

# **METHOD FOR GENERATING HIGH-DYNAMIC RANGE IMAGE, CAMERA DEVICE, TERMINAL AND IMAGING METHOD**

## **CROSS-REFERENCE TO RELATED APPLICATIONS**

5           This application is a SG national phase application of an International Application No. PCT/CN2016/100883, which is based upon and claims priority to Chinese Patent Application No. 201510963939.2, filed on December 18, 2015, the entire contents of which are incorporated herein by reference.

## **10    FIELD**

          The present disclosure relates to the camera device technology field, and more particularly, to a method for generating a high-dynamic range image, a camera device, a terminal and an imaging method.

## **15    BACKGROUND**

          With the development of smart phones, it is common increasingly to take photos by the mobile phone. In order to enhance photographing effect of the mobile phone, a variety of methods can be used from the front end to the back end so as to achieve the desired effect. However, for an HDR (High-Dynamic Range) image function when  
20   photographing, it needs to be further improved.

## **SUMMARY**

          The present disclosure aims to solve at least one of the problems in the related art to some extent.

In order to solve the above problems, an aspect of embodiments of the present disclosure provides a method for generating a high-dynamic range (HDR) image. An image sensor includes a pixel array and a filter array disposed on the pixel array. Each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit. The method includes: performing an exposure control to the pixel units within each pixel structure unit respectively. A first part of the pixel units are exposed for a first exposure time, and a second part of the pixel units are exposed for a second exposure time. The first exposure time is greater than the second exposure time.

With the method for generating an HDR image according to the embodiments of the present disclosure, each filter unit in the image sensor covers the plurality of pixel units in the pixel array so as to constitute the pixel structure unit (i.e. a monochromatic pixel), and the pixel units within each pixel structure unit are controlled to be exposed respectively, thereby realizing two-stage exposure within the monochromatic pixel. Compared with interlaced exposure, the obtained HDR image has brighter color and smaller noise, and quality of the HDR image can be improved.

Each filter unit covers  $2 \times 2$  pixel units. Performing an exposure control to the pixel units within each pixel structure unit respectively includes: controlling two pixel units in a row of the pixel structure unit respectively to be exposed for the first exposure time; and controlling two pixel units in another row of the pixel structure unit respectively to be exposed for the second exposure time.

The method further includes: reading outputs of the pixel array, and adding outputs of pixel units within a same pixel structure unit together to obtain a pixel value of the same pixel structure unit; and synthesizing pixel values of all the pixel structure units to obtain a single-frame HDR image. By combining the outputs of pixel units covered by the same filter unit, the obtained image is clearer.

In order to solve the above problems, another aspect of embodiments of the present disclosure provides a camera device. The camera device includes: an image sensor and an image processor. The image sensor includes a pixel array and a filter array disposed

on the pixel array. Each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit. The image processor is configured to perform an exposure control to the pixel units within each pixel structure unit respectively, in which the exposure control comprises controlling a first part of the pixel units to be exposed for a first exposure time, and controlling a second part of the pixel units to be exposed for a second exposure time. The first exposure time is greater than the second exposure time.

With the camera device according to the embodiments of the present disclosure, each filter unit in the image sensor covers the plurality of pixel units so as to constitute the pixel structure unit (i.e. a monochromatic pixel), and the image processor can realize two-stage exposure control for the pixel units within the monochromatic pixel. Compared with interlaced exposure, the obtained HDR image has brighter color and smaller noise, and quality of the HDR image can be improved.

In at least one embodiment, the image sensor includes a complementary metal oxide semiconductor (COMS for short) image sensor.

In at least one embodiment, the filter array includes a Bayer array.

In at least one embodiment, each filter unit covers 2\*2 pixel units and the image processor is further configured to control two pixel units in a row of the pixel structure unit respectively to be exposed for the first exposure time, and to control two pixel units in another row of the pixel structure unit respectively to be exposed for the second exposure time.

