the stored previous digital camera contexts.

20 21. The digital camera of claim 18 wherein the digital camera context includes an associated event type, and wherein digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts if the current time/date corresponds to a current scheduled event that is of a same event type as one of the stored previous digital camera contexts.

25 22. The digital camera of claim 1 wherein the digital camera context is determined to be sufficiently similar to one of the stored previous digital camera contexts by considering a plurality of context factors.

23. The digital camera of claim 22 wherein the context factors include two or more of a time/date factor, a location factor, a scene similarity factor, a scene information factor, a audio similarity factor, or a scheduled event factor.

5

24. The digital camera of claim 1 wherein the power control is a power button.

10 25. The digital camera of claim 24 wherein the power button is a mechanical power button.

26. The digital camera of claim 24 wherein the power button is a touch sensitive surface.

15

27. The digital camera of claim 1 further including:

a data processing system;

a program memory system communicatively connected to the data processing system and storing instructions configured to cause the data processing system to:

20

capture a digital image with the image sensor in response to an activation of the image capture control; and

process the captured digital image according to the selected photography mode.

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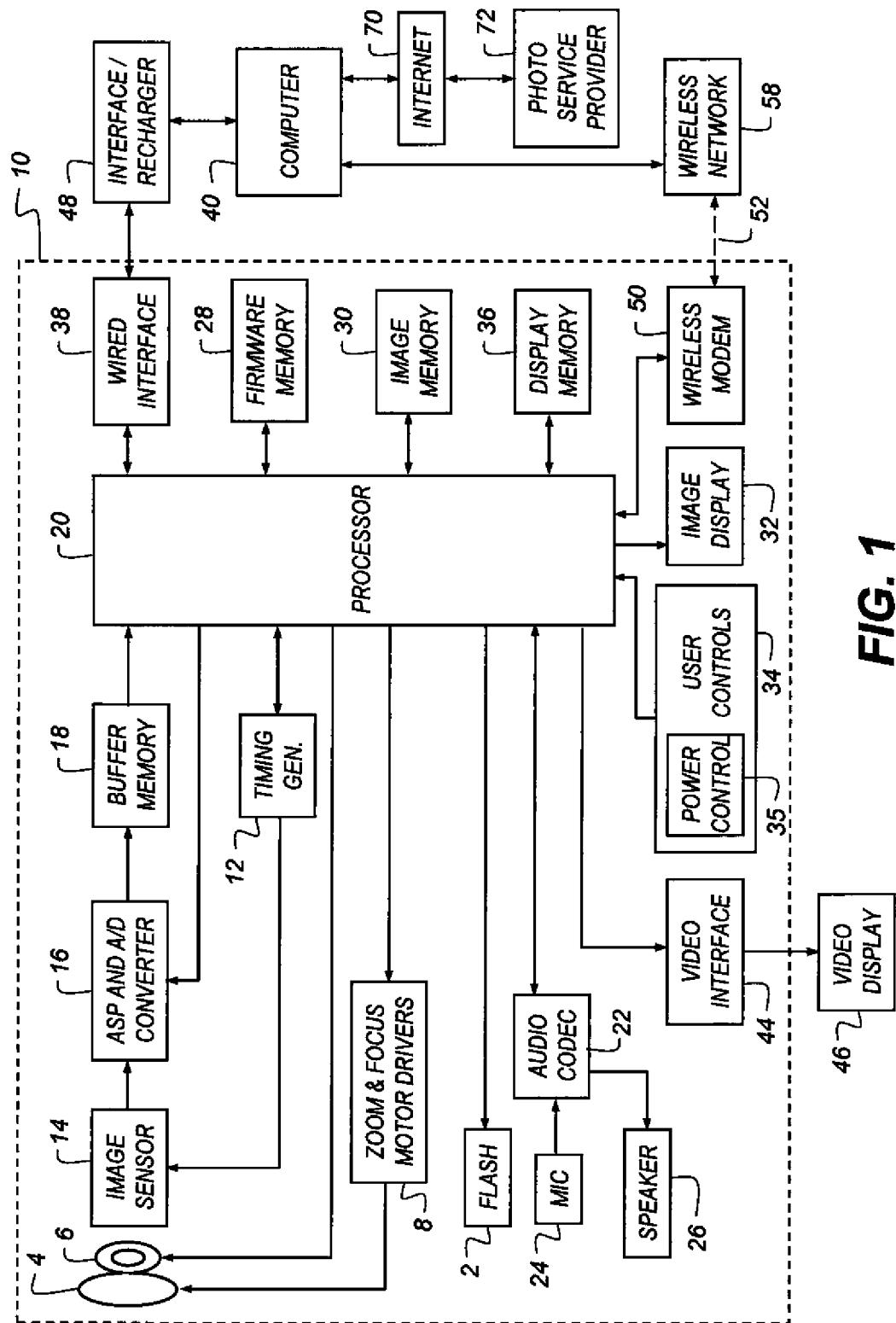


