SUPER-RESOLUTION IMAGE RECONSTRUCTION METHOD AND APPARATUS, COMPUTER DEVICE, AND STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 202010862957.2, titled "METHOD AND APPARATUS FOR RECONSTRUCTING SUPER-RESOLUTION IMAGE, COMPUTER DEVICE, AND STORAGE MEDIUM", filed on August 25, 2020 with the China National Intellectual Property Administration (CNIPA), which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to a method and an apparatus for reconstructing a super-resolution image, a computer device and a storage medium.

BACKGROUND

[0003] Image super-resolution technology aims to reconstruct a high-resolution image from a single low-resolution image. In the past ten years, this technology is widely used in the fields such as high-definition images and surveillance video, and has made great progress.

[0004] According to the conventional technology, the image super-resolution is based on depth learning and may be implemented in the following two ways. One way is to directly learn the mapping from a low-resolution image to a high-resolution image, and the other way is to perform adaptive filtering on pixels.

SUMMARY

[0005] A method for reconstructing a super-resolution image is provided according to a first aspect of the present disclosure. The method includes:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed

image according to the image feature information;

combining preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image.

[0006] A method for image de-noising and de-compression of JPEG is provided according to a second aspect of the present disclosure. The method includes:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image.

[0007] An apparatus for reconstructing a super-resolution image is provided according to a third aspect of the present disclosure. The apparatus includes:

an image acquisition module, configured to acquire an initial-resolution image of a to-be-processed image;

a feature extraction module, configured to extract image feature information of the to-be-processed image, and determine multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

a filter combination module, configured to combine preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

an image reconstruction module, configured to filter pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image.

[0008] A computer device is provided according to a fourth aspect of the present disclosure. The computer device includes a memory and a processor. The memory stores a computer program. The processor, when executing the computer program, implements the following steps:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image.

[0009] A computer-readable storage medium is provided according to a fifth aspect of the present disclosure. The computer-readable storage medium stores a computer program. The computer program, when being executed by a processor, causes the following steps to be implemented:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image

through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image.

[0010] Details of one or more embodiments of the present disclosure are provided in the drawings and descriptions below. Other features and advantages of the present disclosure become clearer from the specification, drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In order to illustrate the embodiments of the present disclosure or technical solutions in the conventional technology more clearly, drawings to be used in the description of the embodiments or the conventional technology are introduced simply hereinafter. It is apparent that the drawings described below only illustrate some embodiments of the present disclosure. For those skilled in the art, other drawings may be obtained according to these drawings without any creative work.

[0012] Figure 1 is a diagram showing an application environment of a method for reconstructing a super-resolution image according to an embodiment of the present disclosure;

[0013] Figure 2 is a schematic flow chart of a method for reconstructing a super-resolution image according to an embodiment of the present disclosure;

[0014] Figure 3 is a schematic diagram showing that image feature information of a to-be-processed image is extracted through a predefined network according to an embodiment of the present disclosure;

[0015] Figure 4 is a schematic diagram showing a predefined filtering parameter information table according to an embodiment of the present disclosure;

[0016] Figure 5 is a schematic diagram showing a process to acquire a Gaussian filter according to an embodiment of the present disclosure;

[0017] Figure 6 is a schematic diagram showing a process to acquire a target filter according to an embodiment of the present disclosure;

[0018] Figure 7 is a schematic flow chart of filtering processing according to an embodiment of the present disclosure;

[0019] Figure 8 is a schematic flow chart of extracting image feature information of a

to-be-processed image according to an embodiment of the present disclosure;

[0020] Figure 9 is a schematic flow chart of extracting first image feature information of a to-be-processed image through a residual network according to an embodiment of the present disclosure;

[0021] Figure 10 is a structural block diagram of an apparatus for reconstructing a super-resolution image according to an embodiment of the present disclosure; and

[0022] Figure 11 is a schematic diagram showing an internal structure of a computer device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0023] Although the method for reconstructing an image based on deep learning according to the conventional technology has a good image restoration effect, it has a high model complexity, a large demand for computing power and a slow reasoning speed. Therefore, the method for reconstructing a super-solution image according to the conventional technology still has a low efficiency.

[0024] In order to make the objectives, technical solutions and advantages of the present disclosure clearer, the present disclosure is described in detail in conjunction with the drawings and embodiments hereinafter. It should be understood that the specific embodiments described herein are merely used for explaining the present disclosure, and are not intended to limit the present disclosure.