The image processor is further configured to read outputs of the pixel array, and to add outputs of pixel units within a same pixel structure unit together to obtain a pixel value of the same pixel structure unit, and to synthesize pixel values of all the pixel structure units to obtain a single-frame HDR image. By combining the outputs of pixel units covered by the same filter unit, the obtained image is clearer.

The image sensor further includes: a micro-mirror array disposed on the filter array. Each micro-mirror corresponds to one pixel unit.

A further aspect of embodiments of the present disclosure also provides a terminal. The terminal includes the camera device according to the above aspect of the embodiments. The terminal can take photos. The obtained HDR images have higher sharpness, brighter colors, and better brightness, and can restore the scene more  
5 thoroughly and more realistically.

In detail, the terminal includes a mobile phone.

The terminal further includes: a central processing unit connected to the camera device and a display device. The central processing unit is configured to control the display device to display the HDR image.

10 An embodiment of the present disclosure also provides an imaging method. An image sensor includes a pixel array and a filter array disposed on the pixel array. Each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit. The method includes: reading outputs of the pixel array; adding outputs of pixel units within a same pixel structure unit together to obtain a pixel  
15 value of the same pixel structure unit; and synthesizing pixel values of all the pixel structure units to obtain a single-frame HDR image.

Since noise of the pixel structure unit is less than the sum of noise of respective pixels before the combination, the method can obtain the image with higher signal-to-noise ratio, brightness and sharpness and less noise under low illumination.  
20 The shortcomings of existing methods can be overcome.

In at least one embodiment, the image sensor includes a register. Each filter unit covers  $2 \times 2$  pixel units. The act of reading further includes: collecting outputs of pixel units in  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows and storing the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows into the register, where  $k=2n-1$ ,  $n$  is a natural number, and  $k+1$  is less than  
25 or equal to a number of rows of the pixel units; and extracting the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows from the register, and adding the outputs of the pixel units within the same pixel structure unit together to obtain the pixel value of the same pixel structure unit.

In at least one embodiment, the act of reading further includes: converting an analog signal generated by each pixel unit into a digital signal for outputting.

In order to solve the above problems, yet another aspect of embodiments of the present disclosure provides a mobile terminal. The mobile terminal includes a housing; a processor; a memory; a circuit board; and a power supply circuit. The circuit board is located in a space formed by the housing. The processor and the memory are arranged on the circuit board. The power supply circuit is configured to supply power for each circuit or component in the mobile terminal. The memory is configured to store executable program codes. The processor is configured to execute a program corresponding to the executable program codes by reading the executable program codes stored in the memory so as to perform the imaging method according to the above embodiments of the present disclosure.

With the mobile terminal according to the embodiments of the present disclosure, by reading the outputs of the pixel array; adding the outputs of the pixel units within the same pixel structure unit together to obtain the pixel value of the same pixel structure unit; and synthesizing the pixel values of all the pixel structure units to obtain the single-frame HDR image, the method can obtain the image with higher signal-to-noise ratio, brightness and sharpness and less noise under low illumination since noise of the pixel structure unit is less than the sum of noise of respective pixels before the combination.

Yet another aspect of embodiments of the present disclosure provides a computer readable storage medium having instructions stored therein. When the processor of the mobile terminal executes the instructions, the mobile terminal performs the imaging method according to the above embodiments of the present disclosure.

Additional aspects and advantages of embodiments of the present disclosure will be given in part in the following descriptions, become apparent in part from the following descriptions, or be learned from the practice of the embodiments of the present disclosure.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a flow chart showing a method for generating an HDR image in an image sensor according to an embodiment of the present disclosure.

5        Fig. 2 is a schematic diagram illustrating combination of four pixel units in the pixel structure unit according to an embodiment of the present disclosure.

Fig. 3 is a flow chart showing a method for generating an HDR image in an image sensor according to an embodiment of the present disclosure.

10       Fig. 4 is a block diagram showing a camera device according to an embodiment of the present disclosure.

Fig. 5 is a block diagram showing a camera device according to another embodiment of the present disclosure.

Fig. 6 is a block diagram showing a terminal according to an embodiment of the present disclosure.

