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[Continued on next page]

(54) Title: CONTINUOUS AUTOFOCUS BASED ON FACE DETECTION AND TRACKING

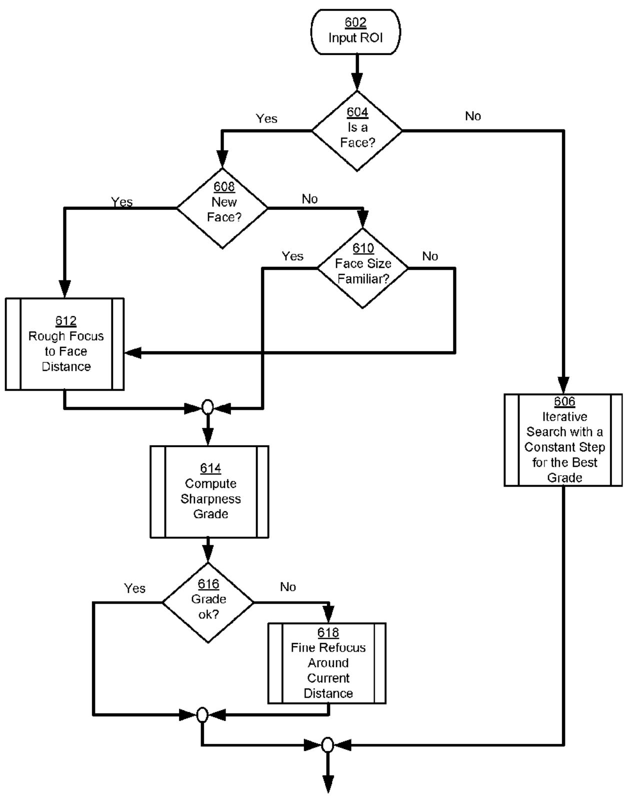

Figure 6

(57) Abstract: An autofocus method includes acquiring an image of a scene that includes one or more out of focus faces and/or partial faces. The method includes detecting one or more of the out of focus faces and/or partial faces within the digital image by applying one or more sets of classifiers trained on faces that are out of focus. One or more sizes of the one of more respective out of focus faces and/or partial faces is/are determined within the digital image. One or more respective depths is/are determined to the one or more out of focus faces and/or partial faces based on the one or more sizes of the one of more faces and/or partial faces within the digital image. One or more respective focus positions of the lens is/are adjusted to focus approximately at the determined one or more respective depths.

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CONTINUOUS AUTOFOCUS BASED ON FACE DETECTION AND TRACKING

BACKGROUND

Digital cameras today often include an auto focus mechanism. Two kinds of conventional auto focus mechanisms are contrast detect auto focus and phase detect auto focus.

CONTRAST DETECT AUTO FOCUS

With contrast detect auto focus, the camera lens is initially positioned at a closest focus point. The lens is incrementally shifted and image sharpness is evaluated at each step. When a peak in sharpness is reached, the lens shifting is stopped. Contrast detect auto focus is used in conventional digital stills cameras or DSCs, camcorders camera phones, webcams, and surveillance cameras. They are very precise, based on pixel level measurements and fine scanning. They can focus anywhere inside a frame, but they typically only focus around the center of the frame. However, contrast detect auto focus mechanisms are slow, because they involve scanning a focus range. Also, they do not allow tracking of an acquired subject. Further scanning is involved to determine whether the subject has moved to front or back focus, known as focus hunting. Contrast detect auto focus mechanisms are typically inexpensive and rugged.

PHASE DETECT AUTO FOCUS

Phase detect auto focus generally involves special optoelectronics including a secondary mirror, separator lenses and a focus sensor. The separator lenses direct light coming from opposite sides of the lens towards the auto focus sensor. A phase difference between the two images is measured. The lens is shifted to the distance that corresponds to the phase difference. Phase detect auto focus is used in conventional single lens reflex cameras or SLRs. These are generally less precise than contrast detect autofocus mechanisms, because the phase difference cannot always be assessed very accurately. They can only acquire focus in fixed points inside a frame, and these are typically indicated manually by a camera user. They are typically fast, as relative positions of the subject can be detected by single measurements. They allow tracking, as it can determine whether the subject has moved to front or back focus, but only by hopping from one focus point to another. Phase detect auto focus mechanisms are typically expensive and fragile. Figure 1 illustrates how a phase detect auto focus mechanism works, i.e., when the phase difference is zero as in the middle graphic, then the subject is understood to be in focus.

It is desired to have an improved auto focus mechanism that does not have the significant drawbacks of either of the contrast detect and phase detect auto focus mechanisms. United States published patent application no. 2010/0208091 describes a camera that detects a face in an image captured by the camera, and calculates the size of the face. It selects from amongst a number of previously stored face sizes, one that is closest to the calculated face size. It retrieves a previously stored lens focus position that is associated with the selected, previously stored face size. It signals a moveable lens system of the digital camera to move to a final focus position given by the retrieved, previously stored lens focus position. A problem with the technique described in the US 2010/0208091 is that it will have a significantly high rate of non-detection of faces due to their blurry, out of focus state. Unless a further enhancement is provided, this will result in an unsatisfactorily slow image capture process.

SUMMARY

An autofocus method is provided for a digital image acquisition device based on face detection. The method involves use of a lens, image sensor and processor of the device. A digital image is acquired of a scene that includes one or more out of focus faces and/or partial faces. The method includes detecting one or more of the out of focus faces and/or partial faces within the digital image by applying one or more sets of classifiers trained on faces that are out of focus. One or more sizes of the one of more respective out of focus faces and/or partial faces is/are determined within the digital image. One or more respective depths is/are determined to the one or more out of focus faces and/or partial faces based on the one or more sizes of the one of more faces and/or partial faces within the digital image. One or more respective focus positions of the lens is/are adjusted to focus approximately at the determined one or more respective depths. One or more further images is/are acquired of scenes that include at least one of the one or more faces and/or partial faces with the lens focused at the one or more respectively adjusted focus positions.

Upon adjusting the one or more respective focus positions, the method may further include performing a fine scan, and fine adjusting the one or more respective focus positions based on the fine scan. The scene may include at least one out of focus face and/or partial face not detected by applying the one or more sets of face classifiers, and wherein the method further comprises applying a contrast detect scan or a phase detect scan or both for acquiring said at least one out of focus face or partial face or both not detected by applying said one or more sets of classifiers trained on faces that are out of focus.

The one or more partial faces may include an eye region.

The method may include adjusting at least one of the one or more respective focus positions when at least one of the one or more faces and/or partial faces changes size at least a threshold amount. The method may also include tracking the at least one of the faces and/or partial faces, and determining the change in size of the at least one of the one or more faces and/or partial faces based on the tracking.