[0025] The method for reconstructing a super-resolution image according to the present disclosure may be applied to the application environment shown in Figure 1. A terminal 11 communicates with a server 12 through a network. The server 12 acquires a to-be-processed image sent by the terminal 11 through the network. The server 12 acquires an initial-resolution image of the to-be-processed image. The server 12 extracts image feature information of the to-be-processed image, and determines multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information. The server 12 combines preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image. The server 12 filters pixel information of

corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be processed image. The server 12 returns the super-resolution image of the to-be processed image to the terminal 11 to complete the reconstruction of the super-resolution image. The terminal 11 may be, but is not limited to, various personal computers, laptops, smartphones, tablets and portable wearable devices. The server 12 may be implemented by an independent server or a server cluster formed by multiple servers.

[0026] As shown in Figure 2, a method for reconstructing a super-resolution image is provided according to an embodiment. The method is illustrated with an example that the method is applied to the server 12 in Figure 1, and the method includes the following steps 21 to 24.

[0027] In step 21, an initial-resolution image of a to-be-processed image is acquired.

[0028] The to-be-processed image is a single low-resolution (LR) image. The initial-resolution image is an initial high-resolution (HR) image acquired by performing a simple interpolation on the single low-resolution image.

[0029] The terminal sends a request for reconstructing a super-resolution image to the server. The request carries the low-resolution image which is to be processed in the reconstruction of a super-resolution image. The low-resolution image may be a single image or in a form of a data set formed by multiple images. After verifying the request for reconstructing a super-resolution image sent by the terminal, the server extracts the to-be-processed image with a low resolution from the request for reconstructing a super-resolution image. Moreover, the server may acquire a storage address and a list of the to-be-processed image from the request, and the server acquires the image from the storage address provided by the terminal according to the list of the to-be-processed image.

[0030] After acquiring the low-resolution image which is to be processed in the construction of a super-resolution image, the server preliminarily processes the low-resolution to-be-processed image by an interpolation algorithm, to acquire the initial-resolution image. The interpolation algorithm may be nearest neighbour interpolation, bilinear interpolation, bicubic interpolation, or the like. The initial-resolution image acquired by interpolating the to-be-processed image has a resolution higher than the resolution of the to-be-processed image, and the initial-resolution image is then filtered by subsequent target filters to acquire

the super-resolution image.

[0031] In this step 21, the server acquires the to-be-processed image from the terminal, and preliminarily processes the to-be-processed image to acquire the initial-resolution image. The initial-resolution image may be directly used in the subsequent filtering processing, thereby improving a reconstruction efficiency of the super-resolution image.

[0032] In step 22, image feature information of the to-be-processed image is extracted, and multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image are determined according to the image feature information.

[0033] Specifically, the image feature information of the to-be-processed image is extracted through a predefined network shown in Figure 3, and multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image are further determined according to the image feature information.

[0034] The predefined network may further be divided into three parts, namely, a local fusion part, a pixel shuffle part, and a convolution part.

[0035] The local fusion part is formed by multiple local fusion units. Each of the local fusion units is a local fusion block (LFB) based on efficient residual learning. Each of the local fusion units is able to extract an image feature of the to-be-processed image, and perform a deep residual learning. A structure of the local fusion unit is shown in an expansion box in the lower part of Figure 3. The local fusion unit mainly includes the following two branches. One branch passes through multiple residual blocks (RB), and outputs of the multiple residual blocks are connected together to pass through a convolution layer (Conv) to be multiplied by a parameter δ_2. The other branch is directly multiplied by a parameter δ_1. Finally, a sum of outputs of the two branches is calculated as an output of one local fusion unit.

[0036] The pixel shuffle part is formed by a pixel shuffle component, and is able to convert a low-resolution image feature into a high-resolution image feature.

[0037] The convolution part is able to perform a convolution operation, make a linear combination coefficient regress, and output the linear combination coefficient as multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image.

Three dimensions of the filtering parameters are H_S, Ws, and L respectively, where H represents a height of the image, W represents a width of the image, s represents a magnification, and L represents a quantity of the preset filters.

[0038] In this step 22, the image feature information of the to-be-processed image is extracted through the predefined network including the local fusion part, the pixel shuffle part and the convolution part. After acquiring the image feature information, the corresponding filtering parameters are further acquired. In this way, the quantity of models is reduced, the computation speed is improved, and the modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0039] In step 23, the preset filters are combined according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image.