15       Fig. 7 is a block diagram showing a terminal according to another embodiment of the present disclosure.

Fig. 8 is a flow chart showing an imaging method according to an embodiment of the present disclosure.

20       Fig. 9 is a flow chart showing an imaging method according to another embodiment of the present disclosure.

Fig. 10 is a flow chart showing an imaging method according to yet another embodiment of the present disclosure.

## **DETAILED DESCRIPTION**

Reference will be made in detail to embodiments of the present disclosure. Examples of the embodiments will be shown in drawings, in which the same or similar elements and the elements having same or similar functions are denoted by like reference numerals throughout the descriptions. The embodiments described herein  
5 according to drawings are explanatory and illustrative and used to generally understand the present disclosure. The embodiments shall not be construed to limit the present disclosure.

In general, for a single-frame HDR image, RGGB (Red-Green-Blue) is used as a unit. The exposure time of interlaced exposure is inconsistent. The photographed  
10 row undergoing short exposure and the photographed row undergoing long exposure are combined into a single HDR image so as to generate the single-frame HDR image. However, the long exposure may cause serious noise, that is, during the usage of the long exposure, signals can be increased, and meanwhile noise also can be increased, such that sharpness of the whole single-frame HDR image would be significantly  
15 reduced. In addition, during the interlaced exposure, it is not clear whether the current row is in a bright scene or a dark scene, if the bright scene is combined with the long exposure, pixels in the current row may be over-exposed. If the over-exposure occurs, the pixels in this row will become unavailable, and this row needs to be complemented by interpolation of pixels in the next row or pixels in the last row, such that the  
20 sharpness may be significantly reduced.

In order to improve the image effect, there are a variety of methods. For example, for improving SNR (Signal Noise Ratio), the pixel merged method can be used in an image sensor with 16M pixels so as to achieve the improvement of the effect. A method for generating an HDR image and a camera device according to embodiments of the  
25 present disclosure are based on the image sensor with 16M pixels. 4M pixels are

generated from the 16M pixels and are output, thereby improving the effect of the HDR image, and greatly improving the speed for the HDR image.

A method for generating an HDR image in an image sensor according to an embodiment of the present disclosure will be described below with reference to the  
5 drawings.

Fig. 1 is a flow chart showing a method for generating an HDR image in an image sensor according to an embodiment of the present disclosure. As illustrated in Fig. 1, the method includes followings.

S1, an image sensor is provided.

10 The image sensor can include a pixel array and a filter array disposed on the pixel array. The filter array can include a plurality of filter units with different colors. Each filter unit can cover a plurality of pixel units (such as  $s \times s$  pixel units,  $s \geq 2$ ) in the pixel array so as to constitute a pixel structure unit. In some embodiments, the image sensor can include a complementary metal oxide semiconductor (COMS for short) image  
15 sensor.

In some embodiments, the filter array can include a Bayer array.

For example, as illustrated in Fig. 2, each filter unit covers  $2 \times 2$  pixel units, i.e. four pixel units. In addition, the four pixel units, such as photodiodes, in the region indicated by the sum operator ( $\Sigma$ ), correspond to a filter unit of the same color. The four pixel  
20 units are regarded as a pixel structure unit i.e., a monochromatic pixel.

It is understandable that, in addition to the structure of  $2 \times 2$  pixel units, there are structures of  $3 \times 3$ ,  $4 \times 4$ , and even any  $n \times m$  ( $n$  and  $m$  are natural numbers) pixel units. The number of pixel units that can be arranged on the pixel array is limited. If each pixel

structure unit contains too many pixel units, resolution of the image may be limited. For example, if a pixel value of the pixel array is 16M, the combined image with the resolution of 4M is obtained when each pixel structure unit having the structure of 2\*2 pixel units is used, and the combined image with the resolution of 1M is obtained when  
5 each pixel structure unit having the structure of 4\*4 pixel units is used. Therefore, each pixel structure unit with 2\*2 pixel units is a better arrangement, which can improve brightness and sharpness of the image in the premise of sacrificing less resolution as possible.

