

IMAGE PROCESSING METHOD, DEVICE, AND READABLE STORAGE MEDIUM

[0001] This application claims the priority to Chinese Patent Application No. 202111469660.0, titled "IMAGE PROCESSING METHOD, DEVICE, AND READABLE STORAGE MEDIUM", filed on December 3, 2021 with the China National Intellectual Property Administration, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present application relates to the technical filed of image processing, and in particular to an image processing method, an electronic device, and a computer-readable storage medium.

BACKGROUND

[0003] Webcasting is a technology to acquire a signal (audio and/or video) by setting up a separate signal acquisition device on-site, to import the signal into a broadcasting terminal (broadcasting device or platform), to upload the signal to a server by the broadcasting terminal through the network and to publish the signal to a specified website for watching. In some darker scenes, the acquired video streaming is usually processed to increase its brightness, so that users can clearly see the images during the webcast. Currently, the processing method is to evenly brighten the interface of the video streaming as a whole. That is, all parts of the images generated during the webcast are processed with equal brightness. Since the scene may change from dimness to brightness, the interface being equally brightened as a whole may be too bright to provide comfort visual experience.

SUMMARY

[0004] In view of this, one object of the present application is to provide an image processing method, electronic device, and a computer-readable storage medium, to provide users with better visual experience.

[0005] In order to solve the above technical problems, in a first aspect, the present

application provides an image processing method, including: acquiring a to-be-processed image from video streaming, where the to-be-processed image is in an RGB format; converting the to-be-processed image into a first image in a YUV format, and extracting data for a Y component of the first image; generating a correction parameter for pixels in the first
5 image based on the data for the Y component of the first image; performing gamma correction on the data for the Y component for the pixels based on the correction parameter to obtain corrected data; replacing the data for the Y component with the corrected data to obtain a second image, and converting the second image into a processed image in the RGB format; inputting the processed image and an optimized image of a previous image into an evaluation
10 model to obtain an evaluation parameter indicating a brightness difference between the processed image and the optimized images; and determining the processed image as an optimized image corresponding to the to-be-processed image if the evaluation parameter is beyond a target range.

[0006] Optionally, the acquiring the to-be-processed image from the video streaming
15 includes: acquiring an initial image from the video streaming based on the previous image, and normalizing the initial image to obtain a normalized image; mapping the normalized image onto a linear color space to obtain a first transition image; heightening contrast for each color component in the first transition image to obtain a second transition image by; mapping the second transition image onto a gamma color space to obtain a third transition image; and
20 de-normalizing the third transition image to obtain the to-be-processed image.

[0007] Optionally, generating the correction parameter for the pixels in the first image based on the data for the Y component of the first image includes: ranking the data for the Y component for the pixels in order of sizes or frequencies to obtain a data queue; and determining target data corresponding to a preset proportion in the data queue as the
25 correction parameter.

[0008] Optionally, the generating correction parameter for pixels in the first image based on the data for the Y component of the first image includes: determining respective adjacent ranges for the pixels; ranking the data for the Y component of the pixels and adjacent pixels within the respective adjacent ranges in order of sizes or frequencies to obtain a data queue;
30 and determining target data corresponding to a preset proportion in the data queue as the correction parameter.

[0009] Optionally, the performing the gamma correction on the data for the Y component for the pixels based on the correction parameter to obtain the corrected data includes: generating a power inversely proportional to a difference between maximum brightness and the correction parameter based on the difference, and performing the gamma correction on the data for the Y component based on the power to obtain the corrected data.

[0010] Optionally, the generating the power inversely proportional to the difference between maximum brightness and the correction parameter based on the difference and performing the gamma correction on the data for the Y component based on the power to obtain the corrected data includes: generating the difference between the maximum brightness and the correction parameter, wherein the difference is greater than zero; generating the power based on the difference and a preset threshold; wherein the power is inversely proportional to the difference and is greater than zero; solving a power function, where a base of the power function is a ratio of the data for the Y component to the maximum brightness and an exponent of the power function is the power; and multiplying solution of the power function by the maximum brightness to obtain the corrected data.

[0011] Optionally, if the evaluation parameter is within a target range includes: updating the correction parameter, performing the gamma correction on the data for the Y component for the pixels based on the updated correction parameter to update the corrected data; updating the processed image with the update corrected data, and updating the evaluation parameter with the updated processed image, until the evaluation parameter is beyond the target range; and determining the updated processed image as the optimized image.

[0012] Optionally, the updating the correction parameter includes: decreasing the correction parameter if the processed image is darker than the optimized image of the previous image; and increasing the correction parameter if the processed image is brighter than the optimized image of the previous image.

[0013] Optionally, the image processing method further includes: outputting the processed image visually; acquiring user feedback on the processed image, generating training data based on the user feedback, and training the evaluation model with the training data.

[0014] Optionally, the image processing method further includes: generating optimized video streaming from processed images of all images in the video streaming and outputting the optimized video streaming visually.

[0015] In a second aspect, the present application also provides an electronic device including: a memory configured to store a computer program; and a processor configured to execute the computer program to implement the image processing method mentioned above.

[0016] In a third aspect, the present application also provides a computer-readable medium storing a computer program that, when executed by a processor, implements the image processing method mentioned above.

[0017] The image processing method according to the present application acquires the to-be-processed image from the video streaming; and the to-be-processed image is in an RGB format. The first image is acquired by converting the to-be-processed image into an image in a YUV format, and data of the Y component corresponding to the first image is extracted. Brightness correction parameters corresponding to all pixels in the first image respectively are generated based on the data of the Y component. Corrected data is obtained by correcting the data of the Y component corresponding to all pixels respectively with gamma brightness correction based on the brightness correction parameters. A second image is obtained by replacing the data of the Y component with the corrected data, and a processed image is obtained by converting the second image into the RGB format. The processed image and an optimized image of a previous frame are inputted into an evaluation model, and an evaluation parameter indicating a brightness difference between the processed image and the optimized image of the previous frame is obtained. The processed image is determined as a brightness-optimized image corresponding to the to-be-processed image if the evaluation parameter is not located in a target range.