[0040] Figure 4 is a schematic diagram of a predefined filtering parameter information table in the present disclosure, that is, a predefined filter dictionary. The filtering parameter information table includes multiple preset filters, and the quantity of the preset filters is the same as the quantity of the multiple filtering parameters corresponding to each of pixel positions. The predefined filtering parameter information table includes two types of filters, that is, a Gaussian filter and a difference of Gaussians filter. The difference of Gaussians filter is acquired by a difference between two Gaussian filters.

[0041] Figure 5 shows a way to acquire a Gaussian filter.

[0042] First, a standard circular filter is changed into an ellipse by controlling a length σ_1 of a semi-major axis and a length σ_2 of a semi-minor axis; then, the ellipse is rotated counterclockwise by θ, to acquire an ellipse inclined at a certain angle; and last, the length σ_1 of the semi-major axis and the length σ_2 of the semi-minor axis of the ellipse are simultaneously adjusted, that is, the length σ_1 of the semi-major axis and the length σ_2 of the semi-minor axis are both multiplied by a coefficient γ, so as to scale on the ellipse and acquire a final result.

[0043] Figure 4 shows a coefficient of each filter in detail. The coefficient γ may be equal to 1.0, 0.6 or 0.2. r represents a ratio of the length of the semi-major axis to the length of the semi-minor axis (that is, σ_2 divided by σ_1), and may be equal to 1.0, 0.8, 0.6, 0.4 or 0.2. θ represents a rotation angle, and may be equal to 0, 30, 60, 90, 120 or 150 degrees.

[0044] Figure 6 is a schematic diagram showing that multiple preset filters are combined to acquire a target filter.

[0045] The server may combine the preset filters with the multiple filtering parameters corresponding to each of pixel positions according to the predefined filtering parameter information table, to acquire the target filter corresponding to the pixel position.

[0046] In this step 23, the filtering parameters are combined with the preset filters according to the pixel position, to acquire the target filter corresponding to the pixel position in the to-be-processed image. The initial-resolution image of the to-be-processed image is filtered by multiple target filters corresponding to all the pixel positions, to acquire the super-resolution image. In this way, the quantity of models is reduced, the computation speed is improved, and the modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0047] In step 24, pixel information of corresponding pixel positions in the initial-resolution image is filtered through the multiple target filters, to acquire the super-resolution image of the to-be-processed image.

[0048] The filtering is a common processing method in image processing. Different combinations of filters corresponding to each pixel may be acquired in steps in Figure 6. The filters are applied to the initial-resolution image acquired through an interpolation processing, to acquire the final result.

[0049] Figure 7 shows a schematic diagram of filtering processing. As shown in Figure 7, the initial-resolution image of the to-be-processed image serves as an input, and the target filter corresponding to the pixel position in the to-be-processed image serves as a filtering processing device. The initial-resolution image is filtered once, to acquire the super-resolution image HR-Y, and the super-resolution image HR-Y serves as a result of the super-resolution image reconstruction.

[0050] According to the embodiment, the method for reconstructing an super-resolution image has a good image restoration effect through once filtering. Moreover, the quantity of models is reduced, the computation speed is improved, and the modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0051] In the above method for reconstructing a super-resolution image, an initial-resolution image of a to-be-processed image is acquired; image feature information of the to-be-processed image is extracted; multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image are determined according to the image feature information; preset filters are combined according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and pixel information of corresponding pixel positions in the initial-resolution image is filtered through multiple target filters corresponding to all the pixel positions, to acquire the super-resolution image of the to-be-processed image. In this present disclosure, the multiple filtering parameters corresponding to each of pixel positions of the to-be-processed image are combined with the preset filters to acquire the target filter, and then multiple target filters are used to filter the initial-resolution image of the to-be-processed image to acquire a super-resolution image. With the new strategy for reconstructing a super-resolution image proposed by the present disclosure, a good image restoration effect can be realized through once filtering. Moreover, the quantity of models is reduced, the computation speed is greatly improved, and the entire modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0052] In an embodiment, as shown in Figure 8, the step 22 of extracting image feature information of the to-be-processed image includes the following steps 81 and 82.

[0053] In step 81, first image feature information of the to-be-processed image is extracted through a residual network.

[0054] In step 82, pixel shuffle is performed on the first image feature information to acquire second image feature information corresponding to the first image feature information, and the second image feature information is determined as image feature information of the to-be-processed image. Image resolution corresponding to the second image feature information is higher than image resolution corresponding to the first image feature

information.