S2, an exposure control is performed to the pixel units within each pixel structure  
10 unit respectively. A first part of the pixel units are exposed for a first exposure time, a second part of the pixel units are exposed for a second exposure time, and the first exposure time is greater than the second exposure time. In detail, the first exposure time can correspond to the long exposure and the second exposure time can correspond to the short exposure, that is, a two-stage exposure can be achieved in a single pixel, i.e., the  
15 pixel structure unit, and the pixel units undergoing the two-stage exposure are in the same color.

In an embodiment of the present disclosure, for each filter unit covering 2\*2 pixel units, two pixel units in a row of each pixel structure unit respectively are controlled to be exposed for the first exposure time; and two pixel units in another row of the pixel  
20 structure unit respectively are controlled to be exposed for the second exposure time. For example, as illustrated in Fig. 2, four pixel units are combined into one pixel structure unit. The upper two pixel units are subjected to the long exposure. The lower two pixel units are subjected to the short exposure. Therefore, the control of the long exposure and the short exposure in the monochromatic pixel (i.e. the pixel structure unit)  
25 can be realized.

Further, concerning the reading-out of pixel values, in an embodiment of the present disclosure, as illustrated in Fig. 3, the above method can further include followings.

5 S3, outputs of the pixel array are read, and outputs of pixel units within a same pixel structure unit are added together to obtain a pixel value of the same pixel structure unit.

In some embodiments, it may be assumed that the output of each pixel unit is  $S$ .

10 In detail, outputs of the pixel units in  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows are collected and stored into the register, where  $k=2n-1$ ,  $n$  is a natural number, and  $k+1$  is less than or equal to the number of rows of the pixel array; and the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows are extracted from the register, and the outputs of the pixel units within the same pixel structure unit are added together to obtain the pixel value of the same pixel structure unit.

15 That is, the imaging information of the pixel units undergoing the long exposure and the short exposure in each pixel structure unit is combined, i.e. the photographed row undergoing short exposure and the photographed row undergoing long exposure are combined into a single pixel so as to obtain the pixel value generated by the single pixel structure unit.

20 S4, the pixel values of all the pixel structure units are synthesized to obtain a single-frame HDR image.

The combined image in each pixel structure unit is merged into the single-frame HDR image, such that the 4M of HDR image is obtained.

25 It can be seen that, with the method for generating an HDR image according to an embodiment of the present disclosure, each filter unit can cover the plurality of pixel units, for example, based on the image sensor with 16M pixels, 4M pixels can be

obtained by merging 16M pixels, that is, four pixel units are combined into one pixel structure unit, i.e. a single pixel; further, each pixel unit is subjected to a separate exposure, such that the control of the long and short exposure can be realized. Therefore, the obtained HDR image has a brighter color and a smaller noise, thereby avoiding emergence of unnecessary noise when some images are generated in RGGB way, and providing an implementation of a clear single-frame HDR, and providing to a user with a better photography experience.

Further, since the four pixel units with the same color are combined into one pixel structure unit i.e. the monochromatic pixel, the control of the long and short exposure can be realized in the single pixel. Therefore, the obtained HDR image does not have chaotic noise. Further, in the case where the current pixel unit undergoes the long exposure in a bright scene, since the long and short exposure is performed in the same large pixel, even if the interpolation compensation is performed, sharpness suffers less damage but remains consistent, such that sharpness of the HDR image is guaranteed.

Based on the method for generating an HDR image according to the embodiments of the above aspect, a camera device according to an embodiment of the present disclosure will be described below with reference to the drawings.

Fig. 4 is a block diagram showing a camera device according to an embodiment of the present disclosure. As illustrated in Fig. 4, the camera device 100 can include an image sensor 10 and an image processor 20.