[0018] It can be seen that, the acquired to-be-processed image is converted into the YUV format. Data of Y component indicates the brightness of the image. The image color is less affected by brightness correction through the conversion of color format. The overall brightness condition of the to-be-processed image is determined based on the data of Y component corresponding to all pixels respectively in the to-be-processed image, and then the basis for adjusting the brightness, that is, the brightness correction parameters are determined. The data of Y component is corrected through the gamma correction based on the condition of the data of Y component based on the brightness correction parameters, thereby brightening the dark part of the to-be-processed image significantly while brightening slightly or even not brightening the bright part, depending on actual needs. Therefore, the image is clear and

natural. The processed image is obtained by generating the second image with the acquired correction data and converting them to an RGB format. The evaluation model is trained and acquired based on the needs and preferences of image brightness from users, and has good adaptive abilities both in space and time. The evaluation model can evaluate whether the brightness change responding to the time series of the processed image compared with the optimized image of previous frame is well. The target range indicates an inappropriate brightness change of the processed image from the optimized image of the previous frame. The target range not within the target range shows that the brightness for the to-be-processed image is optimized appropriately, so that the processed image is determined as the brightness optimized image after optimizing the brightness, and the process for optimizing the to-be-processed image ends. The gamma brightness correction on different to-be-processed images is adapted to the brightness change of the scene of the video streaming based on the evaluation parameter, so that the brightness of the processed images is continuous in the time domain. The brightness of the video streaming remains generally stable throughout all the moments, and therefore users can have a better visual experience since all processed images each are corrected by the gamma brightness correction.

[0019] In addition, an electronic device and a computer-readable storage medium are provided according to the present application, and have the same beneficial effects as the above method.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] To describe the technical solutions in the embodiments of the present application or in the conventional technology more clearly, the accompanying drawings required for describing the embodiments or the conventional technology are briefly introduced hereinafter. Apparently, the accompanying drawings in the following description show merely the embodiments of the present application, and a person of ordinary skill in the art can derive other drawings from these accompanying drawings without creative efforts.

[0021] Figure 1 is a schematic diagram of a hardware structure applicable to an image processing method according to an embodiment of the present application;

[0022] Figure 2 is a schematic diagram of a hardware structure applicable to the image processing method according to another embodiment of the present application;

[0023] Figure 3 is a schematic flowchart of the image processing method according to an embodiment of the present application;

[0024] Figure 4 shows a to-be-processed image according to an embodiment of the present application;

5 **[0025]** Figure 5 is a processed image obtained from a related processing method according to an embodiment of the present application;

[0026] Figure 6 is a schematic flowchart of conversion from an RGB format to a YUV format according to an embodiment of the present application;

10 **[0027]** Figure 7 is a schematic flowchart of an image processing method according to an embodiment of the present application;

[0028] Figure 8 is a diagram showing comparison between effects before and after image processing according to an embodiment of the present application;

[0029] Figure 9 is a diagram showing comparison between effects before and after image processing according to another embodiment of the present application; and

15 **[0030]** Figure 10 is a schematic diagram of an effect for optimizing a video streaming according to an embodiment of the present application.

DETAILED DESCRIPTION

20 **[0031]** In order to make the purpose, technical scheme and advantages of the embodiments of the present disclosure more clear, technical solutions in the embodiments of the present disclosure will be described clearly and completely in the following with reference to the drawings in the embodiments of the present disclosure. Apparently, the described embodiments are only some, rather than all of the embodiments of the present disclosure. All the other embodiments obtained by those skilled in the art based on the embodiments in the present application without any creative work fall into the protection scope of the present application.

25 **[0032]** In order to facilitate understanding, first of all, a hardware structure, which is applied in the solution corresponding to the image processing method, and/or, the audio processing method according to the embodiments of the present application is described.

Reference is made to Figure 1, which is a schematic diagram of a hardware structure applicable to an image processing method according to an embodiment of the present application. An electronic device 100 included a processor 101 and a memory 102. Alternatively, the electronic device 100 further includes one or more of a multimedia module 103, an information input/information output (I/O) interface 104 and a communication module 105.

[0033] The processor 101 is configured to control the electronic device 100 to perform all or part of the steps in the image processing method, and/or the audio processing method. The memory 102 is configured to store multiple types of data to support the operation of the electronic device 100, where the data may include, for example, an instruction of application or method used to operate on the electronic device 100, and the related data of the application. The memory 102 includes any type of volatile storage devices or non-volatile storage devices or their combinations, for example, one or more of a Static Random Access Memory (SRAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), an Erasable Programmable Read-Only Memory (EPROM), a Programmable Read-Only Memory (PROM), a Read-Only Memory (ROM), a magnetic memory, a flash memory, a disk or a compact disk. In this embodiment, the memory 102 at least stores programs or data implementing the following processing of: acquiring a to-be-processed image from video streaming, where the to-be-processed image is in an RGB format; converting the to-be-processed image into a first image in a YUV format, and extracting data for a Y component of the first image; generating a correction parameter for pixels in the first image based on the data for the Y component of the first image; performing gamma correction on the data for the Y component for the pixels based on the correction parameter to obtain corrected data; replacing the data for the Y component with the corrected data to obtain a second image, and converting the second image into a processed image in the RGB format; inputting the processed image and an optimized image of a previous image into an evaluation model to obtain an evaluation parameter indicating a brightness difference between the processed image and the optimized images; and determining the processed image as an optimized image corresponding to the to-be-processed image if the evaluation parameter is beyond a target range.

[0034] The multimedia module 103 may include a screen and an audio module. The screen may be a touch screen, and the audio module is configured to output and/or input an audio signal. For example, the audio module may include a microphone configured to receive an

audio signal from outside. The received audio signal may be further stored in the memory 102 or sent by the communication module 105. The audio module at least includes a loudspeaker to output the audio signal. The I/O interface 104 provides an interface between the processor 101 and other interface modules, and the interface modules may be a keyboard, a mouse, a button, and so on. The button may be a virtual button or a physical button. The communication module 105 provides wired or wireless communications between the electronic device 100 and other devices. The wireless communication includes, for example, one or more of Wi-Fi, Bluetooth, Near Field Communication (NFC for short), 2G, 3G or 4G. Accordingly, the communication module 105 includes: a Wi-Fi module, a Bluetooth module and an NFC module.