[0055] As shown in Figure 3, the local fusion unit serves as the residual network, and includes one or more cascaded residual blocks, splicing layers connected in series, convolution layers connected in series, a channel separation module and the like. An input of the residual blocks is connected to an output of feature extraction. A feature fusion module extracts a feature image inputted into the residual block and a feature image outputted by a last stage residual block, fuses feature images at different stages, and outputs a fused feature image to a next residual network, until the iterative training is completed.

[0056] After acquiring a deep feature extracted from the image block by the multi-stage residual networks, the pixel shuffle module shuffles the feature images to improve the resolution of the image. Then, the convolution layer may be used to make the linear combination coefficient regress, to acquire multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image.

[0057] According to the embodiment, the first image feature information is acquired through the residual network, pixel shuffle is performed on the first image feature information to acquire the second image feature information, so as to acquire an entire image feature information of the to-be-processed image, which has a good image restoration effect. Moreover, the quantity of models is reduced, the computation speed is greatly improved, and the modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0058] In an embodiment, as shown in Figure 9, the above step 71 of extracting the first image feature information of the to-be-processed image through the residual network includes the following steps 91 and 92.

[0059] In step 91, the to-be-processed image is divided into multiple image blocks each with a same size.

[0060] In step 92, feature information of the multiple image blocks is extracted through multiple residual branches in the residual network and serves as the first image feature information of the to-be-processed image.

[0061] Specifically, the to-be-processed image is divided into multiple image blocks each with a same quantity of pixels. The image blocks are respectively inputted into the residual

network, feature extraction is performed through the residual network to acquire feature information of the multiple image blocks, and the feature information serves as the first image feature information of the to-be-processed image. In the embodiment, the image is divided into multiple image blocks, which improves the processing speed of image.

[0062] In an embodiment, the above step 22 of acquiring the initial-resolution image of the to-be-processed image is performed as follows. The to-be-processed image is acquired, and linear interpolation is performed on the to-be-processed image. An image processed through the linear interpolation is determined as the initial-resolution image.

[0063] Specifically, the server acquires the to-be-processed image, and performs linear interpolation on the to-be-processed image, for example, magnifies the to-be-processed image through the bicubic interpolation, to acquire the initial-resolution image of the to-be-processed image. In this embodiment, a preliminary high-resolution image may be acquired through a simple linear interpolation, which uses less data and fewer model units, and has simple configuration and faster running speed.

[0064] In an embodiment, the above step 22 of determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information is performed as follows. Convolution is performed on the image feature information, to acquire a combination coefficient corresponding to the pixel position in the to-be-processed image. The combination coefficient includes the multiple filtering parameters corresponding to the pixel position.

[0065] Specifically, the combination coefficient corresponding to the pixel position in the to-be-processed image may be acquired through convolution. The combination coefficient includes the multiple filtering parameters corresponding to the pixel position, and three dimensions of the combination coefficient are Hs, Ws, and L, where H represents a height of the image, W represents a width of the image, s represents a magnification, and L represents the quantity of the preset filters. In the embodiment, the combination coefficient regresses through a simple convolution, to acquire multiple filtering parameters corresponding to the pixel position in the to-be-processed image. Then, the multiple filtering parameters corresponding to the pixel position in the to-be-processed image are combined with the preset filters to acquire the target filter, and then the initial-resolution image of the to-be-processed image is filtered by multiple target filters to acquire the super-resolution image. In this way, a

good image restoration effect can be realized through once filtering. Moreover, the quantity of models is reduced, the computation speed is improved, and the modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0066] In an embodiment, the step of combining the preset filters according to the multiple filtering parameters corresponding to each of pixel positions to acquire the target filter corresponding to the pixel position in the to-be-processed image are performed as follows. Multiple preset filters corresponding to the multiple filtering parameters are determined based on the predefined filtering parameter information table. The multiple preset filters corresponding to the filtering parameters are linearly weighted to acquire the target filter corresponding to the pixel position in the to-be-processed image.