In an embodiment of the present disclosure, the image sensor 10 can include a pixel array 11 and a filter array 12 disposed on the pixel array 11. The filter array 12 can include a plurality of filter units 121 with different colors. Each filter unit 121 can cover a plurality of pixel units 112 (such as  $s \times s$  pixel units,  $s \geq 2$ ) in the pixel array 11 so as to

constitute a pixel structure unit 111. In detail, each filter unit covers 2\*2 pixel units, for example, the pixel units 112 labeled as 1, 2, 3 and 4 in Fig. 3 constitute the pixel structure unit 111, and the pixel unit 1, the pixel unit 2, the pixel unit 3, and the pixel unit 4 correspond to the filter unit F such as a red filter unit. It can be considered that  
5 2\*2 pixel units with the same color are combined into one monochrome pixel. Therefore, 4M pixels may be formed from 16M pixels.

The image processor 20 is configured to perform an exposure control to the pixel units 112 within each pixel structure unit 111 respectively. In detail, the image processor 20 is configured to control a first part of the pixel units 112 to be exposed for a first  
10 exposure time, and control the second part of the pixel units 112 to be exposed for a second exposure time, in which the first exposure time is greater than the second exposure time. For example, the first exposure time can correspond to the long exposure and the second exposure time can correspond to the short exposure.

Further, the image processor 20 is further configured to read outputs of the pixel  
15 array 11, and to add the outputs of the pixel units 112 in the same pixel structure unit 111 together to obtain a pixel value of the same pixel structure unit 111, and to synthesize the pixel values of all the pixel structure units 111 to obtain a single-frame HDR image.

In detail, for each filter unit covering 2\*2 pixel units, the image processor 20 is  
20 further configured to control two pixel units 112 in a row of each pixel structure unit 111 respectively to be exposed for the first exposure time, and to control two pixel units 112 in another row of the pixel structure unit 111 respectively to be exposed for the second exposure time. As illustrated in Fig. 2, the upper two pixel units are subjected to the long exposure and the lower two pixel units are subjected to the short exposure. That

is, the same pixel structure unit 111, i.e. the monochromatic pixel, is subjected to the long and short exposure.

Further, since the four pixel units 112 with the same color are combined into one pixel structure unit 111 i.e. the monochromatic pixel, the control of the long and short exposure can be realized in the single pixel. Therefore, the obtained HDR image does not have chaotic noise. Further, in the case where the current pixel unit undergoes the long exposure in the bright scene, since the long and short exposure is performed in the same large pixel, even if the interpolation compensation is performed, the sharpness suffers less damage but remains consistent, such that sharpness of the HDR image is guaranteed.

It can be seen that, with the camera device 100 according to an embodiment of the present disclosure, each filter unit can cover the plurality of pixel units so as to form one pixel structure unit 111, i.e. a monochromatic pixel, and each pixel unit undergoes a separate exposure, such that the control of the long and short exposure can be realized in the monochrome pixel. Therefore, the obtained HDR image has a brighter color and a smaller noise, thereby improving the quality of the HDR image. In addition, sharpness of the HDR image can be ensured even when interpolation compensation is performed.

As illustrated in Fig. 5, the image sensor 10 further includes a micro-mirror array 13 disposed on the filter array 12. Each micro-mirror 131 corresponds to one pixel unit 112. Each micro-mirror 131 corresponds to one pixel unit 112 with regard to shape, size, and position. The micro-mirror 131 can gather light into the photosensitive portion of the pixel unit 112 to enhance the photosensitivity of the pixel unit 112, thereby improving the quality of the image. In some embodiments, each filter unit 121

corresponds to 2\*2 pixel units 112 and 2\*2 micro-mirrors 131 so as to form the pixel structure unit 111.

Fig. 6 is a block diagram showing a terminal according to an embodiment of the present disclosure. The terminal 1000 can include the camera device 100 according to the above aspect of embodiments. In detail, the terminal 1000 may include a mobile phone.

As illustrated in Fig. 7, the terminal 1000 further includes a central processing unit 200 connected to the camera device 100 and a display device 300. The central processing unit 200 is configured to control the display device 300 to display the HDR image. In this way, the image captured by the terminal 1000 may be displayed on the display device 300 for the user's browsing. The display device 300 can include an LED display or the like.

The terminal 1000 according to the embodiments of the present disclosure can take photos and obtain the HDR image with higher sharpness and brighter color. The dark part of the image is darker and the bright part of the image is brighter, such that the light and shade contrast is more obvious, and the scene can be restored more thoroughly and realistically.