[0035] The electronic device 100 can be implemented by one or more of an Application Specific Integrated Circuit (ASIC for short), a Digital Signal Processor (DSP for short), a Digital Signal Processing Device (DSPD for short), a Programmable Logic Device (PLD for short), a Field Programmable Gate Array (FPGA for short), a controller, a microcontroller, a microprocessor, or other electronic devices, to perform the image processing method.

[0036] The structure of the electronic device 100 shown in Figure 1 is not a limitation for the electronic device according to the embodiment of the present application. In practice, the electronic device 100 includes more or less parts than that shown in Figure 1, or some parts may be combined.

[0037] It should be understood that, the number of the electronic device is not limited in the embodiments of the present application. The image processing method, and/or the audio processing method may be performed by multiple electronic devices operating cooperatively. In an embodiment, reference is made to Figure 2, which shows a schematic diagram of a hardware structure applicable to the image processing method according to another embodiment of the present application. As shown in Figure 2, the hardware structure includes: a first electronic device 11 and a second electronic device 12. The first electronic device 11 and the second electronic device 12 are connected over a network 13.

[0038] In the embodiment of the present application, the hardware structures of the first electronic device 11 and the second electronic device 12 can refer to the electronic device 100 in Figure 1. It can be understood that, two electronic devices 100 are included in the present embodiment and the two electronic devices exchange data with each other. Furthermore, the

form of the network 13 is not limited in the embodiments of the present application. That is, the network 13 is a wireless network (WIFI, Bluetooth), or a wired network.

[0039] The first electronic device 11 and the second electronic device 12 may be a same electronic device, for example, the first electronic device 11 and the second electronic device 12 are both servers. The first electronic device 11 and the second electronic device 12 may also be different electronic devices, for example, the first electronic device 11 is a smartphone or other terminals, and the second electronic device 12 is a server. In an embodiment, a server with better calculation ability may serve as the second electronic device 12, thereby efficiently and reliably processing data and even image. Further, a smartphone with low cost and wide range of applications serves as the first electronic device 11, so that the user can intersect with the second electronic device 12. It should be understood that the interaction process may be that, the smartphone acquires the images composing the video streaming and sends the video streaming or the images to the server, and the server performs the brightness correction. The server sends the obtained brightness-optimized image to the smartphone.

[0040] Based on the description above, reference is made to Figure 3, which shows a schematic flowchart of an image processing method according to the embodiment of the present application. The method in the embodiment includes the following step S101 to step S109.

[0041] In step S101, the to-be-processed image is acquired from the video streaming.

[0042] The video streaming is the video whose brightness is to be corrected, and includes multiple video frames. Each of the video frames is a to-be-processed image and is to be processed. For example, the video frames are determined as the to-be-processed image and then are processed sequentially. The to-be-processed image is in an RGB format. The RGB format is also called RGB color, which represents the usually said three primary colors. R represents Red (red color), G represents Green (green color) and B represents Blue (blue color). Any visible color in the nature is formed by mixing the three colors, and then the mixing colors under an RGB format is also called additive mixing.

[0043] In order to ensure that the image brightness in the video streaming at each moment meets the requirement, the non-first video frame is selected as the to-be-processed image and the brightness of this frame corrected. Specifically, the to-be-processed image at the present moment can be determined based on the video frame processed at last moment. The first

video frame has no corresponding optimized image of a previous frame, and then no corresponding determination basis exists, so no processing is done on the first video streaming. Alternatively, the brightness (for example, an average brightness) of the first video streaming can be adjusted to a preset brightness. In addition, to better correct the brightness, a series of pre-processing may be performed on the original video streaming to acquire an image easier to correct its brightness, that is, the to-be-processed image. Preferably, in one implementation, the contrast of the video frame may be improved to make bright parts brighter and dark parts darker, which makes the correction intensity determination more accurately in the following gamma brightness correction. Specifically, the process of acquiring the to-be-processed image from the video streaming includes the following step 11 to step 15.

[0044] In step 11, an initial image is acquired from the video streaming based on a previous frame. The initial image is normalized and a normalized image is obtained.

[0045] In step 12, a first transition image is obtained by mapping the normalized image to a linear color space.

[0046] In step 13, a second transition image is obtained by improving the contrast of each color component in the first transition image.

[0047] In step 14, a third transition image is obtained by mapping the second transition image to a gamma color space.

[0048] In step 15, the to-be-processed image is obtained by de-normalizing the third transition image.

[0049] The initial image indicates the video frame at the next moment, corresponding to the image of the previous frame in the video streaming. The image of the previous frame indicates the to-be-processed image of the last image processing process, that is, the image of a frame immediately previous to the to-be-processed image in the video streaming. Normalizing indicates mapping the pixel value of each color component in the initial image to the range from 0 to 1. The normalized pixel value can be mapped to the linear color space in a certain way, and the mapped image, i.e., the first transition image can be obtained. The contrast of the image is heightened by heightening the contrast of the first transition image. Compared to heightening the contrast in the nonlinear space such as the gamma space,

heightening the contrast in the linear space has a better robustness for the processed image, i.e., a better visual effect, for the image. The third transition image obtained by mapping the second transition image to a gamma color space, is de-normalized to complete the restoration of the pixel value. In another word, the to-be-processed image is obtained by mapping the pixel value from the range between 0 and 1 to the value range in the original color component. Details about the mapping onto the color space are not limited in the present embodiment, but may be configured as needed.

[0050] In S102, the to-be-processed image is converted into a YUV format to obtain a first image, and data of Y component corresponding to the first image is extracted.

[0051] YUV format is a color coding method and has three color components: Y, U and V. The Y component indicates the luminance (or Luma), i.e., the grayscale. The U and V components indicate the chrominance (or Chroma), which describes the color and saturation of the image and specify the color of pixels. The data of Y component indicating the luminance is obtained by converting the to-be-processed image from an RGB format into a YUV format. It should be clarified that, each pixel in the first image has a piece of YUV data, and therefore multiple pieces of data of Y component corresponding to the obtained first image are acquired, and the number of pieces of data of Y component is equal to the number of the pixels in the first image. For example, the first image (the to-be-processed image) has H pixels along the long side and has W pixels along the wide side, the number of pixels is $W \times H$, and the number of the data of Y component is also $W \times H$. Details about the converting the image format is not limited in the present embodiment.