[0067] The predefined filtering parameter information table is actually a predefined dictionary. It is assumed that the dictionary includes L filters, image feature information of the image is extracted, to acquire L coefficients for each of pixel positions of the image. For each of the coefficients, the coefficient is multiplied by a preset filter corresponding to the coefficient in the predefined filtering parameter information table, and a sum of multiplication results of the L coefficients and corresponding preset filters is determined as a final filter corresponding to each pixel. The final filter serves as the target filter corresponding to the pixel position in the to-be-processed image. In the embodiment, multiple filtering parameters corresponding to each of pixel positions of the to-be-processed image are combined with the preset filters to acquire the target filter, and then the initial-resolution image of the to-be-processed image is filtered by multiple target filters to acquire the super-resolution image. In this way, a good image restoration effect can be realized through once filtering. Moreover, the quantity of models is reduced, the computation speed is greatly improved, and the modeling framework is easy to be optimized, thereby improving the reconstruction efficiency of the super-resolution image.

[0068] In an embodiment, the target filter may be acquired from the following equation:

$$\mathrm{F}_i = \sum_{l=1}^{L} \Phi_{i,l} D_l ,$$

where, F_i represents a single target filter, D represents the predefined filtering parameter information table, L represents the quantity of the preset filters in the predefined

filtering parameter information table, and Φ represents filtering parameters.

[0069] For each of the coefficients, the coefficient is multiplied by a preset filter corresponding to the coefficient in the predefined filtering parameter information table, and a sum of multiplication results of the coefficients and corresponding preset filters is determined as a final filter corresponding to each pixel. The final filter serves as the target filter corresponding to the pixel position in the to-be-processed image. In the embodiment, multiple filtering parameters corresponding to each of pixel position of the to-be-processed image are combined with the preset filters to acquire the target filter, which improves the reconstruction efficiency of the super-resolution image.

[0070] In an embodiment, the method for reconstructing a super-resolution image according to the present disclosure may further be used for image de-noising and image de-compression of JPEG.

[0071] The processes of the image de-noising and the image de-compression of JPEG are the same as the processes in the method for reconstructing a super-resolution image, in which it is only required to remove steps of performing linear interpolation on the to-be-processed image and performing pixel shuffle on the first image feature information, since the image de-noising and the image de-compression of JPEG are not required to be performed up sampling and the input and output are the same in size.

[0072] It is to be understood that, although steps in the flow charts of Figure 2, Figures 8 and 9 are sequentially showed according to an indication of arrows, the steps are not necessarily sequentially performed in the sequence indicated by the arrows. Unless otherwise explicitly specified in this specification, execution of the steps is not strictly limited in a certain order, and the steps may be performed in other sequences. In addition, at least some steps in Figure 2, Figures 8 and 9 may include multiple steps or multiple stages. The steps or the stages are not necessarily performed at the same moment, and instead may be performed at different moments. The steps or the stages are not necessarily performed sequentially, and instead may be performed in turn or alternately with other step or at least some of steps or stages of other step.

[0073] In an embodiment, as shown in Figure 10, an apparatus for reconstructing a super-resolution image is provided. The apparatus includes an image acquisition module 101, a feature extraction module 102, a filter combination module 103 and an image reconstruction

module 104.

[0074] The image acquisition module 101 is configured to acquire an initial-resolution image of a to-be-processed image.

[0075] The feature extraction module 102 is configured to extract image feature information of the to-be-processed image, and determine multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information.

[0076] The filter combination module 103 is configured to combine preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image.

[0077] The image reconstruction module 104 is configured to filter pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire the super-resolution image of the to-be-processed image.

[0078] In an embodiment, the feature extraction module 102 is further configured to extract first image feature information of the to-be-processed image through a residual network; and perform pixel shuffle on the first image feature information to acquire second image feature information corresponding to the first image feature information, and determine the second image feature information as image feature information of the to-be-processed image. Image resolution corresponding to the second image feature information is higher than image resolution corresponding to the first image feature information.

[0079] In an embodiment, the feature extraction module 102 is further configured to divide the to-be-processed image into multiple image blocks each with a same size; and extract, through multiple residual branches in the residual network, feature information of the multiple image blocks as the first image feature information of the to-be-processed image.

[0080] In an embodiment, the feature extraction module 102 is further configured to acquire the to-be-processed image; and perform linear interpolation on the to-be-processed image, and determine an image processed through the linear interpolation as the initial-resolution image.

[0081] In an embodiment, the feature extraction module 102 is further configured to convolute the image feature information to acquire a combination coefficient corresponding to

the pixel position in the to-be-processed image. The combination coefficient includes the multiple filtering parameters corresponding to the pixel position.