An embodiment of the present disclosure according to yet another aspect further provides an imaging method. The image sensor includes a pixel array and a filter array disposed on the pixel array, and each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit.

Fig. 8 is a flow chart showing an imaging method according to an embodiment of the present disclosure. As illustrated in Fig. 8, the method can include followings.

S1', outputs of the pixel array are read.

S2', the outputs of the pixel units within the same pixel structure unit are added together to obtain a pixel value of the same pixel structure unit.

S3', the pixel values of all the pixel structure units are synthesized to obtain a single-frame HDR image.

5        With the imaging method according to the embodiments of the present disclosure, it is assumed that the output of each pixel unit is S, the noise of each pixel unit is N, and the pixel structure unit includes m pixel units, so the pixel value of the pixel structure unit is  $n*m*S$  and the noise of the pixel structure unit is  $\frac{\sqrt{n*m*N^2}}{n*m}$ . In the case of n = 2, m = 2, the noise of the pixel structure unit is about  $n*m*N/2$ . So the brightness of  
10        the pixel structure unit is improved under the low brightness environment, and the signal to noise ratio is increased.

Referring to Fig. 9, in some embodiments, each filter unit of the same color in the image sensor corresponds to 2\*2 pixel units and the image sensor includes a register. S2' further includes followings.

15        S201', outputs of the pixel units in the  $k^{th}$  and  $(k+1)^{th}$  rows are collected and stored into the register, where  $k=2n-1$ , n is a natural number, and  $k+1$  is less than or equal to the number of rows of all the pixel units.

S202', the outputs of the pixel units in the  $k^{th}$  and  $(k+1)^{th}$  rows are extracted from the register, and the outputs of the pixel units within the same pixel structure unit are  
20        added together to obtain a pixel value of the same pixel structure unit.

In this way, the register can be used to achieve the processes of outputting, caching and combining the pixel units.

Referring to Fig. 10, in some embodiments, S2' further includes followings.

S301', an analog signal generated by each pixel unit is converted into a digital signal.

S302', the digital signals of the pixel units within the same pixel structure unit are  
5 added together so as to obtain the pixel value of the pixel structure unit.

In this way, on one hand, the image processing module, which is generally a digital  
signal processing chip, can directly process the output of the image sensor; on the other  
hand, compared with the technical solution in which the output in the analog signal  
format of the image sensor is directly processed through the circuit, the image  
10 information is retained. For example, for the image sensor with 16M pixels, the method  
according to the embodiments of the present disclosure, can be capable of generating  
the pixel structure unit of 4M pixels (with merging 2\*2 pixels), or generating the  
original image with 16M pixels (i.e., without merging).

An embodiment of the present disclosure according to yet another aspect further  
15 provides a mobile terminal. The mobile terminal includes a housing; a processor; a  
memory; a circuit board; and a power supply circuit. The circuit board is located in a  
space formed by the housing. The processor and the memory are arranged on the circuit  
board. The power supply circuit is configured to supply power for each circuit or  
component in the mobile terminal. The memory is configured to store executable  
20 program codes. The processor is configured to execute a program corresponding to the  
executable program codes by reading the executable program codes stored in the  
memory so as to perform the imaging method according to the above aspect of  
embodiments.

An embodiment of the present disclosure further provides a computer readable storage medium having instructions stored therein. When the processor of the mobile terminal executes the instructions, the mobile terminal performs the imaging method illustrated in Fig. 8.

5        It is to be noted that, in the context, relational terms such as first and second are used only to distinguish an entity or an operation from another entity or another operation without necessarily requiring or implying that such entities or operations have any such actual relationship or sequence. Moreover, terms “include”, “comprise” or any other variant thereof is intended to encompass a non-exclusive inclusion such that  
10       processes, methods, articles, or devices that include a series of elements include not only those elements but also those that are not explicitly listed. In the absence of more restrictions, the elements defined by the statement “including a ...” do not preclude the presence of additional elements in the process, method, article, or device that includes the elements.