[0052] In S103, brightness correction parameters are generated corresponding to all pixels in the first image respectively based on the data of Y component.

[0053] Each piece of data of Y component indicates brightness of one pixel, and all the pixels corresponding to the first image indicates the overall brightness of the first image. Whether the first image is relatively dark and the degree of darkness can be determined based on the brightness I, and the corresponding brightness correction parameters can be determined based on the brightness. The brightness correction parameters are basic parameters for generating the gamma parameter adopted for the following gamma brightness correction. Since the gamma parameter is generated in different ways, the number of the brightness correction parameters and the specified determination for the brightness correction parameters

are not limited. Specifically, in the case that the gamma parameter is less than 1, the part with lower brightness in the image is stretched while the part with higher brightness is compressed. Further, it can be seen that the darker parts in the image are brightened greatly, while the brighter parts in the image are brightened less. In the case that the gamma parameter is greater than 1, the part with higher brightness in the image is stretched while the part with lower brightness is compressed; and it can be seen that the contrast of the image is heightened. In the present embodiment, in order to adjust the brightness, the brightness correction parameters are within the range between 0 and 1. Since the values of brightness correction parameters affect the improved brightness with a gamma brightness correction, the brightness correction parameters are determined by the data of Y component corresponding to all pixels of the first image. The brightness correction parameters are determined based on the overall brightness of the first image and the degree to what extent the gamma brightness correction is performed is determined by the overall brightness of the first image.

[0054] In an embodiment, the brightness correction parameters are global parameters, that is, all the pixels of the first image have the equal brightness correction parameter. The global brightness correction parameters can be determined rapidly, and the brightness of the first image can be corrected evenly based on the global brightness correction parameter. Specifically, the generating brightness correction parameters corresponding to all pixels in the first image respectively based on the data of Y component includes the following step 21 to step 22.

[0055] In step 21, the data of Y component corresponding to the pixels are ranked in order of sizes or frequencies to obtain a data queue .

[0056] In step 22, the target data within in a preset range in the data queue are determined as the brightness correction parameters.

[0057] For sorting the data of Y component, one way is to sort it by values from large to small, another way is to sort it by values from small to large. Alternatively, the occurrence frequency of the data of Y component can be counted, and the data of Y component can be sorted by the occurrence frequency from high to low or the occurrence frequency from low to high. The preset range may be 95% or 80%, that is, the number of the selected data of Y component is 5% or 20% of all data, and the selected data of Y component with sequence numbers greater than 95% or 80% of the total number are determined as the target data within

in the preset range, and the target data is determined as the brightness correction parameters. Since the brightness correction parameters of the global parameter only needs to be corrected once, then the determination speed is relatively rapid. However, the global parameter cannot perform brightness correction to one image according to conditions of different parts. In order to solve the mentioned problem, in another embodiment, the brightness correction parameters are local parameters, that is, the brightness correction parameters corresponding to all pixels are different, and the local brightness correction parameters can be locally self-adaptable. Specifically, the generating brightness correction parameters corresponding to all pixels in the first image respectively based on the data of Y component includes the following step 31 to step 33.

[0058] In step 31, adjacent ranges for the pixels are determined respectively.

[0059] In step 32, the data of Y component corresponding to the pixels and adjacent pixels within the adjacent range are ranked in order of sizes or frequencies to obtain a data queue.

[0060] In step 33, the target data within in a preset range in the data queue is determined as the brightness correction parameter.

[0061] The adjacent range indicates a range with a closer distance from the specified pixel. The pixels within the adjacent range can be seen as a part of an image, whose overall brightness can be indicated by all data for the Y component of the pixels together. The size of the adjacent range and determination of the adjacent range are not limited. For example, the adjacent range can be a range of two pixels away from a pixel. That is to say, other pixels with distances less than or equal to two pixels from a certain are all within in the adjacent range of the pixel, and the other pixels are called the adjacent pixels.

[0062] By ranking the data of Y component corresponding to the pixels in the adjacent range and determining the brightness correction parameters, the brightness correction parameters corresponding to the pixels in one part can be determined based on the brightness of the part in the image, so that the following gamma brightness correction is self-adaptive locally.

[0063] In S104, the corrected data is obtained by correcting the data of Y component corresponding to all pixels with gamma brightness correction based on the brightness correction parameters.

[0064] The gamma parameter for the gamma brightness correction is determined based on the obtained brightness correction parameters, and the data of Y component corresponding to all pixels are corrected with the gamma brightness correction based on the gamma parameter. The gamma brightness correction is correcting the data of Y component based on a gamma transform formula, and the gamma transform formula is as below.

$$s=c*r^{\gamma}$$

[0065] In the formula, c is a coefficient. In the application scene of the present application, c is the maximum brightness value, which is 255. r is the data of Y component after normalized, γ is the gamma parameter, s is the corrected data. Details for generating a gamma brightness correction based on the brightness correction parameters can be configured as required, and are related to the selection of the brightness correction parameters. In an embodiment, the acquiring the corrected data by correcting the data of Y component corresponding to all pixels with gamma brightness correction based on the brightness correction parameters includes the following step 41.

[0066] In step 41, a power inversely proportional to a difference between maximum brightness and the correction parameter is generated based on the difference, and the gamma correction is performed on the data for the Y component based on the power to obtain the corrected data.

[0067] In this embodiment, the brightness difference can be determined based on the maximum brightness value and the brightness correction parameters. The maximum brightness value indicates the maximum value of the parameter in Y component within the selectable range. The brightness difference indicates the brightness of the first image or a certain part in the first image. It should be understood that, the smaller the brightness difference is, the brighter the brightness is; and in the opposite, the larger the brightness difference is, the darker the brightness is. In the case that the gamma parameter is less than 1, the smaller the gamma parameter is, the more the dark part is brightened, and the larger the gamma parameter is, the less the dark part is brightened. In view of this, the gamma parameter is inversely proportional to the brightness difference. That is, the smaller the brightness difference is, the larger the gamma parameter is, and the larger the brightness difference is, the smaller the gamma parameter is.