The method may further include increasing depth of field by stopping down the aperture of the digital image acquisition device.

The one or more faces and/or partial faces may include multiple faces and/or partial faces located respectively at multiple different depths approximately determined based on their different determined sizes.

The determining of the one or more depths may include assigning at least one average depth corresponding to at least one of the one or more determined sizes.

The determining of the one or more depths may include recognizing a detected face or partial face or both as belonging to a specific individual, calling a known face or partial face spatial parameter from a memory that corresponds to the specific face or partial face or both, and determining a depth corresponding to a determined size and the known face or partial face spatial parameter.

The adjusting of the one or more respective focus positions may utilize a MEMS (microelectromechanical system) component.

One or more processor readable media are also provided that have code embodied therein for programming a processor to perform any of the methods described herein.

A digital image acquisition device is also provided including a lens, an image sensor, a processor and a memory that has code embedded therein for programming the processor to perform any of the methods described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a conventional phase detect auto focus mechanism.

Figure 2a is a plot of sharpness versus focus position of a lens in a digital image acquisition device in accordance with certain embodiments.

Figure 2b illustrates a digital image including a face that is out of focus and yet still has a face detection box around a detected face region.

Figures 3a-3b illustrate a first example of digital images including sharp and out of focus faces, respectively, that are each detected in accordance with certain embodiments.

Figures 4a-4b illustrate a second example of digital images including sharp and out of focus faces, respectively, that are each detected in accordance with certain embodiments.

Figure 5 illustrates a digital image including a sharp face and an out of focus face.

Figure 6 is a flow chart illustrating a method in accordance with certain embodiments.

Figure 7 illustrates a calculation of focus distance based on face size.

Figures 8a-8d illustrate digital images including relatively sharp faces 8a and 8c and relatively out of focus faces 8b and 8d.

Figure 9 illustrates a digital camera image pipeline in accordance with certain embodiments.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Normal contrast detect autofocus is slow and hunts when a subject moves out of focus. Falling back to contrast detect auto focus, when a blurry face is not detected, could too often slow the process provided by US 2010/0208091. A method that uses face detection to speed up focusing and reduce focus hunting in continuous autofocus is provided. Highly reliable face detection is first of all provided even when the face is not in focus by providing one or more sets of trained classifiers for out of focus faces and/or partial faces. For example, three sets of face classifiers may be provided: one trained to sharp faces, another trained to somewhat blurry faces, and a third trained to faces that are even more blurry and out of focus. A different number of classifier sets may be trained and used. This advantageous technique will have far fewer non-detection events than the technique of US 2010/0208091, leading to a faster and more reliable image capture process. Face detection particularly by training face classifiers that may or may not be evenly illuminated, front facing and sharply-focused have been widely researched and developed by the assignee of the present application, e.g., as described at U.S. patents nos. 7,362,368, 7,616,233, 7,315,630, 7,269,292, 7,471,846, 7,574,016, 7,440,593, 7,317,815, 7,551,755, 7,558,408, 7,587,068, 7,555,148, 7,564,994, 7,565,030, 7,715,597, 7,606,417, 7,692,696, 7,680,342, 7,792,335, 7,551,754, 7,315,631, 7,469,071, 7,403,643, 7,460,695, 7,630,527, 7,469,055, 7,460,694, 7,515,740, 7,466,866, 7,693,311, 7,702,136, 7,620,218, 7,634,109, 7,684,630, 7,796,816 and 7,796,822, and U.S. published patent applications nos. US 2006-0204034, US 2007-0201725, US 2007-0110305, US 2009-0273685, US 2008-0175481, US 2007-0160307, US 2008-0292193, US 2007-0269108, US 2008-0013798, US 2008-0013799, US 2009-0080713, US 2009-0196466, US 2008-0143854, US 2008-0220750, US 2008-0219517, US 2008-0205712, US 2009-0185753, US 2008-0266419, US 2009-0263022, US 2009-0244296, US 2009-0003708, US 2008-0316328, US 2008-0267461, US 2010-0054549, US 2010-0054533, US 2009-0179998, US 2009-0052750, US 2009-0052749, US 2009-0087042, US 2009-0040342, US 2009-0002514, US 2009-0003661, US 2009-0208056, US 2009-0190803, US 2009-0245693, US 2009-0303342, US 2009-0238419, US 2009-0238410, US 2010-0014721, US 2010-0066822, US 2010-0039525, US 2010-0165150, US 2010-0060727, US 2010-0141787, US 2010-0141786, US 2010-0220899, US 2010-0092039, US 2010-0188530, US 2010-0188525, US 2010-0182458, US 2010-0165140 and US 2010-0202707.

After detection of an out of focus face and/or partial face, the technique involves relying on face size to determine at which distance the subject is located. That is, when the focus position of lens is not disposed to provide an optimally sharp image at the value of the sharpness peak illustrated at Figure 2a, then the subject face will be out of focus such as illustrated at Figure 2b. With the advantageous classifiers trained to detect out of focus faces as provided herein, the blurry face illustrated at Figure 2b is nonetheless detected as illustrated by the rectangle framing the subject's face. Face detection knows if a subject has moved towards or away from focus by analyzing the change in face size (larger=front, smaller=back). This allows face detection to track a face as it moves closer/further from the camera.

Figures 3a-3b illustrate a first example of digital images including sharp and out of focus faces, respectively, that are each detected in accordance with certain embodiments. In Figure 3a, the distance to the subject is one meter and the distance to the focal plane is one meter, so the face is sharp and the focusing element does not need to be moved. In Figure 3b, the distance to the subject is one meter, but the distance to the focal plane is 0.2 meters, so the face is blurry although advantageously still detected by using classifiers trained to detect blurry faces (as indicated by the rectangle framing the subject's face). The focusing element would be moved in accordance with these embodiments upon detection of the blurry face of Figure 3b to focus at one meter instead of 0.2 meters due to estimating the distance to the face as being one meter based on the size of the detected face.

Figures 4a-4b illustrate a second example of digital images including sharp and out of focus faces, respectively, that are each detected in accordance with certain embodiments. In Figure 4a, the distance to the subject is 0.5 meters and the distance to the focal plane is 0.5 meters, so the face is sharp and the focusing element does not need to be moved. In Figure 4b, the distance to the subject is 0.5 meters, but the distance to the focal plane is 0.25 meters, so the face is blurry although advantageously still detected by using classifiers trained to detect blurry faces. Note that the focus is not as far off as in Figure 3b, and so a different set of classifiers may be used trained to detect less blurry faces than those used to detect the face of Figure 3b. The focusing element would be moved in accordance with these embodiments upon detection of the blurry face of Figure 4b to focus at 0.5 meters instead of 0.25 meters due to estimating the distance to the face as being 0.5 meters based on the size of the detected face.