15       The logic and/or step described in other manners herein or shown in the flow chart, for example, a particular sequence table of executable instructions for realizing the logical function, may be specifically achieved in any computer readable medium to be used by the instruction execution system, device or equipment (such as the system based on computers, the system comprising processors or other systems capable of  
20       obtaining the instruction from the instruction execution system, device and equipment and executing the instruction), or to be used in combination with the instruction execution system, device and equipment. As to the specification, “the computer readable medium” may be any device adaptive for including, storing, communicating, propagating or transferring programs to be used by or in combination with the  
25       instruction execution system, device or equipment. More specific examples of the computer readable medium comprise but are not limited to: an electronic connection (an electronic device) with one or more wires, a portable computer enclosure (a magnetic

device), a random access memory (RAM), a read only memory (ROM), an erasable programmable read-only memory (EPROM or a flash memory), an optical fiber device and a portable compact disk read-only memory (CDROM). In addition, the computer readable medium may even be a paper or other appropriate medium capable of printing  
5 programs thereon, this is because, for example, the paper or other appropriate medium may be optically scanned and then edited, decrypted or processed with other appropriate methods when necessary to obtain the programs in an electric manner, and then the programs may be stored in the computer memories.

It should be understood that each part of the present disclosure may be realized by  
10 the hardware, software, firmware or their combination. In the above embodiments, a plurality of steps or methods may be realized by the software or firmware stored in the memory and executed by the appropriate instruction execution system. For example, if it is realized by the hardware, likewise in another embodiment, the steps or methods may be realized by one or a combination of the following techniques known in the art: a  
15 discrete logic circuit having a logic gate circuit for realizing a logic function of a data signal, an application-specific integrated circuit having an appropriate combination logic gate circuit, a programmable gate array (PGA), a field programmable gate array (FPGA), etc.

Those skilled in the art shall understand that all or parts of the steps in the above  
20 exemplifying method of the present disclosure may be achieved by commanding the related hardware with programs. The programs may be stored in a computer readable storage medium, and the programs comprise one or a combination of the steps in the method embodiments of the present disclosure when run on a computer.

Reference throughout this specification to “an embodiment,” “some  
25 embodiments,” “an example,” “a specific example,” or “some examples,” means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. Thus, the appearances of the above phrases in various places throughout this specification are not necessarily referring to the same embodiment or

example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples. In addition, under the situation of not conflicting mutually, those skilled in the related art may combine different embodiments or examples with  
5 features of different embodiments or examples described through this specification.

Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that the above embodiments cannot be construed to limit the present disclosure, and changes, alternatives, and modifications can be made in the embodiments without departing from spirit, principles and scope of the present  
10 disclosure.

## WHAT IS CLAIMED IS:

1. A method for generating a high-dynamic range (HDR) image, comprising:

5 providing an image sensor, wherein the image sensor comprises a pixel array and a filter array disposed on the pixel array, and each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit; and

performing an exposure control to the pixel units within each pixel structure unit respectively, wherein a first part of the pixel units are exposed for a first exposure time, 10 a second part of the pixel units are exposed for a second exposure time, and the first exposure time is greater than the second exposure time;

wherein each filter unit covers  $2 \times 2$  pixel units and performing an exposure control to the pixel units within each pixel structure unit respectively comprises:

controlling two pixel units in a row of the pixel structure unit respectively to be 15 exposed for the first exposure time; and

controlling two pixel units in another row of the pixel structure unit respectively to be exposed for the second exposure time.

2. The method according to claim 1, further comprising:

20 reading outputs of the pixel array, and adding outputs of pixel units within a same pixel structure unit together to obtain a pixel value of the same pixel structure unit; and

synthesizing pixel values of all the pixel structure units to obtain a single-frame HDR image.

25 3. The method according to claim 2, wherein reading outputs of the pixel array, and adding outputs of pixel units within a same pixel structure unit together to obtain a pixel value of the same pixel structure unit further comprises:

collecting outputs of pixel units in  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows and storing the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows into the register, where  $k=2n-1$ ,  $n$  is a natural 30 number,  $k+1$  is less than or equal to a number of rows of the pixel units; and

extracting the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows from the register, and adding the outputs of the pixel units within the same pixel structure unit together to obtain the pixel value of the same pixel structure unit.