[0082] In an embodiment, the filter combination module 103 is further configured to determine multiple preset filters corresponding to the multiple filtering parameters based on a predefined filtering parameter information table; and linearly weight the multiple preset filters corresponding to the multiple filtering parameters, to acquire the target filter corresponding to the pixel position in the to-be-processed image.

[0083] In an embodiment, the filter combination module 103 is further configured to acquire the target filter from the following equation:

$$\mathrm{F}_i = \sum_{l=1}^{L} \Phi_{i,l} D_l ,$$

where, F_i represents a single target filter, D represents the predefined filtering parameter information table, L represents the quantity of the preset filters in the predefined filtering parameter information table, and Φ represents the filtering parameters.

[0084] For the specific descriptions of the apparatus for reconstructing a super-resolution image, reference may made to the above descriptions of the method for reconstructing a super-resolution image, which are not repeated herein. The modules in the above apparatus for reconstructing a super-resolution image may be implemented in whole or in part by software, hardware, and a combination thereof. Each of the above modules may be embedded in or independent of a processor in the computer device in a hardware form, or may be stored in a memory in the computer device in a software form, so as to be called by the processor to perform operations corresponding to the above modules.

[0085] A computer device is provided according to an embodiment. The computer device may be a server, and an internal structure of the computer device may be as shown in Figure 11. The computer device includes a processor, a memory, and a network interface that are connected to a system bus. The processor of the computer device is used to provide computing and control capabilities. The memory of the computer device includes a non-volatile storage medium and an internal memory. The non-volatile storage medium stores an operating system, a computer program, and a database. The internal memory provides an environment for the operation of the operating system and the computer program in the

non-volatile storage medium. The database of the computer device is used to store data for reconstructing a super-resolution image. The network interface of the computer device is used to communicate with external terminals through network connection. The computer program is executed by the processor to implement a method for reconstructing a super-resolution image.

[0086] Those skilled in the art may understand that the structure shown in Figure 11 is only a block diagram of a partial structure related to the solution of this disclosure, and is not considered as a limitation to the computer device to which the solution of this disclosure is applied. Specifically, the computer device may include more or fewer components than those shown in Figure 11, or may combine with some components, or may arrange a different component.

[0087] A computer device is provided according to an embodiment. The computer device includes a memory and a processor. The memory stores a computer program, and the processor, when executing the computer program, performs the following steps:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image.

[0088] In an embodiment, the processor, when executing the computer program, is further configured to perform the following steps: extracting first image feature information of the to-be-processed image through a residual network; and performing pixel shuffle on the first image feature information, to acquire second image feature information corresponding to the first image feature information, and determining the second image feature information as image feature information of the to-be-processed image. Image resolution corresponding to

the second image feature information is higher than image resolution corresponding to the first image feature information.

[0089] In an embodiment, the processor, when executing the computer program, is further configured to perform the following steps: dividing the to-be-processed image into multiple image blocks each with a same size; and extracting, through multiple residual branches in the residual network, feature information of the multiple image blocks as the first image feature information of the to-be-processed image.

[0090] In an embodiment, the processor, when executing the computer program, is further configured to perform the following steps: acquiring the to-be-processed image; and performing linear interpolation on the to-be-processed image, and determining an image processed through the linear interpolation as the initial-resolution image.

[0091] In an embodiment, the processor, when executing the computer program, is further configured to perform the following steps: convoluting the image feature information, to acquire a combination coefficient corresponding to the pixel position in the to-be-processed image. The combination coefficient includes the multiple filtering parameters corresponding to the pixel position.

[0092] In an embodiment, the processor, when executing the computer program, is further configured to perform the following steps: determining multiple preset filters corresponding to the multiple filtering parameters based on a predefined filtering parameter information table; and linearly weighting the multiple preset filters corresponding to the multiple filtering parameters, to acquire the target filter corresponding to the pixel position in the to-be-processed image.

[0093] In an embodiment, the processor, when executing the computer program, is further configured to perform the following steps: acquiring the target filter from the following equation:

$$\mathrm{F}_i = \sum_{l=1}^{L} \Phi_{i,l} D_l ,$$

where, F_i represents a single target filter, D represents the predefined filtering parameter information table, L represents the quantity of the preset filters in the predefined filtering parameter information table, and Φ represents the filtering parameters.

[0094] A computer-readable storage medium is provided according to an embodiment. The computer-readable storage medium stores a computer program. The computer program, when being executed by a processor, causes the following steps to be implemented:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining multiple filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the multiple filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through multiple target filters corresponding to all the pixel positions, to acquire the super-resolution image of the to-be-processed image.