Once the distance to the subject is determined by computation or estimation in accordance with a look up table based for example on the formula provided at Figure 7, the focusing element of the camera may be moved directly to a position that will cause it to focus on the corresponding distance without having to scan the entire focus range. Furthermore, in continuous mode, it can be determined whether the subject has moved in the direction of front or back focus by measuring the change in face size. This enables the movement of the focus element in the right direction, thus reducing focus hunt. The process can be sped up still further by utilizing MEMs technology, e.g., as set forth at any of US patents 7,769,281, 7,747,155, 7,729,603, 7,729,601, 7,702,226, 7,697,834, 7,697,831, 7,697,829, 7,693,408, 7,663,817, 7,663,289, 7,660,056, 7,646,969, 7,640,803, 7,583,006, 7,565,070, 7,560,679, 7,555,210, 7,545,591, 7,515,362, 7,495,852, 7,477,842, 7,477,400, 7,403,344, 7,359,131, 7,359,130, 7,345,827, 7,266,272, 7,113,688 and/or 6,934,087. This idea can be generalized to any object that can be identified and tracked, even if its size is not known in advance.

As mentioned, a highly advantageous feature is provided whereby the face detection process is reliably performed on faces even when they are out of focus. This enables advantageous auto focus techniques in accordance with embodiments described herein to detect faces before actually starting to focus on them. Once a blurry, out of focus face is detected, a rough distance may be calculated to the subject. This is possible, as human faces do not vary in size considerably. Further precision may be provided by using face recognition, whereby a specific person's face is recognized by comparison with other face data of the person stored in a database or by manual user indication or because one or more pictures have been recently taken of the same person or combinations of these and other face recognition techniques. Then, the specifically known face size of that person can be used.

The distance to subject may be calculated by also taking into account the focal length of the lens (and sensor size if this is not 35mm equivalent). When the distance to subject is known, the focusing element may be directly moved to the corresponding position without any additional scanning. Then only a fine contrast-detect scan is optionally performed around that distance. The contrast is measured onto the face area or on the eye region of the face if the face is too large and/or only partially detected. This is advantageous to reduce the computational effort for calculating contrast. In video mode, the same may be performed every time focus is to be achieved on a new face. Once focus is achieved on a certain face, the variation in face size is monitored in accordance with certain embodiments. If the changes are not significant, the algorithm measures the contrast onto the face rectangle (or eye area or other partial face region) and if this does not drop below a certain value, the focus position is not adjusted. Conversely, if the contrast drops but the face size does not change, a fine refocusing may be done around the current focus distance. If the face size is found to change more than a certain margin, the new size is compared against the old size to determine whether the subject has moved in front or back focus. Based on this, the focusing element is moved towards the appropriate direction (back or forth), until focus is reacquired. Advantageously, focus tracking is provided without hunting. For example, if the face size has increased, it can be determined that the subject has moved in front focus, so the focusing element is moved so that it focuses closer.

This method can be generalized to any object of known size, as previously mentioned. For example face detection can be changed for pet detection. Furthermore, the method may be generalized to objects of unknown size. Once focus is acquired on a certain object using the normal contrast-detect and/or phase-detect algorithm, that object can be tracked and monitored with regard to its variations in size. The method involves determining whether the object has become larger or smaller and by how much, and continuous focusing is provided without hunting even on objects of unknown size.

When a scene includes multiple faces as illustrated at Figure 5, the multiple faces in the frame may be detected. The distances that correspond to the sizes of each of these faces are then calculated. The distances are sorted and stored for the multiple faces. A divide-et-impera style search may be performed across the focus distances. At each step, the COC diameter may be calculated for each of the distances given the lens aperture, focal length and focus distance. In one embodiment, a measure of global sharpness may be measured across the multiple faces given these diameters. The outcome of these searches will be a focus distance that would theoretically maximize sharpness across all faces in the photo. The lens will be focused directly at that distance and, if required, a fine scan sequence can be done to ensure even more precision. This technique could even be put in conjunction with an auto-exposure technique so that if not enough depth of focus or DOF is available, the auto focus or AF algorithm can decide to stop down the aperture in order to increase DOF. Many other options are available, e.g., a composite image of sharp faces may be provided by rapid capture of multiple images: one image captured at each of the calculated focus positions, or a user may select when face to focus on, or the largest face may be focused on, among other possibilities. Weighting of faces is discussed in the earlier applications cited above.

Figure 6 is a flow diagram illustrating a method in accordance with certain embodiments. A region of interest or ROI is input at 602. It is determined at 604 whether the ROI is a face. If not, then at 606 an iterative search with a constant step is performed for the best grade. If a face is detected, then it is determined at 608 whether it is a new face. If not, then at 610 it is determined whether the face size is the same or close to the face size previously determined. If it is, then no focus adjustment is needed, but if the size of the previously detected face is determined to have changed size, then rough focus to face distance is performed at 612. If the detected face is determined to be a new face at 608, then the rough focus to face distance is performed at 612. A sharpness grade may be computed at 614. If the grade computed at 614 is determined to be OK at 616, then the process ends, but if the grade is not OK, then a fine refocus around the current distance is performed at 618.

Figure 7 illustrates the computation of the distance to the subject. The distance to subject is proportional to the image resolution in pixels and to the 35 mm equivalent focal length in this embodiment, and inversely proportional to the size in pixels of the detected face. There is also a multiplier of 150/36. Figures 8a-8d simply show examples of different distances of faces and focus depths, with the first line of the table at left in each showing the computed or estimated distance to object/subject based on the calculation illustrated at Figure 7.

A digital camera image pipeline is illustrated at Figure 9. Acceleration by hardware implementation may be used to obtain still faster face detection.

The technique in accordance with embodiment described herein scores high in many categories. For example, it is fast, requires very low power and produces very low motor wear. In video mode, it knows whether the subject has moved in front or back focus, so it does not need to hunt. This feature can enable continuous autofocus in movie mode for DSCs and camera phones, which is something that is not available in current technologies. Furthermore, the technique does not require any additional hardware so it is cheap to implement, and it is rugged (passes any drop test) and does all this without compromising the quality of the focus in any way. It is also highly accurate. Multi-face autofocus is also provided which enables the camera to focus on multiple faces, located at various depths. With multi-face AF in accordance with embodiments described herein, this can be done by assessing the sizes of the faces, calculating the distance to each of the faces and then deciding on a virtual focus distance that maximizes sharpness across all these faces or otherwise as described above. Moreover, the focus will then be achieved almost instantly, without having to scan the focus range or measure sharpness on multiple areas in the image, i.e., this can otherwise be very slow if together they cover a large area of the frame.