[0068] The gamma transform formula may be as a power function, and the gamma

parameter is the power. The normalized data of Y component is determined as r, and the corrected data is acquired after gamma calculation.

[0069] Furthermore, the step 41 above further includes the following steps from step 51 to step 54.

5 **[0070]** In step 51, a brightness difference greater than zero is generated based on the maximum brightness and the brightness correction parameter.

[0071] In step 52, the power is generated based on the brightness difference and a preset threshold. The power is inversely proportional to the brightness difference and the power is greater than zero.

10 **[0072]** In step 53, the power function is solved. A base of the power function is a ratio of the data of the Y component to the maximum brightness and an exponent of the power function is the power

[0073] In step 54, the corrected data is obtained by multiplying the solution of the power function by the maximum brightness.

15 **[0074]** Since the gamma parameter is greater than zero, the brightness difference is generated by subtracting the brightness correction parameter from the maximum brightness. After obtaining the brightness difference greater than zero, the power is obtained by inputting the brightness difference and the preset threshold to the preset formula and solving the formula. Details about the formula are not limited. For example, the formula may be as below.

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$$gamma = 1 - \beta \times (255 - y_max) / 255$$

[0075] In the formula, gamma is the gamma parameter, β is the preset threshold, and the value of β is not limited. For example, β is equal to 0.45. y_max is the brightness correction parameter, and $255 - y_max$ is the brightness difference.

25 **[0076]** In S105, a second image is obtained by replacing the data of Y component with the corrected data, and a processed image is obtained by converting the second image into the RGB format.

[0077] The obtained corrected data is determined as the latest data of Y component and the last data of Y component are replaced by the obtained corrected data. The second image is

obtained by combining the data of U component, the data of V component and the latest data of Y component. The processed image is obtained by converting the second image into the RGB format. Although the brightness of the processed image is corrected once, the processed image may still fail to meet the preset requirement (for example, the image quality requirement) or the requirements from users. In order to ensure the effect for brightness correction, the processed image is evaluated after obtained.

[0078] In S106, the processed image and an optimized image of a previous frame are inputted into an evaluation model, and an evaluation parameter indicating a brightness difference between the processed image and the optimized image of the previous frame is obtained.

[0079] The evaluation model is the model for evaluating the brightness of the image after processed. The structure and type of the model is not limited. For example, the evaluation model may be acquired by training a convolutional neural network model. For example, the training data may be utilized to train the convolutional neural network model, and then the evaluation model is acquired. There are multiple pieces of data, and each piece of the training data includes two training images. The two training images are called the first training image and the second training image. The first training image and the second training image are two images at two adjacent moments in a time series. The brightness of the first training image and the second training image may be the same or different. The images are labeled based on the brightness difference of the image. For example, the first average brightness of the first training image and the second average brightness of the second training image are calculated, and the brightness difference is obtained by subtracting the second average brightness from the first average brightness. The obtained brightness difference is determined as the label of the present group of training images. Alternatively, the brightness may be calculated based on the pixel positions with a weighted average algorithm, and the brightness difference is obtained by subtracting the calculated second average brightness from the calculated first average brightness. The label may be manually annotated or automatically annotated. The convolutional neural network model is adopted as an initial model, and it is trained by multiple pieces of data. The initial model is able to learn. Specifically, the evaluation model

expresses the brightness difference between two images in the form of output evaluation parameters. For example, the large evaluation parameter indicates that the brightness difference between the two images is smaller. The small evaluation parameter indicates that the brightness difference between the two images is smaller.

5 **[0080]** Since the brightness of the scene in which different video frames are generated in the video streaming may change, the final effect obtained after the same brightness correction process is performed on different to-be-processed images using the same brightness correction parameter is different. The optimized image of a previous frame refers to the brightness optimized image corresponding to the previous frame, and the previous frame image is the
10 previous frame mentioned in the above step S101. In order to keep the brightness of the processed image corresponding to each video frame in the video streaming relatively stable in time series, the processed image and the optimized image of the previous frame can be inputted into the evaluation model, and the evaluation model is configured to output evaluation parameters. The brightness difference between the processed image and the
15 optimized image of the previous frame are indicated by the evaluation parameters, so as to use the evaluation parameters to evaluate whether the brightness of the processed image is consistent with the optimized image of the previous frame. The form of the evaluation parameters is not limited, for example, it may be a percentage.

[0081] In S107, whether the evaluation parameter is not within in a target range is
20 determined.

[0082] If the evaluation parameter is within in the target range, step S108 is performed. Otherwise, step S109 is performed.

[0083] In S108, the brightness correction parameter is updated, the gamma correction is performed on the data of the Y component for the pixels based on the updated correction
25 parameter to update the corrected data, the processed image is updated with the update corrected data, and the evaluation parameter is updated with the updated processed image, until the evaluation parameter is beyond the target range. The updated processed image is determined as the optimized image.

[0084] The target range refers to the range indicating the brightness of the processed image being inconsistent with the optimized image of the previous frame, and the brightness difference is large. Details about the target range and upper and lower limits are not limited. The evaluation parameter within the target range means that the brightness difference between the optimized image and the processed image of the previous frames is large, and the brightness optimization effect is poor, and it is determined to perform brightness correction on the to-be-processed image again. In view of this, the brightness correction parameter is updated to re-perform gamma brightness correction. That is, step S104 is performed again after updating the brightness correction parameter to obtain updated corrected data, and the processed image is updated with corrected data. Next, the evaluation parameter is updated, until the updated evaluation parameter is not in the target range. Finally, the brightness-optimized image is obtained.

[0085] In an embodiment, the brightness correction parameter is determined and the gamma brightness correction is performed in the above manner, the process of updating the brightness correction parameter may include the following step 61 and step 62.