[0095] In an embodiment, the computer program, when being executed by the processor, further causes the following steps to be implemented:

extracting first image feature information of the to-be-processed image through a residual network; and

performing pixel shuffle on the first image feature information to acquire second image feature information corresponding to the first image feature information, and determining the second image feature information as image feature information of the to-be-processed image. Moreover, image resolution corresponding to the second image feature information is higher than image resolution corresponding to the first image feature information.

[0096] In an embodiment, the computer program, when being executed by the processor, further causes the following steps to be implemented:

dividing the to-be-processed image into multiple image blocks each with a same size; and

extracting, through multiple residual branches in the residual network, feature information of the multiple image blocks as the first image feature information of the to-be-processed image.

[0097] In an embodiment, the computer program, when being executed by the processor,

further causes the following steps to be implemented:

acquiring the to-be-processed image; and

performing linear interpolation on the to-be-processed image, and determining an image processed through the linear interpolation as the initial-resolution image.

[0098] In an embodiment, the computer program, when being executed by the processor, further causes the following steps to be implemented: convoluting the image feature information to acquire a combination coefficient corresponding to the pixel position in the to-be-processed image. The combination coefficient includes the multiple filtering parameters corresponding to the pixel position.

[0099] In an embodiment, the computer program, when being executed by the processor, further causes the following steps to be implemented:

determining multiple preset filters corresponding to the multiple filtering parameters based on a predefined filtering parameter information table; and

linearly weighting the multiple preset filters corresponding to the multiple filtering parameters, to acquire the target filter corresponding to the pixel position in the to-be-processed image.

[0100] In an embodiment, the computer program, when being executed by the processor, further causes the following steps to be implemented: acquiring the target filter from the following equation:

$$\mathrm{F}_i = \sum_{l=1}^{L} \Phi_{i,l} D_l ,$$

where, F_i represents a single target filter, D represents the predefined filtering parameter information table, L represents the quantity of the preset filters in the predefined filtering parameter information table, and Φ represents the filtering parameters.

[0101] Those skilled in the art may understand that all or some of the procedures of the method in the foregoing embodiments may be implemented by a computer program instructing relevant hardware. The computer program may be stored in a non-volatile computer-readable storage medium. When the computer program is executed, the procedures of the foregoing method embodiments may be implemented. Any reference to a memory,

storage, a database, or another medium used in the embodiments provided in this disclosure may include a non-volatile and/or volatile memory. The non-volatile memory may include a read-only memory (ROM), a magnetic tape, a floppy disk, a flash memory or an optical memory. The volatile memory may include a random access memory (RAM), or an external cache memory. As an illustration rather than a limitation, RAM may be in multiple forms, such as a static random access memory (SRAM) or a dynamic random access memory (DRAM).

[0102] The technical features in the foregoing embodiments may be randomly combined. For concise description, not all possible combinations of the technical features in the embodiments are described. However, the combinations of the technical features are to be considered as falling within the scope recorded in this specification provided that they do not conflict with each other.

[0103] The foregoing embodiments only show several implementations of the present disclosure and are described in detail, but they are not to be construed as a limit to the patent scope of the present disclosure. It should be noted that those skilled in the art may further make variations and improvements without departing from the ideas of the present disclosure, and all the variations and improvements fall within the protection scope of the present disclosure. Therefore, the protection scope of this present disclosure shall be subject to the protection scope of the appended claims.

CLAIMS

1. A method for reconstructing a super-resolution image, comprising:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining a plurality of filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the plurality of filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through a plurality of target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image;

wherein the determining the plurality of filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information comprises:

convoluting the image feature information to acquire a combination coefficient corresponding to each of pixel positions in the to-be-processed image, wherein the combination coefficient comprises the plurality of filtering parameters corresponding to the pixel position;

wherein the combining preset filters according to the plurality of filtering parameters corresponding to each of pixel positions to acquire a target filter corresponding to the pixel position in the to-be-processed image comprises:

determining a plurality of preset filters corresponding to the plurality of filtering parameters based on a predefined filtering parameter information table; and

linearly weighting the plurality of preset filters corresponding to the plurality of filtering parameters, to acquire the target filter corresponding to the pixel position in the to-be-processed image.

