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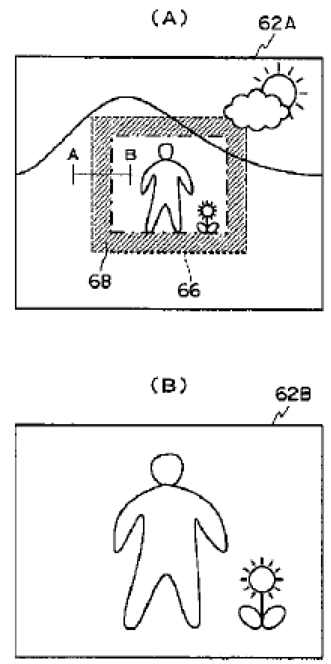
(54) [Title of the Invention] Digital Camera

(57) [Abstract]
[Problem] To provide a digital camera that can prevent unnatural boundary regions even when a telephoto captured image is combined in the center of a wide-angle captured image, and that can obtain images at various magnifications using a simple configuration.
[Solution] Provided is a digital camera having a wide-angle first imaging system and a telephoto second imaging system, which generates a scaled down image 66 that is scaled down to the same magnification as a captured image 62A taken using the first imaging system from a captured image 62B taken using the second imaging system, and this is synthesized with the captured image 62A taken using the first imaging system. At this time, correction data is generated to correct the image in the peripheral regions 68 on the basis of image data of the peripheral region 68 of the scaled down image 66 and image data of the peripheral region 68 of the captured image 62A, and the correction data is used as image data of the peripheral regions 68. The correction data is determined so that continuity of image data is maintained around the peripheral regions.



[Claims]
[Claim 1] A digital camera comprising:
a first imaging system including a first image sensor for imaging a subject and a first lens for forming an image of the subject on the first image sensor;
a second imaging system including a second image sensor for imaging the subject and a second lens with a focal length longer than the first lens for forming an image of the subject on the second image sensor;
a scale-down means for scaling down the second captured image taken with the second image sensor to an image with a shooting angle that is almost the same as that of the first captured image taken with the first image sensor; and
a synthesizing means for correcting the continuity of the image data in the peripheral regions based on the image data of a predetermined peripheral region of the image scaled down by the scale-down means and the image data corresponding to the peripheral region of the first captured image, and synthesizing the first captured image and the image scaled down by the scale-down means.
[Claim 2] The digital camera according to claim 1, wherein the synthesizing means comprises:
a correction data generating means for generating correction data to correct the continuity of the image data in the peripheral regions based on the image data of the predetermined peripheral region of the image scaled down by the scale-down means and the image data corresponding to the peripheral region of the first captured image; and
a replacement means for synthesizing the first captured image with the image scaled-down by the scale-down means while replacing the image data in the peripheral regions with the correction data.
[Claim 3] The digital camera according to claim 2 further comprising: a means for setting the shooting angle; and a scale-up means for scaling up the captured image of the subject taken with the first image sensor to an image at the shooting angle,
wherein the scale-down means scales down the captured image taken with the second image sensor to an image at the shooting angle,
the correction data generating means generates correction data for correcting the continuity of the image data in the peripheral regions based on the image data of the predetermined peripheral region of the scaled down image scaled down to an image at the shooting angle, and image data corresponding to the peripheral region of the scaled-up image scaled up to an image at the shooting angle, and
the replacing means synthesizes the scaled-up image and the scaled down image while replacing the image data in the peripheral regions with the correction data.
[Detailed Description of the Invention]
[0001]
[Technical Field of the Invention] The present invention relates to a digital camera and, more specifically, to a digital camera equipped with multiple imaging systems.
[0002]
[Prior Art] In recent years, digital cameras equipped with image sensors such as CCDs have become more widely available. In digital cameras, when an image is captured, an image of the subject is formed on the light-receiving surface of the CCD, and each sensor in the CCD performs a signal charge conversion corresponding to the amount of incident light. The signal charges accumulated by the CCD are retrieved pixel by pixel and converted into image data, which is then recorded on a memory card or other recording medium.
[0003] Digital cameras with multiple image sensors have also been proposed. For example, a technique has been disclosed in JP 2001-103466 A that improves the image quality in the center of an image by synthesizing a telephoto image with a wide-angle image.
[0004]
[Problem to Be Solved by the Invention] However, the conventional technology experiences a problem in which the boundary between an image taken with a wide-angle lens and an image taken with a telephoto lens is unnatural, causing a deterioration in image quality.
[0005] In addition, in order to obtain images at various imaging magnifications, use of a high-magnification zoom lens or an electronic zoom function that can realize an imaging magnification not covered by the optical zoom using digital processing to scale up the captured image is required.
[0006] When using a high-power zoom lens, a problem occurs in that space for an actuator, etc., becomes necessary, and the control system becomes more complex. When an electronic zoom function is used, a problem occurs in that the image quality deteriorates if excessive electronic zooming is used.
[0007] It is an object of the present invention to solve these problems by providing a digital camera that can prevent unnatural boundary regions even when a telephoto captured image is combined in the center of a wide-angle captured image, and that can obtain images at various magnifications using a simple configuration.