In methods that may be performed according to preferred embodiments herein and that may have been described above, the operations have been described in selected typographical sequences. However, the sequences have been selected and so ordered for typographical convenience and are not intended to imply any particular order for performing the operations, except for those where a particular order may be expressly set forth or where those of ordinary skill in the art may deem a particular order to be necessary.

Claims:

1. An autofocus method for a digital image acquisition device based on face detection, comprising:

using a lens, image sensor and processor of a digital image acquisition device;

acquiring a digital image of a scene that includes one or more out of focus faces or partial faces or both;

detecting the one or more out of focus faces or partial faces or both within the digital image by applying one or more sets of classifiers trained on faces that are out of focus;

determining one or more sizes of the one of more respective out of focus faces or partial faces or both within the digital image;

determining one or more respective depths to the one or more out of focus faces or partial faces or both based on the one or more sizes of the one of more faces or partial faces or both within the digital image;

adjusting one or more respective focus positions of the lens to focus approximately at the determined one or more respective depths; and

acquiring one or more further images of scenes that include at least one of the one or more faces or partial faces or both with the lens focused at the one or more respectively adjusted focus positions.

2. The method of claim 1, further comprising, upon adjusting the one or more respective focus positions, performing a fine scan, and fine adjusting the one or more respective focus positions based on the fine scan.

3. The method of claim 2, wherein the scene comprises at least one out of focus face or partial face or both not detected by applying said one or more sets of face classifiers, and wherein the method further comprises applying a contrast detect scan or a phase detect scan or both for acquiring said at least one out of focus face or partial face or both not detected by applying said one or more sets of face classifiers.

4. The method of claim 1, wherein at least one of the one or more partial faces comprises an eye region.

5. The method of claim 1, further comprising adjusting at least one of the one or more respective focus positions when at least one of the one or more faces or partial faces or both changes size at least a threshold amount.

6. The method of claim 5, further comprising tracking the at least one of the faces or partial faces or both, and determining the change in size of the at least one of the one or more faces or partial faces or both based on the tracking.

7. The method of claim 1, further comprising increasing depth of field by stopping down the aperture of the digital image acquisition device.

8. The method of claim 1, wherein the one or more faces or partial faces or both comprise multiple faces or partial faces or both located respectively at multiple different depths approximately determined based on their different determined sizes.

9. The method of claim 1, wherein the determining of the one or more depths comprises assigning at least one average depth corresponding to at least one of the one or more determined sizes.

10. The method of claim 1, wherein the determining of the one or more depths comprises recognizing a detected face or partial face or both as belonging to a specific individual, calling a known face or partial face spatial parameter from a memory that corresponds to the specific face or partial face or both, and determining a depth corresponding to a determined size and the known face or partial face spatial parameter.

11. The method of claim 1, wherein the adjusting one or more respective focus positions comprises utilizing a MEMS (micro-electro mechanical system) component.

12. One or more processor readable media having code embodied therein for programming a device having a processor, that uses a lens and image sensor to acquire a digital image of a scene that includes one or more out of focus faces or partial faces or both, to perform any of the above methods.

13. A digital image acquisition device including a lens, an image sensor, a processor and a memory having code embedded therein for programming the processor to perform an autofocus method based on face detection in accordance with any of the methods of claims 1-11

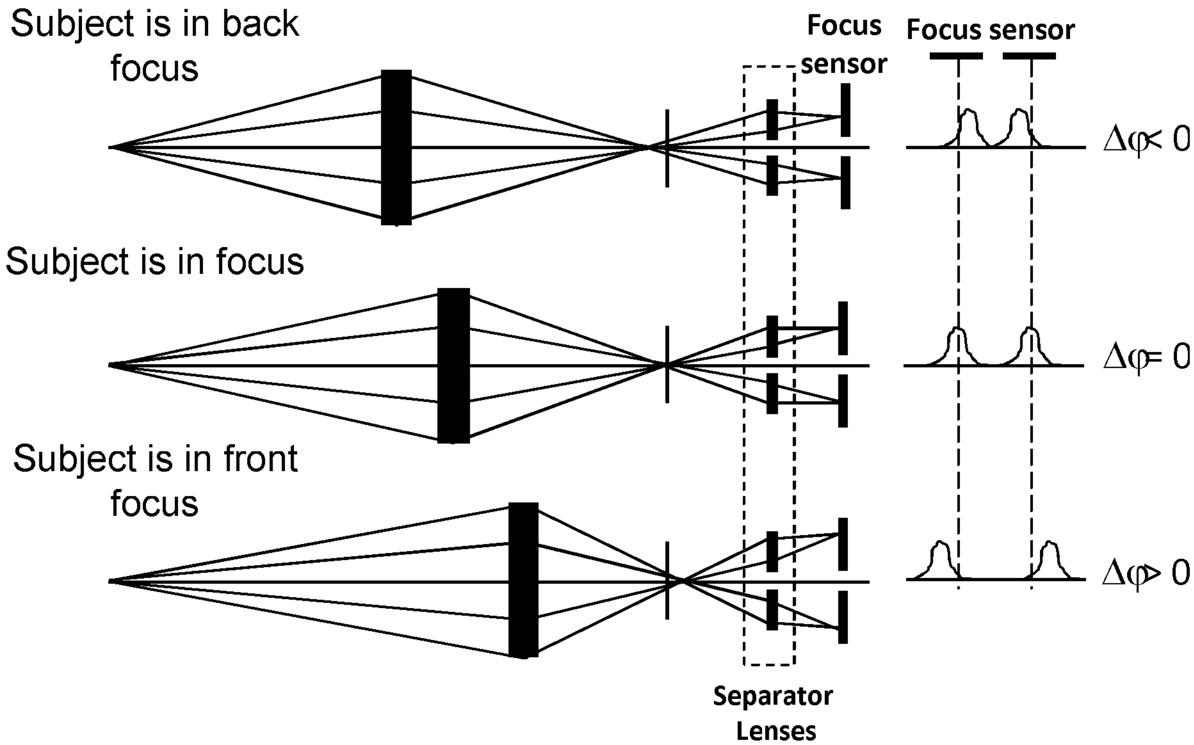
Subject is in back focus
Focus sensor
Focus sensor
Δφ< 0
Subject is in focus
Δφ= 0
Subject is in front focus
Δφ> 0
Separator Lenses