FIG. 1

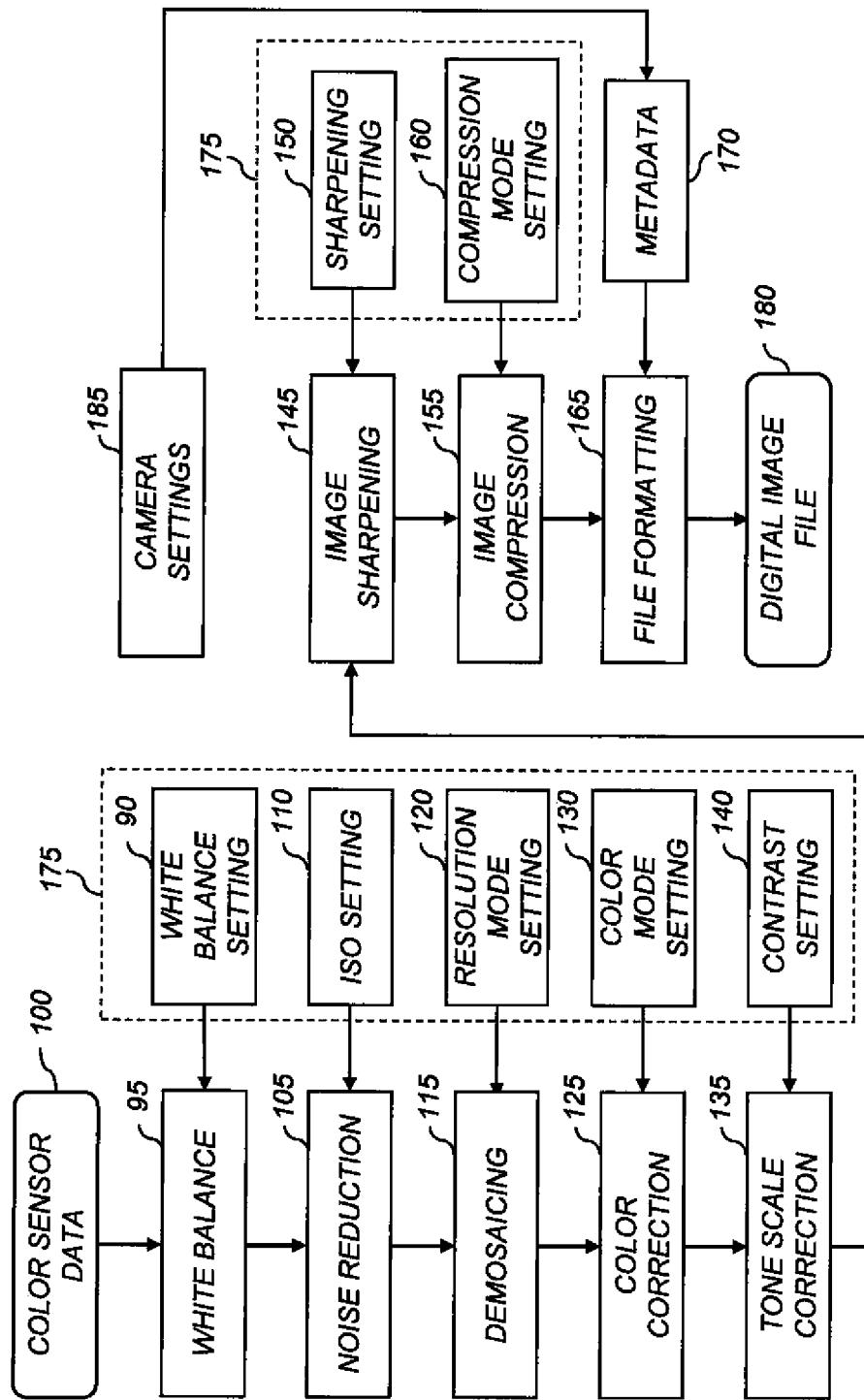