[0008]
[Means for Solving the Problem] In order to achieve this object, the invention according to claim 1 is a digital camera comprising a first imaging system including a first image sensor for imaging a subject and a first lens for forming an image of the subject on the first image sensor, a second imaging system including a second image sensor for imaging the subject and a second lens with a focal length longer than the first lens for forming an image of the subject on the second image sensor, a scale-down means for scaling down the second captured image taken with the second image sensor to an image with a shooting angle that is almost the same as that of the first captured image taken with the first image sensor, and a synthesizing means for correcting the continuity of the image data in the peripheral regions based on the image data of a predetermined peripheral region of the image scaled down by the scale-down means and the image data corresponding to the peripheral region of the first captured image, and synthesizing the first captured image and the image scaled down by the scale-down means.

[0009] The present invention has two imaging systems, and each imaging system has an image sensor and a lens for forming an image of the subject on the image sensor. For example, the second lens can be a telephoto lens with a focal length that is longer than that of the first lens, and the first lens can be a wide-angle lens. In other words, the two imaging systems can be used to obtain images with shooting angles. In addition, the first image sensor and the second image sensor are composed of, for example, CCDs with approximately the same number of pixels.

[0010] The scale-down means scales down the second captured image taken with the second image sensor to an image with a shooting angle that is almost the same as that of the first captured image taken with the first image sensor. In other words, an image corresponding to the center of the first image is generated from the second image.

[0011] The synthesizing means synthesizes the first captured image with the image that has been scaled down using the scale-down means. At this time, an image that has been scaled down using the scale-down means is generated from an image taken with the telephoto second imaging system, so the amount of information is greater than the amount of information in the central portion of the first captured image. This enables the image quality in the center of the image to be improved.

[0012] In addition, there is a risk that the boundary between the first image and the image that has been scaled down using the scaling means will be discontinuous, resulting in a deterioration in image quality. Therefore, the synthesizing means corrects the continuity of the image data in the peripheral regions based on the image data of a predetermined peripheral region of the image scaled down by the scale-down means and the image data corresponding to the peripheral region of the first captured image during synthesis. This keeps the images from looking unnatural at the boundary.

[0013] As stated in claim 2, the digital camera may be configured so that the synthesizing means comprises a correction data generating means for generating correction data to correct the continuity of the image data in the peripheral regions based on the image data of the predetermined peripheral region of the image scaled down by the scale-down means and the image data corresponding to the peripheral region of the first captured image, and a replacement means for synthesizing the first captured image with the image scaled-down by the scale-down means while replacing the image data in the peripheral regions with the correction data.

[0014] As stated in claim 3, the digital camera may be configured to further comprise a means for setting the shooting angle, and a scale-up means for scaling up the captured image of the subject taken with the first image sensor to an image at the shooting angle, in which the scale-down means scales down the captured image taken with the second image sensor to an image at the shooting angle, the correction data generating means generates correction data for correcting the continuity of the image data in the peripheral regions based on the image data of the predetermined peripheral region of the scaled down image scaled down to an image at the shooting angle, and image data corresponding to the peripheral region of the scaled-up image scaled up to an image at the shooting angle, and the replacing means synthesizes the scaled-up image and the scaled down image while replacing the image data in the peripheral regions with the correction data. This enables images to be obtained at any shooting angle set using the setting means.

[0015] At least one of the first lens and the second lens may be a zoom lens. This provides an effect equivalent to a high-power zoom.

[0016]
[Embodiments of the Invention]
(First Embodiment) The following is a detailed description of an example of the first

embodiment of the present invention with reference to the drawings.