5           4.           A camera device comprising:

an image sensor, wherein the image sensor comprises a pixel array and a filter array disposed on the pixel array, and each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit; and

an image processor, configured to perform an exposure control to the pixel units  
10 within each pixel structure unit respectively, wherein the exposure control comprises controlling a first part of the pixel units to be exposed for a first exposure time, and controlling a second part of the pixel units to be exposed for a second exposure time, wherein the first exposure time is greater than the second exposure time;

wherein each filter unit covers  $2*2$  pixel units and the image processor is further  
15 configured to control two pixel units in a row of the pixel structure unit respectively to be exposed for the first exposure time, and to control two pixel units in another row of the pixel structure unit respectively to be exposed for the second exposure time.

5.           The camera device according to claim 4, wherein the image sensor  
20 comprises a complementary metal oxide semiconductor (COMS) image sensor.

6.           The camera device according to claim 4 or 5, wherein the filter array comprises a Bayer array.

25           7.           The camera device according to any one of claims 4 to 6, wherein the image processor is further configured to read outputs of the pixel array, and to add outputs of pixel units within a same pixel structure unit together to obtain a pixel value of the same pixel structure unit, and to synthesize pixel values of all the pixel structure units to obtain a single-frame HDR image.

30

8. The camera device according to claim 4, wherein the image sensor further comprises:

a micro-mirror array disposed on the filter array, each micro-mirror corresponding to one pixel unit.

5

9. The camera device according to claim 8, wherein each micro-mirror corresponds to one pixel unit in shape, size and position.

10. A terminal comprising a camera device according to any one of claims 4 to 9.

10

11. The terminal according to claim 10, wherein the terminal comprises a mobile phone.

12. The terminal according to claim 10 or 11, wherein the terminal further comprises:

15

a central processing unit connected to the camera device and a display device, wherein the central processing unit is configured to control the display device to display the HDR image.

20

13. An imaging method, applied to a camera device according to claim 4, wherein the camera device comprises an image sensor having a pixel array and a filter array disposed on the pixel array, and each filter unit in the filter array covers a plurality of pixel units in the pixel array so as to constitute a pixel structure unit, and the method comprises:

25

reading outputs of the pixel array;

adding outputs of pixel units within a same pixel structure unit together to obtain a pixel value of the same pixel structure unit; and

synthesizing pixel values of all the pixel structure units to obtain a single-frame HDR image.

30

14. The method according to claim 13, wherein each filter unit covers 2\*2 pixel units.

5 15. The method according to claim 13 or 14, wherein the image sensor comprises a register, and the act of reading further comprises:

collecting outputs of pixel units in  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows and storing the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows into the register, where  $k=2n-1$ ,  $n$  is a natural number,  $k+1$  is less than or equal to a number of rows of the pixel units; and

10 extracting the outputs of the pixel units in the  $k^{\text{th}}$  and  $(k+1)^{\text{th}}$  rows from the register, and adding the outputs of the pixel units within the same pixel structure unit together to obtain the pixel value of the same pixel structure unit.

16. The method according to any one of claims 13 to 15, wherein the act of  
15 reading further comprises:

converting an analog signal generated by each pixel unit into a digital signal for outputting.

17. A mobile terminal, comprising: a housing; a processor; a memory; a  
20 circuit board; and a power supply circuit, wherein the circuit board is located in a space formed by the housing, the processor and the memory are arranged on the circuit board; the power supply circuit is configured to supply power for each circuit or component in the mobile terminal; the memory is configured to store executable program codes; the processor is configured to execute a program corresponding to the executable program  
25 codes by reading the executable program codes stored in the memory so as to perform the imaging method according to any one of claims 13 to 16.

18. A computer readable storage medium having instructions stored therein, wherein when the processor of the mobile terminal executes the instructions, the mobile  
30 terminal performs the imaging method according to any one of claims 13 to 16.