2. The method according to claim 1, wherein the extracting image feature information of

the to-be-processed image comprises:

extracting first image feature information of the to-be-processed image through a residual network; and

performing pixel shuffle on the first image feature information to acquire second image feature information corresponding to the first image feature information, and determining the second image feature information as the image feature information of the to-be-processed image; wherein image resolution corresponding to the second image feature information is higher than image resolution corresponding to the first image feature information.

3. The method according to claim 2, wherein the extracting first image feature information of the to-be-processed image through a residual network comprises:

dividing the to-be-processed image into a plurality of image blocks each with a same size; and

extracting, through a plurality of residual branches in the residual network, feature information of the plurality of image blocks as the first image feature information of the to-be-processed image.

4. The method according to claim 1, wherein the acquiring an initial-resolution image of a to-be-processed image comprises:

acquiring the to-be-processed image; and

performing linear interpolation on the to-be-processed image, and determining an image processed through the linear interpolation as the initial-resolution image.

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5. The method according to claim 1, wherein the target filter is acquired from the following equation:

$$\mathrm{F}_i = \sum_{l=1}^{L} \Phi_{i,l} D_l ,$$

wherein, F_i represents a single target filter, D represents the predefined filtering parameter information table, L represents a quantity of preset filters in the predefined filtering parameter information table, and Φ represents the filtering parameters.

6. A method for image de-noising and de-compression of JPEG comprising:

acquiring an initial-resolution image of a to-be-processed image;

extracting image feature information of the to-be-processed image, and determining a plurality of filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

combining preset filters according to the plurality of filtering parameters corresponding to each of pixel positions, to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

filtering pixel information of corresponding pixel positions in the initial-resolution image through a plurality of target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image;

wherein the determining the plurality of filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information comprises:

convoluting the image feature information to acquire a combination coefficient corresponding to each of pixel positions in the to-be-processed image, wherein the combination coefficient comprises the plurality of filtering parameters corresponding to the pixel position; and

wherein the combining preset filters according to the plurality of filtering parameters corresponding to each of pixel positions to acquire a target filter corresponding to the pixel position in the to-be-processed image comprises:

determining a plurality of preset filters corresponding to the plurality of filtering parameters based on a predefined filtering parameter information table; and

linearly weighting the plurality of preset filters corresponding to the plurality of filtering parameters, to acquire the target filter corresponding to the pixel position in the to-be-processed image.

7. The method according to claim 6, wherein the extracting image feature information of the to-be-processed image comprises:

dividing the to-be-processed image into a plurality of image blocks each with a same size;

and

extracting, through a plurality of residual branches in the residual network, feature information of the plurality of image blocks as the first image feature information of the to-be-processed image.

8. The method according to claim 6, wherein the target filter is acquired from the following equation:

$$\mathrm{F}_i = \sum_{l=1}^{L} \Phi_{i,l} D_l ,$$

wherein, F_i represents a single target filter, D represents the predefined filtering parameter information table, L represents a quantity of preset filters in the predefined filtering parameter information table, and Φ represents the filtering parameters.

9. An apparatus for reconstructing a super-resolution image, comprising:

an image acquisition module, configured to acquire an initial-resolution image of a to-be-processed image;

a feature extraction module, configured to extract image feature information of the to-be-processed image, and determine a plurality of filtering parameters corresponding to each of pixel positions in the to-be-processed image according to the image feature information;

a filter combination module, configured to combine preset filters according to the plurality of filtering parameters corresponding to each of pixel positions to acquire a target filter corresponding to the pixel position in the to-be-processed image; and

an image reconstruction module, configured to filter pixel information of corresponding pixel positions in the initial-resolution image through a plurality of target filters corresponding to all the pixel positions, to acquire a super-resolution image of the to-be-processed image;

wherein the feature extraction module is further configured to convolute the image feature information to acquire a combination coefficient corresponding to each of pixel positions in the to-be-processed image, wherein the combination coefficient comprises the plurality of filtering parameters corresponding to the pixel position; and

the filter combination module is further configured to: determine a plurality of preset filters corresponding to the plurality of filtering parameters based on a predefined filtering parameter information table; and linearly weight the plurality of preset filters corresponding to the plurality of filtering parameters, to acquire the target filter corresponding to the pixel position in the to-be-processed image.

10. A computer device, comprising:

a memory, storing a computer program; and

a processor, wherein the computer program, when being executed by the processor, causes steps of the method according to any one of claims 1 to 5 to be implemented.

11. A computer-readable storage medium storing a computer program, wherein the computer program, when being executed by a processor, causes steps of the method according to any one of claims 1 to 5 to be implemented.