[0017] FIG. 1 is a block diagram showing the configuration of a digital camera. This digital camera 10 has two independent imaging systems (a first imaging system 12A and a second imaging system 12B), and subject images are formed on the light-receiving surfaces of CCD 18A and 18B via imaging optics 14A and 14B, respectively.

[0018] The first imaging system 12A is used to capture images, and the second imaging system 12B is used for autofocus (AF) control.

[0019] Imaging optics 14A are composed of a first lens group 19A with an imaging lens 15A and a focus lens 16A, and an aperture 17A. Similarly, imaging optics 14B are composed of a second lens group 19B with an imaging lens 15B and a focus lens 16B, and an aperture 17B.

[0020] Lens group 19A is a wide-angle single focal length lens whose shooting angle α is wider than the shooting angle β of lens group 19B, for example, as shown in FIG. 2 (A) and (B). (In other words, its focal length is shorter.) Lens group 19B is a telephoto single focal length lens whose shooting angle β is narrower than the shooting angle α of lens group 19A. (In other words, its focal length is longer.) The lens groups 19A and 19B may be composed of zoom lenses (variable focal length lenses). Either of lens groups 19A and 19B may be composed of a single focal length lens.

[0021] In addition, CCD 18A and CCD 18B can be, for example, CCDs of the same size, that is, the same number of pixels. Therefore, when the image captured with the first imaging system 12A is the captured image 62A shown in FIG. 3 (A), the image captured by the second imaging system 12B is the scaled-up captured image 62B at the center of FIG. 3 (A), as shown in FIG. 3 (B).

[0022] Note that CCD 18A corresponds to the first image sensor in the present invention, CCD 18B corresponds to the second image sensor in the present invention, the first lens group 19A corresponds to the first lens in the present invention, and the second lens group 19B corresponds to the second lens in the present invention.

[0023] The subject images formed on the light-receiving surfaces of CCD 18A and CCD 18B via their respective imaging optics 14A and 14B are subjected to signal charge conversion by each sensor in the CCD that corresponds to the amount of incident light. The accumulated signal charges are retrieved by CCD drive pulses applied by CCD drive circuits 20A and 20B, and are sequentially output from CCD 18A and CCD 18B as voltage signals (analog image signals) corresponding to each signal charge.

[0024] CCD 18A and CCD 18B each have a shutter drain via a shutter gate, and the accumulated signal charges can be swept to the shutter drain by driving the shutter gates with shutter gate pulses. In other words, the CCDs 18 have a so-called electronic shutter function that controls the accumulation time (shutter speed) of the charge accumulated by each sensor via shutter gate pulses.

[0025] The signals retrieved from CCD 18A and CCD 18B are processed by correlated double sampling (CDS) in CDS circuits 22A and 22B, and by color separation into R, G, and B color signals, and the signal level of each color signal is adjusted (for example, by prewhite balance processing).

[0026] Image signals that have undergone the prescribed analog signal processing are applied to A/D converters 24A and 24B, converted to R, G, and B digital signals by A/D converters 24A and 24B, and then stored in memories 26A and 26B. The memories 26A and 26B may be a single memory, or a separate memory for each imaging system. Data other than image data is also stored in memories 26A and 26B.

[0027] A timing signal generating circuit (TG) 28 provides appropriate timing signals to the CCD drive circuits 20A and 20B, the CDS circuits 22A and 22B, and the A/D converters 24A and 24B in response to commands from the CPU 30, and each circuit is driven synchronously by timing signals applied from the timing signal generating circuit 28.

[0028] The CPU 30 is the control unit that performs overall control of each circuit in the digital camera 10, and is connected via a bus 32 to, for example, a gain adjustment circuit 34, a gamma correction circuit 36, a luminance and color difference signal processing circuit (known as a YC processing circuit) 38, a compression and decompression circuit 40, a card interface 44 for a memory card 42, and a display driver 48 for driving a display unit 46.

[0029] The CPU 30 controls the corresponding circuit blocks based on signals inputted from a control panel 50, controls the zooming operations of the imaging lenses 15A and 15B and the autofocusing (AF) operations of the focus lenses 16A and 16B, and performs automatic exposure adjustments (AE).