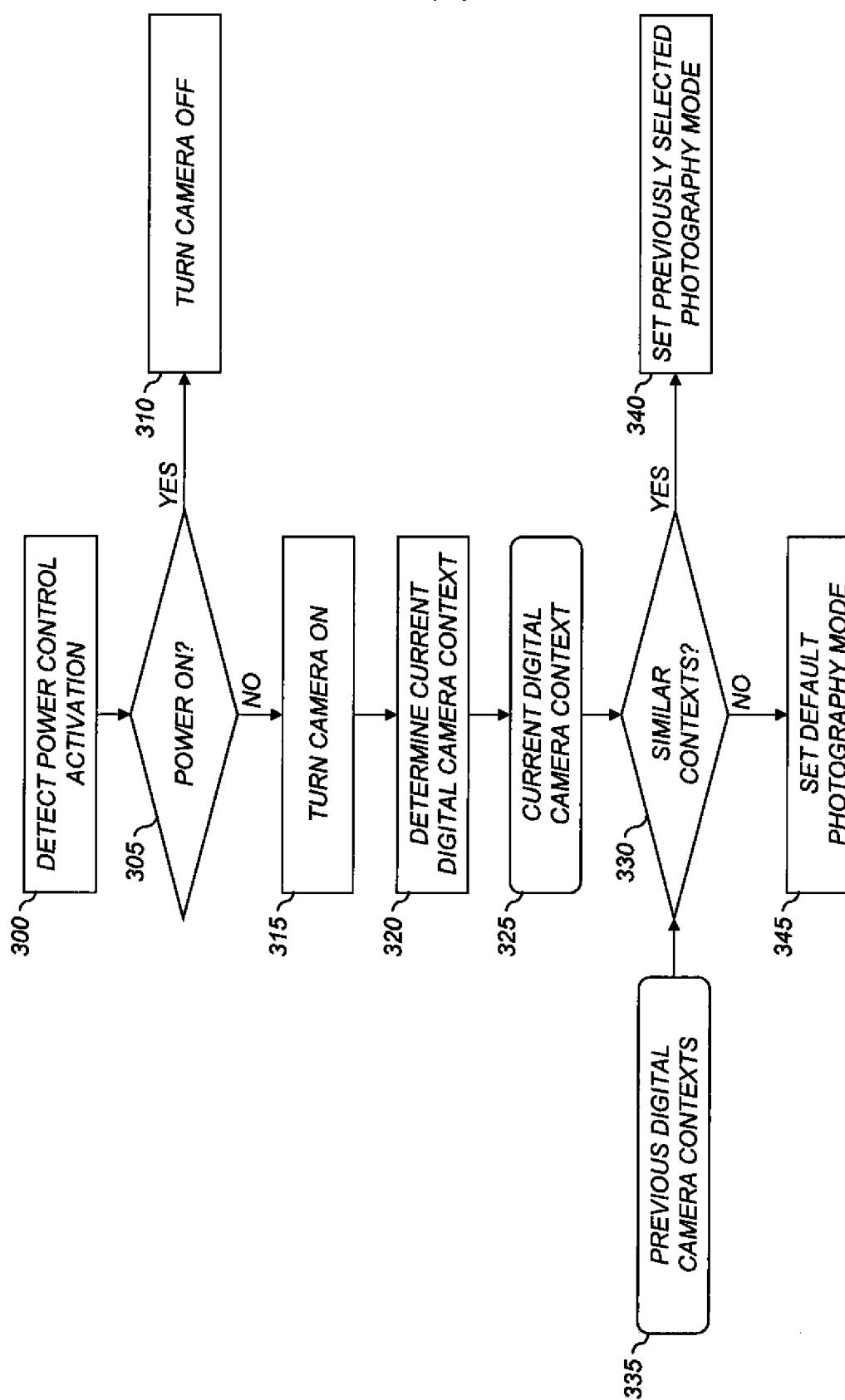
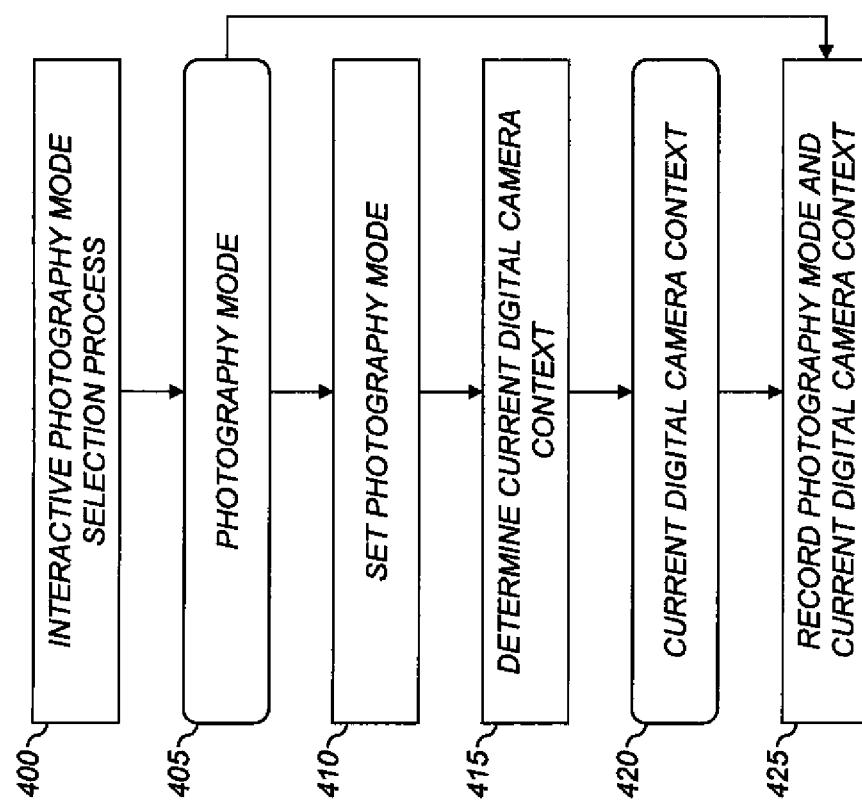