[0086] In step 61, if the processed image is darker than the optimized image of the previous frame, the brightness correction parameter is decreased

[0087] In step 62, if the processed image is brighter than the optimized image of the previous frame, the brightness correction parameter is increased.

[0088] If the processed image is darker than the optimized image of the previous frame, and the evaluation parameter is in the target range, the brightness correction parameter is decreased to increase the brightness difference, which in turn leads to a decrease in the gamma parameter. Therefore, the brightness increases significantly. Otherwise, the brightness correction parameter is increased to reduce the brightness difference, and the gamma parameter is increased so that the image is brightened slightly.

[0089] Furthermore, in an embodiment, the evaluation model determines the benchmark brightness for brightness evaluation according to the user preference. That is, the brightness of the processed image matches not only the brightness of the optimized image of the previous

frame but also the benchmark. For example, the first video frame in the video streaming has no corresponding previous frame. The generated processed image of the first frame is compared with the benchmark brightness to determine whether to update the correction parameter and further determine the degree to what extent the subsequent brightness correction is to be performed. In addition, the user feedback on the processed image is also obtained, and then the evaluation model is trained so that the evaluation model can meet the user preference. Specifically, the method further includes the following steps 71 and 72.

[0090] In step 71, the processed image is outputted visually.

[0091] In step 72, user feedback on the processed image is acquired, training data is generated based on the user feedback, and the evaluation model is further trained based on the training data.

[0092] Details about the user feedback information are not limited herein. The training data includes the user feedback information and the processed images, and the evaluation model is further trained with the training data, so that the evaluation model can more accurately understand the user preference for image brightness.

[0093] Since the to-be-processed images are from the video streaming, the processed images corresponding to all the video frames in the video streaming form the optimized video streaming, and the optimized video streaming is visually outputted so that users can view videos with appropriate brightness.

[0094] In S109, the processed image is determined as a brightness-optimized image corresponding to the to-be-processed image if the evaluation parameter is not within in a target range.

[0095] The evaluation parameter not within the target range means that the brightness difference between the optimized image of the previous frame and the processed image is small, the brightness optimization effect is better, and there is no need to perform brightness correction on the to-be-processed image again. Therefore, the processed image is determined as the brightness optimized image of the to-be-processed image.

[0096] By applying the image processing method according to the embodiment of the present application, the to-be-processed image is converted into YUV format after obtained. The data of Y component represents the brightness of the image, through the conversion of the color format, the image color is less affected by the brightness correction. According to the data of Y component corresponding to each pixel in the to-be-processed image, the overall brightness of the to-be-processed image can be determined, and then the basis for brightness correction, that is, the brightness correction parameter, is determined. With the brightness correction parameter, the gamma brightness correction is performed on the data of Y component based on the conditions of the data of Y component, and the dark part of the to-be-processed image can be greatly improved, while the bright part can be slightly improved or not improved, so that the image is clear and natural. The obtained correction data is used to generate the second image and then converted to the RGB format to obtain the processed image. The evaluation model is trained based on the user needs and preferences for image brightness, and is spatially and temporally self-adaptive. The evaluation model can evaluate whether the brightness change of the processed image is better or not compared with the optimized image of the previous frame in the time series. The target range indicates an inappropriate brightness change of the processed image from the optimized image of the previous frame. The target range not within the target range shows that the brightness for the to-be-processed image is optimized appropriately, so that the processed image is determined as the brightness optimized image after optimizing the brightness, and the process for optimizing the to-be-processed image ends. The gamma brightness correction on different to-be-processed images is adapted to the brightness change of the scene of the video streaming based on the evaluation parameter, so that the brightness of the processed images is continuous in the time domain. The brightness of the video streaming remains generally stable throughout all the moments, and therefore users can have a better visual experience since all processed images each are corrected by the gamma brightness correction.

[0097] Based on the above-mentioned embodiments, this embodiment is described as an example. Firstly, reference is made to Figure 4 and Figure 5. Figure4 shows a to-be-processed image according to the embodiment of the present application. Figure 5 shows a processed

image obtained from a related processing method. It can be seen that the relevant processing method brightens the to-be-processed image as a whole including the bright part, resulting in poor image quality and loss of bright part information. Moreover, there is no correlation between image frames in the video streaming, and when the brightness of the external scene changes, the brightness of the processed video streaming also changes.

[0098] In order to solve the above problems, an image processing method is provided according to the present application. Figure 6 is a schematic flowchart showing conversion from an RGB format into a YUV format according to the embodiment of the present application. Firstly, the preset threshold β and the preset proportion (for generating y_max) are set, and the RGB image is inputted as the to-be-processed image, and then the to-be-processed image is processed. Specifically, the RGB information of each pixel is obtained and normalized to [0, 1] to obtain R' data, G' data and B' data, or R1 data, G1 data and B1 data. R' data, G' data and B' data are converted from gamma space to linear space respectively. The conversion is detailed as follows. When R' data, G' data or B' data are less than or equal to 0.04045, they are divided by 12.92. When RGB value is greater than 0.04045, the processing returns to $\text{pow}((\text{RGB}+0.055)/1.055, 2.4)$. That is:

$$\text{color2} = \frac{\text{color1}}{12.92}, \quad \text{color1} \leq 0.04045 \quad (1)$$

$$\text{color2} = \left(\frac{\text{color1} + 0.055}{1.055} \right)^{2.4}, \quad \text{color1} > 0.04045 \quad (2)$$

[0099] In the above formula, color1 is R' data, G' data and B' data, that is, the data corresponding to the normalized image. color2 is the data corresponding to the first transition image, which is divided into R" data, G" data and B" data, or R2 data, G2 data and B2 data.

[0100] After the conversion, contrast enhancement is performed to enhance the contrast of the image. The formula is as follow:

$$\text{color3} = \text{hdr mode} \times (\text{color2} / \text{hdr mode})^{\text{hdrGamma}} \quad (3)$$

[0101] In the above formula, hdrmode and hdrGamma are two constant parameters for adjusting the brightness of the image, and are greater than zero. hdrmode and hdrGamma are

set as required. Color3 is the data corresponding to the second transition image, and is divided into R''' data, G''' data and B''' data, or R3 data, G3 data and B3 data. When the value of color2 is 1.5857, the outputted image is the same as the original image. That is, in case of RGB<1.5857, the brightness of the image decreases, and in case of RGB>1.5857, the brightness of the image increases.