Figure 1

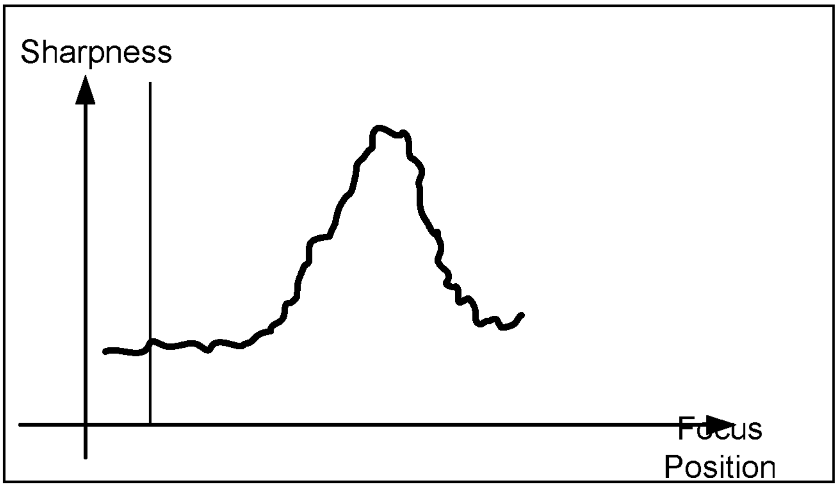

Figure 2A

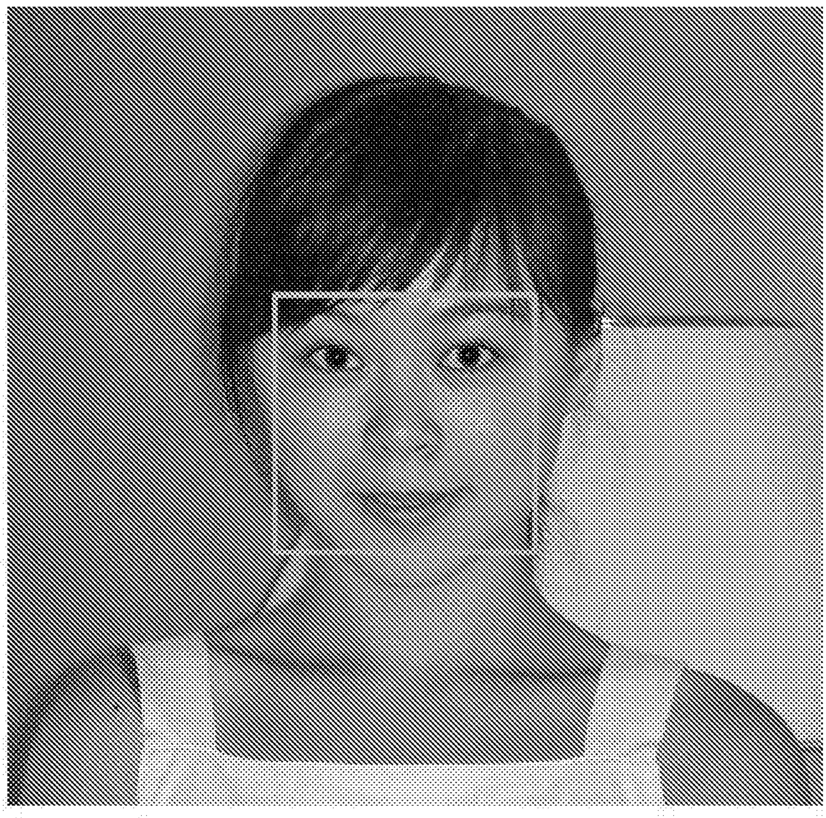

Figure 2B

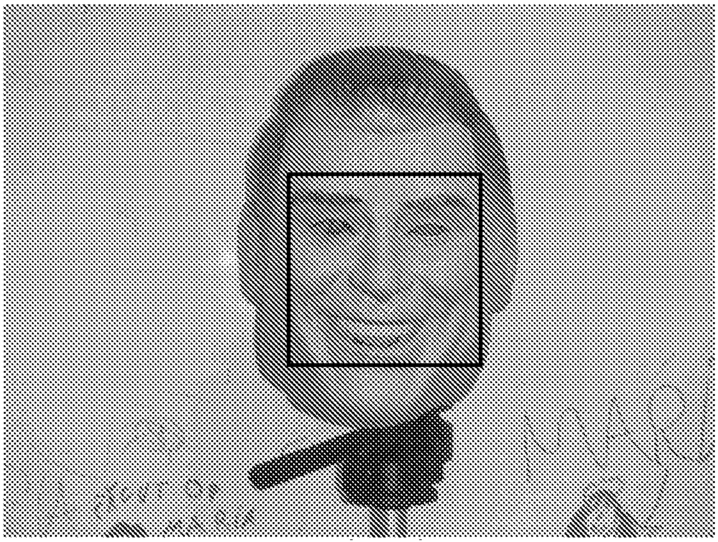

Figure 3A

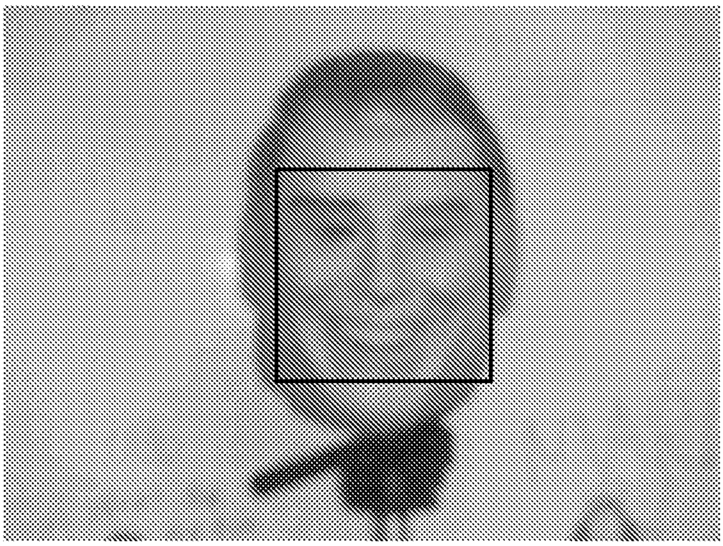

Figure 3B

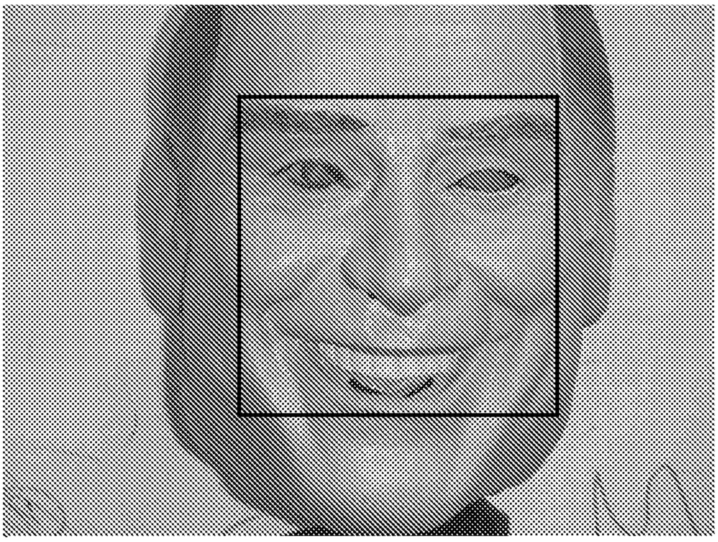

Figure 4A

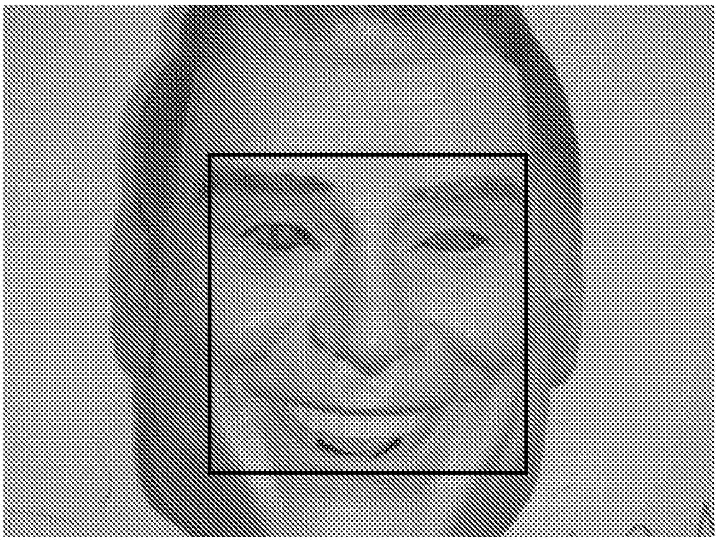

Figure 4B