FIG. 2

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**FIG. 3**

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**FIG. 4**

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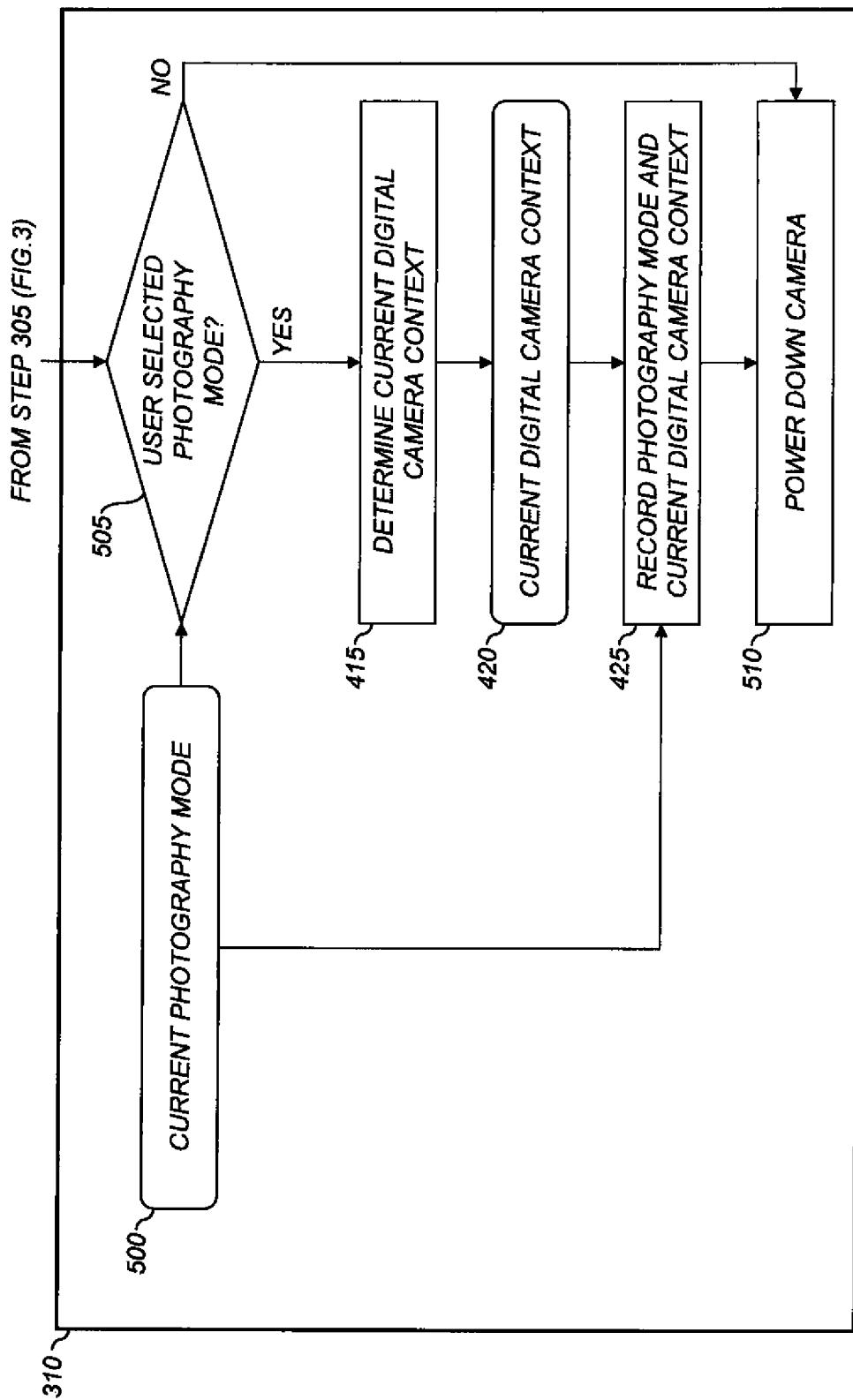