[0102] After the processing, the image is converted to gamma color space with the following formulas.

$$color4 = 12.92 \times color3, \quad color3 \leq 0.0031308 \quad (4)$$

$$color4 = 1.055 \times color3^{\frac{1.0}{2.4}} - 0.055, \quad color3 > 0.0031308 \quad (5)$$

[0103] In the above formulas, color4 is the data corresponding to the third transition image, and is divided into R'''' data, G'''' data and B'''' data, or R4 data, G4 data and B4 data.

[0104] The to-be-processed image is generated by multiplying color4 by 1.2 and then is mapped to the range [0, 255] as shown below:

$$color5 = 1.2 \times color4 \times 255 \quad (6)$$

[0105] In the formula above, color5 is the data corresponding to the to-be-processed image, and is divided into R''''' data, G''''' data and B''''' data, or R5 data, G5 data and B5 data. The obtained to-be-processed image, that is, the RGB image to be rendered is converted into YUV format as follows.

$$\begin{aligned} Y &= 0.299R + 0.587G + 0.114B \\ U &= -0.147R - 0.289G + 0.436B \\ V &= 0.615R - 0.515G - 0.100B \end{aligned} \quad (7)$$

[0106] The R data, G data and B data in formula (7) respectively refer to R5 data, G5 data and B5 data. The brightness correction parameter is obtained by obtaining the brightness Y component information of the image (that is, the data of Y component), analyzing and ranking the distribution of the brightness values of the image. The value of top 95% the brightness sequence from small to large is determined as the brightness correction parameter. The value

of the top 95% is the preset proportion. Assuming that the width and height of the image are w pixels and h pixels respectively, the brightness values of $w \times h$ pixels are recorded, and the frequency of occurrence of each brightness value is counted. The brightness values of 0 to 255 and the frequency of occurrence are ranking in ascending order of brightness values, and the brightness at the percent of the $w \times h \times 0.95$ brightness from small to large as the maximum brightness y_max . The reason why the largest brightness is determined as the maximum brightness is that most images have some pixels with brightness of 255, which results in failure to perform brightness correction. The gamma correction is performed as follows.

$$Y' = \left(\frac{Y}{255}\right)^{gamma} \times 255 \quad (8)$$

$$gamma = 1 - \beta \times (255 - y_max) / 255 \quad (9)$$

[0107] Y' is the corrected data. β ranges from 0 to 1. When the entire image is dark, y_max is smaller, and the gamma value is larger, and then the video is brightened significantly. When the image is normally bright, y_max approximates 255, the gamma value approximates 1, and then the image is brightened slightly. In practice, β is equal to 0.45. The U,V components remain unchanged, the $Y' U V$ image is formed and then is converted into an RGB image to obtain the rendered image, that is, the processed image. The conversion from YUV image to RGB image is as follows.

$$\begin{aligned} R &= Y + 1.140V \\ G &= Y - 0.394U - 0.581V \\ B &= Y + 2.032U \end{aligned} \quad (10)$$

[0108] Reference is made to Figure 7, which is a schematic flowchart of the image processing method according to the embodiment of the present application. The input video is processed by an adaptive algorithm, as shown in formula 11.

$$\tilde{H}_{out} = APA(H_{in}, \beta, y_max) \quad (11)$$

[0109] In formula 7, APA indicates the processing on the image by the adaptive algorithm, that is, the brightness correction. H_{in} indicates the input image. $\tilde{H}_{out}$ indicates the iterative

image obtained by the adaptive algorithm, that is, the processed image, which together with the previous frame of the to-be-processed image in the video streaming, that is, the optimized image of previous frames $\tilde{H}_{out(last)}$, are inputted into the evaluation network MASK. The evaluation network outputs a score. According to the score, it is determined whether the processed image is of the best quality and/or user expected brightness. If not, for example, in the target range, the system re-sends the original video to the adaptive algorithm for optimization. The video is optimized by adjusting β and y_max until the outputted result is the user expected, has the best quality, and the highest score. Then, the video is outputted, as shown in Formula 12.

$$\hat{H}_{out} = \max_{\beta, y_max} Marks(\tilde{H}_{out(last)}, APA(H_{in}, \beta, y_max)) \quad (12)$$

[0110] $\hat{H}_{out}$ is the final output result after iteration, that is, the optimized video streaming.

[0111] Reference is made to Figure 8 and Figure 9. Figure 8 is a diagram showing comparison between effects before and after image processing according to the embodiment of the present application. Figure 9 is a diagram showing comparison between effects before and after image processing according to the embodiment of the present application. The image a and the image b are video frames in the video streaming acquired by the anchor in a live video scene, and the image a1 and the image b1 are video frames in the optimized video streaming. It can be seen that in the image a1 in Figure 8, compared with the image a, the darker part of the face is brightened, so that the picture looks clear and natural, and the bright part of the original image is slightly or not adjusted adaptively. In the image b1 compared with the image b in Figure 9, the brightness of the darker scene behind the face is adaptively enhanced, making the picture look clear and natural.

[0112] Reference is made to Figure 10, which is a schematic diagram of an effect for optimizing a video streaming according to the embodiment of the present application. The graph shows the response curve of each pixel in the small image. It can be seen from the curve that the brightness correction method according to this application performs well in response to the time domain, and is continues and self-adaptive in the space domain.

[0113] The computer-readable storage medium according to the embodiment of the present application is introduced below. The computer-readable storage medium described below corresponds to the image processing method described above .

[0114] The present application also provides a computer-readable storage medium, on which a computer program is stored. When the computer program is executed by a processor, the steps of the above-mentioned image processing method are implemented.

[0115] The computer-readable storage medium may include: a U disk, a mobile hard disk, a read-only memory (ROM), a random access memory (RAM), a magnetic disk or an optical disk, etc., which can store program codes.