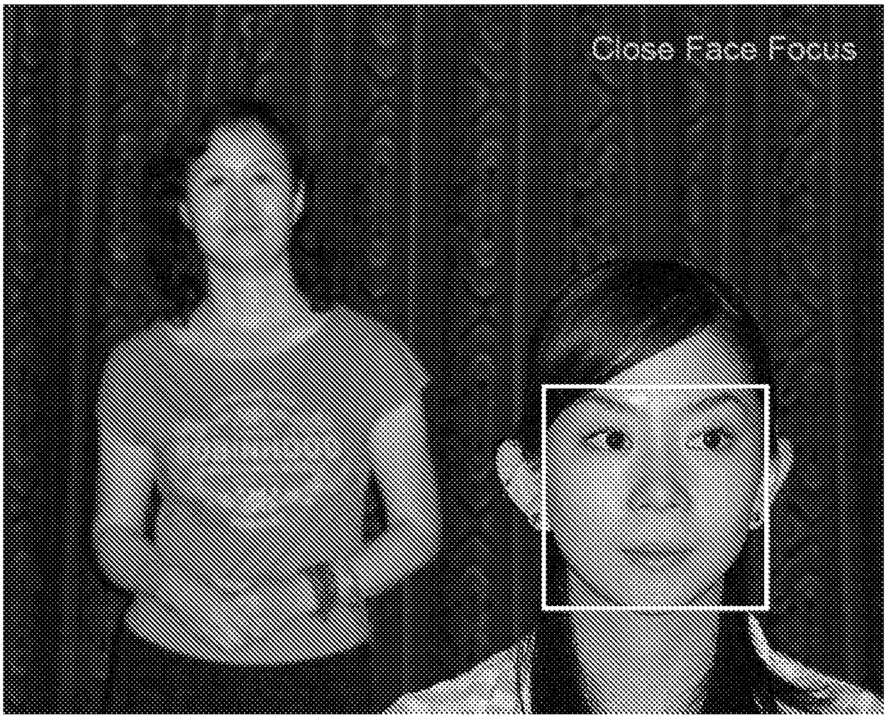

Figure 5

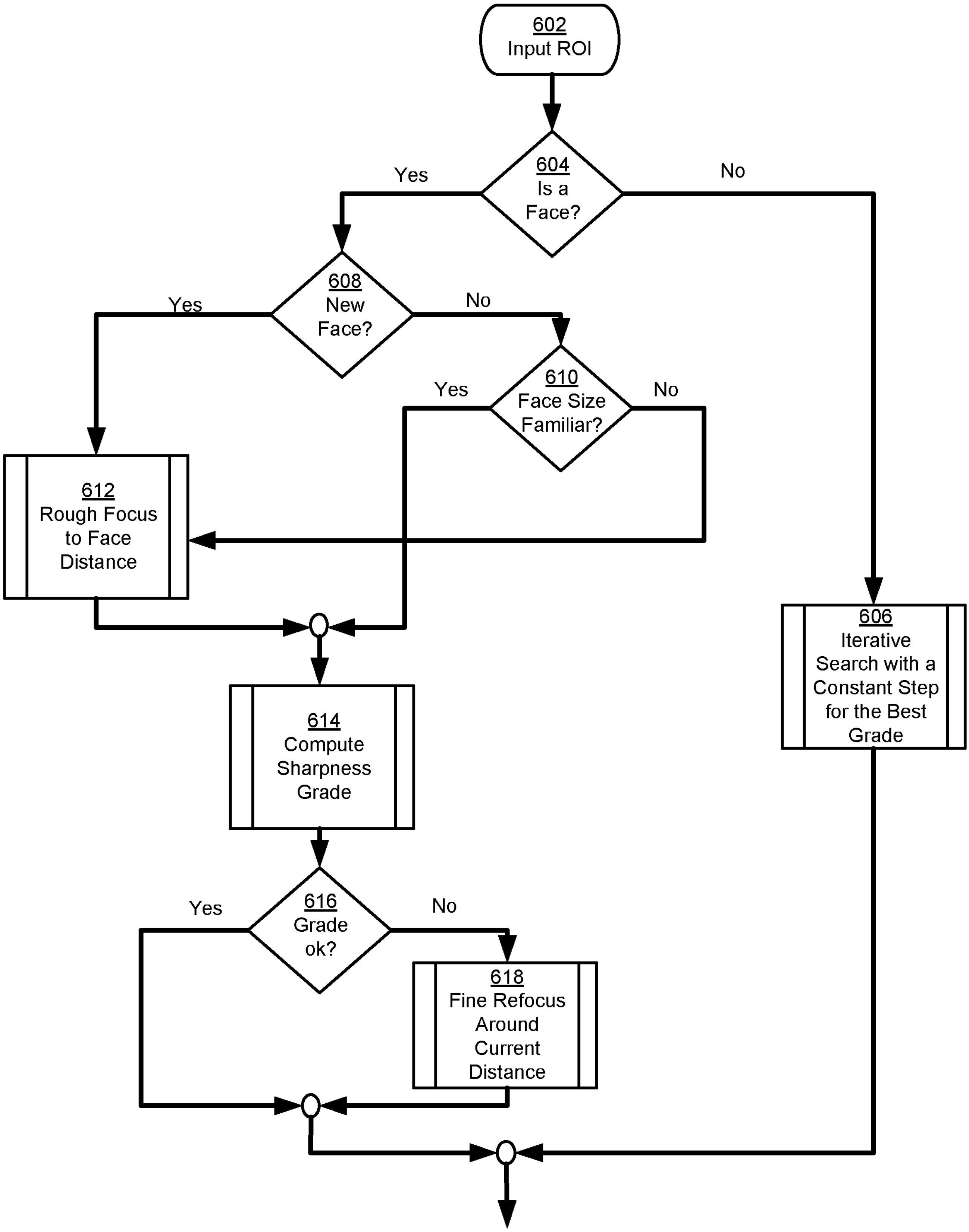
602
Input ROI
604
Is a
Face?
Yes
No
608
New
Face?
Yes
No
610
Face Size
Familiar?
Yes
No
612
Rough Focus
to Face
Distance
606
Iterative
Search with a
Constant Step
for the Best
Grade
614
Compute
Sharpness
Grade
616
Grade
ok?
Yes
No
618
Fine Refocus
Around
Current
Distance