[0030] The control panel 50 includes a release button used to give an instruction to start recording images, a means for selecting the camera mode, a zoom control, and other input means. These input methods can take a variety of forms, such as switch buttons, dials, and sliding knobs, or they can take the form of items in a settings menu selected on a touch panel or using a cursor on a LCD monitor display screen. The control panel 50 may be located on the camera body, or it can be separated from the camera body in the form of a remote control transmitter.

[0031] CPU 30 performs various calculations such as focus evaluation calculations and AE calculations based on the image signals outputted from CCD 18A and CCD 18B, and the driving circuits 52A and 52B of the imaging lenses 15A and 15B, the focus lenses 16A and 16B, and the apertures 17A and 17B are controlled based on these calculations. In other words, when the lens groups 19A and 19B are composed of zoom lenses, the motors 54A and 54B are driven to zoom the imaging lenses 15A and 15B and change the imaging magnification. These motors 54A and 54B can be omitted when a manual zooming configuration or a single focal length lens is used.

[0032] The motors 56A and 56B are driven to move the focus lenses 16A and 16B to the focus position and set the apertures 17A and 17B to the appropriate aperture values. The motors 56A and 56B are stepping motors, and the focus lens position is controlled by controlling the number of steps. The motors 56A and 56B are not limited to stepping motors, and can be, for example, DC motors. Stepping motors and DC motors, etc. can also be used for motors 54A and 54B.

[0033] A contrast AF system is used for AF control in which the focus lenses 16A and 16B are moved so that the high-frequency component of G signals is maximized. In other words, the motors 56A and 56B are driven via the drive circuits 52A and 52B to move the focus lenses 16A and 16B and position them where the contrast value is at the maximum value.

[0034] For AE control, the subject luminance (imaging EV value) is determined based on integration of the R, G, and B signals in a single frame by the integration circuits 60A and 60B, and the aperture value and shutter speed are determined based on this imaging EV value. The apertures 17A and 17B are driven via the drive circuits 52A and 52B, and the CCD 18A and CCD 18B charge accumulation time is controlled using an electronic shutter to reach the determined shutter speed. As a result, optimal exposure adjustment and focusing are performed simply by pointing the imaging lenses 15A and 15B of the digital camera 10 at the subject.

[0035] During imaging and recording, the AF operation is performed when the release button is "half-pressed," and the metering operation is repeated several times to obtain the exact imaging EV. The final aperture value and shutter speed for imaging is then determined based on the imaging EV. The apertures 17A and 17B are then driven to the final aperture value when the release button is "fully press", and the charge accumulation time is controlled by the electronic shutters at the determined shutter speed. Instead of AE control based on image signals acquired from CCD 18A and CCD 18B, other well-known photometric sensors may be used.

[0036] The digital camera 10 also has a strobe light emitting device 55 and a light-receiving element 57 for light adjustment. A mode is selected in response to operation of the strobe mode setting button on the control panel 50, such as a "low-luminance auto-flash mode" which automatically triggers the strobe light emitting device 55 in low-luminance situations, a "forced-flash mode" which triggers the strobe light emitting device 55 regardless of subject brightness, or a "flash prohibited mode" that prohibits the strobe light emitting device 55 from emitting light.

[0037] The CPU 30 controls the charging of the main capacitor of the strobe light emitting device 55 and the timing of discharge (light emission) to the light emitting tube (such as a xenon tube) based on the strobe mode selected by the user, and stops light emission based on the measurement results from the light-receiving element 57. The light-receiving element 57 receives reflected light from the subject illuminated by the strobe and converts it into electrical signals corresponding to the amount of light received. Signals from the light-receiving element 57 are integrated by an integrating circuit not shown in the figure, and when the integrated level of received light reaches the predetermined appropriate level of received light, the strobe light emitting device 55 stops emitting light.

[0038] Data outputted by the A/D converters 24A and 24B is stored in the memories 26A and 26B and applied to the integration circuits 60A and 60B. The integration circuits 60A and 60B divide the imaging screen into multiple blocks (for example, 64 blocks in an 8 × 8 format) and perform integration operations on the G signals received from each block. A luminance signal (Y signal) may be generated from R, G, and B data to perform the luminance signal integration operation. The integration circuits 60A and 60B can also be used in conjunction with the AF calculation circuit and the AE calculation circuit. The information (calculation results) on the integrated values obtained by the integration circuits 60A and 60B are inputted to the CPU 60.

[0039] The CPU 30 calculates the evaluation value E for the imaging screen based on

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