[0116] The above embodiments are described in a progressive manner. Each of the embodiments is mainly focused on describing its differences from other embodiments, and reference may be made among these embodiments with respect to the same or similar parts. Since the devices disclosed in the embodiment corresponds to the method disclosed in the embodiment, the description for the device is simple, and reference may be made to the method in the embodiment for the relevant parts.

[0117] Those skilled in the art should further appreciate that the units and algorithm steps of the examples described in conjunction with the embodiments disclosed herein may be implemented by electronic hardware, computer software, or a combination thereof. In order to clearly illustrate inter-replacement between the hardware and software, the components and steps of each example have been generally described according to their functions in the above description. Whether these functions are implemented by means of hardware or software depends on the specific application and design constraints of the technical solution. Those skilled in the art may implement the described function by using different methods for each particular application, but such implementation should not be considered as beyond the scope of the present disclosure.

[0118] The steps of the method or algorithm described in conjunction with the embodiments of the present disclosure may be implemented by hardware, a software module executed by a processor, or a combination thereof. The software module may be located in a

Random Access Memory (RAM), an internal memory, a Read Only Memory (ROM), an Electrically Programmable ROM, an Electrically-Erasable Programmable ROM, a register, a hard disk, a removable disk drive, a CD-ROM, or any other storage medium known in the art.

5 **[0119]** Finally, it should also be noted that in this specification, relationship terms such as "first" and "second" etc. are only used to distinguish one entity or operation from another, and do not necessarily require or imply that there is any such actual relationship or order between these entities or operations. Moreover, the terms "comprise", "include", or any other variation are intended to cover a non-exclusive inclusion such that a process, method, article, or apparatus comprising a set of elements includes not only those elements but also other
10 elements not expressly listed, and may also include elements inherent in such process, method, article, or apparatus.

15 **[0120]** In this specification, specific examples are used to illustrate the principles and implementations of the present disclosure. The above examples are only used to help understand the methods and core ideas of this application. Meanwhile, those skilled in the art may make changes in specific implementations and application scenarios based on concepts of the present disclosure. To sum up, the contents of this specification should not be construed as the limitation of the present application.

CLAIMS

1. An image processing method, comprising:

5 acquiring a to-be-processed image from video streaming, wherein the to-be-processed image is in an RGB format;

converting the to-be-processed image into a first image in a YUV format, and extracting data for a Y component of the first image;

generating a correction parameter for pixels in the first image based on the data for the Y component of the first image;

10 performing gamma correction on the data for the Y component for the pixels based on the correction parameter to obtain corrected data;

replacing the data for the Y component with the corrected data to obtain a second image, and converting the second image into a processed image in the RGB format;

15 inputting the processed image and an optimized image of a previous image into an evaluation model to obtain an evaluation parameter indicating a brightness difference between the processed image and the optimized images; and

determining the processed image as an optimized image corresponding to the to-be-processed image if the evaluation parameter is beyond a target range.

20 2. The image processing method according to claim 1, wherein the acquiring the to-be-processed image from the video streaming comprises:

acquiring an initial image from the video streaming based on the previous image, and normalizing the initial image to obtain a normalized image;

mapping the normalized image onto a linear color space to obtain a first transition image;

25 heightening contrast for each color component in the first transition image to obtain a second transition image;

mapping the second transition image onto a gamma color space to obtain a third transition image; and

de-normalizing the third transition image to obtain the to-be-processed image.

3. The image processing method according to claim 1, wherein the generating the correction parameter for the pixels in the first image based on the data for the Y component of the first image comprises:

5 ranking the data for the Y component for the pixels in order of sizes or frequencies to obtain a data queue; and

determining target data corresponding to a preset proportion in the data queue as the correction parameter.

10 4. The image processing method according to claim 1, wherein the generating the correction parameter for the pixels in the first image based on the data for the Y component of the first image comprises:

determining respective adjacent ranges for the pixels;

ranking the data for the Y component of the pixels and adjacent pixels within the respective adjacent ranges in order of sizes or frequencies to obtain a data queue; and

15 determining target data corresponding to a preset proportion in the data queue as the correction parameter.

5. The image processing method according to claim 1, wherein the performing the gamma correction on the data for the Y component for the pixels based on the correction parameter to obtain the corrected data comprises:

20 generating a power inversely proportional to a difference between maximum brightness and the correction parameter based on the difference, and performing the gamma correction on the data for the Y component based on the power to obtain the corrected data.

25 6. The image processing method according to claim 5, wherein the generating the power inversely proportional to the difference between maximum brightness and the correction parameter based on the difference and performing the gamma correction on the data for the Y component based on the power to obtain the corrected data comprises:

generating the difference between the maximum brightness and the correction parameter, wherein the difference is greater than zero;

generating the power based on the difference and a preset threshold, wherein the power is inversely proportional to the difference and is greater than zero;

solving a power function, wherein a base of the power function is a ratio of the data for the Y component to the maximum brightness and an exponent of the power function is the power; and

5 multiplying the solution of the power function by the maximum brightness to obtain the corrected data.

7. The image processing method according to claim 1, further comprising:

10 if the evaluation parameter is within the target range, updating the correction parameter, performing the gamma correction on the data for the Y component for the pixels based on the updated correction parameter to update the corrected data; updating the processed image with the update corrected data, and updating the evaluation parameter with the updated processed image, until the evaluation parameter is beyond the target range; and

determining the updated processed image as the optimized image.

8. The image processing method according to claim 7, wherein the updating the correction parameter comprises:

15 decreasing the correction parameter if the processed image is darker than the optimized image of the previous image; and

increasing the correction parameter if the processed image is brighter than the optimized image of the previous image.

9. The image processing method according to claim 1, further comprising:

20 outputting the processed image visually; and

acquiring user feedback on the processed image, generating training data based on the user feedback, and training the evaluation model with the training data.

10. The image processing method according to claim 1 further comprising:

25 generating optimized video streaming from processed images of all images in the video streaming and outputting the optimized video streaming visually.

11. An electronic device comprising:

a memory configured to store a computer program; and

a processor configured to execute the computer program to implement the image

processing method according to any one of claims 1 to 10.

12. A computer-readable medium storing a computer program that, when executed by a processor, implements the image processing method according to any one of claims 1 to 10.