Figure 6

Focus distance from Face Size

- Human face is an object of roughly constant size: 15 cm
- Given face size and lens focal distance the distance to subject can be estimated

P – average human face size (150 mm)
P' – size of the face projection onto the sensor
P'' – size in pixels of the detected face
f_{35} – 35mm equivalent focal length
D – distance to subject
I_w – image resolution in pixels (horizontal)
S_w – sensor width in mm (36 mm for full frame sensor)

$$\left.\begin{array}{l} \frac{P'}{P} = \frac{f_{35}}{D} \Rightarrow D = \frac{P \cdot f_{35}}{P'} \\ P' = \frac{P''}{I_w} S_w \end{array}\right| \Rightarrow D = \frac{150 \cdot f_{35} \cdot I_w}{P'' \cdot 36}$$

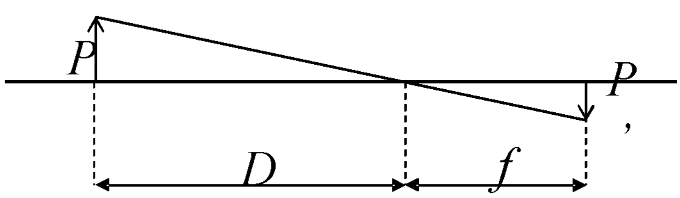

Figure 7

Focus distance from Face Size – Example 1

Dobj [m] estimated	1.1
Dobj [m] measured	1
Dfp [m]	1
f [mm]	14
f35 [mm]	76.5625
Iw [pixels]	2816
P [mm]	140
P`` [pixels]	733

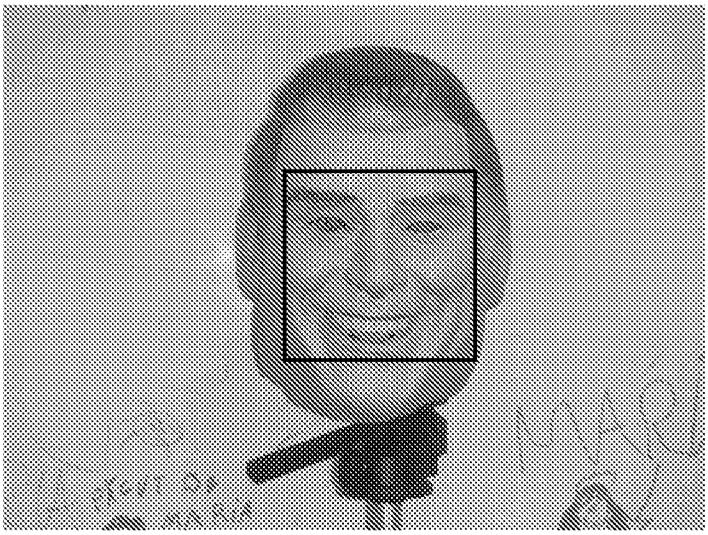

Figure 8A

Focus distance from Face Size – Example 1

Dobj [m] computed	1.1
Dobj [m] measured	1
Dfp [m]	0.2
f [mm]	14
f35 [mm]	76.5625
Iw [pixels]	2816
P [mm]	140
P`` [pixels]	733

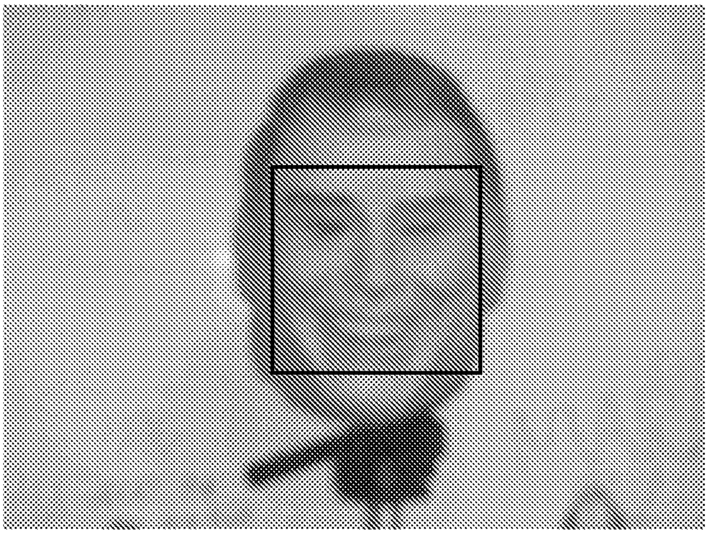

Figure 8B

Focus distance from Face Size – Example 2

Dobj [m] estimated	0.7
Dobj [m] measured	0.5
Dfp [m]	0.5
f[mm]	14
f35 [mm]	76.5625
Iw [pixels]	2816
P [mm]	140
P`` [pixels]	1180