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/044462

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04N5/232

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 G06T G03B

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

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

EPO-Internal , INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7 646 297 B2 (AARON JEFFREY [US]) 12 January 2010 (2010-01-12) cited in the application the whole document -----	1-27
A	GB 2 403 365 A (HEWLETT PACKARD DEVELOPMENT co [US]) 29 December 2004 (2004-12-29) pages 3-6 -----	1-27
Y	JP 7 306436 A (ASAHI OPTICAL co LTD) 21 November 1995 (1995-11-21) abstract -----	1-27
A	JP 2001 211369 A (FUJI PHOTO FILM co LTD) 3 August 2001 (2001-08-03) abstract ----- -----	1-27
	- / -	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	us 2004/119877 AI (SHINOZAKI YOSHIHIKO [JP]) 24 June 2004 (2004-06-24) paragraph [0067] -----	1-27
A	us 2007/248330 AI (PI LLMAN BRUCE H [US] ET AL) 25 October 2007 (2007-10-25) cited in the application paragraphs [0009] , [0010] , [0087] , [0088] -----	1-27
A	EP 1 220 530 A2 (NOKIA CORP [FI]) 3 July 2002 (2002-07-03) the whole document -----	1-27
A	us 2009/297032 AI (LOUI ALEXANDER C [US] ET AL) 3 December 2009 (2009-12-03) -----	1-27
A	DAVID G LOWE: "Distinctive Image Features from Scale-Invariant Keypoints" , INTERNATIONAL JOURNAL OF COMPUTER VISION , KLUWER ACADEMIC PUBLISHERS, B0, vol . 60, no. 2 , 1 November 2004 (2004-11-01) , pages 91-110, XP019216426, ISSN : 1573-1405, DOI : 10.1023/B:VISI .0000029664. 99615. 94 the whole document -----	1-27
A	us 6 571 066 BI (TSAI WEN-YI [TW]) 27 May 2003 (2003-05-27) the whole document -----	1-27
A	us 2007/008321 AI (GALLAGHER ANDREW C [US] ET AL) 11 January 2007 (2007-01-11) the whole document -----	1-27

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2011/044462

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 7646297	B2	12-01-2010	US 2008143518	AI	19-06-2008	
			US 2010066546	AI	18-03-2010	
GB 2403365	A	29-12--2004	JP 2005051753	A	24-02-2005	
			US 2005012830	AI	20-01-2005	
JP 7306436	A	21-11--1995	NONE			
JP 2001211369	A	03-08--2001	JP 4277119	B2	10-06-2009	
US 2004119877	AI	24-06--2004	CN 1533667	A	29-09-2004	
			EP 1483903	AI	08-12-2004	
			WO 03077536	AI	18-09-2003	
			JP 4105957	B2	25-06-2008	
			JP 2003338984	A	28-11-2003	
			TW 595218	B	21-06-2004	
US 2007248330	AI	25-10--2007	US 2010171837	AI	08-07-2010	
			WO 2007126707	AI	08-11-2007	
EP 1220530	A2	03-07--2002	GB 2370709	A	03-07-2002	
			US 2002113757	AI	22-08-2002	
US 2009297032	AI	03-12--2009	EP 2289021	A2	02-03-2011	
			JP 2011525012	A	08-09-2011	
			WO 2009148518	A2	10-12-2009	
US 6571066	BI	27-05--2003	CN 1501158	A	02-06-2004	
US 2007008321	AI	11-01--2007	EP 1902392	A2	26-03-2008	
			EP 2161670	AI	10-03-2010	
			EP 2287755	AI	23-02-2011	
			JP 2009500982	A	08-01-2009	
			US 2010245625	AI	30-09-2010	
			US 2011099478	AI	28-04-2011	
			WO 2007008386	A2	18-01-2007	