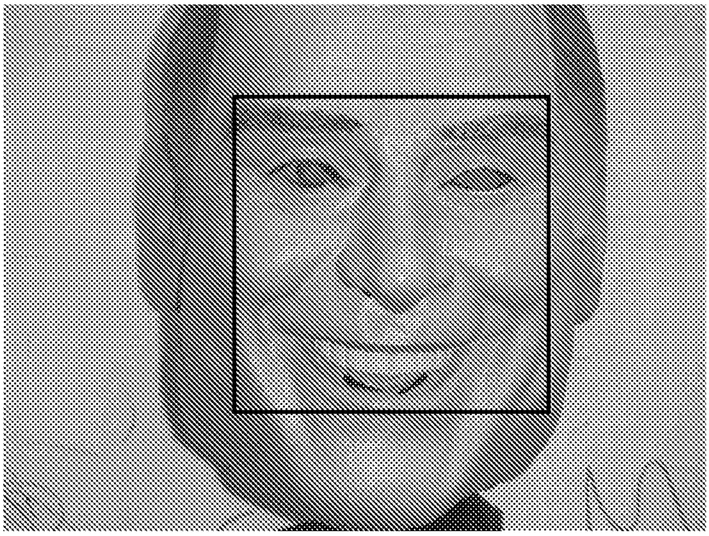

Figure 8C

Focus distance from Face Size – Example 2

Dobj [m] estimated	0.7
Dobj [m] measured	0.5
Dfp [m]	2.5
f[mm]	14
f35 [mm]	76.5625
Iw [pixels]	2816
P [mm]	140
P`` [pixels]	1180

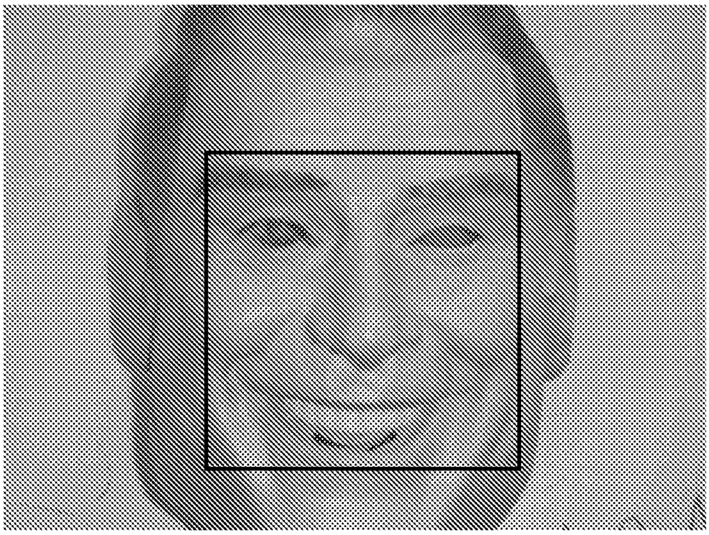

Figure 8D

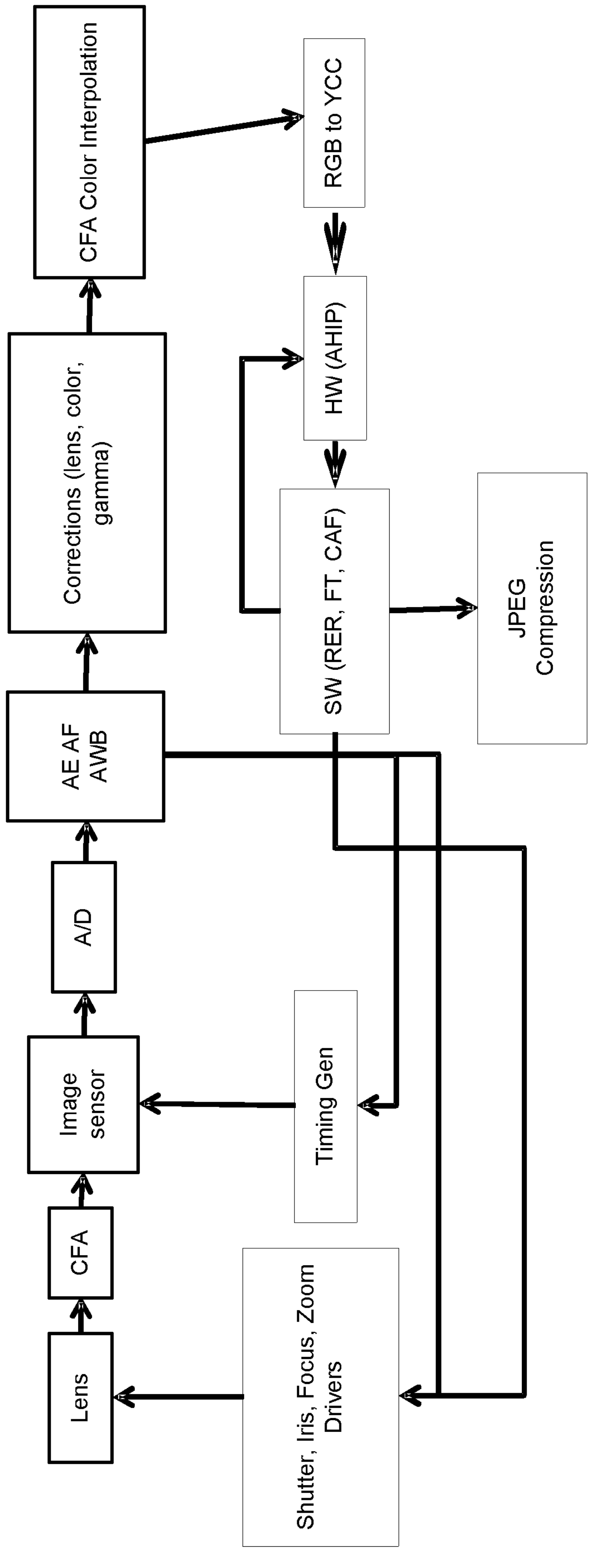
Lens
CFA
Image sensor
A/D
AE AF AWB
Corrections (lens, color, gamma)
CFA Color Interpolation
RGB to YCC
HW (AHIP)
SW (RER, FT, CAF)
JPEG Compression
Timing Gen
Shutter, Iris, Focus, Zoom Drivers

Figure 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/066835

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

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

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 2 037 320 A1 (SONY CORP [JP]) 18 March 2009 (2009-03-18) paragraphs [0010] - [0034], [0047] - [0049]; figures 3,4,6-8,14,16-19 -----	1-13
X	US 2005/270410 A1 (TAKAYAMA MASAHIRO [JP]) 8 December 2005 (2005-12-08) abstract; figures 1B, 4-6 -----	1-13
X	US 2007/030381 A1 (MAEDA TOSHIAKI [JP]) 8 February 2007 (2007-02-08) paragraphs [0050] - [0054]; figures 4, 5 -----	1-13
	-/--	

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

[X] See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 January 2012	18/01/2012

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

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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